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Developing the RIAM method (rapid impact assessment matrix) in the context of impact significance assessment

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ABSTRACT

In this paper the applicability of the RIAM method (rapid impact assessment matrix) is evaluated in the context of impact significance assessment. The methodological issues considered in the study are: 1) to test the possibilities of enlarging the scoring system used in the method, and 2) to compare the significance classifications of RIAM and unaided decision-making to estimate the consistency between these methods. The data used consisted of projects for which funding had been applied for via the European Union's Regional Development Trust in the area of Central Finland. Cases were evaluated with respect to their environmental, social and economic impacts using an assessment panel. The results showed the scoring framework used in RIAM could be modified according to the problem situation at hand, which enhances its application potential. However the changes made in criteria B did not significantly affect the final ratings of the method, which indicates the high importance of criteria A1 (importance) and A2 (magnitude) to the overall results. The significance classes obtained by the two methods diverged notably. In general the ratings given by RIAM tended to be smaller compared to intuitive judgement implying that the RIAM method may be somewhat conservative in character.

1. Introduction

In environmental impact assessment (EIA) the potential environmental and social impacts of a proposed project are identified and evaluated by the project executives in association with the responsible environmental authorities and different interest groups (Sadler, 1996; Wathern, 1988). In particular the assessment seeks to determine the key issues responsible for the overall environmental burden of the project so as to plan suitable measures to mitigate these impacts. To achieve this goal the essential question to be answered is whether a project is likely to cause significant environmental change, which can then be used as a trigger for authoritative actions relative to the project (Kjellerup, 1999). Judgements about impact significance are often made throughout the EIA process starting from the early phases of impact identification until the final stage of the assessment, when the feasibility of the project is judged by the environmental authorities (Kjellerup, 1999), further increasing the importance of this element.

Despite its vital role in EIA, and in environmental management, the evaluation of impact significance is still widely considered as one of the most difficult and least understood elements of the process mainly due to its subjective and value-full nature (Duinker and Beanlands, 1986; Lawrence, 2007). Subjectivity complicates the evaluation process since views about the importance of particular environmental impacts often diverge among stakeholders in accordance with their personal values and attitudes (Sadler, 1996). A unanimous resolution to the problem is thus seldom possible, which emphasises the need to carefully define the methods used in the assessment and to justify the results obtained (Sadler, 1996; Wood, 2003). However the methodology employed to make significance determinations continues to vary substantially among EIA practitioners hindering comparison of assessments made not only between projects but also inside a single project. The methods commonly used rely substantially on the inconsistent judgements of environmental experts despite the fact that more explicit methods might already exist in the scientific literature (Wood et al., 2006). In many studies on the effectiveness of EIA (Hilden et al., 1997; Sadler, 1996; Sandham and Pretorius, 2008) impact significance determination, or impact evaluation in general, is widely stressed as one of the key areas in need of further development to enhance the overall performance of EIA. Based on these studies two issues in particular can be underlined as the main objectives of future research: 1) the standardisation of the general theory of the determination of impact significance, and impact evaluation in general and 2) the development of transparent and consistent frameworks to assist EIA practitioners in conducting and documenting impact significance judgements.

RIAM (rapid impact assessment matrix) is a matrix method developed to bring subjective judgements in a transparent way into the EIA process. The method was developed by Cristopher Pastakia (Pastakia, 1998; Pastakia and Jensen, 1998) at the end of the 1990s, and since then it has been widely tested in many assessment

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situations and case studies (e.g. Al Malek and Mohamed, 2005; El-Naqa, 2005; Haie, 2006; Pastakia and Jensen, 1998). RIAM is based on the standard definition of concepts used in the EIA process. With the help of the method different impacts and their significance can be evaluated using commonly defined criteria, each of which has its own ordinal scales. Thus notably varied expressions used in the evaluation phase of EIA can be translated into a numerical form, which can be easily compared and reviewed by stakeholders not involved in the actual evaluation process. The results of the assessment are placed on a simple matrix, which leaves permanent and reasoned records about the judgements made. In RIAM impact significance is modelled as a multicriteria problem, in which the complex nature of the concept is broken down into smaller, more accessible attributes (criteria) for the decision-makers to work with. Evaluating the significance of impacts this way is a widely used approach in the literature on environmental decision-making, when constructing systematic methods for impact evaluation (Bojórquez-Tapia et al., 1998; Cloquell-Ballester et al., 2007; European Comission, 1999; Thompson, 1990). In the original RIAM method five evaluation criteria are used, namely impact importance (A1), magnitude (A2), permanence (B1), reversibility (B2) and cumulativity (B3) (Pastakia, 1998).

