

Effects of human activities on aquatic eco systems around Kandy

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Abstract

Sri Lanka is a highly bio diverse, 3rd world country with many different eco systems. Among them various types of aquatic ecosystems are significant. Kandy is a district in Central province of Sri Lanka with many different aquatic eco systems which are paramount to the whole country. But various human effects such as water pollution and introduction of invasive species have caused havoc on aquatic ecosystems around Kandy, drastically reducing their bio diversity

In order to prove that human activities cause wreckage in aquatic habitats we conducted 2 experiments. In the 1st experiment our team collected water samples from 3 different aquatic eco systems (Kandy Lake, Mahaweli river and Udaperadeniya stream) and tested them for pH level, hardness, turbidity, nitrite, ammonia, E-coli and total coliform. Then the above results were compared with each other as well as with earlier test results. In the 2nd experiment we calculated the growth rate of a invasive species and a local species of aquatic plants.

The pH levels of the Mahaweli river, Kandy Lake and Udaperadeniya water stream have increased. The turbidity level is in the adverse range. Hardness level is average. The amount of ammonia is reduced. But nitrate is at a very abnormal and adverse level. According to above results Mahaweli river and Kandy Lake are clearly polluted. Because both of above eco systems are situated in urban areas. Udaperadeniya water stream is comparatively less polluted, as it's situated in a area with less population density. In the 2nd experiment we calculated the growth rates of *Hydrilla sp.* and *Cryptocoryne wenditii*. The growth rate of *Hydrilla sp.* was 20.33% and the growth rate of *Cryptocoryne wenditii* was 4.18%.

According to the results obtained by above tests and experiments we can conclude that pollution rates have increased up to a certain level. For example, the pH of Kandy Lake in 1986 was 8.5 and in 2022 it has increased to 7.5 proving that the pH is gradually reaching an acidic level. Adding waste water from various human facilities can be depicted as the main reason for the deviation in above parameters. Though it's still ill-suited for aquatic organisms, concentration of pollutants in Mahaweli river has reduced during 2019 to 2022. This clearly show that pollution is notably decreased with the reduction of human activities in the vicinity of aquatic eco system. Also as shown by the 2nd experiment, the growth rate of invasive species is very much higher than that of local species. So, the invasive species easily populate at higher rate over competing the local species.

Due to human activities in the vicinity of water bodies they have become densely polluted, causing harsh living conditions for the aquatic organisms. Introduction of invasive species have reduced the population density of the native species in the water bodies. So it is evident that human activities directly affect the organisms in the aquatic ecosystems and thus, responsible for the rapid deterioration of those organisms.

Key words - Kandy, Aquatic eco-systems, Pollution, Invasive species

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Introduction

Sri Lanka is a developing 3rd world country with rich bio diversity. Biological diversity or biodiversity, refers to the variety of life in all its forms including plants, animals and microbes that exist and interact in the various biological communities and ecosystems. Sri Lanka is the host for 4000 species of flowering plants, 107 species of freshwater fish, 59 species of amphibians, 174 species of reptiles, 435 species of birds, 140 species of mammals and several thousand invertebrates. Within the Asian region Sri Lanka has the highest species density for flowering plants, amphibians, reptiles and mammals. Irrespective of the size Sri Lanka has a rich eco system diversity because of its topographic and climatic heterogeneity as well as its coastal influence. [1]Species found only in one area or only in a country is known as endemic species. The following are the details of the percentage of each species that is endemic to the island. Fish – 41%, Amphibians – 65%, Reptiles – 52%, Birds – 10%, Mammals – 5%, Land Snails – 80%, Freshwater crabs – 100%, Flowering plants 28%. Because Sri Lanka has an unusually high number of endemic species as shown above, Sri Lanka is considered as one of the 34 bio diversity hotspots around the world. Sri Lanka is also a water rich country with many diverse natural ecosystems [2] spread all around the country. An ecosystem can be described as a community of species, occupying a given area, interacting together and with the physical environment within which it exists. There are 2 types of eco systems

1. Natural terrestrial ecosystems in Sri Lanka e.g.: - tropical wet evergreen forests, tropical sub montane and montane forests, mixed evergreen forests, grasslands, scrub forest, Savannah, Sand dunes and beaches.
2. Man-made terrestrial ecosystems in Sri Lanka e.g.: - home gardens, agriculture fields, botanical gardens, monocultures and mixed plantations.
3. Natural aquatic ecosystems in Sri Lanka e.g.: - marshes, streams, rivers, estuaries, lagoons, coastal seas, sea grass beds and mudflats, mangroves and salt marshes, coral reefs, sandstone reefs and villus.
4. Man-made aquatic ecosystems e.g.: - tanks, reservoirs, canals, ponds and lakes.

