SIMGRO, a GIS supported hydrological model

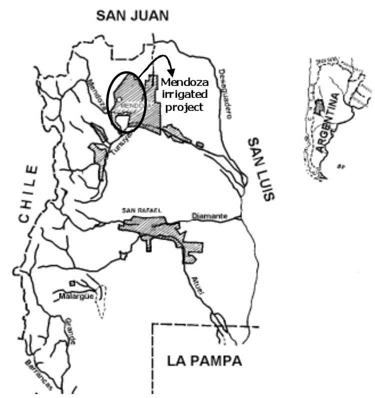


Fig. 1 Province of Mendoza

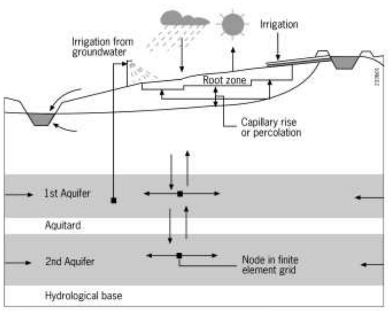
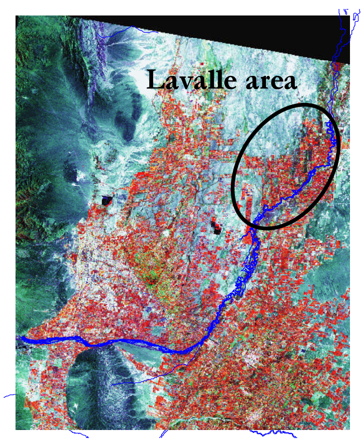


Fig. 2 Simgro model



Case study of the Lavalle irrigated area, Mendoza, Argentina

1. Introduction

In Argentina there is about 1.36 mln. ha under irrigation. The Province of Mendoza has approximately twenty percent of the total irrigated land in Argentina (see Fig. 1). In Mendoza Province water is allocated on the basis of the area for which the farmers have irrigation water rights. Studies indicate that the actual cultivated area is much smaller than the area having water rights. This leads to over-irrigation and often to gradually rising water tables in wet years. Frequently, the result is soil salinization, which reduces productivity and causes environmental degradation.

Simulation models of hydrological and irrigation management are able to identify solutions to the problems described above. The use of such models can support decision making on water management aspects. The benefit of a modelling tool is its use in situations with changing conditions affecting the hydrological system. An important aspect is the need to simulate the hydrological system (groundwater and surface water) and to include operational irrigation practice.

The objective of this study is to demonstrate the use of the hydrological model SIMGRO for an irrigated area and to give recommendations on the sustainable use of the available water resources.

2. Hydrological model SIMGRO

SIMGRO (SIMulation of GROundwater and surface water levels) is a distributed physically-based model that simulates regional saturated groundwater flow, unsaturated flow, actual evapotranspiration, irrigation, stream flow, groundwater and surface water levels, and groundwater abstraction. The model is used within the GIS environment Arcview (user interface AlterrAqua). This allows the possibility of using digital geographical information (soil map, land use, watercourses, etc.) in order to convert these to input data. Further use is the presentation of results and analyzing these together with specific input parameters.

Irrigation allocation

The practise of water allocation in an irrigated area is needed by the model, based on field measurements of the water distribution. The module IRRIG was developed to translate the available information to input data for SIMGRO. The programme IRRIG requires water volumes on a monthly basis for the different management units in an irrigated area (command areas), both from surface water and groundwater. Further required information is the application depth, the duration of a gift and the number of applications per month. Also information on the variation of the application depth over the growing season must be given. Based on all the information the water distribution to each command area and crop in time is calculated and used by SIMGRO.

3. Lavalle irrigated area

The modelling area (50,000 ha) is situated in the northern part of the area irrigated by Mendoza River. The irrigation area is situated west of Mendoza River. In Figure 3 the area is shown with the irrigation and drainage canals. Based on the infrastructure of irrigation and drainage canals, the surface water is schematized by the AlterrAqua interface in subcatchments, separately for irrigation and for drainage (Fig. 3). Further data on land-use, soil type and water allocation is needed to complete the input data for SIMGRO.

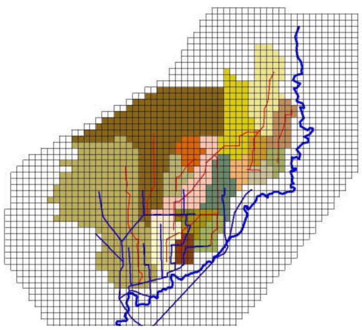


Fig. 3 Lavalle modelling area and the irrigation and drainage canals

4. Example simulations

The model was run for a the years 1996-1998. Figure 4 shows the variation of the phreatic groundwater level. The short interval fluctuation of this level can be attributed to the groundwater extractions, which supplement the surface water irrigation. Further an analysis was carried out to quantify the effect when more groundwater is used for irrigation. Figure 5 shows the influence of the groundwater extractions on the groundwater levels. The first scenario assumes the presents water allocation, with a small amount of groundwater extractions, the second scenario assumes the situation when about two times more groundwater is extracted. The results show that the effect is pronounced in the summer months when farmers use the largest amounts of groundwater.

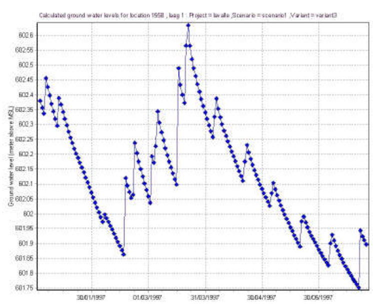


Fig. 4 Change in phreatic groundwater level for the irrigation season 1997/1998

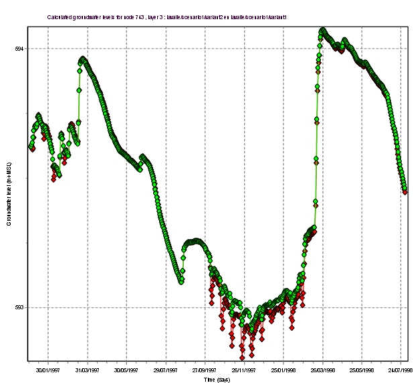


Fig 5 Comparing groundwater levels (green: present situation; red: increased groundwater extractions)

5. Conclusions

The use of models can support decision making on water management aspects for irrigated areas. The advantage of a model, such as SIMGRO, is that it can be used in situations where changing conditions affect the hydrological system. For instance, the model will predict the effects that may be caused by changes in surface water and groundwater allocation or a change in the irrigation and drainage infrastructure.
Such regional integrated hydrological models help elucidate effects on a regional scale, in which interaction between surface water and groundwater is included. Once calibrated, a hydrological model is an excellent tool for the integrated planning of irrigated areas and for the rational management of water resources. For instance, the model will predict the effects that may be caused by changes in surface water and groundwater allocation or a change in the irrigation and drainage infrastructure. Different kinds of scenarios can be simulated relatively easily and accurately.
Further analysis will be carried out to find solutions for a sustainable use of the water resources.

Reference

Querner, E.P., J.A. Morábito and D. Tozzi, 2006. SIMGRO, a GIS supported regional hydrological model in irrigated areas: case study in Mendoza, Argentina. (Draft paper).
Kupper, E., E.P. Querner, J.A. Morábito and M. Menenti, 2002. Using the SIMGRO regional hydrological model to evaluate salinity control measures in an irrigation area. Agric. Water Man. 56: 1-15.

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