Methodology for the calculation of industrial flood damage and its application to an industry in Vereeniging

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Abstract

The usual way to calculate flood damage is to use flood-damage curves. It is possible to develop standard flood-damage functions for some land uses. However, it is not possible to develop a standard flood-damage function for industries. The best option is then to complete questionnaires at every industrial plant on the flood plain and to use this information to calculate flood damage.

To calculate industrial flood damage, the damage to four components must be estimated and added to obtain the total damage to the plant. The four components are plant and equipment, raw materials, completed goods and structure. These components were combined to calculate the flood-damage potential for a plant on the Vereeniging flood plain. The mean annual damage was calculated as R0.94 m.

Introduction

From time to time nature proves that man should never become complacent and sit back thinking that his knowledge of the environment is adequate enough to understand it. The floods that caused great destruction in South Africa in late 1995 and early 1996, are a case in point. Consequently, the Water Research Commission is still financing research in this field. Since 1974, the University of the Orange Free State has been conducting flood-damage research first applying the *ex post* and later the *ex ante* approach. The calculation of potential flood damage in urban settlements forms part of this research. Urban flood-damage research is undertaken in residential, commercial, industrial and informal settlements. This article focuses on industrial flood-damage research.

Theory for the calculation of industrial flood damage

According to Penning-Rowsell and Chatterton (1977), there are two basic methods for calculating industrial flood damage. The first method is to project historic flood damage to provide standard depth/damage data. Criticism against this method is that documented historical information, which does not always exist, must be used. Another disadvantage is that damage can be over- or underestimated. If the survey is conducted just after the flood, replacement costs could be used instead of depreciated value (thus an overestimation), or cleaning-up costs and structural damage could be underestimated. The second method is to make use of the knowledge that the managers of industrial plants have of how their undertakings are affected by floods (Smith, 1993). The chief disadvantage of this method is that the damage is estimated without the occurrence of a flood, and that the information is therefore of a hypothetical nature. As early as 1965, Kates (1965) propagated the advantages of an artificial approach (using information gathered in the absence of a flood). The fact that general data provide more constant flood-damage functions and are more adaptable to the testing of flood-damage reduction options, was one of his motivations for using this method.

Kates (1965) proposes a synthesis for the calculation of industrial damage. Four sets of basic information are necessary as inputs for the artificial process:

- **Location maps** from which the location of industrial properties can be obtained.
- **Hydrological maps** that can be used to define the flood plain, and to determine flood depths and differences in flood characteristics.
- A set of **unit damage functions** which can be used for the calculation of damage to components of an industrial plant. Separate functions can be used for structural damage, damage to the contents of the plant and production damage. This damage can be expressed in terms of different unit values. Examples of such units are square metres of structure, monetary value of contents or production.
- An **adaptation option function** that reflects the adaptation of flood damage over time and space as a result of a process of training, change and the presence of more information.

The four sets of information are represented graphically in Fig. 1.

If the four basic sets of information are used, the synthesis process could be constituted as follows:

- The location maps can be used to give a description of the region's industrial complex during the period under investigation.
- A flood plain is defined by the hydrological maps that determines which parts of the industrial complex are on the flood plain.
- Each separate production unit or undertaking on the flood plain must specify the location, size and economic valuation of its structure, contents and production over a certain period of time.
- Appropriate unit damage functions are allocated to the different components of the structure, contents and production. The selection of the appropriate flood-damage function is based firstly on the hydrological maps in order to take the changes in hydrological factors into consideration, and sec-

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