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An overview of several models used in hydrological studies

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Abstract: Climate change is not just a daily and fashionable expression. Their impact on hydrological regime is visible all around the world and the effects cannot be neglected. Floods and droughts occurred with an increased frequency and higher magnitude.
Indifferent of the scale of water hazard event or the scale of a theoretical study, specialized modelling programs are widely used. The uncertainties from hydrological studies required such an approach in order to be able to answer at different challenging questions on sustainable development. Several models used in hydrological studies which covered Romanian territory (and not only) are presented in this paper.
This paper is based on the outcomes results from the bilateral project 20BIL/2017 "Regionalization of hydrological parameters in calculating flooding for small catchments", project carried out by "Research within Priority Sectors" Program financed by EEA Grants
Keywords: hydrological models, floods, hydrological studies

1. INTRODUCTION

Most forecasts on climate changes indicate an alteration of average temperature and precipitation values leading to a significant increase of water hazards (droughts and floods) frequency. This may not be only a result of climate changes, humans adding to the severity of these events [1].

Climate changes are a contributor factor in the appearance of flood and droughts but they play the role of a trigger factor in exacerbating droughts and floods [2].

Climate changes and human actions, mainly through land-use changes and engineering works, significantly increased the frequency and severity of floods.

The race for developing a grey protecting infrastructure against flood at the sacrifice of several valuable ecosystem services is no longer an option. However, the society needs to develop and the social and economic developments in the modern world will require a new system integrating ecological needs in traditional flood control systems.

It is clear that events like floods and droughts can't be avoided, but the hydrological extremes related to these events can be sustainable managed using a series of actions based on two inter-connected approaches: prevention approach and post-event management approach. The main objective remains the necessity of limiting the consequences of water hazards on socio-economic sectors but also the need of quickly and sustainable recovering after an event like this.

Thus, hydrological studies are very important in setting up some reliable strategies for managing water related hazards. Moreover, there is very important to adopt some complex hydrological models able to cover a whole range of situations in forecasting and subsequently managing these kinds of hazards.

2. IFAS

IFAS is software to calculate river discharge by using satellite based rainfall and ground based rainfall data.

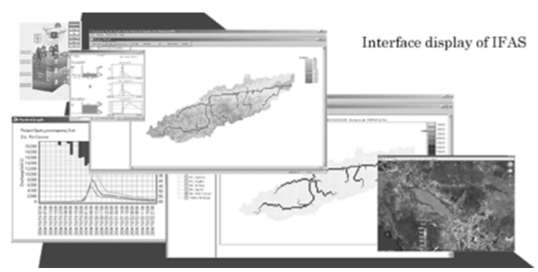

Figure 1 Interface display of IFAS [3]

Some values (parameters) used by this software can be got free of charge (topography, Land Use and satellite-based rainfall data).

IFAS enables to predict and analyse the time and the scale of the flood in insufficiently gauged basins. In the frame of IFAS software, river channel network is created by elevation. Water flows to lower mesh, but sometimes there is the depressed cell which is the lowest out of surrounding areas [3].

IFAS allows modifying the elevation of these depressed cells automatically. Then all river channels are connected and all cells flow into the most downstream cell [3].

The conceptual framework on which IFAS had been done in presented in the following figure:

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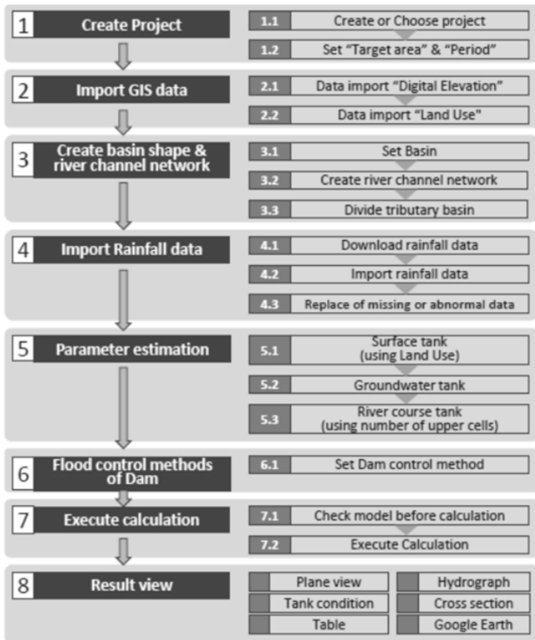

Figure 2 IFAS conceptual framework [3]

Figure 3 Representing a hydrographic basin using IFAS

IFAS integrates data on rainfall gathered from satellites and ground stations as a way to estimate runoff conditions which can be used to forecast floods. Runoff conditions are estimated combining rainfall data, the digital elevation model and the corresponding land-use data for the basin.

