

Construction Of A System For Monitoring The Pollution Of Water Bodies With Waste

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Abstract. *In recent decades, there has been a sharp increase in waste that pollutes the environment. It can be categorically stated that non-degradable waste has the largest share in them. They are most easily discharged and condensed in water bodies on land, and subsequently in the world's oceans.*

Still, measures are usually taken after floods or other emergencies occur. Not enough preventive measures are being taken.

The report proposes a model for monitoring and recording unregulated dumping in and around mainland water bodies. The aim of the research is to develop a system for monitoring pollution in and around water bodies, transmitting this information, analyzing it and making decisions about the removal of pollutants. As a secondary goal, a preventive measure to limit pollution can also be indicated, because when there is control and subsequent punishments, the violations also decrease to a significant extent. A review was also made of good practices in the collection of waste in water bodies. A system for collecting information and removing the accumulated waste is proposed.

It is also proposed to implement a method put in place last year in Australia to collect waste in running water. A mobile version will also be developed to signal the presence of waste, when every citizen will be able to signal the presence of such unregulated pollution.

You will also use your knowledge after equipping the astronomy club to observe space debris and to create floating island fruits from the plastic waste in the world's oceans. In addition, technologies are used that are innovative and have the potential to solve these global problems.

In carrying out the research, various methods were used - analysis, data synthesis, data processing and others.

Keywords: *collection, monitoring, monitoring system, pollution, waste, water bodies.*

I. INTRODUCTION

The protection of the environment and the preservation of the ecological balance has been a hot topic since the end of the last century and the beginning of the XXI century [1], [2]. Particularly dangerous are non-biodegradable wastes, which in natural conditions cannot break down or require thousands and tens of thousands of

years to do so. The topic of the presence of waste, mainly plastic, in water bodies around the world is very topical, because pollution in the world's oceans and riverbeds is constantly increasing. According to researchers, there are several islands of plastic and other waste in the Pacific Ocean with a total area larger than the area of Bulgaria, for example. Developed economies dispose of much of their waste there, and it is also a graveyard for space debris, which is obtained from the downfall of decommissioned space man-made objects. The fact that the amount of used and non-recycled plastic is increasing every year is alarming, and at a significant rate [3]. Despite the introduced restrictions on the use of plastic packaging, they are still extremely widely used. The pollution of the earth's surface with non-degradable waste increases every year, and in Bulgaria this is visible everywhere around us - in populated areas, in the mountains and forests, along the roads and railways and especially along the streams and rivers. There is a lack of elementary culture in the disposal of waste, and traveling around Bulgaria by car, bus, railway or even on foot, we come across large amounts of waste, including plastic [4]. Almost every settlement has unregulated dumps and places filled with construction, plastic, household and other waste [5], [6].

The goal of the development is to help limit the pollution of the environment with this type of waste and to promptly detect illegal dumps, even in hard-to-reach areas of riverbeds. The development, in which students and cadets from Vasil Levski National Military University also participate, aims to first study the pollution, collect information and map the polluted areas, take actions to reduce the pollution and carry out subsequent control. Since the pollution is the greatest in water bodies, it is precisely them and their pollution that are considered, and in particular those located on the earth's surface [1], [7], [8].

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II. MATERIALS AND METHODS

In turn, water bodies are divided into land water bodies on the one hand and seas and oceans on the other. Therefore, we divided our project conditionally into two parts - in the first part we will examine the waste in the streams, rivers, lakes and swamps on the continental part of the Earth, and in the second part we will pay attention to the pollution of the world's oceans. In both parts, there are many human-contaminated sites, but each has its own specifics for monitoring, mapping and taking measures to reduce the existing waste [2], [9]. Each contamination can also have its own specifics for its tracking and subsequent removal. It can be said that the same river that flows through different countries has different characteristics of the terrain through which it flows and the degree of pollution both of the river itself and of the nearby land areas. There are enterprises that dump their waste at night, when the controlling authorities are not working, and therefore one of the directions to limit pollution is the use of sensors and cameras that work in a continuous mode and can be traced back in time when, who and how caused the pollution of water bodies and the coast or dumped unregulated hazardous waste. During the last floods in September 2023 along the Southern Black Sea coast of Bulgaria, many discharges of waste water were seen near the coast, no larger than 20 meters. The development is also in this direction.