So, it is explicit that there are numerous species of organisms living in the different ecosystems found throughout Sri Lanka. And it's important to protect the biodiversity of Sri Lanka because there are compelling economic, scientific, aesthetic and ethical reasons

or values attached to biodiversity. Such as food production, industrial purpose e.g.: -fabric production, recreational purposes, maintaining water quality, recycling nutrients, soil conservation, protection of our watersheds, regulation of climate, in carbon sequestration and pollination.

Kandy is located in the mountainous and thickly forested interior of the island. The city is located in between multiple mountain ranges including the Knuckles Mountain range and the Hanthana Mountain Range, giving the city an elevation of 500 meters (1,600 ft) above sea level. Kandy which is situated in central province [3] is a water rich area with high bio diversity and is considered as a water catchment area. There are many distinct aquatic ecosystems in Kandy such as rivers (Mahaweli river, Hulu Ganga, Pinga Oya, Nanu Oya) lakes (Kandy Lake), streams, reservoirs (Victoria reservoir, Polgolla reservoir, Kotmale reservoir) and water springs. Areas of Mahaweli river in Gatambe and Warathanna are considered as bio diversity rich ecosystems and declared as an Environmental Protection Area (EPA). In Sri Lanka ground water is the main source of water. Therefore, Kandy is very important to the whole country as it is rich in ground water resources (populous in water springs) and, as many rivers and streams flow through Kandy. So, the aquatic habitats of Kandy are important to the whole country.

However, with the time various human activities that has resulted by the increasing of human population density, economic development, industrialization, urbanization etc. have caused disruptions in aquatic eco systems around Kandy [4]. Poor land use and planning, increasing human population density, indiscriminate exploitation of biological resources, improper use of weedicides and insecticides, construction of dams and mini hydro power plants, erosion, plant/ animal trade, loss of traditional crop and livestock varieties and breeds human – wildlife conflicts, unsystematic waste disposal is some of human activities which may lead to water pollution, overexploitation, eutrophication, bio degradation, introduction of invasive alien sp.(Water Hyacinth, *Salvinia molesta*, *E.crassipes*, *Pistia stratiotes*, *Ludwigia sedioides*, *Cabomba caroliniana*, *Mayaca fluviatilis* and *Echinodorous spp.*) Habitat loss and habitat fragmentation. The absence of an integrated conservation management approach, legal systems remaining static though aquatic ecological factors and human factors have evolved and weak enforcement of legislations have further accelerated the demolition of aquatic eco systems around Kandy. [5]And reason for the invasive species to spread rapidly is that 32% of the plants traded in Sri Lanka as ornamental aquatic plants are recognized for their invasive behavior elsewhere in the world. So they spread easily because they are commonly introduced to the local

ecosystems. [6] Some examples for the effect of humans on aquatic ecosystems in Kandy are given below

- Construction of dams across major rivers, especially the Mahaweli, has affected the downstream vegetation. Due to further diversion and impoundments in the upstream areas of the Mahaweli river, the water flow has been reduced causing the drying up of about one third of the villus in the Mahaweli villu system and affecting the aquatics. Further, this has facilitated the spread of alien plants such as *Eichhornia crassipes*, *Xanthium indicum* Koenig and *Salvinia molesta* affecting the natural villu vegetation.
- Construction of mini-hydropower plants at a rapid rate during the past few years has added to deterioration of many habitats of aquatic plants. One of the most affected groups being the family Podostemaceae, a group of flowering plants that only grows on stones in rapidly flowing streams and rivers with changing water levels. Due to this habitat preference, it occurs only in few specific localities and is difficult to be conserved under in situ conditions. The richest site for these members at Gannoruwa-Hallolluwa area of the Mahaweli river is presently being disturbed by the construction of a mini-hydropower plant.
- The construction of the Upper Kotmale hydropower project and restriction of downstream water flow have affected many downstream plants including *Zeylanidium subulatum* (Gardner) C. Cusset and *Z. olivaceum* (Gardner) Engl. of the Podostemaceae.
- The Mahaweli river along Peradeniya to Katugastota, on both sides of the bank, could be identified as one of the severely affected areas due to development activities along the river bank. This stretch once again includes the Gannoruwa-Hallolluwa area, one of the richest aquatic floral habitats providing home to three Critically Endangered (two endemics and one native), three Endangered (one endemic and two native), three Vulnerable (endemic) and one native endangered species.
- Constructions and savage development processes carried out in Kandy lakeside which adds tons of pollutants and heavy metals to the lake affecting flora and fauna on lake surface. Heavy traffic jams in lakeside also responsible for sedimenting pollutants in the lake.(Phosphate, Nitrate, Toxic cyanobacteria and organic waste)

This has caused a massive declination of biological diversity in aquatic habitats around Kandy. [7] Resulting many organisms to be endangered and extinct. (*Aponogeton*, *Cryptocoryne*, *Lagenandra*) So, it is imperative to find methods for conservation of ecosystems.

