Trends of wetland reclamation in Colombo Metropolitan Region in Sri Lanka and strategies to minimize adverse impact

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Abstract

The disappearance of wetlands in the Colombo Metropolitan Region (CMR) in Sri Lanka is increasing at an alarming rate since the 1980s. Both wetland and urban lands in CMR have become important geographical areas in the country both socio- economically and politically. CMR serves as economic and administrative hubs in the country. This background causes to accumulate population and infrastructure facilities in and around the CMR. Therefore, urban development demands more land for the urbanization process. Reclamation of wetland adjacent to urban areas has become a common solution to the high demand for land in CMR, Sri Lanka. The main objectives of this study are to find the trends of wetland reclamation in CMR and develop effective and efficient strategies to minimize the adverse impact of wetland reclamation process. The primary data was collected from two methods namely, interpretation of air photographs taken in 1959 and satellite images of 1989 and 1918 which appeared on Google Map and field surveys. Secondary data was collected from reviewing literature. Results of this study indicate that, the 63.46% of the wetland in CMR have disappeared during the last 59 years since 1959. The overall wetland reduction rate is higher since 1989. In addition, there is a trend for the disappearance of the wetland extent which is changing spatially and temporally.

Keywords: Wetland Reclamation, Urban Development.

Introduction

Wetland reclamation has become a common practice in almost all urban areas around world, particularly in fast developing regions such as South, South East and East Asia (Ramsar, 2016, 2018). The remaining lands that can be converted easily for urbanization activities in many urban areas around the world including Sri Lanka are wetlands. It is obvious that fast urbanization causes rapid growth of urban land (Qian *et al*, 2015). A significant and speedy urbanization was projected by the United Nations (1989) in the less developed countries even in the 1980s. The demand for land due to the accelerated urbanization process in Sri Lanka is significant (Peiris: 2006, Dept. of Census and Statistics: 2012, UDA: 2018). Since urban development plans are not implemented as scheduled, sprawl urbanization process can be seen in Sri Lanka creating environmental, socio-economic, political and cultural issues (Ranasinghe, 2014, Ranaweera & Rathnayake, 2017). Among them, the lack of exact data and information on the trend of wetland reclamation, special and temporal distribution of reclaimed land and the identification problems associated with wetlands have become the main problems in the field of land reclamation in Sri Lanka.

The term "Wetland" is defined in this study as all types of inland wetland areas as described in the Ramsar Convention and the Wetland Classification Report of the Wetland Management Strategy- 2016 of the Metro Colombo Urban Development Project (MCUDR), Sri Lanka (Landscape and Urban Design Office,2016). Accordingly, 'land area covered perennially or periodically with static or flowing, fresh, brackish or salty water, mash, fen and peat-lands are considered as low land. Paddy fields active or abandoned, man- made ponds, lakes rivers and other kinds of water ways or drainage paths and other low lying land areas where the rain water is accumulated temporally, are also considered as wetlands' in this study (Ramsar Convention, Landscape and Urban Design Office,2016, Peiris: 2006).

It has been identified that the wetlands in and around Colombo are reducing at an alarming rate due to the urbanization process (Peiris, 2006). The wetland reclamation process particularly in the Southwest of Sri Lanka has led to a substantial conversion of agricultural land to non-agricultural uses (Madduma Bandara, 2007). Among urban centers in the Southwest, land use pattern in CMR is changing rapidly than in other urban areas (Kotagama, SW & Bambaradeniya, CNB, 2006 and Ranaweera & Rathnayake, 2017).

There is evidence to the fact that the equilibrium of the natural environment within and around the urban centers in the Colombo district is diminishing significantly due to the wetland reclamation process (Landscape and Urban Design Office,2016). This situation is significant when reclaiming all forms of wetlands into urban land (Ranaweera & Rathnayake, 2017). Unplanned, illegal or unauthorized wetland reclamation processes have been identified as the main causes that have led to environmental degradation in urban areas. Changes of surface drainage patterns, the reduction of the extent of low-lying

areas that retain rain water and the collapsing of main cycles of the ecosystem are the main impacts witnessed immediately after unplanned wetland reclamation activities. Soil erosion and degradation, surface and ground water pollution, disappearance of wild life and scenic beauty, accumulation of solid and liquid waste into open environment and increasing breeding places for mosquitoes can also be considered as impacts of unplanned and illegal land reclamation (Landscape and Urban Design Office,2016). It is clear that these impacts cause other issues. Disasters such as floods and health issues in urban areas can be seen as a consequence of unplanned land use. These have been identified as the root cause that reduce the potential of the urban centers. At the same time, inactive urban centers would not provide due support to national development as is needed and as is expected. Therefore, adverse impacts of wetland reclamation in urban areas should be controlled to ensure the functions of the urbanized areas in at their fullest capacity.

Urban centers in any country can be considered as regulators and driving forces of the overall development process of a country (Ranasinghe, 2014). Urban centers can be considered as the icon that represents the historical, cultural, political, social and other qualities of a nation. Therefore, the sustainable existence of an urban area has to be guaranteed to showcase the greatness of a nation and to ensure the sustainable future of a country.

Urban centers play multifaceted roles to provide opportunities to the development process in Sri Lanka by absorbing all forms of pressure exerted from internal and external sources. The high demand for land has become one of the main causes of pressure that is exerted on urban areas particularly in fast developing region such as CMR of Sri Lanka (UDA, 2018). Though there are contradictions among urban developers, environmentalists and land seekers, the process of wetland reclamation in urban areas is faster than finding solutions for illegal wetland reclamation and providing alternatives for demanding land. Therefore, it has become an urgent need to find strategies to control the adverse impacts of wetland reclamation in urban areas in the Colombo Metropolitan Region (CMR) in Sri Lanka.

