



## The Environmental Issues and Appropriacy of Adapted Management Strategies

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### ABSTRACT

*Environmental issues are a ubiquitous but vague concept. Understanding these problems' nature and how anthropogenic actions contribute to them is essential. At present, it is possible to identify many environmental issues on different scales in the world and Sri Lanka. Therefore, this research mainly aimed to identify the main environmental issues and the appropriacy of adapted management strategies in Egoda Guruwala GN Division in Sri Lanka. Interviews and field observations were used as the main data collection method. The ranking method was used to identify the most prominent issues, and the results were interpreted using Problem Tree analysis. Further, it investigates the strengths and weaknesses of the management strategies in a qualitative methodological approach. The results found that there are five main environmental problems, [1] soil erosion and land degradation, [2] deforestation, [3] environmental pollution, [4] invasive species spreading, and [5] other problems. The study found different management strategies such as planting trees, trenching in sloped areas, raising awareness, using the popper waste disposal method, properly implementing the rules, and composting the carbonic waste. However, the study found another environmental issue due to unsustainable management strategies. As a rural area, the community already has the potential to use sustainable environment management strategies to reduce the environmental issues that may arise in the future. Even so, lack of accountability and ignorance may cause on developing the current situation. Therefore, this study enables us to identify the possible management strategies that may take at a domestic and community level to control and minimize the future environmental issues in the study area.*

## **1. Introduction**

Everything that surrounds or affects an organism during its lifetime is collectively known as its environment. The environment is "the total of living, non-living components; influences and events surrounding an organism". Each organism (from viruses to humans) must rely on another organism and environment for food, energy, water, oxygen, shelter, and other needs. The relationship and interaction between organisms and the environment are highly complex. The environment consists of living (biological) and non-living (abiotic) compositions. The environment is not static. Both biological and abiotic factors are in flux and keep changing continuously (Shankar IAS Academy, 2018).

"Environmental problems" is a universal but indistinct concept. It is essential to identify the nature of these problems and how they arise from human use of the environment. The environment provides many "goods and services" to the human population. We can categorize them into three general human groups and all other species (European Commission, 2015). The first one is that the environment provides us with the necessary resources. Secondly, in consuming resources, human beings produce more "waste". The environment serves as the "sink" or "waste bank" of such wastes as much as possible and makes the environment suitable for human habitation, for example, by cleaning contaminated air. Finally, like all other species, humans must have a place to live, and the environment provides our "Habitat". When human beings abuse the ability of the environment to perform a single function, the result is "environmental problems" in the form of pollution, resource scarcity, overcrowding, and overpopulation. However, not only must the environment satisfy all three functions, but when a given environment is used for one function, its ability to implement the other two functions may be affected (Dunlap & Jorgenson, 2012; Paul R. Ehrlich & Anne H. Ehrlich, 1972).

The journey up to the present day has seen numerous attempts to alter the natural environmental circumstances, starting with the first steps man took to conquer the environment. In those various efforts, it is possible to identify many environmental issues on different scales. Environmental problems in the world and Sri Lanka can be traced back to increasing human impact on the environment due to rapid population growth, expansion of agricultural activities, and industrialization. (Shankar IAS Academy, 2018; UNEP, 2001). Such as land degradation, deforestation, environmental pollution, soil erosion, mangrove reduction, invasive species spreading, disasters, climate change, waste disposal problems, biodiversity loss, natural resource depletion, and etc. Therefore, at present most countries take different adaptation strategies on a global and regional scale to minimize those environmental issues (Holden, 2017; Geekiyanage et al., 2015; Shankar IAS Academy, 2018; MENR, SRI LANKA: National Environmental Policy and Strategies, 2003; MENR & UNEP, Sri Lanka Environment Outlook, 2009).

Sri Lanka is a developing country with a total land area of 65,610 km<sup>2</sup>, and 21.3 million people live in this country. It is located in the tropical region and has inherited natural beauty from the distant past. This country belongs to a wide range of terrestrial and freshwater ecosystems with high biodiversity (Geekiyanage et al., 2015). Also, a few people who followed environmentally friendly methods to achieve their daily needs have lived in this country. The beginning of the environmental problems can be identified with the gradual population growth, urbanization, and agricultural expansion. Those environmental problems have accelerated with the massive population growth and the increasing industrialization in Sri Lanka since the 1980s (Ileperuma, 2000). Industrialization led to an increase in energy consumption in Sri Lanka. This rapid growth can be identified in agriculture, industries, economy, and development sectors. Due to

these, significant environmental problems have emerged in every country (Zubair, 2001).