Methodology

Experiment 1[8]

➤ To test pH value

1. Wash the pH meter by distilled water.
2. Insert the pH meter in the water sample and keep sometime to stabilize the solution.
3. After stabilization, record the pH value.

➤ To test turbidity (measurement about substances which are not dissolved in water)

1. Wash the turbidity cells by distilled water.
2. Shake the water sample as non-soluble components may sink in the sample.
3. Pour the sample in to a turbidity cell, close the lid and wipe the cell to avoid external interferences.
4. Keep the turbidity cell in the turbidity meter and allow light rays of the meter to travel through.
5. Record the final reading in NTU s (Nephelometric turbidity units)

➤ To test hardness

1. Pour 100ml from the water sample to a measuring cylinder.
2. Put that 100ml in to a round bottom flask.
3. To make pH value 10 add 02 drops from the buffer.
4. To get accurate readings put 02 drops from Man ver indicator. Then the solution turns to purple colour.

5. Read initial readings of the Biurette pipe.
6. Put 3-5 drops of EDTA (Ethylenediamine tetra acetic acid) solution (1 mol dm^{-3}) to water sample which has turned purple now.
7. Take the final reading.
8. Get the difference of final and initial readings.

➤ To test NH_3 Concentration

1. Take 02 cells which are free from external interferences which are known as gram solutions.
2. 02-gram solutions are 25ml distilled water sample and 25ml water sample which is going to test. (put into 02 cells and cover by lids & wipe the surface of cells)
3. To stabilize other anions and cations present in the testing water sample put 02 drops from the mineral stabilizer.
4. Then take a standard pipette and take 1ml of Nessler's indicator to it and put it into both cells.
5. Keep both solutions about 1 minute to happen the reaction.
6. Select the testing component as NH_3 in photospectrometer. (meter used to measure ion concentration)
7. Keep the cell filled with distilled water in the photospectrometer and the reading would come as 0 for the distilled water.
8. After some time keep testing water sample filled cell in photospectrometer and take the readings. (for pure water this value should be less than 0.06 mg l^{-1})

➤ To test NO_2^- (nitrites)

1. Take 02 cells and fill both cells with water samples which is needed to be tested up to 10 ml.

2. From the taken 02 cells choose 01 cell as sample (though we have taken same water sample in 02 cells, 01 cell is considering as distilled water sample)
3. Put some powder from Nitriver -3 chemical photopillar to the cell which is considered as sample to be tested.
4. Adjust photospectrometer and keep for 20 minutes.
5. After 20 minutes keep the cell in the spectrometer and get the readings in mgl-1.

➤ To test NO_3 (nitrates)

Due to the unavailability of necessary chemicals, we were unable to test for nitrates.

➤ To test E coli bacteria

The procedure was performed by the chemist. Stating simply, the microorganisms were filtered using filter papers and was allowed to grow by incubating at 37° Celsius.

Experiment 2

Materials

- Hydrilla sp. (invasive)
- Cryptocoryne wendtii (local)
- Identical tanks
- Culture medium

- Water

Method

1. Adding equal amounts of culture medium to 2 identical tanks. (3 kg)
2. Planting equal number of plants (5 plantlets) in the 2 tanks, after measuring their initial length and calculate their average initial lengths.(L1)
3. Adding equal amount of water from the same source to water tanks. (30 liters)
4. Allow species to grow in culture medium under same controlled conditions.
5. Maintain controlled conditions such as Temperature and pH level.
6. Take observations and readings
 - a. Final lengths
 - b. Average final length (L2)
 - c. Growth rates [9] (by comparing initial lengths of the plants with final lengths of the plant)

at the end of 2 weeks.
7. Comparing average growth rates of the two plants.

$$\text{Growth rate} = \frac{L2 - L1}{L1} \times 100\%$$

Results

Experiment-01

Kandy lake(Bogambara lake)

Sample location- 7.2928311,80.6380613

Mahaweli river

Sample location- Near Katugasthota

7.30755,80.6392016

Stream

Sample location- Udaperadeniye

Pollutants

	Controlled	Kandy Lake	Udaperadeniye water stream	Mahaweli river
pH	6.5-8.5	7.563	7.864	6.5
Turbidity(NTU)	>1	7.47	1.5	Not founded
Hardness(mgdm ⁻³)	61-120	90	38	71.8
Ammonia concentration(mgl ⁻¹)	0.25-32.5	0.1	-0.05	0.2
Nitrite(NO ₂) concentration (mgl ⁻¹)	>0.1	0.474	0.024	0.3

