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Earth Observation and Geoinformatics to Monitoring the Environmental Status of Urban Streams Inextricably Linked to People's Mental Health

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Abstract. The general condition of urban watercourses is inextricably linked to ecological balance and public health (physical and mental well-being). Given the vulnerability of these systems to climate change and human pollution, this work aims to demonstrate the effective use of environmental indicators to: a) rapidly assess soil and water conditions near urban streams and b) highlight the importance of geoinformatics and earth observation supported by ground-based techniques. There is a great need for new technology and methods for spatial and temporal monitoring and further quantification of environmental quality in urban streams and the land surrounding them to sensitize policymakers and the public to the environmental degradation of these exceptional habitats and to further protect people's mental health.

Keywords. Environmental indicators, pollution, degradation, mental health, public health, geoinformatics

1. Introduction

Urbanization is rapidly increasing, with over half the world's population living in cities and projections suggesting over 90% urbanization by 2050, especially in Asia and Africa [1]. This growth leads to more megacities and smaller cities, impacting ecosystems like rivers, often causing "urban stream syndrome" [2]. While studies link psychological stress with natural and urban environments, empirical research on how urban water degradation affects mental health is lacking [3]. Degraded landscapes and noise pollution in cities contribute to stress, anxiety, and other mental disorders. This paper emphasizes

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the importance of maintaining good environmental conditions in urban streams for city dwellers' mental health. Achieving this requires continuous monitoring of environmental indicators [4-6]. Rivers are crucial ecosystems supporting socio-economic and ecological services, but human activities such as channelization and wastewater discharges degrade them, making rivers among the most vulnerable ecosystems [4].

2. Methods

2.1. Monitoring of environmental degradation in urban streams

In monitoring the health of urban streams, researchers can utilize many methods. These methods include remote sensing imagery, ground monitoring, water chemistry analysis, and examining the water's biological integrity (Table 1, Fig.1). Remote-sensing imagery employs satellites, aircrafts, and drones for spatial and temporal monitoring, with parameters such as chlorophyll and suspended materials being monitored [7, 8, 9]. Ground monitoring of riparian zones assesses the quality and soil characterization, utilizing visual protocols such as "Stream Visual Assessment Protocol" (SVAP) and assessing soil indicators like texture and chemical composition [5, 6, 10, 11]. Water chemistry analysis evaluates physical, chemical, and biological characteristics, with parameters including pH, dissolved oxygen, and heavy metal concentrations [12, 13]. Additionally, water biological integrity assessments examine indices like the Index of Biotic Integrity (IBI) focusing on taxonomic abundance and trophic structure of aquatic species [14, 15].

Table 1. Methods for monitoring urban stream health

Technique	**Method**
Remote Sensing Imagery	Utilizes satellites, aircraft, and drones to capture spatial and temporal data
Ground Monitoring	Focuses on assessing riparian zone quality and soil characteristics
Water Chemistry	Analyzes physical, chemical, and biological characteristics of water
Water Biological Integrity	Evaluates biological indicators to assess ecosystem health