Forest cover loss, land degradation, haphazard waste disposal, air pollution, climate change, unregulated sand mining, loss of biodiversity, pollution of inland waters, pollution of marine and coastal ecosystems, and unsustainable use of natural resources have been identified as the primary environmental problems in the region by the Ministry of Environment and Natural Resources of Sri Lanka (MENR-SL) and the United Nations Environment Program (UNEP). Since Sri Lanka has transitioned from an agricultural to an industrial economy, the country has faced many productions related to environmental issues in the present (Geekiyana et al., 2015).

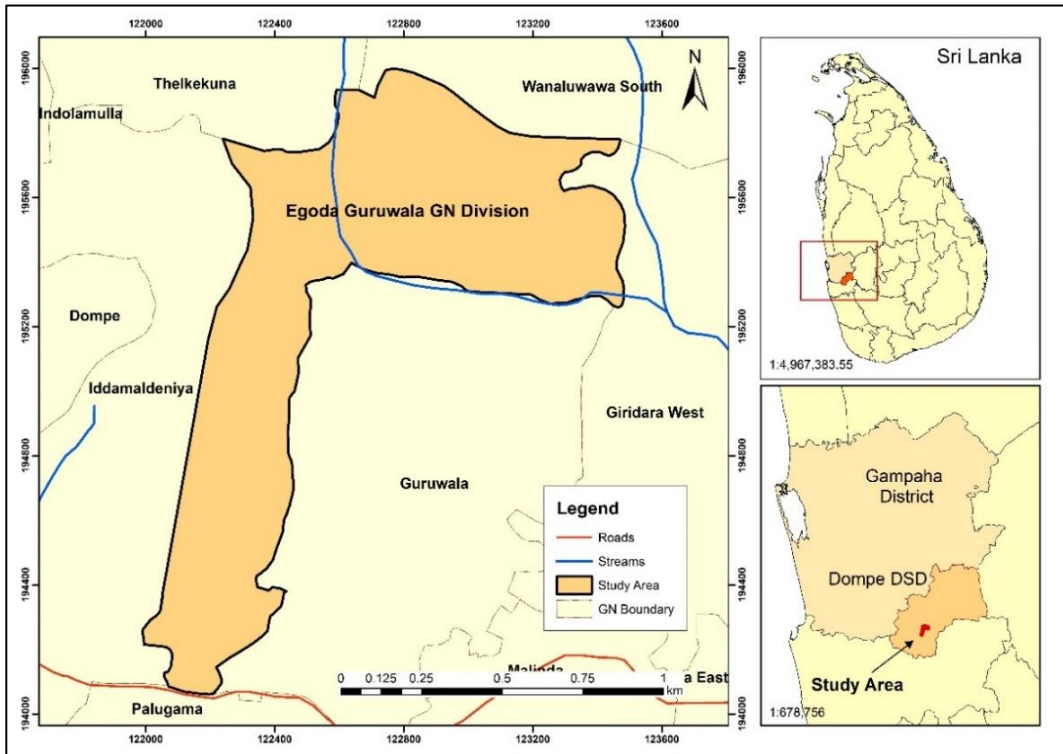
The high population density and the continuous efforts to improve rural peoples living standards have put tremendous pressure on the country's natural environment. As a result, in the past few decades, the resource base has declined significantly due to unsustainable use. Therefore, the government, the private sector, and other sectors have taken many initiatives to promote various environmental management strategies and sustainable development in the country (Geekiyana et al., 2015; MENR, SRI LANKA: National Environmental Policy and Strategies, 2003). To achieve social and economic development, it is also imperative to be aware of the environmental damage that may occur. It must be recognized that although uncontrolled development can bring immediate benefits, it will undermine the development process and cause irreparable damage to the natural resources that are the foundation of development. Therefore, only by protecting the natural environment and the life support system to protect the environment, we can maintain its environmental sustainability (Thirlwall, 1994). Given these circumstances, legal, political, and institutional interventions

aimed at solving environmental problems have been taken since the 1980s. Since 1992, the national environmental action plan has been in place, and various measures have been taken to control environmental degradation in various sectors. However, these actions fall far short of the conditions required to ensure that the development process remains sustainable and that environmental integrity is maintained. Especially at the regional level, many environmental problems can still be identified on different scales (MENR, SRI LANKA: National Environmental Policy and Strategies, 2003; Geekiyana et al., 2015). Therefore, this study mainly aimed to identify the main environmental issues in the *Egoda Guruwala* GN division in Gampaha District. Secondly, it investigated the management strategies adapted to solve those problems and their strengths and weaknesses in achieving those objectives. The final part of this paper suggested the regionally applicable measures to minimize those environmental problems.