Bacterial activity

	Controlled	Kandy Lake	Udaperadeniye water stream	Mahaweli river
E- Coli	0 count of per 100ml	119 bacteria per 100ml	73 bacteria per 100ml	Too numerous to count
Total Coliform	>1 colony forming unit per 100ml	Too numerous to count	Too numerous to count	Too numerous to count (Due to present of high E- coli coliform is not visible)

Comparison of pollutant accumulation by year

	Mahaweli River		Kandy Lake	
Tested year	2019	2022	1986 [10]	2022
pH	5.34 pH	6.5 pH	8.3 pH	7.563 pH
Turbidity	-	5.62 NTU	13 NTU	7.47 NTU
Hardness	65.0 mgdm-3	61.8 mgdm-3	89.20 mgdm-3	90 mgdm-3
Ammonia	0.4 mgl-1	0.2 mgl-1	-	0.1 mgl-1
Nitrtite	6.0 mgl-1	0.3 mgl-1	0.19 mgl-1	0.747 mgl-1
Total coliform per 100ml	-		591.8-1408.2	

Experiment – 02

[Plant experiment – 01]

Plant Name – *Hydrilla sp.* (invasive species)

Time – 2 weeks

	A	B	C	D	E	Average
Initial length	10.6 cm	10.9 cm	11.6 cm	9.9 cm	11.1 cm	10.82 cm (L1)
Final Length	12.7 cm	13.1 cm	14 cm	11.8 cm	13.5 cm	13.2 cm (L2)

$$\text{Growth Rate} = \frac{L2-L1}{L1} \times 100 = \frac{13.2-10.82}{10.82} \times 100 = 20.33\%$$

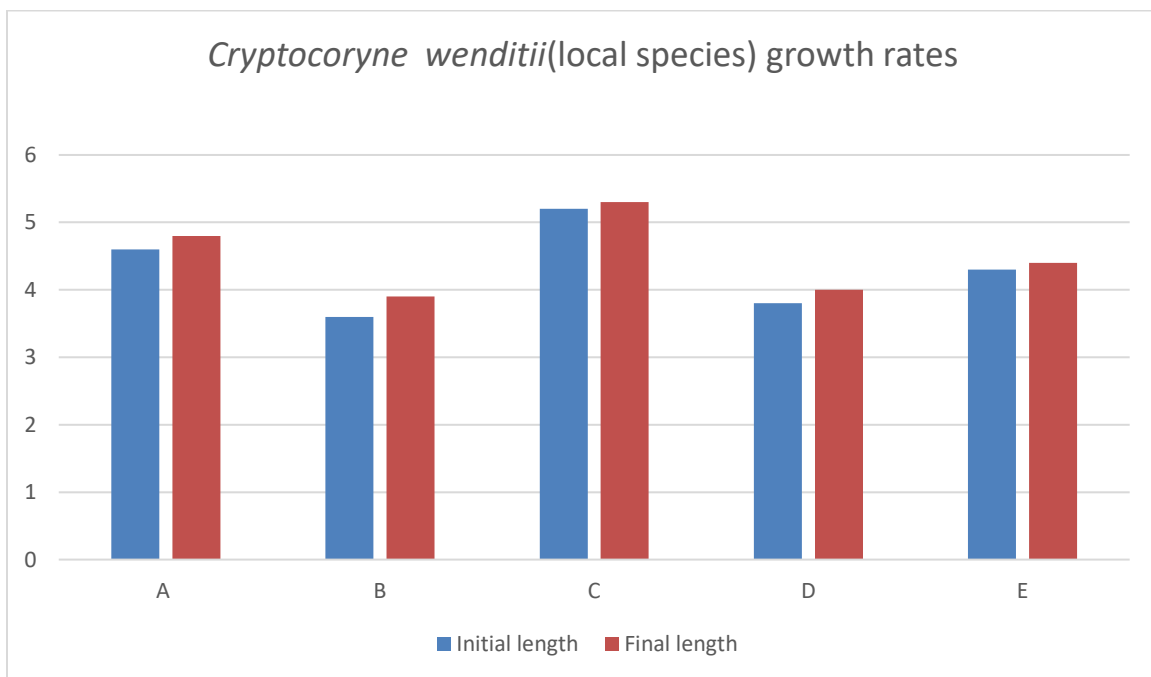
[plant experiment – 02]

