Analysis of the spatial variation of drinking water availability in Nilwala River basin using Geographic Information Systems

By

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The work described in this thesis was carried out by me under the supervision of Dr. (Rev.) Pinnawala Sangasumana and Dr. H. M. Ranjith and a report on this has not been submitted in whole or in part to any university or any other institution for anther Degree/ Diploma.

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ABSTRACT

Water is the one of most important of all natural resources. It is vital for all living organisms and major ecosystems, as well as human health, food production and economic development. Difficult to purify, expensive to transport and impossible to substitute, water is essential to life. Drinking water is not an infinite resource. There is a limited amount which cannot be increased, yet it is constantly under threat from overuse and pollution. In the past 100 years the world's population tripled, but water use increased six fold. Rivers and lakes are stretched to their limits – many of them dried up or polluted with the differing in chemical composition. With ground water taking up an average 1400years to be replaced, aquifers are being drained far faster than their natural rate of recharge. It already affects every continent and around 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water.

This study presents a GIS methodology to perform a preliminary selection of suitable drinking water areas and what are causes relating water availability, integrating multicriteria. It is more important matter to decision making process in the future development activities. GIS is the skillful tool for the suitability analysis. Most of research not applying GIS to theses researches. There for this study is the fulfillment of GIS application in the water research field.

Chapter 1
Introduction

1.1 Introduction

Water is essential for life. The safety and accessibility of drinking-water are major concerns throughout the world. The amount of fresh water on earth is limited, and its quality is under constant pressure. Preserving the quality of fresh water is important for the drinking-water supply, food production and recreational water use. Health risks may arise from consumption of water contaminated with infectious agents, toxic chemicals, and radiological hazards. Improving access to safe drinking-water can result in tangible improvements to health. Water is a vital natural resource for people all around the world. There is an increasing awareness that our freshwater resources are limited and need to be protected both in terms of quantity and quality. This water challenge affects not only the water community, but also decision-makers and every human being.

Water is a multi-purpose natural resource and has been the foundation of life and human civilizations. Water contributes to the diversity of the biological and physical environment of the world as well as to the diversity of the human culture. Access to adequate water for all is recognized as a universal basic human need. The natural availability of water in an area is governed by hydrological factors. However, people throughout history have continued to alter the natural patterns of spatial availability of water for their benefit. As People Action International (PAI, 1997) states, water is the source of life and development on earth. Life is tied to water, air and food, while food is tied to water. Water is a regional resource, but water shortage is becoming a global issue due to increasing population, economic growth and climate change. Development of new sources of water beside its efficient use, together with conservation measures, should be an important component of any country's national water plan.

Today, a quarter of the world's population is affected by physical water scarcity – mainly in northern Africa, the Middle East, and in parts of India, Pakistan and

China. This means that there is not enough water for all uses, whether agricultural, industrial or domestic. Defining thresholds for stress in terms of available water per capita is more complex, however, entailing assumptions about water use and its efficiency. Nevertheless, it has been proposed that when annual per capita renewable freshwater availability is less than 1,700 cubic meters, countries begin to experience periodic or regular water stress. Below 1,000 cubic meters, water scarcity begins to hamper economic development and human health and well-being (WWAP 2009).

Diseases related to contamination of drinking-water constitute a major burden on human health. Interventions to improve the quality of drinking-water provide significant benefits to health. According to a PAI (1999) estimate, there were 31 countries with a total population of 458 million which faced water stress in 1995. More seriously over 2.8 billion people in 48 countries will face water stress by 2025, based on United Nations medium population projections. Of these 48 countries, 40 are in the Middle East and North Africa. Hinrichsen (1999) predicts that population increase alone will push all of the Middle East into water scarcity over the next two decades.