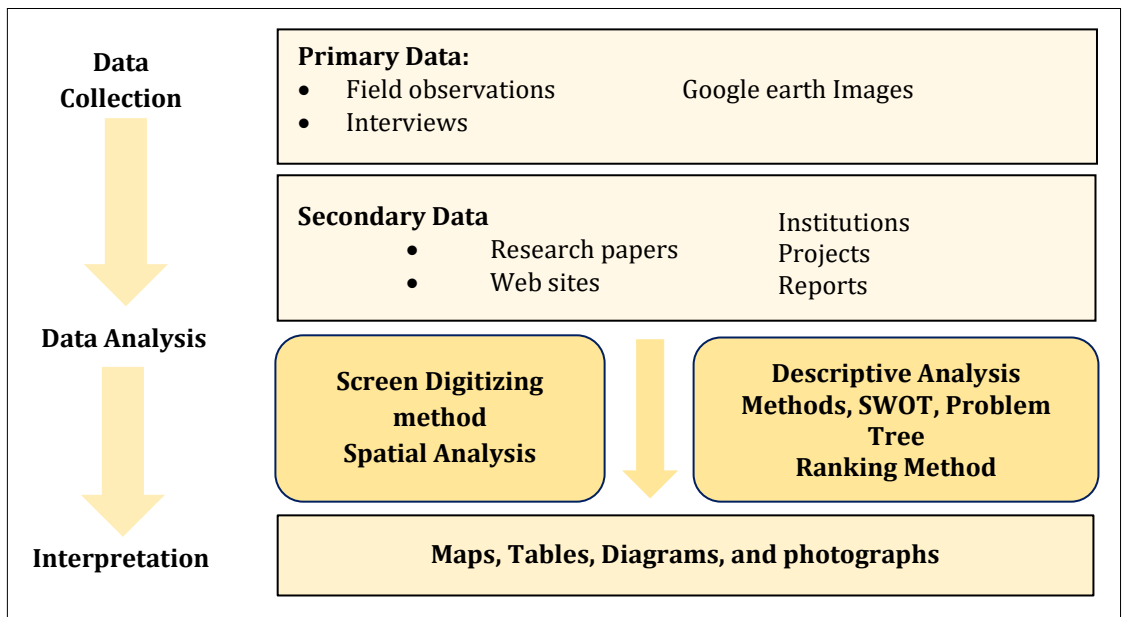
## 2. Materials and Methods

### 2.1 Study Area

*Egoda Guruwala* GN Division, located in Gampaha District, Sri Lanka was selected as the study area of this research. Figure 1 shows the relative and absolute location of the study area. This area has a unique natural location and environment. This area is in Sri Lanka's Wet Zone and receives an average annual rainfall of 2500 mm-4500 mm. The average annual temperature of this area is 25°C - 27°C. According to the Department of Census and Statistics, 1006 of the population (293 households) lived in *Egoda Guruwala* GN Division at the end of 2018 (Dompe Divisional Secretariat, 2022). This GN division is located in a rural area of the country. The main primary economic activities, such as agriculture and livestock management, and the secondary activities, small-scale, manufacturing, and processing, can be identified in this area.



**Figure 1.** Study Area Map (Source: Prepared by Author, based on the data obtained by department of survey, 2022)



**Figure 2.** Methodology of the Research

## 2.2 Data Collection, data analyses and interpretation methods

Both primary and secondary data were used in this study. As a primary data collection method, interviews with the village leaders, community leaders, GN officers, development officers, and families were used. These interviews mainly focused on collecting data regarding the main environmental problems that take place in their lands, the people's views regarding the management strategies that have been taken to manage environmental problems, and the awareness and applications of those management strategies. The ranking method was used to identify the most prominent issues, and the results were interpreted using the Problem Tree analysis. Further, investigated the strengths and weaknesses of the management strategies in a qualitative methodological approach. Field observations were used to identify the current status of environmental problems and the adaptation strategies taken to manage those environmental issues in the study area. Field observations and Google Earth Software were used to analyze those environmental issues' spatial and temporal changes, and the findings were interpreted using maps. Secondary data such as institutions' websites, reports, research articles, and ongoing and previous project reports were also used to collect information regarding existing environmental issues and management strategies in the study area. Figure 2 shows the methodology of the research.

## 3. Results and Discussion

### 3.2 Major Environment Issues in the Study Area

The ranking method was used to identify the significant environmental problems. Accordingly, some of the significant problems in the area can be outlined as follows. Figure 3 shows the Problem Tree Analysis of the research. Figure 4 shows the main environmental issues in the study area.

- Soil Erosion and Land Degradation
- Deforestation
- Environmental Pollution (Land/ Air/ Water)
- Invasive Species Spreading
- Disasters
- Other Environmental Issues (Salination, Pests and Diseases, Natural Resource depletion), High Chemical Fertilizer Use

**Soil erosion and land degradation:** This problem can mainly be observed in areas with low vegetation cover, built-up areas, agricultural sites, and high-elevation areas (above 30m) in the study area. This problem can be identified primarily through the surface land's exposure to high rainfall (above 2500mm) as it causes the removal of natural vegetation cover and steep slopes of the land. The hilly portion of the research region has parts that are 40% over the slope due to elevation differences. Also, this situation has been created due to the preparation of the slopes in a manner suitable for the construction in the areas with heavy construction and due to the preparation of the land with the use of machine equipment in the vicinity of the cultivated lands. Due to this, soil quality has decreased due to soil erosion during heavy rainy times. Figure 5 shows the study area's soil erosion areas and elevation map.

