

System for Assessing Suitability of Water for Irrigation

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Abstract

The development of a decision support system for assessing the suitability of the water for irrigation aims to protect cultivated crops not to be irrigated with water of unsuitable quality. Discussed are the estimation algorithm, based on the methodology, and the general description of the computer programme, following them. The algorithm includes three fundamental steps: establishing of an irrigation water quality indicators database, assessment of the irrigation water quality and issuing recommendations for irrigation water utilization.

The programme structure of the system, which is the topic of this paper, contains three modules: input data uploading and updating; assessment of the irrigation water quality; preparation of recommendations.

The results are presented in groups: Potential irrigation problems, specific toxicity, miscellaneous effects, choice of recommendation related to the obtained indicators.

Keywords: *Water quality assessment; Irrigation; Decision support system; Computer programme*

Introduction

The irrigation of agricultural crops with water of poor quality not only decreases the yield of agriculture output but also substantially worsens its quality. Quality control on the water for irrigation is needed to avoid emerging problems at using inadequate quality water. The purpose is to be developed a guiding manual, expert system type, providing recommendations and suggestions how to use the irrigation water for different crops considering the water quality in the best way. Some specific circumstances have not been taken in consideration because of the extremely great volumes of data to be processed.

The system for quality control on the water for irrigation is needed to avoid agricultural crop production from emerging problems at using inadequate quality water, the protection of water resources, soil fertility, crops production and consumers health. In this paper presented algorithm which focuses on the process of recommendations elaboration for irrigation water

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considering qualitative parameters of the available water. The algorithm is useful as a basis for software development and has been developed on the basis of a methodology. The degree of restriction on the usage of irrigation water has been presented as a remark for all analyzed parameters. They are salinity, infiltration, specific ion toxicity and miscellaneous effects.

The guidelines for evaluation of water quality for irrigation are practical and have been used successfully in general irrigated agriculture for evaluation of the common constituents in surface water, groundwater, drainage water, sewage effluent and wastewater. The specific impact of every one of problematic factors on separate groups of crops and their limitation is presented at detailed algorithm of the system. Ordinarily, no soil or cropping problems are experienced or recognized when the water parameters are lower than those shown for 'no restriction on use'. With restrictions in the sight to moderate range, gradually increasing care in selection of crop and management alternatives is required if full potential of yield is to be achieved. If water quality values found approach or exceed those given for the severe restriction category, it is recommended that before initiating water use in a large project, a series of pilot farming studies should be conducted to determine the economics of the farming and cropping techniques that need to be implemented. The system is based on FAO methodology on water quality for agriculture [1] and the research works of the Land Reclamation Institute of NAGREF, particularly Dr. Panoras and Ilias [2,3] and the research results of own experience of the other authors.

This part examines the structure of a computer programme which will be used not only for recommendations towards the direct users, i.e., farmers, irrigation societies and laboratories, which perform the water chemical analysis but also for the goals of further research. The first version of the programme, functioning in Visual Environment, is being developed following the algorithm. The available software responds to the main tasks of the methodology and the testing in real conditions [4].

Program Structure of the System

The computer programme is based on the described algorithm. It is necessary for preparing of recommendations and suggestions on the usage of irrigation water according to its quality. The computer programme under development functions using the programme environment of Visual Basic.

The main elements of the programme are as follows:

1. Establishing an empty database connected to the programme, containing preliminary information;
2. Input form and preliminary processing of the information on the results of chemical analysis of the water;
3. Recommendation and suggestion forms how to use the irrigation water.

The recommendation how to use the irrigation water is some now a natural continuation of the algorithm for assessment of the irrigation water quality. During the assessment of each indicator of the irrigation water quality on the screen will be displayed recommendations for the farmers, which take in consideration soil characteristics, irrigation methods, etc. After the assessment of the irrigation water by several indicators, general assessment takes place.

Program structure

Program structure of the system corresponds to the algorithm developed in accordance with the agreed methodology and contains two basic structures, as follows:

- Input and updating of initial data.

- Results and recommendations.
- Each of these structures envelops some program blocks.

Input and updating of the initial data: The input data are divided into 3 basic groups depending on the information source and its character i.e.,

1. Data for the water user.
2. General information about irrigated field,
3. Data from laboratory analysis.

Results and recommendations: Results and recommendations on water quality are divided depending on information groups which are processed taking in consideration the data interrelation in each group. This is important for the expert system to be developed in the future. There, the information will be monitored and processed even before the specific analysis. The groups are, as follows:

1. Potential irrigation problems.
2. Specific toxicity.
3. Miscellaneous effects.
4. Recommendations.

System operation algorithms

The basic steps at the operation of the system at its launching are, as follows:

1. Input data uploading, i.e., forms on the specific water user and general information about the irrigated field are being uploaded. The data from the last processing are available because significant part of the information about the water user at the last service provided is the same. The data is being updated with the uploading of the new ones;
2. Uploading of data got from laboratory analysis. If the water source coincides with the source from the last processing, than the previous processing data are shown too because there is very likely that some of them will be the same;
3. Processing the laboratory analysis information and results preserving. The achieved results will be processed together with the data of sensibility and tolerance of the crop and also with the information on irrigated field;
4. Results divided into three groups: potential problems at irrigation, specific toxicity and side effects;
5. Recommendation choice according to the achieved indicators. Recommendation information is kept as a permanent information of the algorithm;
6. Results carried out from the recommendation analysis.