The reduction rate of low land in the Colombo Metropolitan Area is significant (Landscape and Urban Design Office, 2016). It is seldom realized that Colombo is the product of extensive land reclamation (Peiris, 2006). This explanation can be used even for CMR. The rapid process of land reclamation has resulted in environmental degradation, natural disasters and the decrease in the efficiency of urban activities such as traffic, pollution (air, water and soil) (Kotagama, SW & Bambaradeniya, CNB, 2006, Ranasinghe, 2014).

The Colombo Metropolitan Area (CMR)

The total land area belonging to CMR is 369420 hectares in extent and covers three districts namely Colombo, Gampaha and Kalutara. Though the urban population in Sri Lanka is 18.2 %, the urban population in CMR is 77.6% (Census Report of Population and Housing of Sri Lanka, 2012). Hence, three fourth of the total population of CMR lives in urban areas. These three districts are from the Western Province. The traditional capital city of Colombo and its immediate surroundings have been demarcated as the Core Area of the CMR (UDA, 1986:6).

According to the Urban Development Authority (UDA) of Sri Lanka, the Core Area consists of the City of Colombo, Sri Jayawardenapura- Kotte and a few local authorities around these two Municipal Council areas.

The core area and the whole CMR are situated in a wet climatic zone and receive high rainfall during the South West Monsoon period. This area spreads over the left bank and is closer to the outfall of the Kelani river and spanning the catchment areas of Bera and Bolgoda lakes. The western boundary of the CMR as well as the core area is the Indian Ocean. The entire land of the core area is in the coastal low land area. The ground slope of this area is very low.

CMR serves as the economic and administrative hub of the country since time immemorial. Therefore, the accumulation of industries, service centers, residential areas and other commercial activities are not a new phenomenon. Nevertheless, the reduction of low land due to land filling for the construction of buildings and service areas are witnessed particularly after the introduction of the Open Economic Policy in Sri Lanka in 1978.

Objectives

The main objectives of this study are to examine the trends of wetland reclamation in CMR and to recommend the most effective strategies to minimize adverse impacts on the wetland reclamation process.

Methodology

This study uses the epistemological framework, comprising of theoretical and philosophical assumptions encircled around research methods.

Data collection

Primary data was collected from the two methods as follows:

The interpretation of aerial photographs taken in 1959 and satellite images of 1989 and 1918 as appearing in Google Maps.

Scales of satellite images were changed to align with the scale of aerial photographs. The changes of the extent of the demarcated wetlands were calculated by overlapping the previous maps with the new maps using GIS and Excel software.

Field survey.

In order to verify the information obtained from the aerial photographs and to analyze the current situation of the selected areas, the field observation method and discussions with residents were conducted.

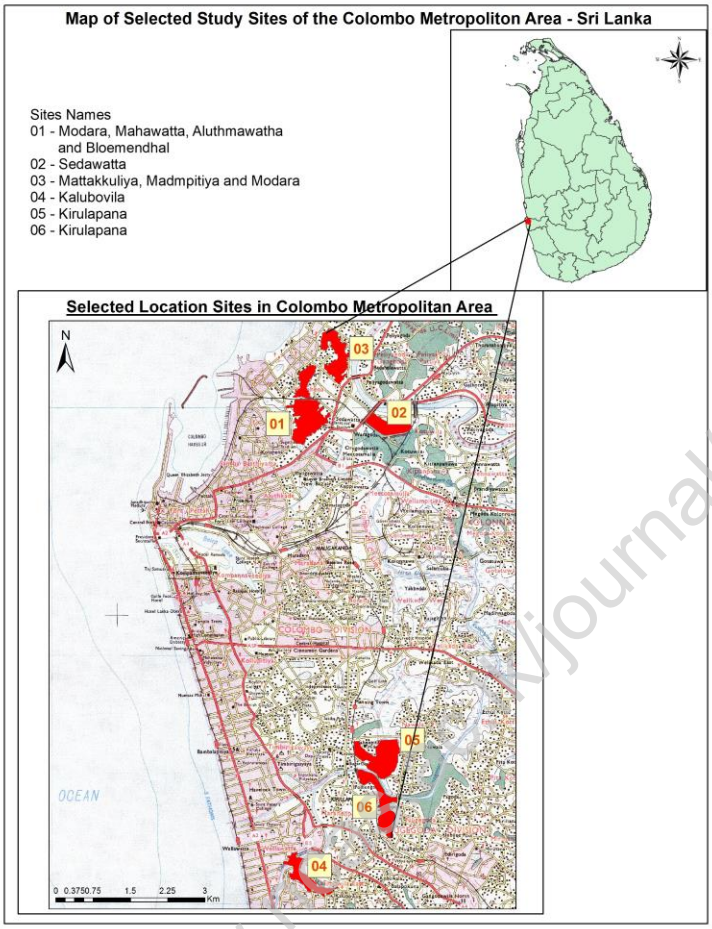
Six land plots were selected to represent the entire study area (Table no.01). The selection was based on the following:

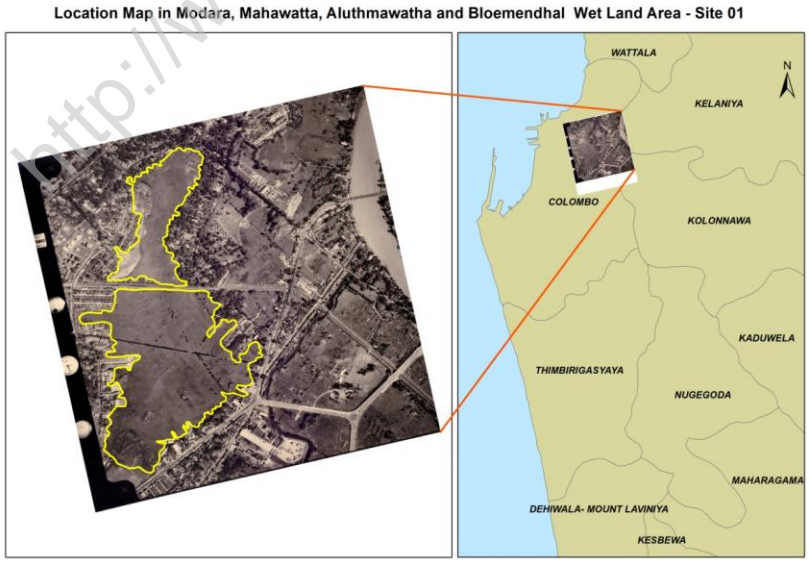
- Land area with more than 5000 m^2 in extent that could be considered as low land.
- Land area that met requirement “a”, depicted in the aerial photograph taken in 1959. These are the first series of aerial photographs taken in Sri Lanka which can be used for studies.
- The selected sites from the aerial photograph should be reclaimed plots and should appear in satellite images taken in 1989 and 1918, visible on Google Maps.