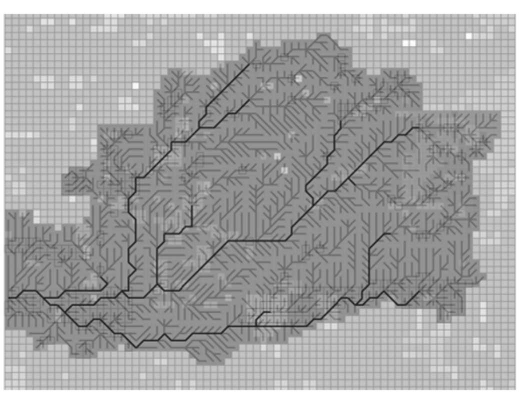

Figure 4 Representation of drainage course in a hydrographic basin using IFAT

Grid data in integrated flood analysis system are treated as data deployed by an approach called UTM (Universal Transverse Mercator). River basin is represented with an aggregate of multiple cells, and distribution model which conducts calculation processing at a cell unit is used. Cell size is the length of a cell, the unit is km [3].

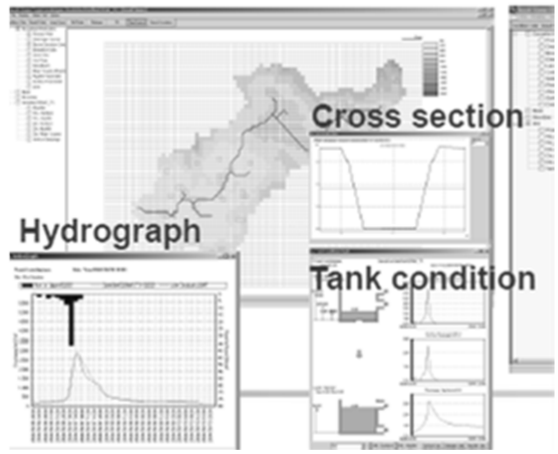

Figure 5 Types of results generated by IFAS

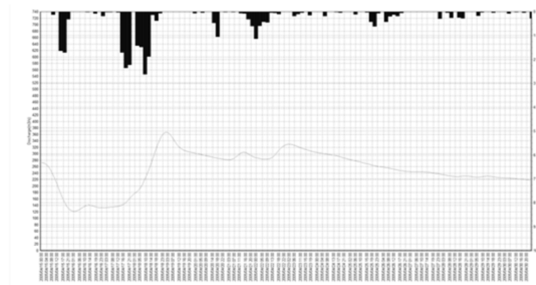

Figure 6 Hydrograph issued by IFAS

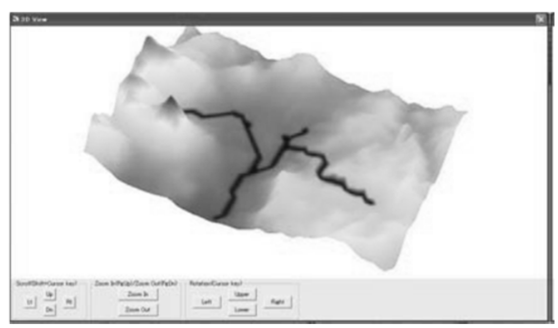

Figure 7 3D model realized in IFAS

3. HIDROESTA

Hidroesta is a program for hydrological and statistical calculations applied in hydrology.

Hydrological studies require substantial analysis of hydrometeorological information; this information may consist of rainfall data, flow, temperature, evaporation. The data collected represent only raw data, but if they are organized and analyzed properly, provide the hydrologist a useful tool that allows him to take the proper decisions. HidroEsta is a tool that facilitates and simplifies the laborious calculations, and the process of analyzing the wealth of information that must be performed in hydrological studies.

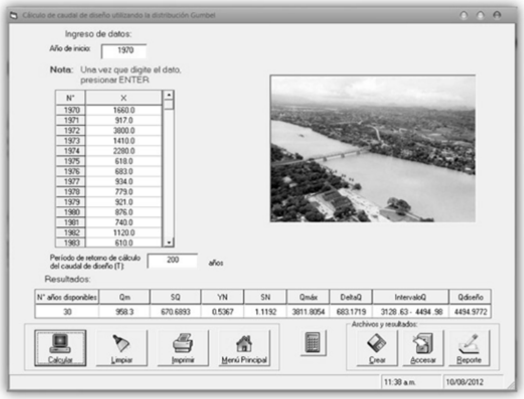

Figure 8 Interface display of Hidroesta

HidroEsta allows [4]:

