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A Review of Environmental Monitoring, Applications, and Categories

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ABSTRACT

Overview of the ideas, actual applications, and predicted future developments of bio monitoring techniques and bio indicators utilized for river ecosystems and what other organisms are present therein. The most common river bio monitoring indicators, which can be used independently or in combination, are periphyton, benthic macroinvertebrates, and fish. A review and critical assessment were conducted to track ecological change through the use of land and aquatic invertebrates as managing tools, their applicability and their worth for evaluating the effects of pollution on a variety of environmental issues. Scientists used techniques for biomonitoring, and to evaluate the environmental health of rivers and streams, a biotic indices and multimetric methodologies are most frequently utilized. However, functional metrics are being used as an additional strategy for expressing ecological integrity. Additionally, recent studies have shown how effectively molecular methods may be used to improve taxonomic resolutions and detect genetic diversity in river bio monitoring. Biomonitoring aquatic metal contamination is a widespread problem that has received a lot of attention, and insects, bivalve mollusks, gastropods, zooplankton, algae, macrophytes, fish, and amphibians are considered biological indicators and contrasted for their benefits and drawbacks in actual biological monitoring of aquatic metal contamination. The common bio monitoring methods bioaccumulation, biochemical changes, observation of morphology models, techniques at the population and community levels, and behavior are all covered. Among the potential uses of biomonitoring are the assessment of actual water-polluted metals, biotreatment, toxicity expectation, and the study of toxicological mechanisms. For the biomonitoring of other perspectives on metal pollution in aquatic habitats are offered.

Keywords- Aquatic ecology, bioindicator, biomonitoring, aquatic invertebrates.

I. INTRODUCTION

The population growth, urbanization, and industrialization due to a sharp rise for adoption of sustainable and ecologically friendly environmental procedures. The monitoring, assessment, modeling, and treatment of contaminated water, air, soil and solid waste streams all fall under this category. Biotechnology offers a wide range of opportunities with uses tools like sensor, remote sensing and sampling to detect pollution, understand trend, evaluate impacts of human activity, and guide for sustainability. Bio monitoring, sometimes referred to as "biological monitoring," is the regular use of living beings or their reactions to gauge the status of or alterations in the surroundings [1]. Or, to put it another way, Bio monitoring is a technique for examining how external variables affect ecosystems and their growth through time or for identifying variations across different locations [2] that reflect accurately the ecological content of bio monitoring. Modeling utilizing biologically based technique is becoming more and more significant in this context [3]. Accordingly, a bio-indicator is a species or set of species such as plants, plankton, animals and microbes that readily reveals the biotic and abiotic status of an environment; refers to the influence of positive or negative environmental variation on a habitat [4], ecosystem, or community; and is revealing the variety of a taxa subgroup or of the wholesale variety within a region. Bioindicator can help us in assessing environmental quality and how it changes over a specific period of time. The information provided by bioindicators is sufficient and reliable, and may be difficult to obtain or calculate as quickly using other methods.

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II. ENVIRONMENTAL MONITORING

2.1. Types of environmental monitoring

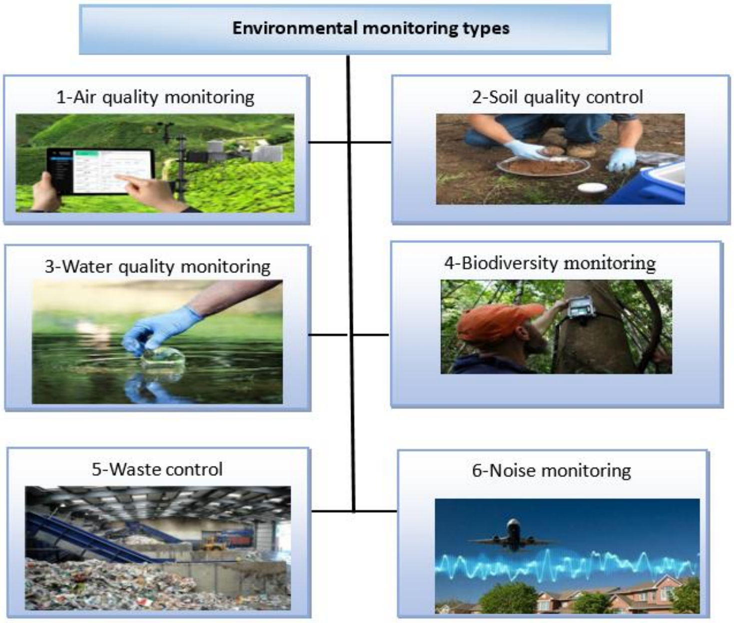

Figure 1. depicted the types of environmental monitoring

2.2. Environmental monitoring goals

1- To establish an exposure baseline.
2- To be in close contact with a potential contaminant.
3- To compute changes in environmental contamination levels.
4- Verifying once more that the pollution control procedures were successful.
5- Assembly of significant and most relevant data.
6- Understand the different types and levels of pollution sources.
7- A recommendation for enhanced mitigating actions to be done.