Table 1. Ground Locations of selected lowlands used for this study

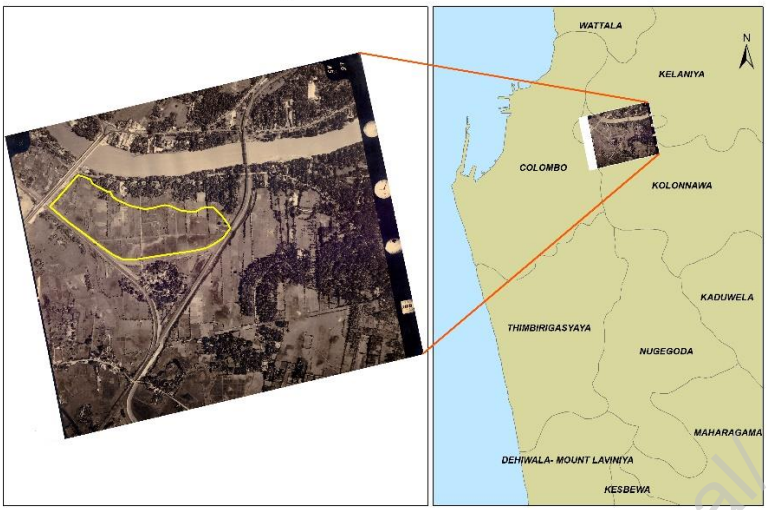
Site	Name of the site	**Land Extent in 1956** (M^2)
S1	Modara, Mahawatta and Bulemendal area	341976
S2	Sedawaththa area	450772
S3	Mattakkuliya and Madampitiya area	2240625
S4	Kalubovila area	331658
S5	Kirulapana area - 1	265677
S6	Kirulapana area - 2	59069

Figure 1.

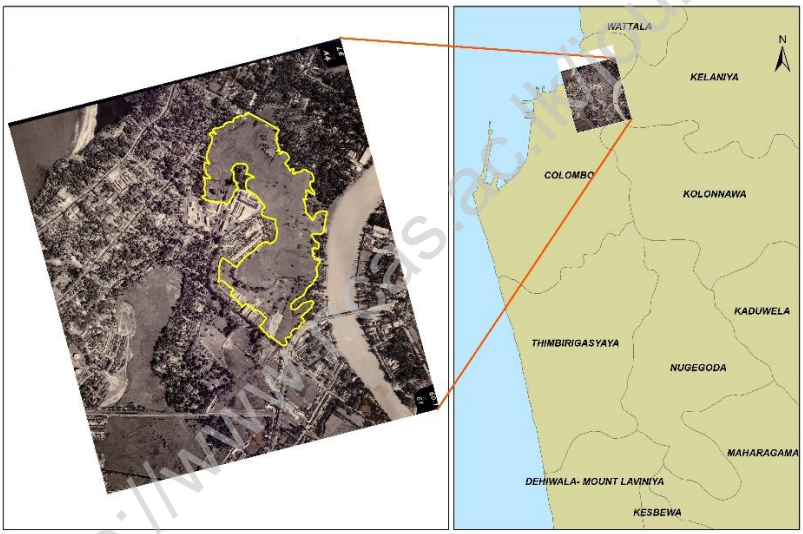




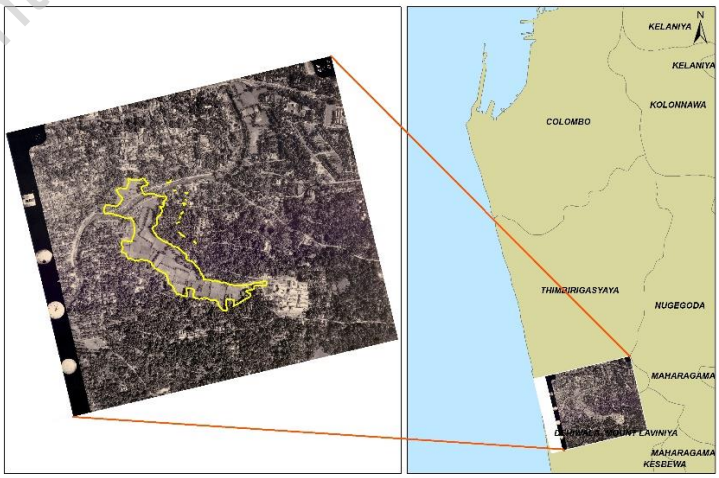
Location Map in Sedawatta Wet Land Area - Site 02



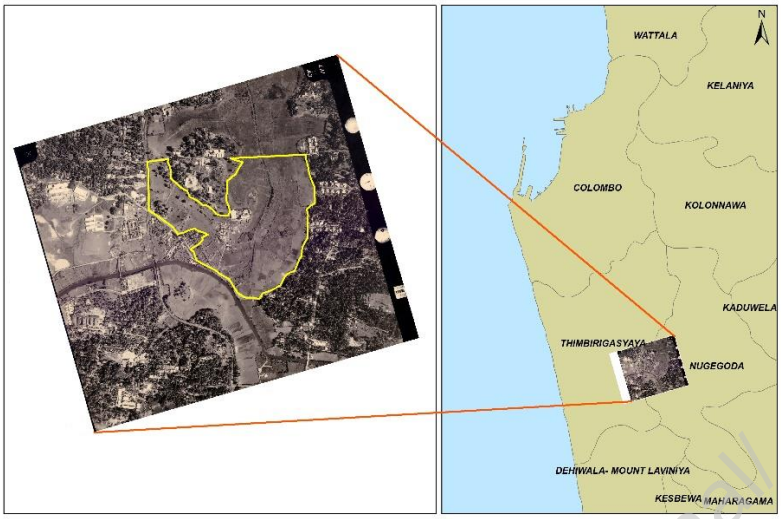
Location Map in Mattakkuliya, Madmpitiya and Modara Wet Land Area - Site 03