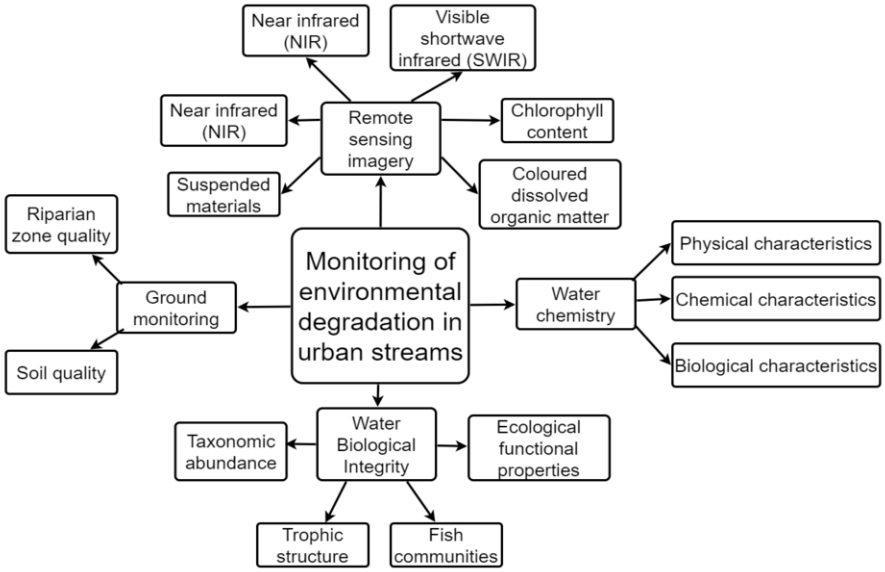

Figure 1. Monitoring methods and parameters for urban stream health assessment

2.2. Monitoring people's mental health

The occurrence of mental disorders is influenced by social, psychological, biological elements as well as environmental factors, particularly the attributes of the urban environment. While urban living can enhance well-being by fostering social networks and providing access to services like healthcare, it also poses challenges such as air pollution, limited space, and noise pollution. Mental, neurological, and substance-related disorders contribute to 13% of the global burden of disease. According to a recent study, the global economic impact of mental disorders totaled approximately USD 2.5 trillion in 2010 and is expected to rise to USD 6.0 trillion by 2030 [16].

Currently, researchers can assess people's mental health using the Child Behavior Checklist (CBCL). This test assesses internalizing and externalizing behaviors for children aged 2 to 18 years [17]. Another tool is the Behavior Assessment System for Children-2 (BASC-2). This is a questionnaire that uses multiple informants to assess a wide range of emotional and behavioral symptoms in adolescents. The BASC-2 covers common mental health problems in children, including depression, anxiety, behavioral problems, and attention deficit disorder [18]. In studies with adults, different approaches have been used to define participants 'mental health status', which may vary depending on the aim of the study, e.g. assessing general mental health or specific related disorders such as depression, anxiety, stress, or distress. The General Health Questionnaire (GHQ) is a validated and widely used instrument to assess general mental health and thus one of the most used tests. Therefore, the inclusion of the GHQ in future studies assessing general mental health could improve comparability and enable meta-analysis across studies. However, other tests such as the Warwick-Edinburgh Mental Well-being Scale (WEMWBS) [19] could also be considered, particularly when investigating the role of green and blue spaces in promoting well-being. Finally, OneAquaHealth project engages in standardization efforts with HL7 FHIR aim to forge synergies while creating and

sharing data sets, following the FAIR principles [20] and using HL7 FHIR questionnaires [21] can fuel research and innovation for a greener, healthier planet while allowing the data to connect to Electronic Health Record Systems [20, 22].

3. Results and Discussion

Literature review illuminates the correlation between urban green and blue spaces and improved mental health. Green areas include vegetation such as trees, grass, forests, and parks, while blue areas refer to visible surface waters such as lakes, rivers, and coastal areas. The presence of green and blue spaces in urban areas is associated with improved mental health, such as a lower risk of depression symptoms and psychological stress [10]. Mechanisms to explain the mental health benefits associated with green spaces and blue spaces include: (a) the intrinsic qualities of green and blue spaces that contribute to health or well-being, as suggested by restoration theory, (b) the healthier environmental conditions associated with green spaces, where lower temperatures, fewer air pollutants and less noise have been found in greener areas, (c) the opportunity to engage in physical activity, and (d) the promotion of social interactions.

Several environmental indicators assess water and soil quality. For water, measurements involve the annual concentrations of dissolved oxygen, BOD, nitrates, phosphorus, ammonium, lead, cadmium, chromium, and copper, offering insights into pollution trends by organic substances, nutrients, and metals. Soil quality, determining its ability to support life, is assessed through physical (texture, bulk density, water content), chemical (pH, nutrient content), and biological indicators (diversity of organisms & fungi).

Given the interdependence of nature and human health, the protection of nature is of crucial importance. Monitoring and rapid assessment can be easily achieved with the help of geoinformatics [23] and earth observation methods. In a five-year collaboration, the European Space Agency, and the World Bank (2013) found that earth observation is a valuable tool that enables rapid and indisputable assessments. Advanced measurement systems enhance forest protection, manage urban expansion, and optimize water resources for agriculture. Earth observation offers objective evidence of progress or establishes baselines for remedial action.

4. Conclusions

This study provides valuable insights into the effective use of environmental indicators for rapid assessment of soil and water conditions near urban streams. It emphasizes the importance of geoinformatics, and earth observation supported by ground-based techniques and health informatics standards. Clarifying the uncertainties that exist is critical to improving our understanding and informing urban planning and public health initiatives aimed at promoting mental well-being in the urban environment.

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