

論文内容の要旨

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Currently, critical issues affecting water quality in river basins are due to human activities such as urbanization, agricultural activities, and industries. Specially in the developing countries in Asia such as Sri Lanka, controlling the effects of these kinds of non-point source pollution is very difficult without assessing the influence of human activities on water quality and identifying the limitation of influence in terms of degradation of water quality. In this sense, the concept of watershed population is used to evaluate the quality of water in a river basin of Sri Lanka and is the key of this research. The influence of population on water quality is based on many human activities such as sewage disposal, land use for infrastructures, building houses, agricultural activities and the vehicles that they used for transportation. The approach taken here was to apply population to the two major water quality analysis processes that are parts of a water quality monitoring system. The contribution of this dissertation is incorporation of the watershed population in selecting the optimum water sampling site network and assessing the influence of non-point contamination sources on the water quality.

The research is expected to propose a model to classify the quality of water in a river basin using the watershed population density in addition to the inclusions. The quantified influence of the population density on the water quality can be used to estimate the necessary facilities of waste water treatment to maintain the requirement of current and future population. Further, it can be involved to establish new urbanization in the water shed areas with maintaining optimum level of population. This might be a practical low-cost strategy for environment management especially for developing countries.

The proposed model is assumed to be implemented in water quality monitoring systems. Monitoring systems used for water quality in rivers usually have been simplified to functions to predict water quality, to find a point-source of contamination, and to control or mitigate the water pollution. The influence assessment model of watershed population on water quality in river basin can serve to enhance the water quality monitoring system while adding a function to assess the influence of the population as the major non-point source of water contamination in some developing countries.

Kelani River in Sri Lanka has been selected for this study because it is rich in biodiversity and many natural resources and plays a major role in the

sustainable development of the country. More than 25% of the Sri Lankan population benefits from the river. Unfortunately, it is considered to be one of the most polluted rivers in Sri Lanka.

The first issue that we should solve is designing a water quality monitoring network in a river basin. The population is used for that process as the factor of development pressure index (DPI) to supportively identify the polluted area due to urbanization. The proposed optimized selection of sampling sites network takes into account new possible sites identified by existing studies to examine pollution sources affecting the water quality. We used multi objective analysis method and genetic algorithm to find the optimized selection of sampling sites networks. In total 14 sites out of 29 were selected as constituents of the water quality monitoring network. The genetic algorithm is highly efficient in the design of the optimized sampling network compared to the brute-force approach.

The second objective of this research is to assess the influence of human activities on water quality. The study of the spatial correlation between urbanization and water quality parameters based on regional perspectives demonstrates that the human activities are positively correlated with degradation of water quality in Kelani River. The Total Coliform (TC), Dissolved Oxygen (DO), and Biochemical Oxygen Demand (BOD) were used to qualitatively define the population ranges using the Bayesian Network (BN) classification model. The results showed that the population density should be approximately less than 2375 to maintain water quality in the watershed for bathing and drinking purposes and less than 2672 for fish and other aquatic organisms. The population ranges proposed in the present study can be implemented by the relevant management authorities in Sri Lanka when they introduce new rules and regulations, set appropriate standards and improve waste water treatment facilities.

In summary, this research has quantitatively identified the ideal population density ranges for a watershed to maintain the quality of water in an appropriate level. This concept can be applied to predict water quality and it is a low cost method for proper environment management by evaluating the influence of human activities. It is suggested that the optimized selection methods to find monitoring network with 14 sampling sites with including new sites to enhance the current water quality monitoring of Kelani river in Sri Lanka.