**Deforestation:** Deforestation is a major environmental problem in this region. Built-up and agricultural area expansion is a leading cause for this issue. Figure 6 shows the land use and land cover in 2006 and 2022. In 2006 there were 18.23 hectares of forest area, which decreased to 11.67 hectares in 2022. In 2006 there were 17.13 hectares of rubber area, which decreased to 9.43 hectares in 2022. Along with this, the expansion of home gardens and cultivated areas can be observed. In 2006 there were 41.99 hectares of home gardens and 1.94 coconut areas. Those areas have been changed to 55.10 hectares of home gardens and 2.79 coconut areas in 2022.

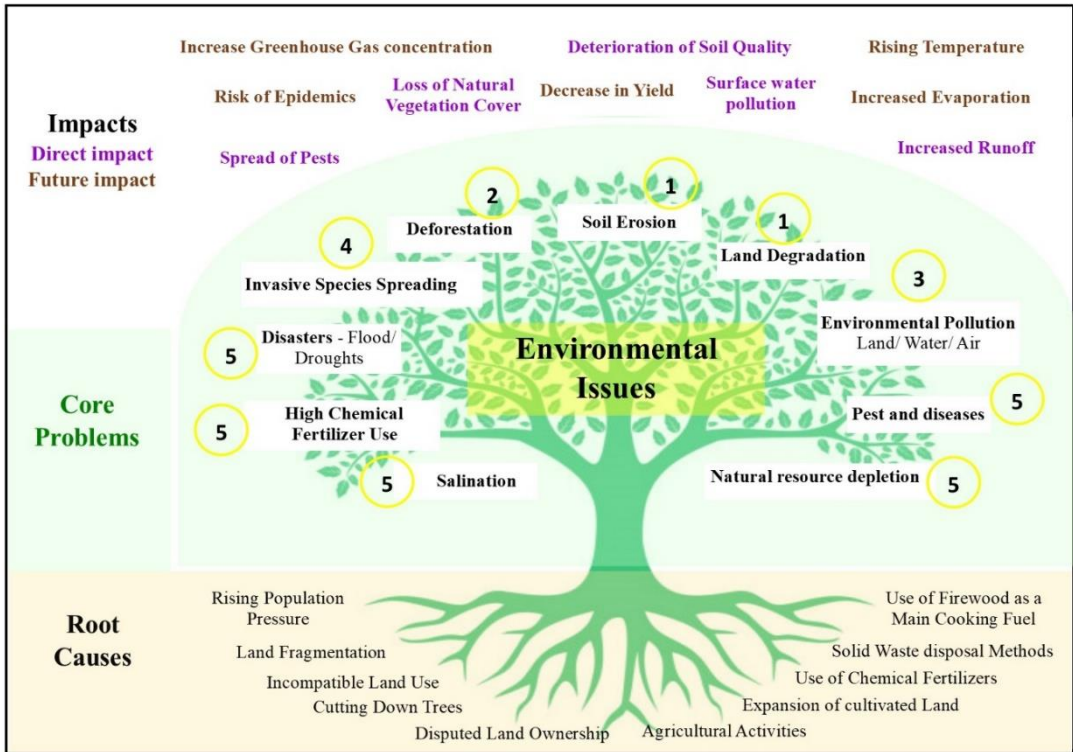
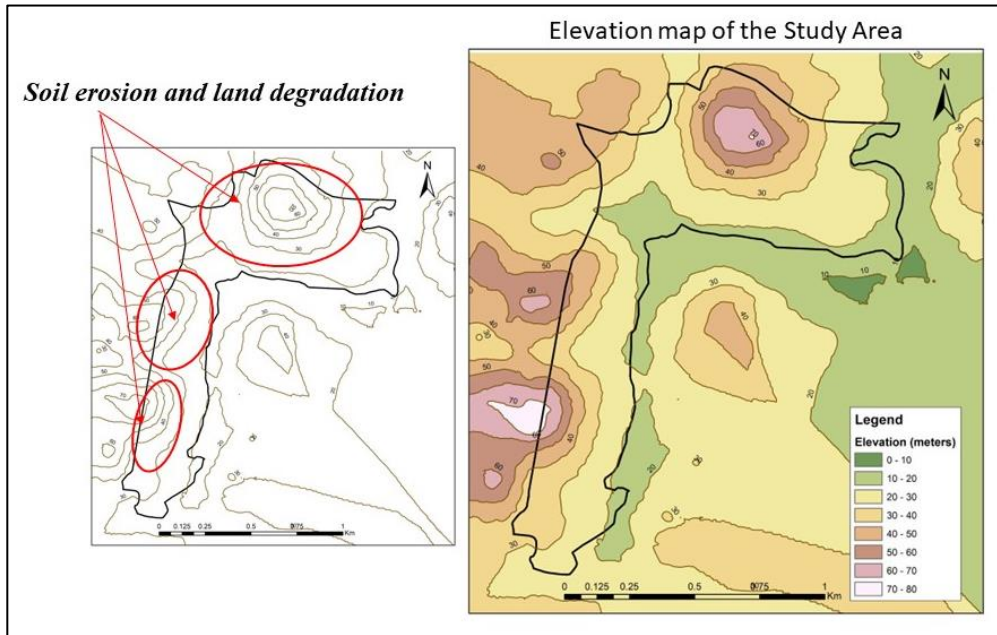