- The calculation of statistical parameters for clustered and nonclustered data;
- Calculation of linear regression, non-linear, simple and multiple regression and polynomial;
- To assess whether a data series fits to a series of distributions: normal, log-normal, gamma, log-Pearson Type III, Gumbel and log-Gumbel. If the data set fits a distribution, to calculate such flows or design rainfall with a return period or given a certain probability of occurrence;
- Calculate from the curve of seasonal variation or duration curve, design events with certain probability;
- Conduct analysis and calculate storm intensities from rain data; it also allows the calculation of the average rainfall for the simple average method, Thiessen polygon and isohyets;
- Calculation of maximum flow with empirical and statistical methods;
- Calculation of evapotranspiration using Thornthwaite, Blaney-Criddle, Penman and Hargreaves as well as water balance calculations.

HidroEsta allows evapotranspiration calculations by Thorthwaite, Blaney-Criddle, Penman and Hargreaves methods as well as and water balance calculations. In the same time the user can perform analysis and calculate storm intensities, from precipitation diagrams data and design the maximum intensity for a duration and return period given from log intensities. It also allows the calculation of the average precipitation by arithmetic average method, Thiessen polygon and isohyets. By using HidroEsta it is possible to store the input information in files, in order to repeat the calculations as many times as desired [4]. It must be mentioned here that HidroEsta doesn't work with negative values of temperatures (the values must be higher or at least equal with 0).

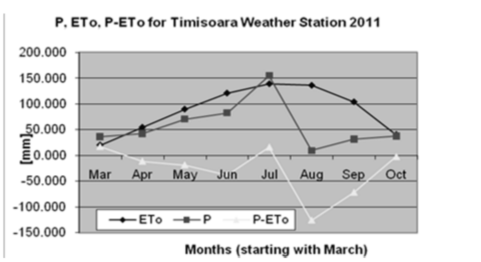

Figure 9 Graphs obtained by using Hidroesta program

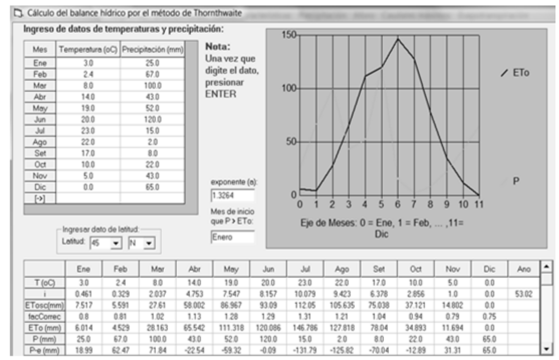

Figure 10 Interface for water balance determined with Thornthwaite method

4. HCANALES

Drainage channels are particularly important structures in the process of controlling excess moisture. For an efficient design of drainage channels, researchers from Costa Rica have developed the HCanales program [5].

Using this program, designers will simplify their work, perform simulations using different parameters, and reduce the time needed for calculations, optimizing the design process of the channels economically and technically.

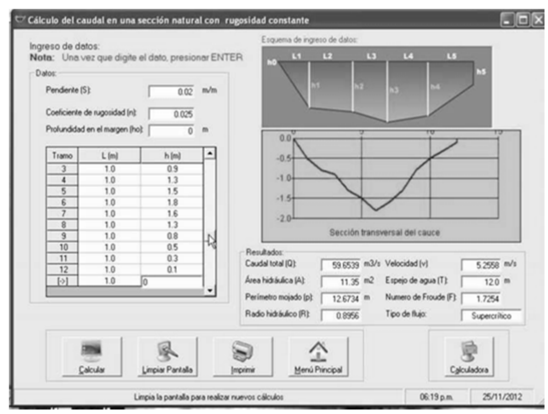

Figure 11 Interface for determining flow for a natural river bed section

Figure 12 The interface of HCanales program

The program allows the design of channels in normal and critical mode, the calculation of the hydraulic jump and remittance as well as the determination of the flow transported by a channel.

The program is very easy to use and has a simple and attractive interface.

5. CONCLUSIONS

Potential exposure to natural hazard risks and climate change impacts differs substantially at regional, national and European level. Furthermore imbalances in vulnerability to these risks will certainly increase in the future undermining, considering the financial and socio-economic disparities, the capacity to respond to natural hazards and climate change.

Computer programs are very important tools when we need to store, retrieve, and process hydrological data. Hydrologists are using watershed models more and more. Modelling seems to be an appropriate approach for addressing complex water resources and environmental problems.

Many users are uncertain about the most suitable hydrologic/water quality model to choose to achieve their objectives, which usually have associated time and cost constraints.

ACKNOWLEDGEMENT

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