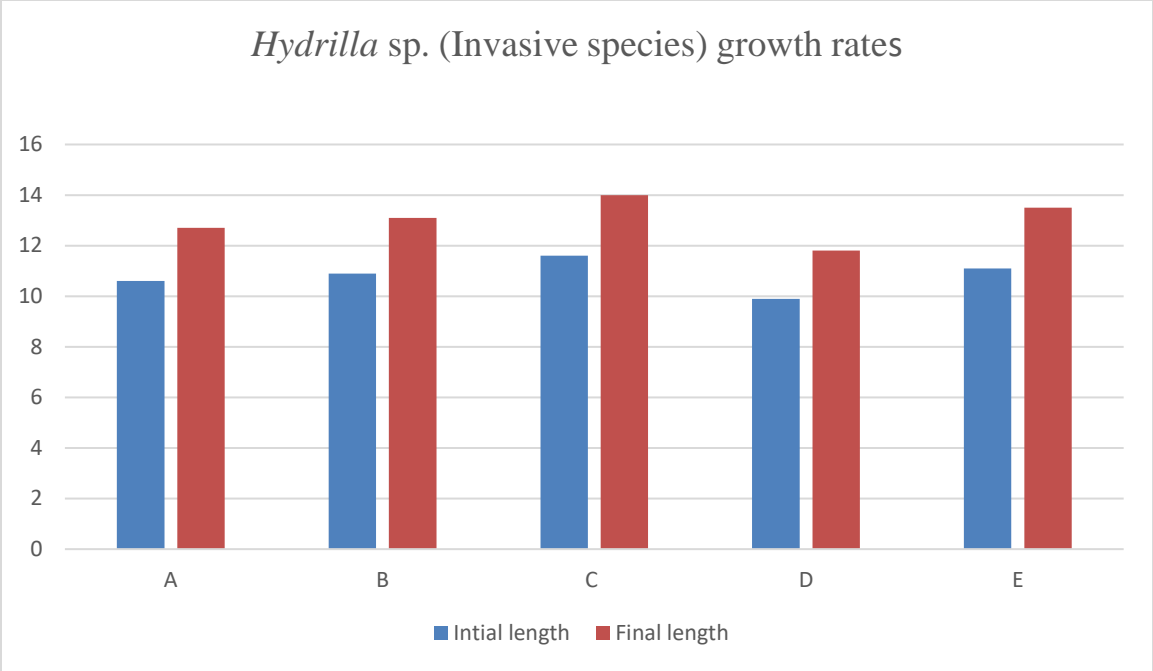
Plant name – *Cryptocoryne wenditii* (local species)

Time – 2 weeks

	A	B	C	D	E	Average
Initial Length	4.6 cm	3.6 cm	5.2 cm	3.8 cm	4.3 cm	4.3 cm
Final Length	4.8 cm	3.9 cm	5.3 cm	4.0 cm	4.4 cm	4.48 cm

$$\text{Growth Rate} = \frac{L_2 - L_1}{L_1} \times 100 = \frac{4.48 - 4.3}{4.3} \times 100 = 4.18\%$$





Discussion

After 30+ days of researching, results were obtained accordingly to the research topic. Research is mainly targeted on pollution and, our observations on invasive sp. and extinct sp. of aquatic animals around Kandy also discussed as an indirect effect of human activities on aquatic eco systems. As we mentioned above pollution readings of parameters like Hardness, Turbidity, pH levels, Ammonia concentration and Nitrate levels[11] thus provides spectator a space to get a clear idea on pollution levels of above mentioned locations, Mahaweli river(Near Katugasthota) , Udaperadeniye stream and Bogambara Lake.

Results were obtained by testing water samples from above mentioned locations. Results clearly depicts the pollution of aquatic water bodies has increased with increasing of population and human activities of that specific area. Acidic pH levels of Mahaweli river near Katugasthota is our main key to explain the high concentration of pollution. Ammonia and Nitrite levels also depict unsuitability for consumption and also high bacterial activity of E-Coli [12] can be used as a main parameter to prescribe there has been a severe pollution in the area of Katugasthota which has severely affected to aquatic eco-systems and their habitats. As well as, readings of Udaperadeniye stream clearly depicts there is less pollution compared to Mahaweli river. Basic pH levels, low turbidity and low level of hardness along with trace amount of E-coli provides proof to less human activities contributes to low level of pollution vice versa high level of human activities has caused more pollution (Mahaweli river near Katugasthota).

As of our observations, human activities around our selected areas are construction of dams across major rivers[13], especially the Mahaweli, has affected the downstream vegetation, construction of mini-hydropower plants at a rapid rate during the past few years, construction of the upper Kotmale hydropower project and restriction of downstream water