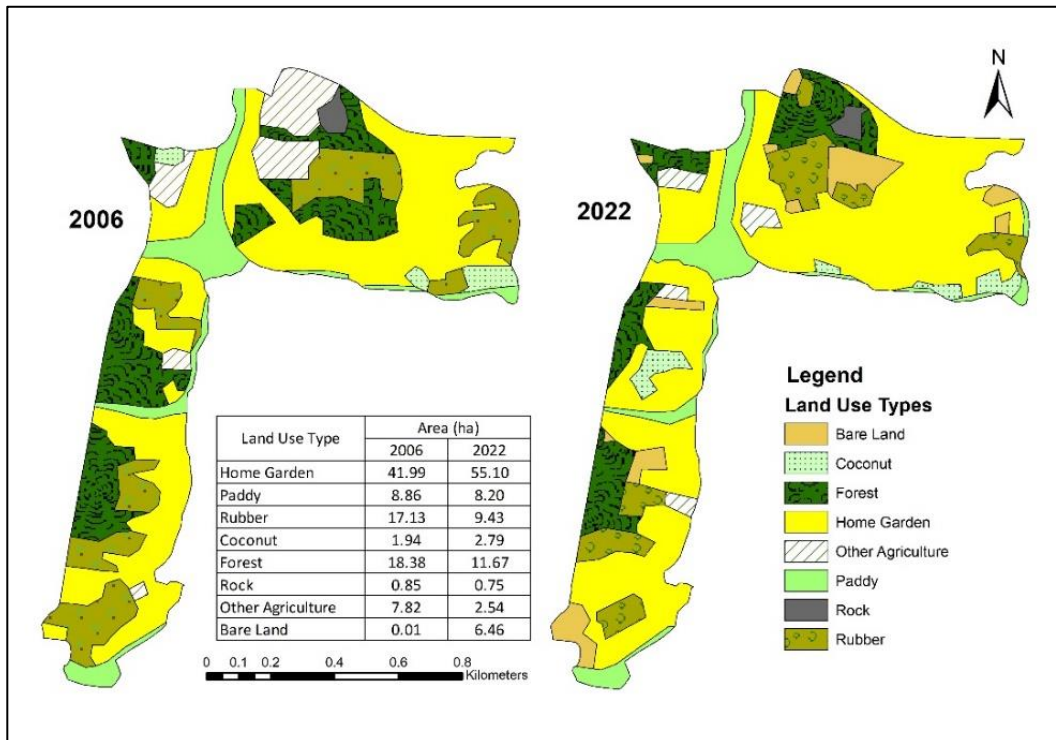
Figure 3. Problem Tree Analysis



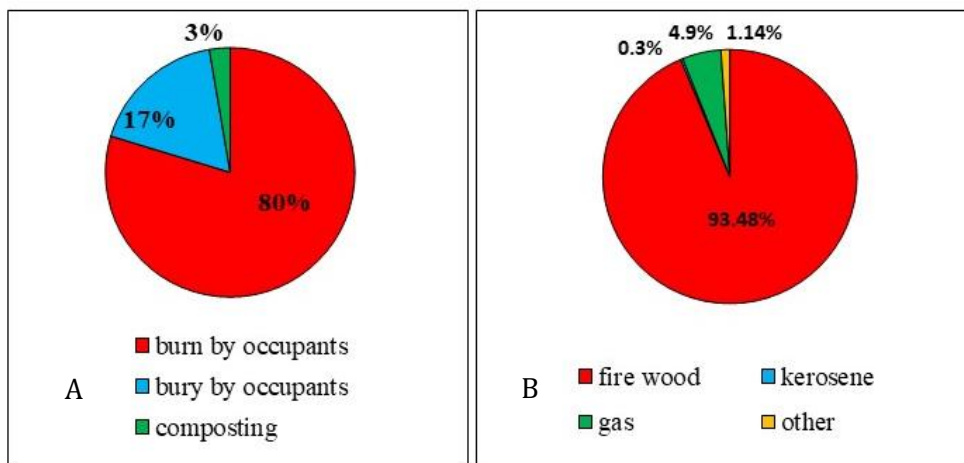
Figure 4. The main environmental issues in the study area