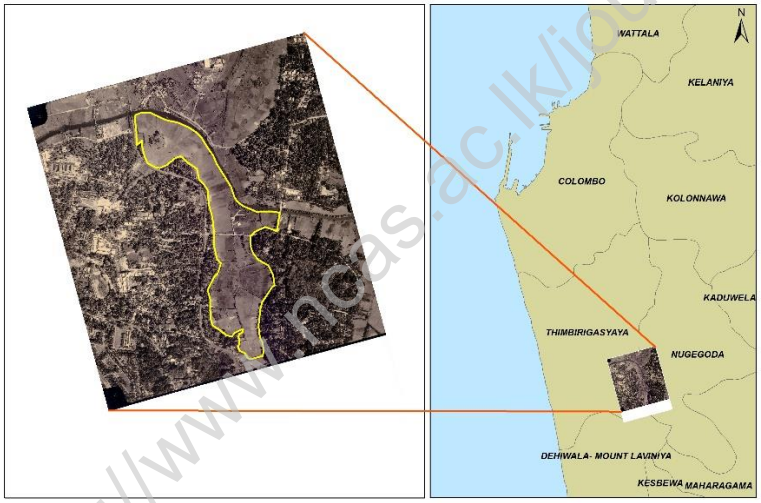
Location Map in Kalubovila Wet Land Area - Site 04



Location Map in Kirulapana Wet Land Area - Site 05



Location Map in Kirulapana Wet Land Area - Site 06



Data Analysis and Results

The basic statistical methods and facilities available on Geographical Information System (GIS) and Remote Sensing (RS) technology were employed to analyze the data gathered from the map interpretation and field survey. The existing land extent in 1956, 1989 and 2018 was calculated for each and every site included in the sample of this study. Maps, tables and line graphs were used to present results. In addition, the change of wetlands was calculated to cover the time periods as follows;

1. 1956 – 1989
2. 1989 – 2018
3. 1956 – 2018

The percentage of change of the wetland extent was calculated using the following equation;

$Y = ((X_1 – X_2) / X_1) * 100$

Where, Y = Percentage of the change of wetland extent - %

X_1 = Wetland extent (M^2) of the upper limit year in the concerned period of time.

X_2 = Wetland extent (M^2) of the lower limit year in the concerned period of time.

Study area

The characteristics of wetland sites taken into consideration in this study as sample sites are different from site to site. The extent and shape, the quality of water, the availability of water, plant density and the types and influence of human activities differ from site to site significantly. Considering all these characteristics, five factors are identified as the most influencing characteristics that regulate the wetland reclamation process particularly in CMR. These factors are as follows,

1. Wetland Type (Based on Ramsar & CMR),
2. Vulnerable level to flood/Odour,
3. Distance to harbour/Commercial hub,
4. No. of Main roads situated at the edge
5. Dominant Land use type around the site

Wetland Type - based on Ramsar Convention & CMR Wetland Classification appeared in the WMSR-2016 of the study sites falls into three categories. They are;

A. Freshwater, Non-tidal, Low herb dominated/ Abandoned paddy.
B. Freshwater, non-tidal, low herb marginal vegetation, flowing water.
C. Freshwater, Non-tidal, Low herb dominated/ Active paddy.

Among six sites, site no. 1, 2 and 5 belonging to wetland type A. Site no. 03 falls in to "B' type and the rest, S4 and S6 come under the "c" wetland category. All these study sites are vulnerable to flood/odour. However, S1 and S5 are highly vulnerable to floods and vulnerable levels of the S3 and S4 are low, while the rest are moderately vulnerable to flood and odour.

The distance to the harbour/Commercial hub from each site vary from 0 .50 – 12.00kms. Three sites namely S4, S5 and S6 are far away or 10 -12km away from the commercial hub. Site 01 and 02 are very close to the Colombo harbour. This is the main harbour in Sri Lanka.

The dominant land use type around the sample area also varies from site to site. Large store rooms or storage tanks such as oil, gas or cement tanks, factories, residential areas or wetlands can be seen as dominant land use types around the study area. Information of the main and significant land use type around the study area are listed in Table 02.

Table 2. Category level of main characteristics of each study sites

Site	Wetland Type (Based on Ramsar & CMR) -1*	Vulnerable level to flood/Odour -2*	Distance to harbor/ Commercial hub -3*	No of Main roads situated at the edge - 4*	Dominant Land use type around the -5*
S1	3	3	5	5	1
S2	3	3	5	1	5
S3	2	1	4	2	1
S4	2	2	3	2	4
S5	1	1	2	3	5
S6	2	3	1	3	5

(. See the table no 03 for description of each category)*

Table 3. Description of main characteristics of each category of study sites

No	Category	Description				
1*	Wetland Type - based on Ramsar Convention & CMR Wetland Classification appeared in the WMSR-2016	1- Freshwater, Non-tidal, Low herb dominated/ Active paddy 2- Freshwater, non-tidal, low herb marginal vegetation, flowing water 3- Freshwater, Non-tidal, Low herb dominated/ Abandoned paddy				
2*	Vulnerable level to flood/Odour	3= High		2 = Moderate	1= Low	
3*	Distance to harbor/ Commercial hub -km	5 0.0- 3.0	4 3.1 - 6.0	3 6.1 - 9.0	2 9.1- 12.0	1 12.1 >
4*	No of main roads situated at the edge of the site	5 >	4	3	2	1
5*	Dominant land use type around the site	1 Large storeroom	2 Large store tanks	3 Factories	4 Residential/Commercial	5 Wetland

Significances of the selected wetlands

A comprehensive study has been conducted on wetlands in and around the Colombo City by the Wetland Management Division of the Sri Lanka Land Reclamation in 2015. The final report of this study named “Metro Colombo Wetland Management Strategy-2016” has explained the value of the wetlands of CMR (Landscape and Urban Design Office,2016).

