

The Acid Test

An expert system for acid sulphate soils

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1. Introduction

Acid sulphate soils are the nastiest soils in the world. They generate sulphuric acid that leaks into drainage and floodwaters; dissolves aluminium, heavy metals and arsenic from soil minerals; and corrodes steel and concrete. Dissolved aluminium, in particular, kills vegetation and aquatic life - causing massive fish kills for example. In sub-lethal doses it stunts growth and breaks down resistance to disease.

Generations of people depending on these soils have been impoverished and, probably, poisoned by their drinking water. Nowadays the impact of acid sulphate soils on the aquatic environment is receiving more attention than agronomic and engineering hazards: the environmental hazards being compounded by the location of acid sulphate soils in coastal wetlands where development pressures are intense.

Very many people are affected or potentially affected and a wide variety of organizations need information about the hazards and how to deal with them.

Table 1 Who needs to know about acid sulphate soils?

- Farmers and planters
- Fishermen and aquaculturalists
- Developers
- Civil engineers and contractors
- Public bodies and regulating agencies
 - drainage boards
 - water supply
 - public health
 - waste disposal
 - environmental protection
- Policy makers and planners
- Consultants and extension staff
- Teachers, students and researchers

Quite a lot of information exists: our own list of references consulted and found to be useful exceeds 500, going back to 1735 (many of them, of course, in Dutch!). There has been an explosion of publications in the last decade but the proportion based on rigorous research is scalable to master the subject.

Now development pressures are such that decisions are being taken willy-nilly. In response, we have taken advantage of information technology to build an expert system

that enables anyone to find quickly the information he or she needs at an accessible technical level. The capacity of a CD-ROM allows us to draw upon a huge amount of digitized illustrative material (e.g. more than one thousand colour pictures). Equally importantly, the system is constructed in such a way that users can add their own local and specialist knowledge and, so, become more expert than the original.

The three programs comprising the system deal with fundamentals and identification of acid sulphate soils (ASS IDENTIKIT), quantitative assessment of the hazards they present (ASSESS), and management and design aspects (ASSMAN). Here we present ASS IDENTIKIT, which is fully operational and available for evaluation.

2. In practice

Questions are the key to the knowledge base. The user asks questions of the system: the system asks questions of the user to elicit the information needed to assess the hazard. IDENTIKIT conforms with Windows 95 design guidelines and no special IT skills are needed.

2.1 Fundamentals

This section frames a sequence of very general questions that may be answered in more or less detail and at different technical levels. The user selects questions of interest from a menu (Table 2) and receives answers first at general level and, if required, at one or more technical levels by selecting a technical 'window'.

At any point in the answer, an appropriate colour picture or diagram can be called upon to illustrate the subject simply by 'clicking' on the passage in text using the mouse. Because the illustrations are digitized, the user can zoom in for more detail. Where microscopic work is involved the zoom facility is enhanced by sequential centered images at magnifications up to x 10 000. Where soil profiles are illustrated, a field description can be called upon for each layer using a 'sample' symbol.

The general text is written without jargon and every technical term is defined in a glossary. Defined terms are identified in the text by *italic* script and individual definitions can be called upon in the same way as illustrations using the mouse. The glossary is amplified by pictures and technical windows in the same way as the main text.

Selected publications are cited in the text and references can be called up using the mouse.

2.2 Site key

The site key is the main part of ASS IDENTIKIT. Here the user interacts with the system to characterize the site or area of interest. On the basis of this information, the system assesses the probability of acid sulphate soil.

The structure of the system is a decision tree (Figure 1). Questions are asked about the land surface, vegetation or land use, surface waters and soil; and the user chooses from a range of possible answers to each question (Figure 2).

The system copes with incomplete information and answers of different degrees of precision (or different technical levels) by rating each piece of information separately according to its value as a predictor of acid sulphate soil.

Table 2. ASS IDENTIKIT – Fundamentals

- What are acid sulphate soils?
- What are the hazards?
- Where and under what circumstances are acid sulphate soils found?
- How extensive are acid sulphate soils?
- How, why and where do sulphides accumulate?
- What is the process of acid generation?
- How much acid can be produced?
- What is the rate of release of acid into drainage waters?

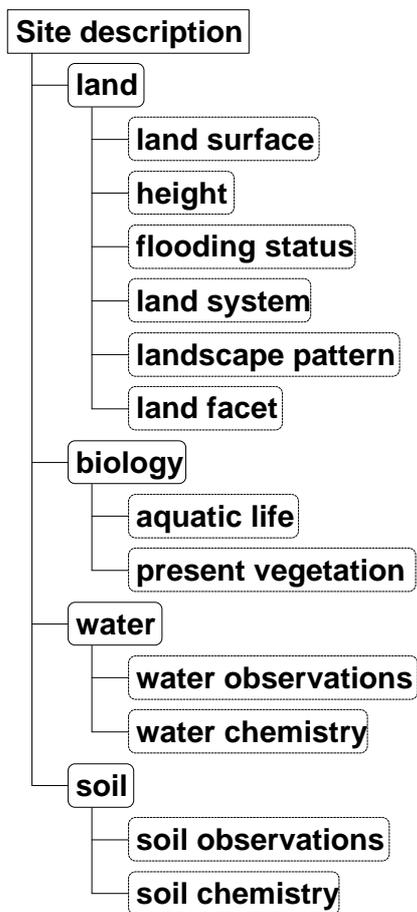


Figure 1 System structure

The rating scale used is + 1.0 (definitely an acid sulphate soil) to - 1.0 (definitely not an acid sulphate soil) with + 0.5 being 'as good as proven' and - 0.5 being 'as good as not' (see Figure 3). The final decision is made according to the highest magnitude answer. Most of the knowledge of the system is subsumed in the allocation of ratings for all the possible pieces of information that may be provided by the user.

The reasoning behind the questions and ratings is given in 'explanation windows' so that the key is also a learning tool. The system is designed for universal application but if the user has local or more specialist knowledge, then a new rating and explanation can be hooked on to the system and saved as a local version of the key.



Figure 2.

Just as in the Fundamentals section, illustrations and definitions of terms can be called upon in the Site Key.

2.3 System output

The end product is an assessment of the likelihood of acid sulphate soil at the site described by the user, according to the quality and detail of the data supplied. The system also provides a text report of the data supplied and identifies important indicators that have not yet been examined.

Finally, the system provides a qualitative soil classification and illustrated examples of the kinds of acid sulphate soil likely to be present. Quantitative assessment is dealt with in the ASSESS program.