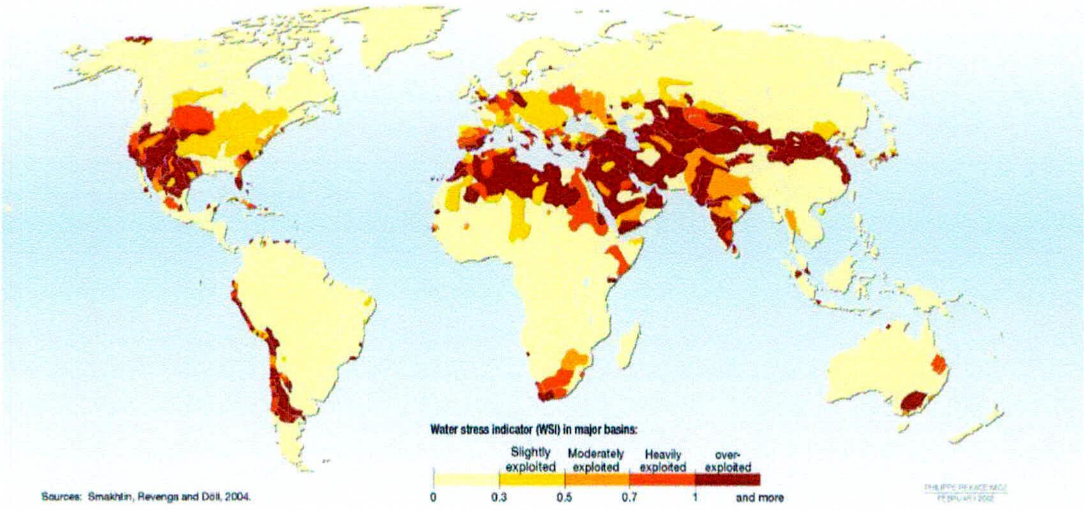

Figure No 1.1 Water Stress Indicators (WSI) in major basins

Gleick (2000) indicates that there are five major drivers demanding a huge expansion of water resources in the 20th century: population growth, industrial development, expansion of irrigated agriculture, massive urbanization and rising standards of living. According to the Gleick world population has grown from 1600 million to more than 6000 million over the last century. Land under irrigation increased from around 50 million hectares to over 267 million hectares. All these factors have led to more than six-fold increase in freshwater withdrawals, from 580x109 m^3/y estimated for 1900 to 3700x109 m^3/y in 2000.

From the above discussion and a comprehensive analysis of the literature, it may be concluded that the world is already facing severe water-related problems. These may be identified as follows:

- 20% of the world's population or more than 1 billion people lack access to safe drinking water, (Simonovic, 2000). Figure 1.1 shows the population without access to safe drinking water.

- 50% of the world's population or more than 3 billion people lack access to sanitation, (Cosgrove, 2000).

- About 80% of all illnesses and more than one third of all deaths in developing countries are related to water. It is estimated that worldwide, around 7 million die yearly from diseases linked to water. Every eight seconds a child dies from a water-related illness that is about 4 million a year, (UNEP, 1999 and Serageldin, 1999).

- Half of the world's rivers and lakes are seriously polluted. Pollution of the waterways and surrounding river basins has created millions of environmental refugees, (Serageldin, 1999).

- Nearly half a billion people in 31 countries face water shortage problems, a figure that is anticipated to rise to nearly two-thirds of the world population by 2025. The worst areas comprise the entire Mediterranean region, including parts of southern Europe, North Africa and Middle East, Northwest and south India, Mongolia, northern China, most of Sub-Sahara Africa and major regions in North and South America, especially the western United States. They will face severe water shortages in the coming years. Europe as a whole also faces severe problems, because half of its lakes have already atrophied, (Cosgrove, 2000 and Serageldin, 1999).

- Aquifers are being extracted at an extraordinary rate - 10% of the world's agricultural food production depends on using extracted groundwater. As a result, groundwater tables fall by up to several metres a year - with the risk of collapse of agricultural systems based on groundwater irrigation in the north China plain, the USA high plains and some major regions depending on aquifers in India, Mexico, Yemen and elsewhere, (Serageldin, 2000).

- Some of the world's biggest cities, including Beijing, Buenos Aires, Dhaka, Lima and Mexico City, depend heavily on groundwater for their water supply. The current overuse is not sustainable, because it takes many years to fill aquifers. Groundwater from aquifers under or close to Mexico City, for example, provides it with more than 3.2 million m3 per day, but already water shortage occurs in many parts of the capital. A related effect is that Mexico City has sunk more than 10 m over the past 70 years. Bangkok, similarly depleting its aquifer for drinking and sanitation, is also slowly sinking. Most of the world's megacities are located on coast lines, where aquifer depletion leads to saltwater intrusion and the contamination of freshwater, (UNEP, 2000 and Cosgrove, 2000).

- Diverting water for irrigation in Central Asia has caused devastating effects. A notorious case is the Aral Sea. This has shrunk to a fraction of its original size and badly degraded in water quality. The latter has caused hundreds of thousands of people to suffer from anaemia and other diseases due to the consumption of water saturated with salts and other chemicals coming from the cotton fields, (Serageldin, 2000).