Accordingly, a countless number of important of wetlands of the study area can be identified. Among them, wetlands have been recognized as fundamental, to the well-being of the residents of Colombo, benefiting the urban poor. Food security, providing the citizens of the area with traditional medicines and acting as effective protection sites from flooding are a few important facts of wetlands of the study area. Further, these wetlands help to reduce the extreme air temperature and make the city a livable geographical area.

The trend of urban wet land reclamation

Colombo Metropolitan Region (CMR) is considered as a city built on and around wetlands (Landscape and Urban Design Office, 2016). The Parliament complex of Sri Lanka, the administrative buildings of numerous ministries, the main commercial buildings, recreational parks and luxurious residential complexes are situated on reclaimed wetlands. The extent of low-lying marshy lands of the Colombo Metropolitan Region (CMR) in Sri Lanka is reducing or contracting at an alarming rate (Samarakoon, 2007:85). The filling of wetlands and converting them to raised dry land for non-agricultural purposes are a common practice particularly in the CMR as well as other urban areas in this country (Ministry of Environment, 2010:16). Most of the marshy lands situated within the study area were prosperous paddy fields or fresh inland water bodies two to three decades ago. Paddy fields have, in many instances, been given up, due to the problem of the stagnation of water and lowering the profit from harvest.

According to the Agrarian Development Act No 46 of 2000, even abandoned paddy fields cannot be utilized for any other purpose except for the cultivating of paddy or similar crops. Furthermore, the Colombo District (Low Lying Areas -LLA) Reclamation and Development Board (Amendment) Act No 52 of 1982 has controlled the use of urban wet lands for any purposes without getting legal permission. However, the government of Sri Lanka has developed a mechanism to utilize low lands for the development purposes of the country. Without having legal permission from the government, the use of low lands for any activities except for agriculture is strictly prohibited in Sri Lanka.

However, the increasing demand for land for activities related to urbanization has led to the filling of wetlands legally and illegally. A rapid urbanization process has been taking place in CMR particularly since the 1980s. Development disparities among regions in Sri Lanka and changes in the composition of the Gross Domestic Production (GDP) in the recent past have influenced a direct increase in the urbanization process in CMR. Among the urban centers of CMR, the urbanization process is significantly high in Colombo and the sub-urban areas.

Colombo, recognized as the “Core Area” of the CMR is the commercial and administrative hub of Sri Lanka. A considerable portion of the land area belonging to the Colombo Municipal Council and other regions of the CMR consist of wetland areas. Therefore, expanding urban activities contributes to the filling of nearby wetlands and converting them into raised land.

The size of the population of CMR is increasing continuously due to the availability of employment opportunities for skilled and non-skilled labourers. This trend is the outcome of the expansion of services and the administrative and industrial sectors of the country. In addition to the increasing socio economic

activities within the CMR, the population migration from other parts of the country is also increasing. This trend shows the importance of CMR in terms of socio- economic and political terms.

The expansion of urban areas is also continuing at an alarming rate. These facts depict the increasing demand for land, continuously. This phenomenon would result in the reduction of low lands. In order to manage low lands sustainably, the temporal and spatial variation of the reduction rate of low lying areas should be identified. This may assist to solve the problems related to the increasing demand for land and to reduce the extent of low lands in CMR.

The impact of urban low land reclamation

The total land area belonging to CMR is 369420 hectares. From the total land area, 20km^2 still remains as wetland. In general, lands reclaimed for urbanized processes in CMR are low lands that comprise of with rain fed paddy fields, marshy lands or barren lands (Landscape and Urban Design Office, 2016). These land areas are situated around naturally raised dry lands. Streams, tributaries and other water bodies which take rain water to the main rivers and the sea runs across these low lands. Land reclamation in CMR directly reduces the extent of these low lands. Yet, the land area prepared for the purpose of Colombo Port city is not considered as a low land category of the current study.

Reduction of wetland areas and accumulation of solid and liquid waste into low lands are the main significant environmental issues identified in the CMR in Sri Lanka (Panditharathne, 2011: 102 -105). The impacts are as follows:

1. Change and collapse of natural drainage pattern
2. Increase in flash floods
3. Pollution of surface and underground water bodies
4. Erosion of soil and soil pollution
5. Increase in communicable diseases
6. Destruction of the natural environment
7. Damage to environmental equilibrium.
8. Reducing the capacity and potential of the CMR.
9. Destroying private and public properties due to floods and water stagnation.
10. Increasing the severity of traffic congestion.

Low lands of core areas in CMR are always filled with water .The accumulated rain water does not drain fast as the slope gradient of these lands is low. The water level of these lands may change with the sudden change of the width and depth of the waterways due to added solid waste into the open

environment or narrowing of water ways from illegal constructions. This situation allows the water to remain for considerable periods of time contributing to the occurrence of flash floods.

Adequate measures have still not been taken to manage the issues related to both solid and liquid waste. At the same time, the encroachment of wetlands and river banks areas of the Core area of CMR have not been controlled completely. One of the main and visible issues emerging from development is the pollution and vulnerability to flash floods of the lower Kelani river basin area. It is a well known fact that, increasing pollution levels of the Kelani river has already created three main issues.

1. Threat to drinking water facilities of more than 80% in the Colombo Metropolitan Region.
2. Pollution of the ground water aquifer, surface water bodies and the destruction of the environmental equilibrium
3. Increase in health issues and health care costs causing socio economic burden

It is envisaged that, the intensity of these issues may increase in the near future owing to the changing land use patterns and impacts of climate change. Extreme rainfall which is predicted to increase in frequency, would increase the frequency of flash floods and increase the inundation areas (Perera, 2014). The rise in sea levels and increasing total population in urban areas mainly due to migration into core areas of the CMR would further increase the intensity of problems faced by the urban area. Immediate and urgent attention is required to develop a plan to control the rapid rate of encroaching low lands of the study area (Landscape and Urban Design Office,2016, Samarakoon, 1987:85).