**Figure 5.** The soil erosion areas and elevation map of the study area. (Source: Prepared by author, based on google earth satellite image, 2022)



**Figure 6.** Land Use and Land Cover in Study Area 2006 – 2022 (Source: Prepared by author, based on google earth satellite image, 2022)



**Figure 7.** The primary solid waste disposal method [A], The principal type of cooking fuel [B] in the study area (Source: Population and housing Census, 2012)

**Environmental Pollution:** Three main types of environmental pollution can be identified in this area. They are air pollution, water pollution, and land pollution. According to the population census and statistics, the leading solid waste disposal methods in this area are burning by occupants (79.6%), burying by occupants (17.62%), and composting (2.6%) (Figure 7. A). Moreover, the primary type of cooking fuel in this area is firewood (93.48%), kerosene (0.3%), gas (4.9%), and other (1.14%) (Figure 7. B). Therefore, those situations highly impact the environmental pollution in this study area, especially land and air pollution. It can be recognized that the lack of a proper waste management system has affected land pollution as well as water pollution. Also, canal water in the vicinity has been polluted due to the wastewater discharged from the houses and the chemical fertilizers applied to the cultivated lands.

**Invasive Species Spreading:** The spread of invasive plants is another major problem in the study area. Large-scale growth of these invasive plant species can be found mainly on roadsides, cultivated areas, and many undeveloped lands. Among those plant species, Iluka (*Imperata cylindrical*), Gandapana (*Lantana Camara*), Wel Pasi (*Salvinia Molesta*), and Yoda Nidikumba

(*Mimosa pigra*) plants can be observed. Figure 8 shows the spreading areas of identified invasive species in the study area.

**Other Environmental Issues:** Apart from these significant environmental issues, several other environmental issues can be identified on a tiny scale in the study area. They are disasters (floods and droughts), salination, high chemical fertilizer use, natural resource depletion and pest (*Piti Makuna*), and diseases (Dengue). During the periods of high rainfall (May – September), the areas located near the channel of the study area face minor flooding. Due to this, water pollution in domestic water sources can also be identified. And also, there are several paddy fields that faced minor flooding events during rainy seasons. Soil salinization can be identified in paddy areas due to the use of machinery. Also, the problems related to pests are widespread in the cultivation area.

### 3.3 The management strategies and their strengths and weaknesses

Different environmental management strategies are adapted to solve our existing environmental problems in the study area. There are many actions were taken by the government, voluntary organizations, rural organizations, institutions, and community-



based organizations. Among these, measures taken at the household level significantly contribute to environmental conservation and mitigate environmental issues. Figure 9 shows the management strategies adapted to solve our existing environmental problems, and Table 1 shows the strengths and weaknesses of those management strategies.

According to the field observations, there are several management strategies adapted to minimize soil erosion, and land degradation can be observed in this area. Such as, trenching in sloped areas, covering crops/crop rotation, stone fences and walls, and cultivation of plant strips/strip cropping. Under the soil conservation act, steps have been taken to reduce soil erosion through trenching and ridges in sloping areas and gardens in this area. The strengths include, "surface runoff control, improved soil health, optimized nutrients in the soil, combat pest and weed pressure, increased water infiltration, protecting open land from damage, durability, and stability, creating natural dams for water, and helping to preserve the strength of the soil". The weaknesses, such as lack of proper maintenance, additional costs, planted when time and labor are limited, and difficulty to repair or relocate, cannot be easily altered. One crop may harbor (host) plant diseases, and pests that are detrimental to the other crop can be identified. To stop and minimize deforestation, management strategies such as planting trees, minimizing burning firewood excessively, raising awareness, permit for cutting down trees laws and regulations methods have been used. Nevertheless, these methods also have strengths and weaknesses. Strengths are Increased infiltration of water into the ground, minimized air pollution, biodiversity conservation, and natural vegetation protection. Weaknesses are the lack of proper maintenance of the newly planted trees, the increase in household wood consumption, unauthorized felling of trees, improper implementation of laws, and political influences.