2.3. Environmental monitoring methods and tools

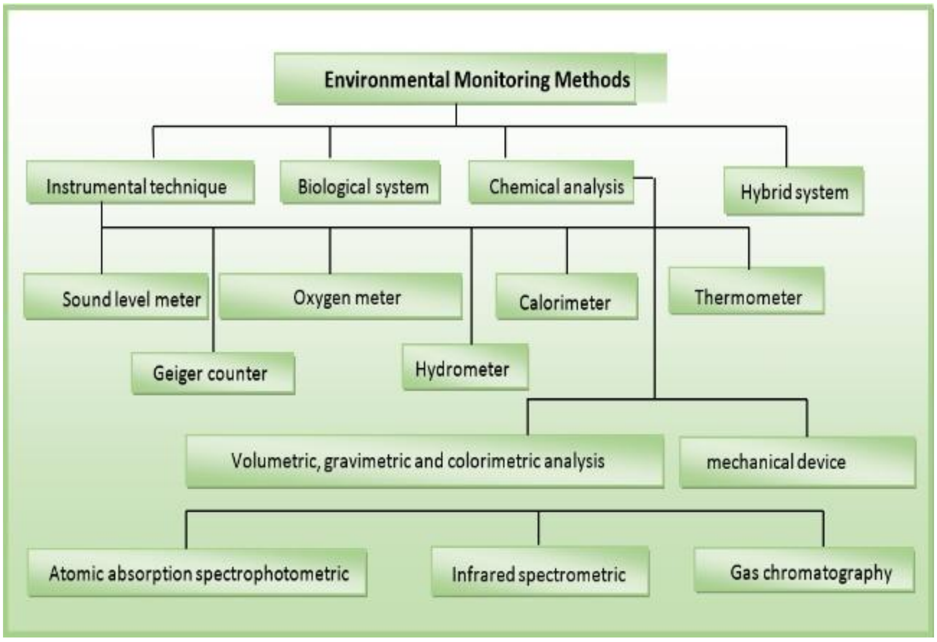

Figure 2. illustrates the environmental monitoring methods and tools

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2.4. Program design for monitoring

It is relatively simple to monitor a single location over time and change can be recognized as long as the sample and sorting techniques and taxonomic resolution are consistent. For large-scale ambient monitoring, issues about trends in environmental quality may be satisfactorily addressed by the detection and assessment of change. There are, however, challenges exist, the first challenge arises when attempting to pinpoint the root causes of environmental damage. A necessity of traditional scientific procedure is the use of controls, in this case a similar location or sites unaffected by the putative influence [5, 6]. Choosing locations before the impact starts, including a site or group of sites that are subject to the impact and one that is not, is the simplest experimental design. However, assessing the effects of an activity that has already begun and may have been in operation for a while is frequently important. It is challenging to determine the biota of a site in the absence of any disturbance. It is generally known that invertebrate populations exhibit significant geographical variation even in the absence of external influences [7].

2.5. Monitoring procedures

Monitoring procedures are split into two categories:

1- Calculations of physical variables
2- Biological parameter measurements.

Each group includes environmental compartments connected to climatic forcing (wind, waves, and tidal current), geomorphological parameters (bathymetry, sediment, mixing), and the physicochemical parameters of the water column [8]. Additionally, includes biological compartments that include all ecological and biological structures (plankton, macro algae, benthic communities, marine mammals, and birds). Recently, researchers applied artificial intelligence to accuracy, speed and forecast future trends of monitoring in several areas such as water and air quality monitoring, climate and ocean monitoring, wildlife conservation, waste management and identifying pollutants [9].

III. BIOLOGICAL SURVEILLANCE

Biological surveillance (biomonitoring) can be used for various biological systems to observing the locative and temporal shifts and assessing the impacts of environment and anthropogenic stressors uses living organisms and their responses [10]. Biomonitoring is essential element of conducting research on water contamination. The most frequent uses of biological monitoring are for routine ambient monitoring, large-scale assessments of ecosystem condition, and evaluations of local environmental impacts. The first sort of monitoring would be used to report on the state of the environment, while the second type would be used to determine if a region's waterways are getting worse, getting better, or staying the same in terms of their overall ecological condition. The third sort of monitoring is conducted on a smaller scale and aims to provide information about how a specific discharge or other activity affects a specific stream or other body of water. The complete biological community may be used for monitoring, or more frequently, a subset of it, such as invertebrates, algae, or fish [11].

IV. BIOINDICATORS

4.1. Usefulness and characteristics

Bio-indicators use when it impossible, difficult measurement of the environmental factors or interpretation is extremely difficult. Generally, it should have the following characteristics:

1- Taxonomic soundness that is simple for non-specialists to detect.
2- A widespread or international dissemination.
3- Low mobility locally.
4- Recognizable ecological traits.
5- Quantitative abundance.
6- Laboratory experiment suitability.
7- High sensitivity to stressors in the environment.
8- Strong quantification and standardization skills.

Rivers and streams represent the most threatened ecosystems on the planet, so there is an urgent need for thorough analytical approaches to assess these ecosystems' current conditions and track their pace of change. Because they offer a wide range of data necessary for effective water management, physical, chemical, and bacteriological measurements are frequently used as the foundation for monitoring [12].

