IV.4 Evaluation of the Discrimination Capability of Criteria by MCQA and Application to an Austrian Water Resources Planning Case

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Introduction

In many multicriterion applications a broad set of criteria is proposed to evaluate a small set of discrete alternatives. Often, the criteria are correlated to each other and their application may lead to a bias evaluation. Also, an impact analysis is required for each criterion which will increase costs and manpower requirements. Therefore, it is essential to evaluate the criteria with respect to the discrimination power in order to obtain a smaller but efficient set of criteria.

The purpose of this paper is to develop a multicriterion concept to investigate the worth and the discriminating power of criteria and to illustrate it by means of a real Austrian case study. Two versions of the Multicriterion Q-Analysis technique (MCQA-I, MCQA-II) have been developed before, whereas MCQA-III is a new contribution. The Q-Analysis concept gives a description of a geometrical structure formed by a simplicial and a vertical complex. The technique was proposed by Atkin (1974). Based on his work, Multicriterion Q-Analysis (MCQA-I) was improved and extended in Duckstein et al. (1982) on the basis of a concordance index only, so that the preference order of projects is computed according to the number of satisfied criteria. A second version of MCQA, called MCQA-II, developed in Hiessel et al. (1985), further reflects the decision maker's negative opinion about an alternative via a discordance index. In the present investigation the set of criteria is represented by the simplex set. The new computational procedure MCQA-III, introduced Eder (1993) assists in finding a preference order among criteria, based on their discriminating power for ranking alternatives. Discordance, concordance, eccentricity and criteria evaluation concepts are combined in an Lp-norm. The objectives and the grouping of thirty-three criteria are first briefly presented. A comprehensive description of the set of alternatives, including ten different hydroelectric power station plans, a National Park project and a "no action" plan follows. In the second part, the transformation of evaluation data is shown. A brief description of MCQA-III is given and subsequently the methodology is applied to the Danube case study. The ranking of criteria obtained by MCQA-III is given and conclusions are finally given with emphasis on the new technique of criteria ranking.
Description of the Case Study

Nine hydroelectric power stations are located along the Austrian section of the Danube. The discussed study area downstream of Vienna is one of the few free flowing parts and is one of the most ecologically attractive sections of the Danube. In 1984 a proposal for an in-stream type of hydropower station located in this area was authorized by the Water Law Authority. Severe opposition by the public and environmental groups stopped the clearing works and then led to the cancellation of the water law concession by the Administrative Supreme Court. Since then, several possible projects for further management of the Danube downstream of Vienna as far as the Slovakian border have been decision has been taken. This board also determined a large set of criteria considered to be of high importance for evaluating any project.

In 1985 the Ministry of Environment established an Ecological Advisory Group to discuss the further development of the flood plains. This board, composed of engineers, regional planners and biologists concluded that the unique characteristics of this Danube sections, should be preserved and proposed a set of criteria to assess the impacts for any project.

Description of Criteria

In general, criteria reflect the performance of alternatives with respect to the objectives, and may be expressed on either an ordinal or a cardinal scale. Most of them can be measured and estimated by empirical data and models and are given as cardinal numbers. Some of these criteria especially ecological and sociological ones, can only be described verbally; a five point scale has been selected: "very good (V=1)", "good (G=2)", "satisfactory (S=3)", "poor (P=4)", "unsatisfactory or bad (B=5)". An ordinal scale can only show whether an alternative is better or worse than another one, but cannot express in a measurable fashion differences in the performance index.

Description of Alternatives

In 1986 the Republic of Austria published the summary report from the Ecological Advisory Board on further development of the Danube east of Greifenstein (Ökologiekommission, 1986) which, together with Kaniak (1980) and Nachtnebel et al. (1988, 1989), serve as a basis for the application of MCQA. Twelve alternatives have been defined. Five different plans in regard to the location and capacity of hydroelectric power stations have been considered as technical possibilities (A3, A5, A7, A9, A11). In addition to each of these plans, complementary measures such as ground water level control in the surrounding area are considered to reduce environmental impacts (A4, A6, A8, A10, A12). Preservation of the Danube as a free flowing river downstream of Vienna to the border of Slovakia is an alternative described by a "no action" plan (A1). The evaluation of this alternative with respect to economic means is not possible because it does not include any energy aspect, neither generation nor import. For this reason, a second alternative has been generated which includes energy import (A2) corresponding to the energy production of the hydroelectric power station in Hainburg. This possibility couples the free river concept with energy import. The costs for this import over a period of 25 years is counted as investment cost in alternative A2. A complete list of alternatives with a brief description by a comparison of the projects is given below.