Environmental pollution (air, land, and water pollution) is a prominent environmental issue in this area. To solve these problems, there are several kinds of adaptation strategies that have been taken in this area. Such as using a popper waste disposal method, environmentally friendly cooking fuels, and carbonic waste compost. However, there are strengths such as cleanliness, protection of the environment's beauty, and minimizing air pollution. Although organic fertilizer is an eco-friendly way to dispose of trash, it has drawbacks such as higher expenses. There are no suitable spaces on land to execute: the lack of awareness, the lack of proper equipment, and the cause of the spread of diseases and pests can also be identified in this regard. To minimize the spread of invasive species (plants), chemical herbicides or chemical control methods has been used. However, there are advantages, such as saving time, reducing regrowth, and using an easy procedure, as well as disadvantages, such as environmental contamination, the eradication of helpful species, and costs. Other methods, pulling, digging, and cutting or mowing-like methods have been used to manage the invasive species spreading (plants). These methods also have strengths and weaknesses. Strengths include cost reduction and the versatility of some plants (for example, as animal feed). Weaknesses are allowing for regrowth; it is challenging to periodically remove as much of the root system.

Floods and droughts are the major natural disasters that can be seen from time to time in this study area. These can also be seen as a problem with seasonal variability in rainfall. In times of these environmental problems, various measures have been taken to mitigate them. Proper maintenance of canals linked with the Kelani river / temporary perimeter barriers is the primary adaptation strategy that has been taken to mitigate floods. Getting a systematic irrigation system to increase aquatic biodiversity can be identified as a natural strength of those strategies.

As a solution to the water resource depletion during this drought events, rainwater harvesting and storing strategies have been used in this area. In order to reduce the problems existing in the use of any chemical fertilizers, a reference to the use of organic fertilizers can be identified, especially in the past few months. However, the strength, such as the protection of beneficial and soil organisms, quality, and organic food. The weaknesses, such as the decrease in yield, extinction of certain crops, and increase in plant Traditional methods and equipment are the best methods to minimize salination in agricultural lands.

Nevertheless, strengths, such as being environmentally friendly and protecting soil organisms. Weaknesses, such as costing a lot of time and effort, have been observed. Moreover, this area's depletion of natural resources is another environmental issue. Several kinds of strategies have been adopted to mitigate this issue. Among them, the proper implementation of the rules and increasing people's awareness is prominent. However, this problem still exists in this area

due to weaknesses, such as unauthorized methods and improper implementation of laws due to political influence, which still exists in this area. Pests and epidemics are also other environmental problems that can be identified in this region. Numerous management techniques have been developed to control epidemics of pests, which are especially prevalent in family gardens, roadside ditches, and paddy fields. Such as using chemical herbicides/ chemical control methods, using traditional control methods, and cleaning the environment. The use of chemical herbicides/ chemical control methods has caused to introduce other problems such as environmental pollution, destruction of beneficial organisms, costs, and unhealthy food. However, some advantages include time savings, reducing regrowth, and becoming a simple technique to control infections and pests. Additionally, the advantages and disadvantages of traditional management methods can be seen, including advantages such as safeguarding beneficial creatures and being ecologically benign, and disadvantages like failing to control pests.



**Figure 9.** The management strategies adapted to solve our existing environmental problems

### 3.4 Proposing Methods to Reduce Environmental Issues

The last part of this paper explains the main environmental issues, adapted management strategies, and the strengths and weaknesses of those management strategies. This part of the paper will propose suitable management strategies to reduce the existing environmental issues.

#### – *Accountability for the use of natural resources*

All the families, farmers, and the government and private sectors are responsible for the environmental degradation in this area. Therefore, agricultural and domestic level pollution and resource consumption could be addressed through awareness programs. The accountability of resource use could be increased by improving all levels of curricula and increasing access to higher education.

#### – *Increase the awareness and laws*

Household units must follow a proper domestic waste management and soil conservation methods and be aware of the limit of natural resource consumption. This can introduce environment-friendly management strategies and awareness of the advantages of those methods. Moreover, it is essential to strengthen existing legislation with higher fines and to formulate sound regulations for improving enforcement.

#### – *Institutional reforms*

The entire administration system requires a comprehensive reform with particular reference to the use of information technology, especially addressing the environmental management sector at the institutional level. The Level management is now completely outdated. There should be performance-based promotion schemes and reward structures in public governance. Level-level intuitions such as the GN office, committees, and officers (GN officer, Development officer) can keep a

record regarding the environmental changes and the issues and their spatial and temporal distribution changes. If they have proper databases, they can directly address the respective authorities to take action.

#### – *Use of new technologies to monitor the environmental issues*

New technologies like GIS, GPS, and Remote Sensing can be used to monitor the spatial and temporal changes in the environment and to observe the feasibility areas for environmental issues. This is very important for executing environment management strategies at the correct time.

#### – *Community-level actions*

The implementation of the rural-level program aimed at mitigating environmental Issues, such as awareness programs, cleaning activities, and *Shramadana*. Also, villagers can act to minimize the environmental issues in their homelands. Using sustainable resource consumption practices, household waste management techniques, using organic fertilizer in backyard gardens, taking steps to prevent soil erosion, protecting already-existing plants on their property, etc.