Results

Data in Table04 and Figure 03 depicts that the extent of wetland of CMR is reducing since 1956 to 2018 at an alarming rate. Table 05 shows the percentages of the reclaimed extent of wetland of three different periods, of selected sites that were calculated using data of Table no 04.

The results of this study, show that, the land extent of all wetlands is reducing significantly from 1959 – 2018. It is clear that the 63.46% of the wetland in CMR have disappeared within the last 59 years since 1959. The overall wetland reduction rate is higher than 1989. Another important trend that can be traced from this study is, the disappearance of wetland extend is changing spatially and temporally (Table 06).

The entire wetland area of site 3 had been reclaimed during the period of 1959 to 2018. The remaining land extent in site no 5 and 4 is also less than 4%. Site 6 is the area that the land reclamation speed is low compared to other sites. The extent of the remaining land area of site no 6 is 59% in 1989 when compared to 1959.

Table 4. Remained Land Extent of wetland site S1- S6 in 1956, 1989 and 2018 each year (M^2)

Site No	Year		
	1959	**1989**	**2018**
S1	341976	200717	86348
S2	450772	275666	69643
S3	2240625	54238	0
S4	331658	106933	12746
S5	265677	218873	5594
S6	59069	51819	34760

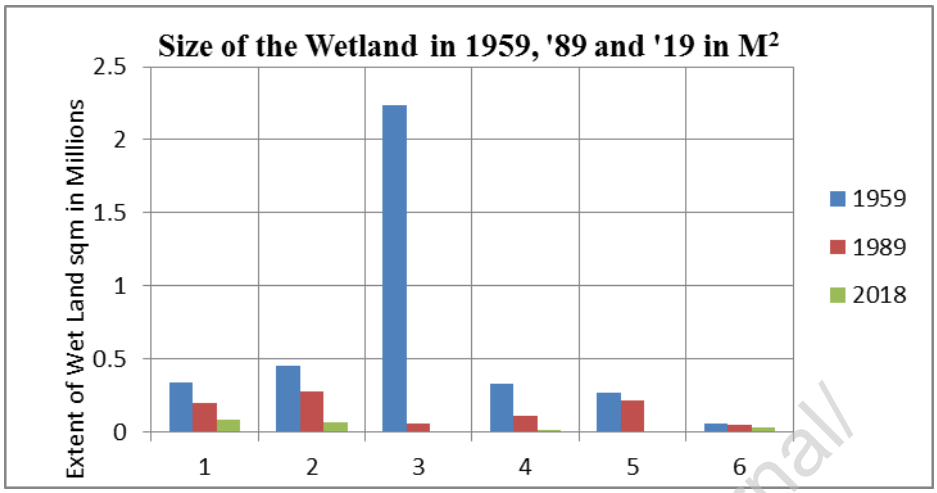
Source: Aerial photographs and image interpretation by the author

Table 5. Percentage of Reclaimed extent of wetland of three different period of times of selected sites

Site No	Period of times		
	1959- 1989	**1989 -2018**	**1959-2018**
S1	41.31	56.98	74.75
S2	38.85	74.74	84.55
S3	97.58	100	100
S4	67.76	88.08	96.16
S5	17.62	97.44	97.89
S6	12.27	32.92	41.15

When analyzing the data of the remaining land of all sites after the reclamation process from 1956 -2018, it can be deduced that, the land extent of all sites has reduced significantly. However, the change of extent of land has not taken place at an equal rate in all sites. Yet, the wet land area of site '3' has completely disappeared and is used for human activities. The wetland area of many sites such as site 5, 4, and 2 and 1 are also on the verge of disappearing (Graph 1 and 2).

Graph 1.



Graph 2.

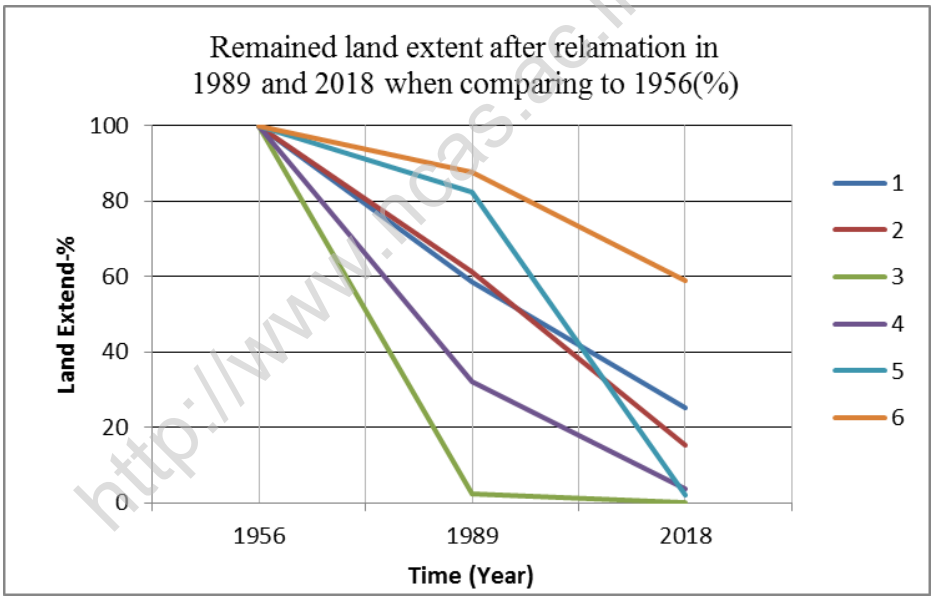


Figure No 3 (S 1- 3)- Part -1

Changing Pattern of the Land Extent of Selected Wetland Sites
From 1956- 1989 and 1989 -2018

