Developing a GIS Methodology for Identifying the Wetlands in Colombo:

A Study Based on Weras Ganga Basin

By

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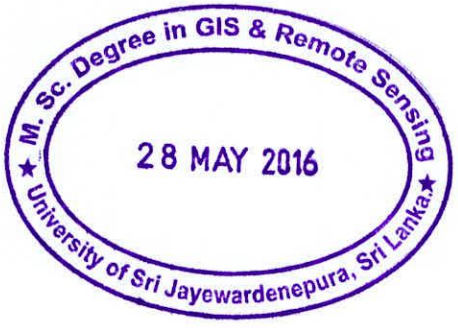

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DECLARATION OF THE CANDIDATE

I do hereby declare that the work describes in this thesis was carried out by me under the supervision of Prof. G.M. Bandaranayake and Mr. S. Sivanantharajah and a report on this has not been submitted in whole or in part to any university or any other institution for another Degree/Diploma

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LIST OF ABBREVIATION

CMR	Colombo Metropolitan Region
CTI	Compound Topographic Index
DEM	Digital Elevation Model
DTM	Digital Terrain Model
DSM	Digital Surface Model
GIS	Geographical Information System
JICA	Japan International Cooperation Agency
MSL	Mean Sea Level
NCC	Natural Colour Composite
NDVI	Normalized Difference Vegetation Index
NWI	National Wetland Inventory
NWSC	National Wetlands Steering Committee
OLI	Operational Land Imager
SCDI	Slope Cost-Distance Index
SLLRDC	Sri Lanka Land Reclamation and Development Corporation
SRTM	Shuttle Radar Topography Mission
TIN	Triangular Irregular Network
TIRS	Thermal Infrared Sensor
TWI	Topographic Wetness Index

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DEVELOPING A GIS METHODOLOGY FOR IDENTIFYING THE WETLANDS IN COLOMBO: A STUDY BASED ON WERAS GANGA BASIN

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ABSTRACT

Wetlands are an immensely important form of land built by the nature which plays a vital role in the global ecosystem. The land type wetlands can be defined as the most important multifunctional ecosystem between terrestrial and aquatic ecosystems. Wetlands cover approximately 6% of the Earth's land surface and it is considered as the most important part of the global ecosystem which maintains bio diversity.

Wetlands provide various short term and long term benefits as environmental, economic and social. Important wetland functions include storage of water, carbon and nutrients, groundwater recharge, storm protection, flood mitigation, shoreline stabilization, erosion control and retention of carbon, nutrients, sediments and pollutants. Besides that, it has a major contribution to Hydrological and Hydrodynamics aspects. Hydrologically undisturbed wetlands are connected with their surrounding terrestrial areas via several Hydrological pathways including groundwater inflow, surface runoff or river water inflow. These several of Hydrological and Hydrochemical conditions created by the mixing of different water sources promote a rich and abundant wildlife .

Unfortunately wetlands are severely deducted during the last few decades due to unplanned reclamations, unauthorized encroachments, dumping of waste, diversion of natural stream paths, unawareness of people etc.

The point of view of society towards the wetlands has been changed optimistically and the responsible authorities have taken actions to prevent further loss and to conserve natural wetlands. However major problems arisen are the cost and consuming of time for identification and restoration of wetlands because it is necessary to have huge

amount of data on detailed surveys, level surveys, land use data, rainfall data etc. and the guidance of professionals like Hydrological experts, engineers, surveyors etc.

This study presents the GIS based methodology to identify wetlands as an efficient and cost effective manner. So under this study several technical solutions have been proposed using GIS to prevent those identified problems under the Study based on Weras Ganga Basin situated in Colombo Metropolitan Region, Western Province, Sri Lanka.

GIS is a fine tool to identify spatial aspect and calculation of the entities that are relevant to study. The research has been carried out in two approaches. Those are terrain indices approach and image classification approach for identifying wetlands. Finally it has been proven that using GIS is the most economical and time saving solution tool which can be applied in use of wetland identification purpose. Also it can be applied to management of wetlands for the responsible authorities and build a national strategy to conserve wetlands.

Key Words: Wetlands, GIS, Terrain indices, CTI, Hydrology

Chapter One

INTRODUCTION

1.1 Background

Wetlands are considered as one of the most valuable natural environmental system found in the most part of the world. Wetlands which cover about 6% of the Earth's land surface are also considered as entities that maintain the global ecosystem as well as establishing the bio diversity. Wetlands are also described as the transitional lands between terrestrial and aquatic systems that have many advantages such as flood water retention, hydrologic regulation, water quality maintenance, wildlife habitat and controlling of soil erosion.

The most realistic definition for wetlands has been given by Ramsar Convention. The Ramsar convention has defined wetlands as follows:

> "Areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres."

Wetlands exist where the ground is saturated or inundated with water for expanded periods during the growing season. Many, but not all, may be flooded for the whole year. The presence and duration of water in the soil influences the type and characteristics of the soils present.

Wetland Identification Protocols, Wetlands were mapped as per the three-parameter approach defined in the Corps of Engineers Wetland Delineating Manual (USACE, 1987). The manual defines wetlands as areas that highlight hydrophytic vegetation, hydric soils and wetland hydrology or standing water. A key indicator of wetland hydrology is saturation of land surfaces by water. Hence it seems hydrology has a vital role in the wetland behavior.