### 4. Conclusion and Recommendation

According to the findings of the study, it can be concluded that there are few numbers of main environmental issues that can be identified in this area. Such as soil erosion and land degradation, deforestation, environmental pollution (land/ air/ water), The spread of invasive species, and other environmental issues such as disasters, salination, pest and diseases, natural resource depletion, and high chemical fertilizer use. Different environmental management strategies are adapted to solve our existing environmental problems in the study area. Many actions taken at the government, voluntary organizations, rural organizations and institutions, village committees and domestic level can be

identified. For example, [1] to minimize soil erosion and land degradation; trenching in sloped areas, cover crops/ crop rotation, stone fences and walls, [2] to stop and minimize deforestation; plant trees, minimize burning firewood excessively, raise awareness, [3] to minimize the environmental pollution; use a popper waste disposal method, environmentally friendly cooking fuels, composting the carbonic waste. However, these methods can identify cases where environmental problems have been successfully managed, and more problems have arisen due to unsustainable methods. Hence, this paper aims to propose a method to manage and minimize these environmental issues in a sustainable manner, such as accountability for the use of natural resources, increasing awareness and laws, institutional reforms, the use of new technologies to monitor environmental issues, and community-level actions.

## 5. References

- Dompe Divisional Secretariat. (2022). *Dompe Divisional Secretariat - Statistical Informations*. Retrieved 2022.09.10, from <http://www.dompe.ds.gov.lk/index.php/en/statistical-information.html>
- Dunlap, R., & Jorgenson, A. (2012). Environmental Problems. (B. P. Ltd, Ed.) *The Wiley-Blackwell Encyclopedia of Globalization*. Retrieved from <https://onlinelibrary.wiley.com/doi/10.1002/9780470670590.wbeog174>
- Environmental Challenges In Sri Lanka. (2015, 10 03). (Simon & Associates) Retrieved 09 01, 2022, from Simon & Associates: <https://www.simonas.net/environmental-challenges-in-sri-lanka/>
- European Commission. (2015). *Science for Environment Policy - Ecosystem Services and Biodiversity*. European Commission. Retrieved from [https://ec.europa.eu/environment/integration/research/newsalert/pdf/ecosystem\\_services\\_biodiversity\\_IR11\\_en.pdf](https://ec.europa.eu/environment/integration/research/newsalert/pdf/ecosystem_services_biodiversity_IR11_en.pdf)
- Geekiyanage, N., Vithanage, M., Wijesekara, H., & Pushpakumara, G. (2015). State of the environment environmental challenges and governance in Sri Lanka. In *Environmental Challenges and Governance Diverse perspectives from Asia* (pp. 106 - 122). Routledge, Taylor & Francis Group, UK. doi:10.4324/9781315717081
- Holden, J. (2017). *An Introduction to Physical Geography and the Environment* (4th edition ed.). Pearson. Retrieved from <https://b-ok.asia/book/2949963/662154>
- Ileperuma, O. A. (2000). Ileperuma. *Journal of the National Science Foundation of Sri Lanka*, 301 - 325. Retrieved from <http://doi.org/10.4038/jnsfsr.v28i4.2644>
- MENR. (2003). *SRI LANKA: National Environmental Policy and Strategies*. Ministry of Environment and Natural Resources. Retrieved from <https://policy.asiapacificenergy.org/sites/default/files/National%20Environmental%20Policy%20and%20Strategies.pdf>
- MENR, & UNEP. (2009). *Sri Lanka Environment Outlook*. Ministry of Environment and Natural Resources and United Nations Environment Program. Retrieved from <https://www.ajne.org/sites/default/files/event/2040/session-materials/sri-lanka-envi-outlook-20091.pdf>
- Paul R. Ehrlich , & Anne H. Ehrlich . (1972). *Population, Resources and Environment* (Second Edition ed.). W. H. Freeman and Company San Francisco. Retrieved from <https://b-ok.asia/book/966638/ff8d3a>
- Shankar IAS Academy. (2018). *Environment* (6th Revised Edition ed.). Shankar IAS

Academy. Retrieved from <https://book.asia/book/3712616/983f73>

Thirlwall, A. (1994). Development and the Environment. In *Growth and Development* (pp. 211 - 231 ). Palgrave, London.: Springer.  
doi:[https://doi.org/10.1007/978-1-349-23195-9\\_9](https://doi.org/10.1007/978-1-349-23195-9_9)

UNEP. (2001). *State of the Environment Sri Lanka*. United Nations Environment Programme. Retrieved from <http://www.sacep.org/pdf/Reports-Technical/2001-State-of-Environment-Report-Sri-Lanka.pdf>

Zubair, L. (2001). Challenges for environmental impact assessment in Sri Lanka. *Environmental Impact Assessment Review*, 21(5), 469 - 478. Retrieved from [https://doi.org/10.1016/S0195-9255\(01\)00081-6](https://doi.org/10.1016/S0195-9255(01)00081-6)