



Harmoni-CA

**ProDec decision procedure editor
and its human-consistent design and use in river
basin management and learning processes**

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Poster abstract

Within the EU project TRANSCAT a decision-oriented software tool ProDec (Decision Procedure Editor) was developed, accessible, along with other Decision Applications, developed at the Systems Research Institute in the Project's framework, through <http://transcat.ibspan.waw.pl> . ProDec is meant for an easy use by a variety of end-users, for both effective design and execution, and learning purposes.

The tool is meant for creation and manipulation of the decision procedures, leading from certain observations or measurements to certain decision concerning actions to be undertaken, or not. The decision procedures elaborated with the help of the ProDec software have the form of decision trees.

These decision trees are composed of the IF... THEN... rules, relating satisfaction of definite conditions to their consequences.

Although ProDec was initially devised for use in the emergency situations, such as floods or grave pollution events, it can be used as a tool – or a model – in any case, when decisions are made in a routine or pre-defined manner, within a similar or the same setting of conditions.

ProDec allows for the definition of all the elements of the respective procedure, starting with the variables (measurements) constituting the basis for inference, their different values, through the rules, and finally the resulting potential actions.

Such a structure of the procedure applies to many domains, but is particularly fit for the river basin management, in view of obvious hydrographic and geographical characteristics of such systems.

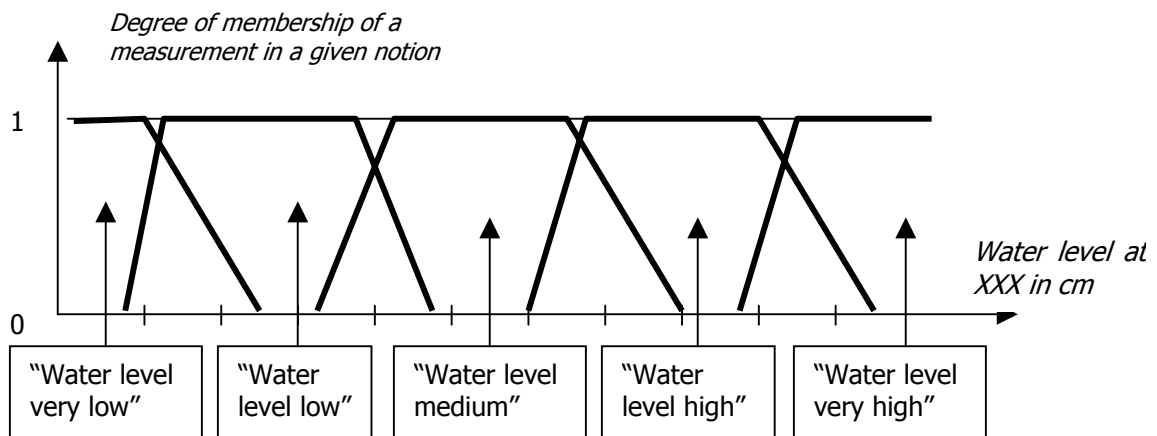
The characteristic feature of the ProDec is the use of *fuzzy set theoretic definitions of the values* taken by individual variables, which are used in the condition terms of the rules edited.

Thus, for instance, assume we deal with a single rule in the form:

IF *WATER LEVEL AT XXX EXCEEDS BBB*
THEN *ALARM LEVEL 2 AT YYY.*

Usually, expression like *EXCEEDS BBB* would take on a numerical form, e.g. ">220 cm", meaning that when water level at XXX is 219 cm, we do not announce alarm, while at 221 cm – we do. Application of fuzzy sets as values of the conditional parts of the rules allows, first, for *flexible treatment* of such conditions, and, second, for the use of *human-consistent verbal expressions*. In addition, we can through such an approach assess the degree, to which the condition is satisfied, and so also the "possibility" (or "degree of need") of firing the consequence.

The range of values of a given conditioning variable (say, water level at XXX), is divided, according to some principles (human experience, hydrological statistics, model results,...) into "values", corresponding to the sub-intervals of the entire range considered. These "values" are assigned linguistic expressions, which are assumed to appropriately render the pragmatic significance of the respective subintervals. An illustration is provided in the diagram for the case of the above example.



Specification of verbal notions similar to the ones shown above in ProDec is easy and intuitive.

The imprecise, but human-consistent manner of expressing values of conditioning variables allows for flexibility also with respect to the simultaneous use of information in the same decision procedure originating from various sources. If human experience can be effectively replaced by precise numbers and relations, ProDec will enable the user to specify the respective "crisp", non-fuzzy values.

Since, in general, the rules obtained are also fuzzy, the output from the procedure, when definite values are inputted, provides also an overview of the potential actions to be undertaken with corresponding degrees of condition satisfaction. Thus, if for an action, say, EMERGENCY STATE AT XXX, we obtain degree of satisfaction equal 1.0, the emergency state at XXX should certainly be introduced. If this degree is, e.g., 0.38, the ultimate decision will definitely be left to the human decision maker, aided also by degree indications for other, associated actions.

ProDec allows for testing of the procedures developed by user-defined setting of various condition values and checking the output from the procedure. In this way both the formal aspect and the human experience are used and verified, as well.

Hence, not only ProDec can be used as a decision-making supporting instrument, on both design and implementation stages, but can effectively support the institutional learning process through the detailed analysis of the procedure's contents and its verification.

The procedure of development and implementation of the decision procedure with ProDec contains, in general, the following stages:

- Determination of the *threats* and *actions* (the "frames" of the situation)
- Division into subareas (an optional stage, associated with possible differences of conditions in different parts of the entire area in question)
- Choice of *measured quantities* (the actual inputs into the procedure)
- Definition of the *degrees of emergency* (i.e. [fuzzy] quantification of the output states, which will be indicated by the procedure for definite combination of input conditions [measurements])
- *Formation and testing of decision rules* (formulation of the rules and testing of their functioning)
- Detailed description of actions (optional: meant to provide additional information on what individual actions are planned to be composed of)
- Installing the system (making the software operational)

- Final testing (e.g. testing for sensitivity to changes in the precise input values, or to definitions of fuzzy values of conditional variables).