System blocks algorithms

Specific blocks of the algorithm are examined according to their presentation in point 3.2. Some of them which only technically referred to the programme software are shown directly in the part below.

Information uploading

In this part, data uploading means data uploading at system exploitation at user level, as well as data blocks input into the algorithm structure and their consequent updating regardless the fact that they are visible or not for the user while he is working with the system.

Personal and operational information: Personal information input is done consequently. If there is a coincidence with the database data shown on the screen, the information will be accepted as granted. Part of the information, which is not significant for the identification of the research subject, can be omitted while some information like code of the target subject, crop cultivated, etc. shall be upload obligatorily, i.e., it is not allowed to go further towards assessment without this information. The same rule is valid even more for the operational information, i.e., for the laboratory chemical analysis results of a specific water sample.

Permanent information: Permanent information is presented mostly in table forms. It shows the crop sensibility towards water quality indicators, soil characteristics and methods of irrigation. Its main role is in the assessment process. Changes, updating and additional information will be rarely applied: if there are accumulation of new knowledge from the reality and from published sources. That is why it can be upload only by the system maintaining specialist who has access to it. Source of this information could be own research, FAO methods and recommendations and analysis of other bibliographic sources.

Information processing and results: Information processing means not only its reliability and correctness but also a follow-up complex analysis of the uploaded data for assessment achievement of the irrigation water indicators and the follow-up formulation of the user recommendation done on the basis of them.

Input data control envelops an assessment of its structure (digital, text and other type of information), as well as data validity check. If there is discrepancy among data concerning their structure/format or inconformity with their admissible range which has been taken in consideration from the other available information, the reason of specific data rejection should be said and the user gets measures for their correction. In the same time, the main indicators TDS, SAR, AdjSAR and LSI will be determined.

The next is data complex analysis. Firstly, an assessment of potential irrigation problems is done (FIG 3.). As a result of this, if there are likely potential irrigation problems with the cultivated crop, for specific indicators will be given user information which contains a short description of the problem and how it could be solved. If data are analyzed for specific toxicity and side effects, the approach is the same (FIG. 4 and 5). During the water quality assessment the system user can look through the information concerning the reflection of the specific indicator on the crop yield and its development, i.e., crop sensibility and the quality indicators of the output.

User recommendations are formulated on the basis of data analysis. They are based on the practical experience in great extend and they are combination of the knowledge included in the methodology.

Preliminary version of programme software

Development of a programme, software is done in environment of Visual Basic. First, the programme version in progress will be tested in laboratory circumstances and its development as independent working programme out of Visual Basic environment will lead to control texts in real circumstances with specific water users.

Input data forms

Input data forms are divided in two groups according to the above grouping of the database: form of personal information about water users and water sources, and form of the laboratory analysis data (FIG. 1).

Each form contains some information and there is envisaged a transfer towards:

1. The other input form.
2. Three forms for results from analysis-assessment.
3. The form on recommendations.

It is envisaged a transfer to a previous inspection of this water source, new research data (Add Record) to be added, as well as data about research available in the database to be deleted (Delete Record). These opportunities are included in the forms bellow and its realization is forthcoming.

| Code | Surname | FirstName | Address | Number | Municipality | MunicipalityP | PostCode | Prefecture | Telephone | Fax | Email | SanplingDate | Date | vWasteV |
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FIG. 1. Input form - water users, water sources, type of water, soil characteristics, methods of irrigation, cultivated crops, date of water sample, taken for laboratory analysis.

FIG. 2. Input form - results of the water chemical analysis.

Forms for water quality assessment and for recommendations

These forms illustrate results from assessment of the potential irrigation problems, specific toxicity, and side effects, as well as the form of issuing user recommendations (FIG. 2).

FIG. 3. Form Potential irrigation problems assessment.

FIG. 4. Form specific toxicity assessment.

FIG. 5. Form side effects assessment.

FIG. 6. Recommendation and suggestion form.

FIG. 3 illustrates a part of a table which could be activated by the user, i.e., it can be shown in the form, in this way, possible negative consequences for the crop in the table using irrigation water could be assessed (FIG. 4 and 5).

The form, recommendations for the user (FIG. 6), contains not only the recommendation formulated in the result of the complex assessment but basic data and preliminary results. In this way, user education is helped for better interpretation of information and if the user is knowledgeable it means qualified usage of the recommendations.

Conclusion and Recommendations for the Follow-Up Research

The results of the research are, as follows:

1. Formulation of a methodology on determining usability of the irrigation water for differing crops on the basis of the results of chemical analysis for its quality;
2. An algorithm for recommendation on the usage of the irrigation water taking in consideration its quality parameters;
3. Software, i.e., a programme on recommendations issue and provisions to the users of how to use the irrigation water.

The computer programme under development contains the main elements of the algorithm. The software helps to achieve the main objectives of the research. However, for testing the relevant versions it is needed longer period of time and selection of suitable data.

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