Fig.1. Waste along the river Iskar, 02.2021

To work on this topic was the pollution caused 4 years ago along the Iskar river near Svoje and many others that we see traveling around our homeland. For more than a week, the cleaning of the water mirror next to the wall of the "Prokopanik" HPP in the Iskar River from the accumulated garbage, the area of which was about 12 decares, was carried out. Additional machinery was also provided to ensure that the process was not interrupted while the lorries took the removed rubbish to the Kostinbrod Regional Landfill. The main goal is to prevent part of the garbage from passing through the hydroelectric plant facilities, so as not to pollute the riverbed towards Svoje and further north. The torrential rains of January 11 and 12, 2019, which caused flooding in Sofia Field, collected all the waste from the ravines of Sofia Field. Most of the garbage is the result of unconscious human activity, but there are also those that are the result of conscious and deliberate work. It is necessary to work in several directions, and above all it is the change of consciousness, together with the system of control and sanctions, and no less important factor is the policy of prevention. In the presence of facilities such as hydroelectric plants, before them, along the course of the river, there should be barrier filters to collect waste [4].

This pollution has sparked interest in creating systems to monitor pollution in or around water bodies and limit environmental pollution. To create these systems, an initial collection of information mainly for Bulgaria was used, but information from other countries was also analyzed. This information was systematized and analyzed, and based on the obtained results, the main tasks to be solved during the construction of the systems were identified. After that, the idea of how to solve the tasks of detecting waste and limiting its quantity has already begun to be discussed. Based on options for finding a solution, models were developed for mapping pollution, waste removal and finding preventions to limit pollution.

And this was not an isolated case. Instead of taking preventive measures, clean up the pollution and continue in the same way until the next big pollution is caused and there will still be no one to blame.



Fig. 2. Drops on the branches of the bushes along the banks of the Mesta River

Siltation and flooding are always observed after an increase in the level of rivers, and after their retreat in a normal state, piles of waste, especially plastic, remain on the banks and vegetation. The riverbeds are an unpleasant sight in the summer, when after the runoff of the violent spring waters and the increased level of the rivers, they return to their normal beds and we see on the surrounding vegetation "flags" made of polyethylene bags, foil and others left on the branches of the trees on the banks. Very often you can even notice "landed" plastic bottles, tubes and even more bulky objects. And the cleanup initiative in April can't make up for pollution the rest of the year. The reporting of the activity with pictures of the cleaned waste is very negative. You just can't imagine how many pictures were taken with 5 bags of collected waste. Similar initiatives are organized annually in different parts of Bulgaria, but trumpeting in the media does not produce results, but real daily activities are needed - little by little, but without interruption. and in other areas this year. But we cannot in 1 day clean up all that we have polluted the other 364 days of the year. It will be much better if we do not pollute for 364 days, then there will be nothing to clean in this 1 day to clean the river, lake or dam. During the COVID pandemic and after its passing, these initiatives again sank into oblivion and proceed as before, with great disregard for environmental protection [1], [10].

If you go along many streams and rivers you will see that there are many unregulated dumps in the river beds and thousands of waste channels connected to the river networks. As a result of the "cleaning" of the riverbeds, the long-standing trees are cut down and bushes are

obtained instead, and thus the condition of the riverbeds deteriorates. As a result, instead of improving the permeability of the water bed after 2-3 years, it is significantly more overgrown with bushy vegetation, and when the river level rises, the flow of water masses becomes difficult. At the same time, the branches of this low and medium-sized vegetation also hold a lot of plastic bags and other waste that people have thrown illegally near the river. In recent years we have witnessed many such pollutions, some of which we show in figures 1 and 2.

III. RESULTS AND DISCUSSION

The goal of the project, which was generated in the gatherings of the "Curious" club at Vasil Levski National Military University, is to make a prototype of a floating device that can move autonomously along the river bed and photograph and study the terrain of the river bed and the surrounding area for the presence of waste and channels that drain into the river. The device will record and transmit information to a central point. The information will be collected and a characterization of the riverbeds along the entire length will be made, based on the collected information, maps of the rivers, landfills and waste pipes will be made. This information will be very valuable because the government authorities do not know or care about such dumps and there are many waste canals built and discharged that are not regulated, legal and do not have basic treatment facilities. The device will be small in size, which will allow it to pass in small streams, and an all-terrain function can also be offered to be able to pass through fords and when the water level drops. There will also be navigation to manage and location tracking for on-demand detection and theft prevention. At the same time, it will store and transmit information about the status of the areas it has checked. After completing his mission, an operator will download the collected information from his memory and it will be processed by a team.



Fig. 3. Prototype of a device for transmitting information

The countries of the European Union are gradually limiting and banning the use of plastic and plastic dishes, bottles, tubes and other products. Until then, countries must comply with the requirements and stop the production of the described plastic items. In some countries such as Austria, the Czech Republic, Greece, Germany, France and others, they have already significantly limited the use of plastic products, but in

countries such as Bulgaria, these measures are lagging behind and practically nothing is being done.

