Sensor-Based Detection of Harmful Algal Blooms (HABs) in Dal Lake, Kashmir: Advancing One Health through Participatory Surveillance

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I. Abstract:

Harmful algal blooms (HABs) pose significant threats to human, animal, and environmental health worldwide. These blooms can contaminate water bodies, produce toxins, and disrupt ecosystems, leading to adverse impacts on public health and aquatic ecosystems. Rapid and accurate detection of HABs is crucial for effective mitigation strategies and timely interventions. This project proposes the development and utilization of sensor-based technologies for the early detection and monitoring of HABs in Dal Lake, Kashmir, and will promote a participatory surveillance approach. By leveraging interdisciplinary collaboration, innovative sensor technologies, and active involvement of the local Kashmiri community, this project seeks to enhance early detection, understanding, and mitigation of HABs, contributing to the One Health framework. The project will address the urgent need for effective monitoring and management of HABs in Dal Lake, with a focus on public health, ecosystem preservation, and participatory engagement. The implementation of this project will have a potential impact on the health and well-being of the local communities residing within and around the lake and the lake ecosystem.

II. Background / Introduction:

Dal Lake, a picturesque tourist spot in Kashmir, holds immense cultural and economic significance. The lake not only captivates visitors with its breathtaking beauty but also sustains the livelihoods of numerous houseboat owners residing within the lake and hoteliers located around its pristine shores [1]. The Mughal gardens, elegantly adorning the banks of Dal Lake, further enhance its allure, offering a serene retreat for both locals and tourists [2]. The lake is also home to a vibrant fishing community, who rely on its abundant waters for their daily catch, contributing to the region's economy and culinary traditions [3]. Moreover, Dal Lake serves as the vegetable bowl of Srinagar, with floating gardens providing fertile ground for cultivating a variety of crops [4]. These floating islands, known as "rad" in the local language, not only serve as a unique farming method but also contribute to the ecosystem by purifying the lake's waters [5]. However, the recurring HABs pose a significant threat to the lake's ecosystem and the livelihoods of local inhabitants associated with it [6]. To address this challenge, this project proposes the development and deployment of sensor-based technologies for real-time monitoring and early detection of HABs in Dal Lake. By enabling swift interventions, these technologies aim to preserve the water quality, protect the delicate ecosystem, and safeguard the livelihoods of those dependent on the lake. Additionally, recognizing the importance of community participation, the project

actively engages local inhabitants in surveillance and monitoring efforts. This participatory approach ensures the sustainability and effectiveness of HAB management strategies, creating a collective responsibility to protect the jewel that is Dal Lake.

III. Project Goals:

1. Procure and optimize sensor-based technologies for the early detection and continuous monitoring of HABs in Dal Lake.

2. Establish a participatory surveillance framework, involving local people and other stakeholders in HAB monitoring, reporting, and decision-making processes.

3. Enhance understanding of HAB dynamics, including species composition, toxin production, and environmental drivers, through comprehensive data collection and analysis.

4. Evaluate the effectiveness and reliability of the sensor-based system and the impact of participatory surveillance on HAB management through field testing and validation.

5. Assess the potential impact of sensor-based HAB detection on public health, environmental management, and ecosystem preservation.

6. Promote knowledge translation and capacity-building activities, ensuring the transfer of research findings and best practices to local people, government agencies, and other relevant stakeholders.

IV. Methods:

1. Sensor Optimization: Engage experts in sensor technology to use and optimize sensor platforms tailored for HAB detection in Dal Lake. Optimize sensor design, sensitivity, and specificity for target algal species and toxins.

2. Field Sampling: Conduct extensive field sampling campaigns in Dal Lake to collect water samples for sensor validation and calibration. Deploy these sensors at strategic locations within the lake for continuous monitoring of algal biomass and toxin levels.

3. Participatory Surveillance Framework: Establish a participatory surveillance framework by engaging local lake inhabitants, fisherfolk, tourist houseboat operators, hotel managers, and relevant stakeholders. Conduct training sessions to educate and empower them in recognizing, reporting, and contributing to HAB monitoring efforts.

4. Data Collection and Analysis: Collect and analyze sensor-generated data, integrating it with other relevant environmental data (e.g., temperature, nutrient levels). Utilize advanced data analysis techniques (e.g., spatial mapping) to identify patterns, predict bloom occurrences, and assess potential health risks.

5. Community Engagement and Knowledge Translation: Conduct workshops, seminars, and awareness campaigns to disseminate information about HABs, their impacts, and the importance of participatory surveillance. Facilitate knowledge exchange between researchers, local people, government agencies, and other stakeholders.

6. Evaluation and Feedback: Regularly evaluate the effectiveness of the sensor-based system, participatory surveillance framework, and community engagement activities. Collect feedback from participants and stakeholders to address any practical challenges, improve implementation strategies, and ensure sustainability.

V. Importance / Contribution:

This project holds significant importance for the health and well-being of communities residing near Dal Lake and the preservation of the lake ecosystem. By developing sensor-based technologies and implementing participatory surveillance, the project aims to achieve the following contributions:

1. Early Detection and Mitigation: Enable early detection of HABs in Dal Lake, facilitating timely interventions to minimize potential health risks and ecosystem damage.

2. Empowerment and Engagement: Engage local communities in participatory surveillance, empowering them with knowledge and skills to monitor, report, and manage HABs effectively.

3. Sustainable Management Strategies: Develop a participatory framework that promotes long-term sustainability and resilience in HAB management, driven by collaborative efforts between communities, researchers, and relevant stakeholders.

4. Knowledge Translation and Capacity Building: Translate research findings into actionable recommendations, educational resources, and guidelines for government agencies, lake management authorities, and local communities.

5. Scientific Advancements: Contribute to the scientific understanding of HAB dynamics in Dal Lake, including species composition, toxin production, and environmental drivers, enhancing the broader knowledge base on HABs in freshwater ecosystems.

VI. How the proposed work fits within the One Health framework:

The proposed work aligns strongly with the One Health framework by addressing the interconnectedness of human, animal, and environmental health. It recognizes the detrimental impacts of HABs on public health, ecosystem functioning, and the local economy of Kashmir. By integrating interdisciplinary approaches, community engagement, and advanced sensor technologies, this project aims to establish a holistic and collaborative HAB monitoring and management system. The participatory surveillance framework emphasizes the importance of community involvement and knowledge exchange, ensuring the project's sustainability and relevance within the One Health context.

VII. Use of funds:

The funds from the Dr. Gregory D. Bossart Memorial One Health Scholarship will be utilized for the following purposes:

1. Sensor Procurement and Optimization: Procurement of sensor components, calibration, and testing.

2. Field Sampling and Data Collection: Collection of water samples, environmental data acquisition, and laboratory analysis.

3. Participatory Surveillance Framework: Training workshops, educational materials, and community engagement activities.

4. Data Analysis and Modeling: Integration and analysis of sensor-generated data, development of predictive models and algorithms.

5. Knowledge Translation and Capacity Building: Workshops, seminars, awareness campaigns, and production of educational resources.

6. Project Evaluation: Monitoring and evaluation activities, feedback collection, and project improvement strategies.

VIII. List of References:

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