



A coupled optimization of groundwater remediation alternatives screening under health risk assessment: An application to a petroleum-contaminated site in a typical cold industrial region in Northeastern China

Ruihui Chen^a, Yanguo Teng^{b,*}, Haiyang Chen^b, Weifeng Yue^b, Xiaosi Su^c, Yaning Liu^d, Qianru Zhang^{a,*}

^a Key Laboratory of Nonpoint Source Pollution Control, Ministry of Agriculture and Rural Affairs, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, 100081 China

^b College of Water Sciences, Beijing Normal University, Beijing 100875, China

^c College of New Energy and Environment, Jilin University, Changchun 130021, China

^d Department of Mathematical and Statistical Sciences, University of Colorado Denver, Denver, CO 80204, USA

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ABSTRACT

Contaminated sites have been recognized as posing serious comprehensive social and environmental issues and have earned worldwide attention. China is becoming one of the largest contaminated sites remediation markets in the world and the contaminated sites in northeastern China need to rehabilitate urgently. However, remediation planning is often hindered by high financial costs resulting from incomplete assessments of pollution and inappropriate remediation plans. In-depth contaminated site assessments can provide the necessary baseline data for remediation alternatives screening. Therefore, risk assessments and remediation decisions will play crucial roles in the rehabilitation and reconstruction of contaminated sites in China. The main objectives of this study were to present a novel method for health risk assessment (HRA) and to demonstrate a multicriteria decision analysis (MCDA) based on this method to select the most suitable remediation alternatives of groundwater and to prioritize management of contaminated site. To demonstrate the HRA and MCDA processes, a typical contaminated site in Longtan, Jilin province, China, was used. The results of this research indicated that Benzene (PhH) and 1,2-Dichloroethylene (1,2-DCE) were the main organic pollutants and the vanillin plant in the north of the site was main pollution source. Pollution migrated from the north to the south and the health risk range in winter was significantly greater than in summer. Four remediation alternatives were proposed on the basis of the HRA results. The MCDA results showed that PRB was the most suitable technology for integrating the relevant environmental, social, economic, and technical aspects required for remediation. This study may help responsible agencies to strengthen local risk-based program screening frameworks for contaminated sites, to promote reconstruction projects, and to increase local public confidence of contaminated sites remediation.

1. Introduction

Various anthropogenic activities lead to serious groundwater pollution worldwide especially at contaminated sites (Bacocchi et al., 2010; C. Li et al., 2020; L. Li et al., 2020). Industrial and commercial operations, industrial disposal and treatment are the main sources of groundwater contamination in China (Kalinowski et al., 2019; Zhang et al., 2019; Chen et al., 2020). The main category of pollutant is mineral oils, which are products of petroleum smelting and chemical production (Rosén et al., 2015; Song et al., 2018; Zhang et al., 2019). In China,

groundwater contamination has been recognized as posing serious eco-environmental and social problems that require immediate remediation and reconstruction actions (Liang et al., 2020; Liu et al., 2019; Ma et al., 2002). It is estimated that there are more than 200,000 potentially contaminated sites in China, of which approximately 90,000 sites, covering 5,480,000 ha, need to be remediate immediately (Rosén et al., 2015; Li et al., 2017; Song et al., 2018; Zhou et al., 2018). About 50% of these sites have been identified and about 10% of them are being remediated. However, it is worth noting that a considerable number of contaminated sites did not achieve the desired remediation effects,

* Corresponding authors.

E-mail addresses: teng1974@163.com (Y. Teng), zhangqianru@caas.cn (Q. Zhang).

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