At the same time, it will be proposed to place nets on all drain pipes to collect the waste found in the running water. There are already such developments in Australia. Such nets can also be placed at the inlets of streams where large amounts of waste have been found. These networks will be equipped with overflow type devices to signal when their capacity is full. The waste is then hauled away, sorted and recycled. In this way, it will help to limit the spread of waste in our surrounding nature [6], [11], [12].



Fig. 4. Plastic waste collection in Australia [6]

In the summer of 2020, Australian authorities installed a new water filtration and waste collection system. This system is incredibly simple and useful. Both the government and citizens have already seen the benefits of its use and its effectiveness. It consists of a simple mesh placed at the outlet of a drainage pipe, which helps to catch large wastes and protect the environment from pollution. These pipes discharge water from residential areas into natural areas, and the waste from these places can be in huge quantities, which harms the environment a lot. Additionally, this trash is usually washed away by heavy tropical rains, which carry it into drainage systems.

The Australian authorities started by installing 2 nets and were amazed by the results – their new filtration system was able to collect more than 360 kilograms of garbage over several weeks. So, it was decided to install these facilities and to minimize the pollution of nature and specifically water. Although installation and maintenance costs money, the overall system is quite cost-effective, as the authorities save significant costs of maintaining the state of the environment. For example, they now save on manual labor costs that they previously had to pay for people to pick up all the waste [6].

The constructed device will also carry out subsequent control to monitor changes in pollution. In this way, the information will be superimposed over a certain period of time, half a year or a year, and an analysis and comparison will be made of the distribution of the waste in the studied sites - streams, rivers or lakes. The information will be passed on to the competent government authorities and they have the power to impose sanctions on violators and to grant or revoke relevant permits. After a certain period of time has passed, the most critical points can be checked more often, and even continuous monitoring of the situation and the disposal of non-degradable waste can be carried out. In this way, in the club, realizing extracurricular employment of students, we stimulate the development of their habits and skills [4], [13].

No less important is the problem with the accumulation of non-degradable and plastic waste in marine water areas. Every year, more than 14 billion tons of waste are thrown into the world's oceans, the majority of which is plastic. Many world experts go so far as to predict in their studies that if pollution continues at the same rate, in 30 years there will be more waste than life in the oceans. And this is tantamount to an eco-catastrophe.

The reason why this type of waste occupies the largest share is that the material is cheap, easy to shape into various products and, at the same time, is very light and relatively durable [12]. However, it is the last factor that makes it extremely harmful to nature. It is recyclable, but not in all its forms. Along with that, when burned, it emits many gases harmful to the atmosphere [2], [3], [5]. When it gets into nature, it degrades as follows:

- Plastic for making straws: about 200 years;
- Plastic plates and cups: about 450 years;
- Diapers made from materials related to the production of plastic materials - between 500 and 800 years;
- Plastic bags - depending on the thickness - from 50 to 200 years;
- Plastic bottles - between 180 and 200 years.

According to various sources, there are about 150 million tons of plastic waste in the world's oceans, and every year between 4.8 and 12.7 million tons of plastic waste fall into the waters of the seas and oceans. According to data from the European Parliament, more than 730 tons of plastic waste fall into the Mediterranean Sea alone every year. The area of floating islands only in the Pacific Ocean is larger than the territory of a country like Bulgaria. And this is as of today, and we can imagine what it will be like in 20 or 30 years, if adequate measures are not taken.

Plastic doesn't just mean uglier beaches, even in untouched places. Marine animals can become entangled in larger floating pieces or become confused and swallow smaller particles. Plastic also attracts toxic substances that end up in the fish's digestive system. From there, along the food chain, it can also reach humans [9]. The effect on human health is unknown at least for now, but it is certain that the damage is significant.



Fig. 5. Island of plastic [13]

Litter also brings economic losses both to the sectors and people connected to the sea, but also to producers. Only 5% of the value of plastic packaging finds reuse in the economy, the rest is simply wasted. The need for more

recycling and to prevent more plastic from entering the oceans is obvious [1], [8], [14].