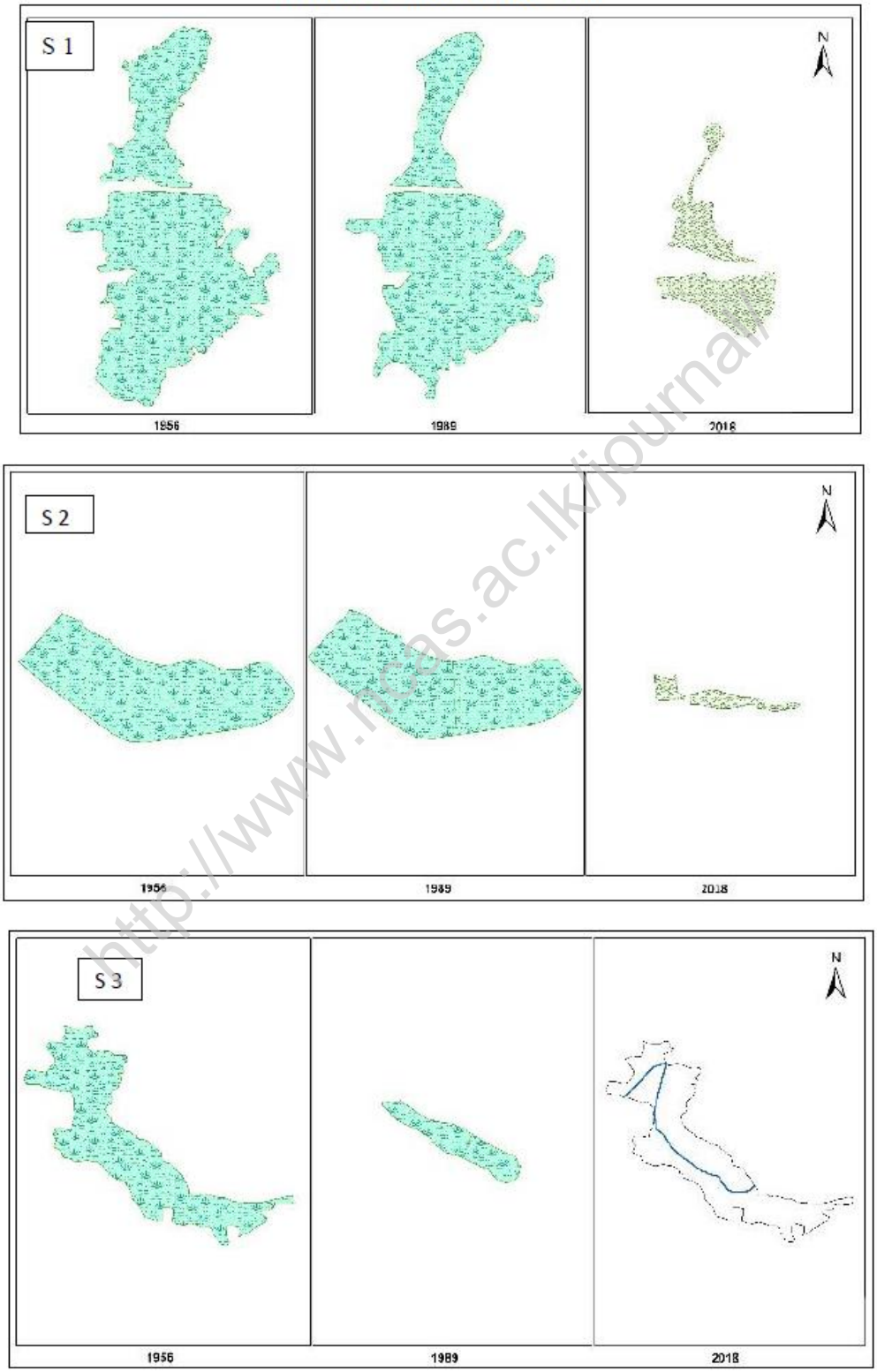
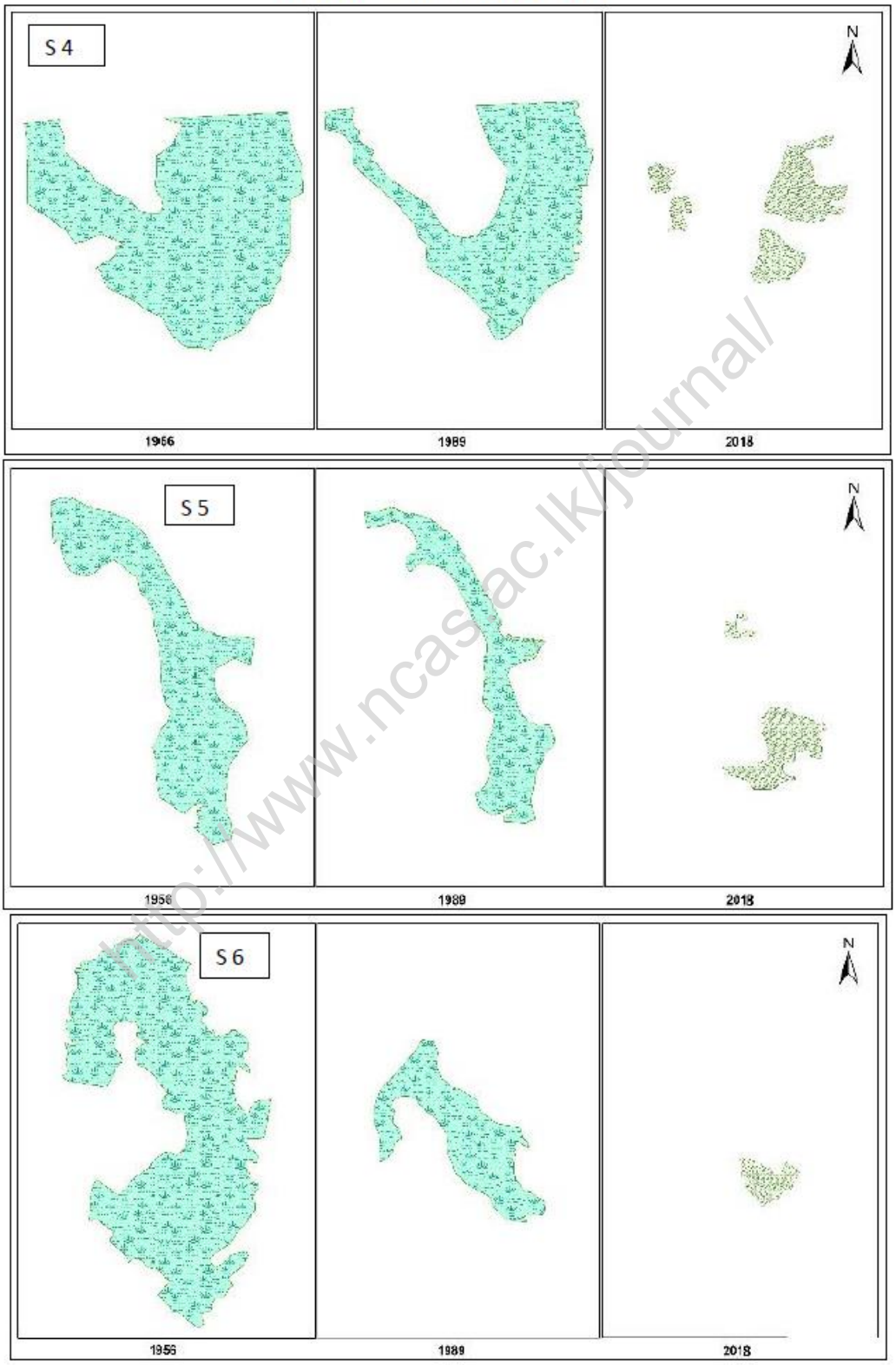