Hydrologically undisturbed wetlands are connected with their surrounding terrestrial areas via several hydrological pathways including groundwater inflow, surface runoff or river water inflow. These several of hydrological and hydrochemical conditions created

by the mixing of different water sources promote a rich and abundant wildlife adapted to wet and often nutrient poor conditions. Important wetland functions include storage of water, carbon and nutrients, groundwater recharge, storm protection, flood mitigation, shoreline stabilization, erosion control and retention of carbon, nutrients, sediments and pollutants.

But unfortunately wetlands are increasingly becoming danger due to human interference. Human in modern society destroy the wetlands for their short term benefits while neglecting the long term benefits. Therefore wetland conservation has become the focal point of concern with present world discussed nowadays due to their importance.

Wetland areas are severely deducted during the past decades due to land reclamation, population pressure, water diversion, dam construction, pollution, biological incursion, desertification, climate change and misguiding policies. To prevent further loss of wetlands and conserve existing wetland ecosystem for biodiversity and ecosystem services and goods, it is important to list and monitor wetlands and their adjacent uplands.
So it is vital importance to identify the effective wetlands and to make strategic plan to conserve them.

GIS is a good tool to identify spatial aspect and calculation of the entities that are desire to study. And that can be used to prevent damage and monitor the valuable resources and habitats of our woodlands, wetlands, and watersheds. Deforestation, loss of biodiversity and resource depletion due to global climate change, CO_2 emissions, logging, forest fires and other human disruptions are threats to the earth's woodlands, wetlands, and watersheds. GIS tools are commonly implemented to measure certain hydrologic parameters such as water level through comparison of remotely sensed data from different date. Fairly accurate water levels can be measured using high resolution images as a means of monitoring wetland desiccation.

GIS allows its users to handle geospatial information to monitor changes in targeted areas. Modeling change with GIS permits conservationists to make well-informed decisions about protection plans, reserve policies and future land-use practices that will most benefit the conservation of forests, biodiversity, wildlife and resources.

1.2 Problem Statement

The protection and restoration of wetlands are an important strategy to protecting the quality of surface and ground water resources and also for flood controlling purposes. But wetland identification and restoration are costly and time consuming task for all parties. It is necessary to have large amount of data, detail surveys, level surveys, field surveys, rain fall data, land use data, geological maps etc. Other than data, it is necessary to have the support of various professionals like hydrological experts, engineers, surveyors, geological experts etc. Therefore, wetlands identification is the main problem for wetland protection and restoration. Under this study it is try to find a methodology for identifying the wetlands with time and cost effective manner.

1.3 Significance of the Study

Wetlands are an important environmental system which is rich in biodiversity. They do a lot of service in terms of ecologically, environmentally, hydrologically and many more. Thus conservation of wetlands is paramount importance.

To conservation purpose, the first step is to identifying wetlands. To identify the wetlands correctly is very critical and that identification is very time consuming and also costly. Therefore, it should find a way to identify the wetlands in time and cost efficient manner.

With the limited resources available it is necessary to develop proactive approaches for focusing protection and restoration of existing wetlands cost and time efficient manner.

Therefore as time and cost effective manner, it is selected the GIS tool for the wetland identification and develop a methodology to identifying the wetlands using GIS.

When go through with literature, it was found very limited studied related to wetlands in Sri Lanka and many researches didn't use GIS for identifying wetlands. Therefore in this study, it is trying to use GIS for identification wetland as a time and cost effective method. GIS is very useful tool which can use for many fields.

In this study, it is check the possibility of identifying wetland possible using GIS though it is still not much popular among the policy making institutions in Sri Lanka, this study may be useful as decision supporting system for policy makers especially in government

organizations. In addition to that, it is helpful to build national wetland inventory using GIS based methods and it can be used to monitor the many changes of the wetlands.

1.4 Objective

The main objective of this study is to develop an appropriate methodology for identifying the wetlands in Colombo area using GIS.

Other Objectives through this study is listed below,

- To identify wetlands using freely available satellite data
- To compare the accuracy of obtaining the watershed areas (catchment Area) by using ArcGIS tool and manual method for hydrological calculations in study area.
- To find the Possibility of using this methodology in order to identify the wetlands in other part of the country.

Chapter Two

LITERATURE REVIEW

2.1 Wetlands

Wetland has several definitions that will changed by country to country. Most commonly used Ramsar definition for wetlands. Ramsar convention on wetlands is discussed in follows;

The Ramsar Convention takes a broad approach in determining the wetlands which come under its mandate. Under the Ramsar Convention, wetlands are defined as:

"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres". (Ramsar Convention Secretariat, 2013).

The societal respect for wetlands has recently changed from former view of vast and wet lands, which have to be drained to fulfill economic purposes, to the now holistic view which regards wetlands as important multifunctional ecotones between terrestrial and aquatic ecosystems providing globally significant environmental, economical and social benefits. Hydrologically undisturbed wetlands are linked with their surrounding terrestrial areas via several hydrological pathways including groundwater inflow, surface runoff or river water inflow (Trepel et al., 2000).

This author is point out that changing the view of the society towards the wetlands and how much they are significance to the environmental, social stability.

2.2 Importance of Using GIS for Identifying Wetlands

The protection and restoration of wetlands and riparian areas are an important aspect in protecting the quality of our water and for flood control. Wetland restoration and mitigation can be costly and time consuming for all parties involved and are often opportunity driven. With the limited resources available it is necessary to develop proactive approaches for focusing mitigation to areas most likely to satisfy management