flow[14], open sewage lines to Mahaweli river near Katugasthota, excessive traffic jams on Katugasthota road, construction of road in lakeside, putting a new layer of tar on the road of lakeside, daily boat rides in lake due to more availability of foreigners, excessive traffic jam in lakeside, etc. and mainly irresponsible dumping of trash was clearly observed. Therefore, effects of those activities and our testing reports on water samples clearly shows that there is a danger and a caution to aquatic bio diversities and their living conditions due to excessive pollution. In line with the hypothesis, rapid loss of bio diversity and accumulation of toxic pollutants in water bodies around Kandy is a major stanza we've tried to convey through our research. Higher pH, ammonia and nitrite levels creates an unhealthy life pattern for aquatic living bodies. As mentioned above, severe polluted readings from Mahaweli river clearly indicates the risk on bio diversity around that area (Katugasthota). Thereby, intoxications, accumulating heavy metals, allergies and bad reproductive conditions may lead to rapid loss of these bio diverse flora and fauna. As of our opinion, high density of population around that area is the main cause for excessive pollution and what we observed can add releasing of sewage lines and dumping garbage to the facts which cause pollutions in that area. Kandy lake pollution is denoted in average levels. Even though pollution is at an average level it still affects the aquatic organisms tremendously. So there may be a low level of risk for bio diversities in Kandy lake compared to selected area of Mahaweli river. As we observed around Kandy lake, pollutants to the lake is majorly added through vehicles driven around lakeside. Heavy metals and dust is incessantly burned through vehicles so that they accumulate in to low levels due to less density and eventually mix with water. Moreover, construction of the lakeside road and drilling holes on the road for maintenance of sewage lines also provides polluted sediments which lead lake water to eutrophication and increase pH levels. Observations of Udaperadeniye stream which was an elevated clear catchment area of water away from human densities, clear samples were obtained with less pollutant levels. Moreover, when comparing the parameters of the Mahaweli river between 2019 and 2022

it is evident that pollution has directly affected the aquatic environment adversely, due to reduction of several human activities in 2022. This reduction is mainly due to the COVID-19 pandemic which caused a reduction in major activities such as transport and many other fuel powered industries which adds tons of pollutants to the eco-systems. Factors like pH have increased, making the water basic which is ideal for the aquatic organisms. Also reduction of factors like Ammonia and hardness greatly increases the favorable living conditions. Though there has been a brief eco-friendly era still pollution exists in reasonable levels causing enough harm to aquatic ecological societies.

So contrary to hypothesized association, human density and construction practices are directly proportional to pollution of aquatic eco systems.

Besides pollution, there's an another major threat which aquatic eco systems has faced recently due to irresponsible human activities. Growing invasive sp. as ornamental flora and fauna has mainly contributed to affect the endemic sp. of Sri Lanka as well as their habitats. A recent conservation assessment of Sri Lanka's freshwater fish has come up with a total of 139 species, of which 61 are found nowhere else on Earth. From those parties 74% of endemic freshwater fish threatened with extinction [15]. Many of Sri Lanka's freshwater fish groups have undergone significant changes and the new studies sheds much needed light on their taxonomic diversity. Invasive sp. like *Hydrilla* and *Cabomba* has caused these species of freshwater fish issues by avoiding light passage through water surfaces up to the bottom. That has affected severely on reproduction rate and feeding patterns of freshwater fish groups that leads to rapid extinction level. Most of Kandy freshwater fish are found outside protected areas and are thus affected directly by all the major drivers of biodiversity loss such as habitat loss and degradation, overexploitation, pollution, invasive alien species, and climate change. According to the data collected by our group aquatic fauna like Rainbow trout (*Oncorhynchus mykiss*), Clown knife fish(*Chitala ornata*), Plecostomus cat fish(*Pterigoplichthys multiradiatus*), Walking cat

fish(*Clarias batrachus*), Guppy(*Poecilia reticulata*), Mosambique Tilapia(*Oreochromis mossambicus*), Giant African Snail(*Lissachantina fulica*) [16] and aquatic flora like *Salvinia molesta*, *E. crassipes*, *Pistia stratiotes*, *Ludwigia sedioides*, *Cabomba caroliniana*, *Mayaca fluviatilis* and *Echinodorous* spp. [17] have identified as invasive species who rules around Kandy vicinity. By that many endemic species like, Sinhala barb(*Dawkinsia singhala*), Blotched filamentous barb(*Dawkinsia srilankensis*), Ceylon Logsucker(*Garra ceylonensis*) [18], Philipps' Garra(*Garra phillipsi*), Red-side barb(*Puntius bimaculatus*), Stoliczka's barb(*Pethia stoliczka*), Freshwater garfish(*Xenentodon cancila*) and aquatic flora like *Aponogeton*, *Cryptocoryne* and *Lagenandra* [19] around aquatic habitats of Mahaweli river, Kandy lake and streams flowing across Kandy area are tend to extinct due to the attack of invasive species. Overpopulation of invasive sp. , minimizing of resources due to overpopulation, increasing the competition for resources, loss of habitats due to overpopulation and dominant variants of invasive species has mainly affected on endemic species' living conditions. As we mentioned above in our 2nd experiment, growth rate of invasive species has depicted a clear deviation compared to the local plant. Arguing by that dominant features of invasive species has a major impact on our endemic and local flora fauna and its diversity.

