# Adaptive Environmental Management System for Lejweleputswa District: A Participatory Approach Through Fuzzy Cognitive Maps

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**Abstract.** South Africa is home to some of the deepest mines in the world. Waste from gold mines constitutes the largest single source of waste and pollution in South Africa [2] Though mining industries develop environmental management systems/plans to identify and mitigate the impacts their operations has on the society, their outcome still poses a threat in terms of environmental pollution to communities around them. There are many ICT-based pollution monitoring solutions, but they do not address the needs of the affected mining communities. Some of the reasons for this include lack of relevant tools to access the systems (smartphones, computers) as well as lack of understanding and appreciation of the disseminated information. The mining communities around Lejweleputswa (South Africa) have learnt to depend on their own local knowledge to prevent or mitigate the impacts that mining operations has on them.

**Keywords:** Fuzzy cognitive maps · Wireless sensor networks · Adaptive · Local communities

## 1 Introduction

South Africa is home to some of the deepest mines in the world and accounts for almost 50 % of the world's found gold reserves [1]. Waste from gold mines constitutes the largest single source of waste and pollution in South Africa [2]. Though mining industries develop environmental management systems/plans to identify and mitigate the impacts their operations has on the society, their outcome still poses a threat in terms of environmental pollution to communities around them. There are many ICT-based pollution monitoring solutions, but they do not address the needs of the affected mining communities. Some of the reasons for this include lack of relevant tools to access the systems (smartphones, computers) as well as lack of understanding and appreciation of the disseminated information. The mining communities around Lejweleputswa (South Africa) have learnt to depend on their own local knowledge to prevent or mitigate the impacts that mining operations has on them.

Our objectives were: (1) to examine community's local knowledge on environmental pollution caused by mining activities. (2) To explore the usage of fuzzy cognitive
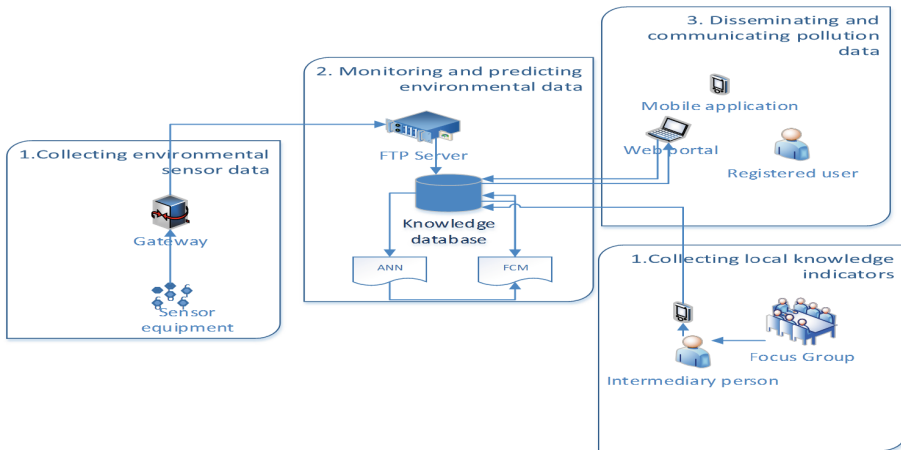
**Fig. 1.** Conceptual framework, the logic of the system.

maps. (3) To collect pollutants data on the area of interest using sensor nodes. (4) To develop an adaptive and acceptable mobile based environmental management system that integrates local knowledge with wireless sensor data.

Developing an adaptive environmental pollution monitoring system could minimize the impacts that mining operations has on the environment if acceptable and understood by mining communities. An adaptive system involves combining, in a dynamic ongoing process, local and scientific environmental knowledge in the co-management of resources and ecosystems publicizing that knowledge in a well understood manner by our communities [3]. To achieve this dynamism, this research makes use of a local based system capable of tracking, monitoring and reporting on air, soil and water pollution as well as receiving local knowledge from the community members around Lejweleputswa by making use of wireless sensor networks (WSN) to gather scientific knowledge and Fuzzy Cognitive Maps (FCMs) for local knowledge.

Methods: This is an exploratory study for firm understanding of the target respondent's knowledge and opinions and test the readiness of the areas of interest by deploying wireless sensors around the community (Fig. 1).

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