Figure No 3 (S 4 - 6)- Part -2

Changing Pattern of the Land Extent of Selected Wetland Sites

From 1956- 1989 and 1989 -2018



The annual wetland disappearance rate percentage (%) varies from 0.51 % - 2.57%. Yet, the average annual wetland reduction rate is 1.114%. Hence, it can be concluded that the remaining wetland of the CMR would disappear within another 33 years or by the year 2051. (Table no 6). However, the wetland reclamation rate varies from site to site.

The wetland named "S5" has the fastest reclamation rate, 2.57% per year. Since this site has already reclaimed 97.44% of its land, this site may completely turn into dry raised land by 2020 or within another year (Table 06). According to the current rate of land reclamation, site S1 would disappear by 2102.

Contributing factor/s for wetland reclamation

Table 06 shows the weightage of the selected contributing factors that regulate the speed of the wetland reclamation process. According to the results of Table 06, the highest and lowest influencing factor/s to increase wetland reclamation rates vary from site to site. The most influencing factor in the increase of the reclaimed land area of S1, S2, S3 and S4 is nearness to the main harbour of Sri Lanka. The second factor that regulates wetland reclamation of S1 is the large number of main roads that run around this site. The most influencing factor that causes to reclaim the site no S5 and S6 is the surrounding areas, also being wetlands. If the dominant land use patterns of the area are storeroom of factories, wetlands are not reclaimed to construct houses (Table 06).

Table No. 06

Category level of main characteristics of each study sites

Site	Rank of Main Category (% of contribution to wetland reclamation)					Reclamation extend -% within Main Period of time		Annual reclamation speed- %	Estimated wetland disappearing year
	1*	2*	3*	4*	5*	1956 – 1989	1989 - 2018		
S1	3 (17.65)	3 (17.65)	5 (29.41)	5 (29.41)	1 (05.88)	41.31	56.98	0.51	2102
S2	3 (17.65)	3 (17.65)	5 (29.41)	1 (05.88)	5 (29.41)	38.85	74.74	01.16	2039
S3	2 (22.22)	1 (11.11)	4 (44.44)	2 (22.22)	1 (11.11)	97.58	100.0	--	00
S4	2 (15.38)	2 (15.38)	3 (23.08)	2 (15.38)	4 (30.78)	67.76	88.08	0.66	2036
S5	1 (08.33)	1 (08.33)	2 (16.67)	3 (25.00)	5 (41.67)	17.62	97.44	2.57	2020
S6	2 (14.29)	3 (21.43)	1 (07.14)	3 (08.33)	5 (35.71)	12.27	32.92	0.67	2118

1	Average wetland extent reduction amount of all sites from 1956 -2018	63.46 %
2	Average annual wetland reduction speed	1.114 %
3	Estimated wetland completely disappearing year	2051

(*. See the table no 03 for description of each category)

Though the popular reason for the change is urbanization, there may be others, such as the expansion of global and local economic activities which were not monitored or controlled by systematic plans. For example, the growth of cargo handling activities of the Colombo harbour may demand for more land to store cargo containers to reclaim all land of site 3. This site is the closest low land area to the Colombo harbor.

Conclusion

It can be concluded that the extent of wetlands of the CMR is reducing at an alarming rate. If the current rate of wetland reclamation continues, most of the wetlands in the CMR may disappear completely. This situation will lead to many environmental issues cited in this study. Therefore, it is an urgent requirement to take immediate steps to prevent the invasion of wetland in CMR as proposed by the final report of the Metro Colombo Wetland Management Strategy- 2016. The current study proposes the following steps as effective and efficient strategies to minimize wetland reclamation speed and to reduce the negative impact of reclaiming wetlands.

1. Making a plan to use vertical space more efficiently for urban area expansion.
2. Introducing new concepts and ideologies for small spaces.
3. Providing alternatives to reduce migration to CMR.
4. Increasing the regional development process of Sri Lanka.
5. Decentralizing activities concentrated in CMR to remote areas.
6. Relocation of non- urban activities from CMR to peripheral regions.

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