Do your results agree with previous researches?

Compared to the results of previous researches, our research ally with them very accurately because there has been a slight upchange of pollution levels though previously checked results were very accurate and we agree with those researches. Besides one or maybe more species of fauna and flora found extinct and the growth rate of invasive sp. has rose compared to previous researches.

Are your findings very different from other studies?

There's a slight difference in the information of invasive and extinct species while aquatic pollution levels remain the same with light level of upchange. Indicates pollution has increased which depicts a bad sign

Do results support existing theories?

Very much yes, our results thus proves pollution is rising in water bodies as well as aquatic eco systems are dying because of pollution. Invasive species and their growth rates indicates higher efficiency levels and it originally supports the existing theories about invasive and extinct sp.

On the journey to collect the data it wasn't very easy. Due to the pandemic we are facing recently, its been more hard to take physical meetings and collect data. One of our group members also got infected with virus and there has been a slight delay too when collecting data. After making proposal we met physically to gather information from Peradeniye university zoology faculty. A day was spent on collecting data about invasive and extinct species of fish and plants around Kandy. Talked to the faculty heads of zoology and botany and talked with few professors who've done similar researches relate to our title. After, headed to the library to collect information and there was a big delay for us in order to get access to the section C of the library where research books been stored. Stayed for few hours of time to go through the library books on aquatic researches. That was the 1st day our group members physically met and we've had several online meetings through those times. It's very hard to take descions through online meetings so we've opted another few dates to meet and collect data for the research. 2nd day of data collecting was hard. We've had several issues when selecting the date that all members of the group are viable to participate. Along with that, distance to the destination points for some members were large too. Finally we gathered to Gatambe water board in order to arrange a date to test water

samples. Unfortunately secretary wasn't available that day so we had to come again. So we've planned on visiting water bodies that we are going to check water samples from. 3rd day of meeting was more like impossible to get all members on the field due to classes and educational discussions. So few of us went to the water board again and secretary directed us to the lab which was located few miles away that we had to walk. After discussing about testing water samples we had to arrange another date to visit water bodies and collect water samples. It's the 4th day and few days remaining to submit final reports. So we had to make things quick. After many online discussions we've opted another date to collect and test water samples. Morning time went to the lab and received sterilized bottles to collect water samples and rode back to selected locations. Laknath and Malith went to collect water samples from Bogambara lake, Seniru went to collect water from Mahaweli river near Katugasthota and Sathmika and Tehan went to collect water samples from Udaperadeniye stream. After walking and collecting water for few hours we returned bottles back to the lab with water samples in order to check for pollutants and bacterial activities. Chemists gave us the opportunity to watch how testing's were done and we got an extra chemistry knowledge about doing testing's via that. After testings has been done we had to return another day in order to collect bacterial testing samples. So here came the 5th day of physical meeting and we headed back to the lab to collect water testings on bacterial activity. As I mentioned above results were accurately received. We thanked chemist and ended our final physical meeting completing all steps to write our final report and abstract. Transportation deformities, time problems and total budget were the main challenges we faced during our physical meetings for research purposes. Writing final report weren't easy too. Hours of zoom meetings to define and arrange final report content was also a challenge along with AL works we got. Finally hoping some good comments to our research and hope everyone will learn and extract something from our research in order to protect our aquatic eco-systems and rise as a nation enriched with a bio diversity which will eventually lead to economic success.

Conclusion

It is evident that the main cause for the pollution of water bodies in the vicinity of the Kandy city, are human activities. Releasing of sewage to water bodies contaminates the water increasing the concentration of disease causing organisms like *Escherichia coli*, *Amoeba* as well as other pollutants such as ammonia, phosphates, nitrates, heavy metals etc. Furthermore, disposal of waste containing plastics and polythene increases the concentration of toxic hydrocarbons in the water bodies which is not conducive for the aquatic organisms in those water bodies while also affecting the eco systems in long term. Another prominent human act which leads to loss of biodiversity in the aquatic environment is introduction of invasive species. These invasive species when introduced become a dominant life form which overtakes over the other species, thus reducing their population density.

Eg:Hydrilla plant can grow very fast and occupy a large space over a short time period.

Eg:Tank cleaner fish when introduced become dominant over other fish and grow at a faster rate and is more resilient to extreme physical conditions.

Other than the above stated causes, some other significant reasons for eco system deterioration are exploitation of biological resources, improper use of weedicides and insecticides, construction of dams and mini hydro power plants, erosion and improper land use. Some examples for the organisms which are endangered due to above stated human activities are given below,

- Podostemaceae, a group of flowering plants that only grows on stones in rapidly flowing streams who are commonly found in Gannoruwa-Hallolluwa area of the Mahaweli river.