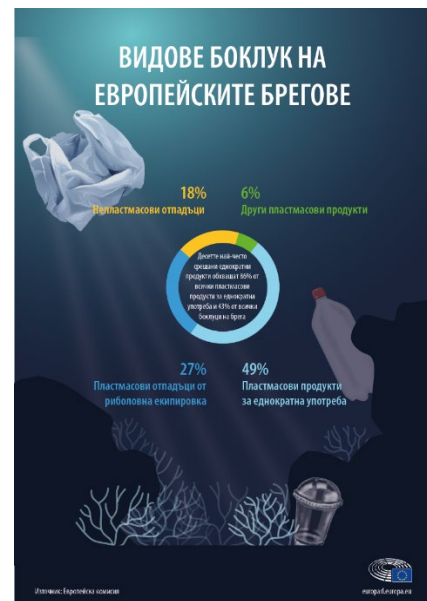


Fig. 6. Types of waste on European shores [15]

Our university is about to build its own astronomical station. We have the assurance of fellow teachers and astronomers from related universities such as Sofia University, VVMU, and the Varna Observatory that we will start joint activities of our club with related clubs in the field of astronomy and in particular and work on projects and programs of the EU, NASA and others [10]. One of our priorities will be to monitor and map both space debris and debris in marine and ocean areas that cannot be hidden from observation from space.

A system based on artificial intelligence (AI) came to our attention, which was able to distinguish plastic waste in the moped by analyzing passenger images captured by the driver. According to the people behind the technology, this is the first time [13].

The combined system analyzes the images taken by the Sentinel-2 passengers of the European Space Agency to distinguish debris floating in the world's oceans [11]. This is possible thanks to the captured and preserved image of these objects - a secure "certificate signature" of what the objects are.

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The algorithm is used in maps around Canada, Scotland, Ghana and Vietnam. The state-of-the-art system is able to distinguish plastics and other materials from water samples with 86% accuracy [13].

The team's plan is to perfect the technology so that it can more accurately detect floating spots in murky pipeline waters and large ponds.

The idea is that this method will be combined with bottoms to follow the platform shutdown and so that they support cleaning operations. However, scientists are adamant that the only way to clean the cloudy oceans is to practically reduce the amount of plastic we produce.

Based on the collected and analyzed information, a schematic diagram of a system for collecting information on pollution in and around water bodies was developed. The developed base unit consists of a device that moves through water, powered by a self-propelled autonomous propulsion unit, and collects information from the water surface and adjacent shoreline. At low water levels, the device can move along the bottom of the water body using an all-terrain chassis powered by the same engine. The device transmits the collected information and also stores it with itself, because there may not be a continuous connection due to movement in rough and difficult areas. After the research is completed, the collected information is removed from the device's memory and stored on a large and powerful medium. The information is analyzed and summarized and on the basis of the data the terrain is mapped, and the data can be superimposed and information about the dynamics of the processes and the results of previous studies can be obtained.

During the construction of the astronomical observatory, it will be possible to carry out the same observation through satellite systems and monitoring of areas potentially threatened by pollution. The general information will be analyzed and submitted to the relevant state authorities for control. The developed pollution control system will be summarized and a principle model of the system will be developed, which will be patented at the next stage of development. The concept project is only the first stage of the overall project for the construction, and there is hope that at the next forum, when funding is found, it will be possible to move to the next stage of implementing the idea.

As a result of the study and the possible implementation of the monitoring and mapping of the water bodies, it is expected that environmental pollution will be reduced and the polluted areas and their pollutants will be detected in a timely manner. This will lead to both an economic and an environmental effect for society, an effect that will be calculated upon final completion of the prototype.

IV. CONCLUSIONS

1. On the basis of the collected information about the pollution of water bodies and the terrains around them for the last more than 5 years, it was concluded that it is necessary to develop a system for control and collection of information about pollution, even in hard-to-reach areas. The information was synthesized and analyzed and based on this assessment, 4 data collection models were created to monitor the spread of plastic and other non-degradable waste. After an analysis of the efficiency and cost of the proposed models, it was chosen to develop a principle scheme for collecting and transmitting information using a light floating vehicle that can move on its own even in conditions of reduced content of water resources. The results will not be achieved easily, but it is necessary to start and step by step to help the development of our planet, because we want to live in a better world!

2. The proposal is not revolutionary, but we should not wait for a revolution to happen to save ourselves from the huge amount of non-degradable plastic waste that is all around us. Everyone should do something small so that all

people can live better and everyone should preferably limit the use of plastic in their daily life.

3. Further development of the idea and creation of a prototype of the device for monitoring the presence of waste in riverbeds is yet to come. There is still a lot of work to be done, but the first steps have already been taken and now the work will continue on building the specific segments of the system and presenting it in the next edition of the conference. We sincerely hope that our conceptual development will attract the attention of interested government institutions and companies and that we will find funding to complete the project.

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