It has been established that bio monitoring is an essential addition to those conventional monitoring techniques. Diatoms and benthic macroinvertebrates are two examples of aquatic animals that can act as bioindicators by integrating their reactions to various environmental conditions and their overall environment [13]. They provide the opportunity to get an ecological picture of how rivers or streams are now faring. Mineral contamination of the water supply is another aspect of it. Environmental management in alpine areas using invertebrate bio indicators follows the same general principles and has a comparable set of applications [14, 15].

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4.2. Use of invertebrates as indicators

Invertebrates are important part of terrestrial and aquatic ecosystem. By their responses at multiple organizational levels, whether a specific animal or the entire invertebrate population as a whole, invertebrates can be helpful as indicators of changes and deterioration in the environment [16], where Bottom or macroinvertebrates are considered powerful indicators of water health for easy to distinguish, live for year or more, limited mobility and considered as integrators of ecology condition [17].Pollution can also have The level selected to represent a changing environment may or may not be appropriate, depending on the influencing factor(s). Although shifts in the invertebrate community as a whole may be a more accurate predictor of longstanding forest degradation or the importance of a certain location for conservation, responses to individual contaminants may be detected by changes in the populations of certain animals or species were acting as precise early warning signs for conservationists [5].

It involves selecting the best indices for each distinct purpose, which requires distinctly identifying the primary issue and described early on, the selection of appropriate bio indicator organisms using stringent criteria, and the clear and thorough testing of the projected response of the bioindicator taxa [18]. Multiple indication replies are widely used in monitoring programs. Due to the fact that information about specific species and species as groupings is usually lacking, also, because environmental stress frequently contains a number of countercurrent forces operating at different levels, with varied degrees of success, involving pesticide, fertilizer, PCB, aluminum, heavy metal, and thermal stress pollution [19].

4.3. What does the bioindicators reveal?

The Employment of invertebrates as bioindicators offers valuable information on pollution levels and ecosystems' health. invertebrates benefit in assessing the influence of pollutants on their tissues and surroundings by measuring the bioaccumulation of pollutants within bodies. This allows for monitoring the concentration of pollutants for instance, heavy metals otherwise any compound. Environmental pollution affects the structure and variety of invertebrate groups. Maybe several species come to be more dominant, while others may decrease in number depending on their tolerance to pollutant concentration. Consequently, the community structure will be change, indicating the presence of pollutants [20], or the population may exhibit diversely behaviors as well as physiological effects, such as reduced feeding, decreased reproduction, altered growth rates, or changes in overall health and disease resistance.

4.4. Categorize of bioindicators

Bioindicators separated based on their function into: environmental indicators (to detect changes in physicochemical environment, monitoring stress and diagnose ecological status) and biodiversity indicators (to detect ecosystem safety, monitor measurement species abundance, observation habitat fragmentation with tracking the success of environmental conservation efforts. Bioindicators can generally be used to reveal:

1- A shifting chemical environment, especially in light of various forms of pollution and a changing physical environment.
2- The habitat's comparative value or quality for conservation.
3- Variations in the habitat's ecological state through time and space.

4.4.1. Physical environment change

There aren't as many researches on the physical environment in terrestrial habitats as there are on the chemical environment, which mostly focus on temperature responses. Responses to changing physical conditions include increased or decreased climate variables include environmental temperatures (mean, range, and frequency of extremes), precipitation patterns, and drought, as well as associated phenomena like the frequency of freeze-thaw cycles and the permanence of snow/ice cover on both a localized and global scale. It also includes variations in UVB exposure related to ozone depletion, in contrast to terrestrial ecosystems, aquatic ecosystems have a far better understanding of how the fundamental physical factors, Invertebrates are influenced by a variety of factors, most notably temperature, depth, and current. Invertebrates can act as helpful bioindicators of recent and past temperature changes, according to certain authorities [21].

4.4.2. Environment chemical change

Macroinvertebrates considered useful bioindicators due to highly sensitive of a variety of chemical changes taking place in land and aquatic settings [22]. A single chemical factor, like pH, single heavy metal pollution, like cadmium, or excess of plant nutrients, especially nitrogen and phosphorus can all play a role in these. It is possible to establish a direct connection between the chemical's concentration and the behavior of one or more indicator species [23].

For instance, the Mayfly Hexagenia has been used as a sentinel species in North America's Great Lakes and major rivers to track the onset of deadly anoxic conditions in the 1950s and the ecosystems subsequent recovery [24]. Additionally, sometimes, the invertebrate community, or a subset of it, employed as a general measure of the health of an ecosystem or the level of pollution, such as "water quality." Additionally, much effort needs to be done to understand how chemical interactions affect invertebrate behavior [25].

V. CONCLUSION

Monitoring is a complex technical that quires enables both the long-term change in the monitored environment through time as well as the early detection of potentially significant effects (i.e., early trends that could become serious), preserving people's lives and health, and constant improvement of the environment.

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