- Three Critically Endangered (two endemics and one native), three Endangered (one endemic and two native), three Vulnerable (endemic) and one native Endangered species are found in The Mahaweli river along the stretch from Peradeniya to Katugastota.
- e.g.: - Dadaya fish.
- Many *Aponogeton*, *Cryptocoryne* and *Lagenandra* species are endangered due to over exploitation.

In order to minimize the above-mentioned factors, waste management must be conducted in a way where it does not adversely affect the environment. This can be done by sending the sewage waste along an alternative route allowing it to partially decompose, and then be released. Through this biogas can also be obtained which can be used for energy purposes. Polythene and plastic can be directed to be recycled. Outdated laws should be updated and new effective laws should be introduced to protect our aquatic ecosystems (especially regarding over exploitation and improper land use). Switching to organic fertilizers also helps tremendously for the preservation of those eco systems. And other environmentally friendly practices used in abroad should be identified and practiced to protect the longevity of our aquatic ecosystems, (E.g: - River restoration practiced by Japan) one of such successive practice is installing wetland units in Kandy lake premises. And informing the public about the importance of ecosystems around them may also play a huge role in preserving the eco systems.

When it comes to invasive species however, reducing their population density in aquatic water bodies would be detrimental to the other natural species since the invasive species are very resilient to extreme conditions. Since their removal is an arduous process, early detection, rapid response, public awareness and preventing further dispersion will play a big part in this process.

Acknowledgement

We would like to extend our sincere gratitude to the Mr. K.W.D.U. Chandrakumara, Principal of Kingswood college, Mrs. Erandi Ranasinghe, Master in charge of research and Committee of Kingswood research unit and Mahamaya research unit for their valuable help and giving us the space to participate in Ingratus'22 research symposium.

We would like to extend our heartfelt gratitude to Zoology and Botany faculty heads of Peradeniye university, Mrs. Inoka Karunaratne and Mrs. Deepthi Yakandawa along with professor K.B.Rathnayake and professor Gehan Jayasooriya who helped us a lot in retrieving information about flora and fauna.

We would like to extend our heartfelt gratitude to the Deputy general manager of national water supply and drainage board Gatambe, Mrs. Asanthi Rabbidigala ,Officer in charge of Hanthana water supply scheme, Mrs. Darshani Ilangagendara ,Head of water board chemistry lab, Lakma Wasalabandara, Lab assistant and other chemisists and bacteriologists who helped us in water and bacteria testings.

Very special thanks goes to our parents who helped us consistently right to the end to make things possible and special thanks to people who helped us in retrieving water samples from Mahaweli river, Kandy lake and special thanks to Pamoda Ariyawanshe for the guidance and special thanks to all other parties who helped us to make this research a success.

References

- [1] <https://amazinglanka.com/wp/sri-lankas-biodiversity/>
- [2] <https://www.slideshare.net/dsamkhan/freshwater-biodiversity-of-sri-lanka>
- [3] <https://kandycity.lk/geography-kandy-sri-lanka/>
- [4] <https://www.ips.lk/talkingeconomics/2013/05/20/biodiversity-as-a-cornerstone-of-sustainable-development-a-sri-lankan-perspective/>
- [7] The national red list 2012 of Sri Lanka
- [6] <https://www.cea.lk/web/en/acts-regulations>
- [7] <https://news.mongabay.com/2020/07/new-assessment-shows-74-of-sri-lankas-freshwater-fish-threatened-with-extinction/amp/>
- [8] <https://blogs.worldbank.org/water/how-test-water-quality-chemical-tests-limited-budgets>
- [9] <https://www.wikihow.com/Measure-Growth-Rate-of-Plants>
- [10] [waterQualityofSriLanka%20\(1\).pdf](#)
- [11] <https://www.fao.org/3/x5624e/x5624e05.htm>
- [12] <https://my.clevelandclinic.org/health/diseases/16638-e-coli-infection>
- [13] <https://archive.internationalrivers.org/environmental-impacts-of-dams>
- [14] http://powermin.gov.lk/english/?page_id=1520
- [15] <https://news.mongabay.com/2020/07/new-assessment-shows-74-of-sri-lankas-freshwater-fish-threatened-with-extinction/>
- [16] https://www.google.com/search?kgmid=/m/09_4zl&hl=en-LK&q=Giant+African+Snail&kgs=5eb8d3c4ccddd2e8&shndl=17&source=sh/x/kp/osrp/2&entrypoint=sh/x/kp/osrp

[17] http://www.auditorgeneral.gov.lk/web/images/special_report/2020/8-iv/LivelihoodEnglish-Report.pdf

[18] https://en.wikipedia.org/wiki/Ceylon_logsucker

[19] https://drive.google.com/file/d/1HauUWCrbCERUuGUMXbjqcDRimsep_Vpv/view