A multi-criteria approach for sewers sorting using dysfunction indicators

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Abstract

Sewer networks represent important assets that require a long term management because of the high level of replacement cost and the long lifetime of these assets. An integrated approach is necessary taking into account the state of the pipes, their environment and the important financial constraints. In this scope, the council of Bas-Rhin (Conseil Général du Bas-Rhin, France) had been realised an inventory of sewers at the scale of the department, by gathering data and information related to the pipes and their environment. The availability of these data allowed a prospective study (Dorchies, 2005) for asset management using the methodology developed in the RERAU project (2000-2005) (ref), which is based on the assessment of dysfunctions indicators according to Closed-Circuit Television (CCTV) inspections using special cameras for pipes with diameter under 1200 mm .

The observations show defaults, encoded in a specific European standard, EN13508-2 (ref). Encoded defaults are assessed into dysfunctions indicators, which can be coupled with environment impacts for expressing risk related to failure occurrences on pipes.

RERAU methodology proposes the use of a multi-criteria approach to involve dysfunctions and impacts in the decision making process of rehabilitation with the help of an Electre-Tri method (Mousseau et al.,2003). We take into account the dysfunctions indicators only.

Using the observed defaults, our application proposes a way to sort pipes into 3 specific categories depending on the level of deterioration, category “ABS” for pipes without dysfunctions or minor dysfunction, the category “ACC”, for pipes with acceptable dysfunctions and the category “INT” for pipes with major dysfunctions, requiring rehabilitation works. The sorting approach is based on the analysis of 8 dysfunctions indicators of sewers pipes that allows assessing :blockage, collapse, decrease of hydraulic capacity, infiltration, chemical attack,... In order to calibrate the decision model, we used a sample of 91 pipes for an inference process according to affectation example built by an expert analysis. The expert gives a global analysis of the statement of each pipe according to the dysfunctions indicators. The expert analysis helps us to define thresholds of the Electre-tri method corresponding to the frontier between the 3 categories defined above. The use of the Electre-tri method and the expert analysis allows assessing the share of each dysfunction in the expert decision process by defining the weight for each dysfunction. According to the parameters obtained, we analyse the sorting given by the Electre-tri method and the expert, it seems that 85 pipes are correctly sorting but for 6 pipes the Electre-tri method gives a sorting different than the expert. After calibrating the Electre-tri method, we used it on a sample of 334 pipes; the sorting obtained seems good for 296 pipes representing 89 % of the sample, but 38 pipes are not correctly sorted in the considered categories. The result obtained is explained by the incapacity of the Electre-tri method to take into account the accumulation of minor dysfunctions that can cause a major dysfunction. In order to avoid the lack of Electre-tri method we assed a weighted sum for criteria and dysfunctions, after the set of pipes not correctly sorted are analysed by the expert and sorted. According to obtained sorting we define a threshold for each category. The proposed approach defines a way to sort a set of sewers network according to CCTV observation that allows assessing dysfunction. With the help of dysfunctions and expert analysis we calibrate a multi-criteria method Electre-tri. After calibration, the method is applied on a more important set of pipes in order to sort them according to their deterioration statement. The approach gives a good sorting of pipes in order to identify pipes requiring rehabilitation or more inspections.

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