During recent decades there has been a growth of interest in the application of multicriteria assessment (MCA) methods to support complex environmental decision-making (Hajkowicz and Higgins, 2008; Janssen, 2001; Kiker et al., 2005), which highlights the need to better understand these methods and how they actually improve the decisions made (Hajkowicz, 2007). In this paper RIAM is examined from a methodological point of view to evaluate the applicability of the method as a tool for EIA and for the determination of impact significance. In practice the study had two main goals. The first was to test the possibilities of enlarging the scoring system used in RIAM and this way increasing the adjustability of the method to different assessment situations and environmental contexts. To do this, the scoring system of RIAM was modified by adding one extra criterion to the framework and extending the ordinal scales used. Secondly the significance classifications of RIAM were compared to the results of unaided decision-making in order to test the validity and accuracy of the results given by RIAM and the amount of consistency shared by these two methods. Regardless of its evident weaknesses unaided decision-making continues to be a commonly used method in the field of environmental management, especially in the context of significance evaluations (Wood et al., 2006), which is why it was chosen as a reference point in the present study. In this paper RIAM is used to evaluate and classify different projects on the grounds of their overall environmental impacts. A similar approach has earlier been used by Kuitunen et al. (2008), who concluded that RIAM can effectively be used to compare the environmental and social impacts of projects even when the cases assessed are different and share only a few common characteristics.

2. Assessment design and methods

The case data used in the study consisted of plans and projects for which funding had been applied via the European Union's Regional Development Trust (RDT) in the area of Central Finland during the half-year period January–June 2004. The main aim of this funding programme is to improve social and economic cohesion, especially in the underdeveloped areas of the member nations, and so enhance sustainability and regional equality in the EU area (Council Regulation (EC) No 1260/1999). The sample consisted of 37 cases varying from simple construction and renovation projects to more substantial education provision plans (Table 1). In the sampling the main intention was to obtain a representative set of cases for which the funding had been applied via the RDT program. The cases were evaluated by an assessment panel of three people (the authors of this article), who were all familiar with the RIAM method. A specific orientation phase was therefore not needed before the first panel meeting. By means of the panel approach different viewpoints can be brought into the evaluation process thereby diminishing the chance that the decisions represent only the views of just one person. When evaluating impact significance this issue can assume to have exceptionally high importance due to the subjective nature of the concept. The case information, on which we based the significance evaluations in the present study, included 1) a preview of the project and its environmental impacts written by the applicant and 2) a statement by the Central Finland official EIA team, which was consulted before the decision about the possible project funding was made in the Central Finland Regional Council. Full EIAs were not carried out for the sample projects, which is the reason why a more detailed analysis of their environmental impacts could not be used to assist the evaluation process.

Table 1
General categories of the assessed projects.

Categories of projects	*n* of cases
Environmental conservation and restoration	3
Tourism and leisure time	10
Water and waste management	10
Development of countryside	5
Development of populated areas	6
Education and information sharing	3
Total	37

In the scoring process the environmental impacts of the projects were categorised into three components, which were then used to evaluate the overall significance of the impacts of each project. The components used were 1) environmental impacts (including both physical and ecological impacts), 2) social impacts (e.g. impacts on local people's health and safety), and 3) socio-economic impacts (e.g. impacts on employment and economic welfare). For each component a single score was given using two different methods, an unaided evaluation approach and a modified RIAM. The evaluation methods are presented in Sections 2.1 and 2.2. The same assessment panel was used in both methods to enable a rational comparison of the evaluation procedures. Before the actual scoring, discussion about the project being assessed and its features were discussed by the panellists to reach a consensus about the environmental impacts on which the scoring was mainly to be based. Because most of the projects were rather small and technically simple, one or two dominant impacts were often found to characterise the entire project, which was also the reason why more a specific characterisation of the impact of the cases was not considered necessary in the study. The assessment panel met four times, during which the projects were systematically assessed and evaluated by the two different methods. The unaided judgement was conducted during the first meeting, after which the RIAM method was applied.

The assessment data were analysed using non-parametric testing, as RIAM does not give continuous scores. When assessing the applicability of the method, the analysis focused particularly on the changes made in the RIAM framework and how these influenced the results yielded by the method. The weight of the different criteria on the final ES scores was assessed by comparing the ranking of the cases given by the RIAM method as a whole and those given by the different criteria categories separately. For this Spearman's rank correlation coefficients were applied. Differences between the unaided judgement and RIAM were tested separately for each impact component using Wilcoxon's rank test (Zar, 1999). Statistical analysis was conducted in relation to class 0 (“no impact”) to combine both positive and negative impacts. Before the analysis the cases judged inconsistently (one method indicating a positive impact and the other negative one) were excluded from the data on the grounds that the differences were due more to the panel's difficulties in identifying the main environmental impacts than to the method itself. Proportion of these cases was however very small in the study data (environmental and economic impact components 3% (1 out of 36 cases) and social impacts 6% (2/36) respectively), which indicates the high level of consistency of the panel judgements in general. The statistical analysis was performed with SPSS 15.0 software.

2.1. Unaided evaluation

In the unaided evaluation, the impacts of the assessed cases were first classified as positive or negative (+/−), after which the importance of the impacts was further defined using the following verbal and numerical scale: major change (4), significant (3), moderate (2), slight (1), no change (0). Although the same scale was applied to all of the projects, the actual scoring was not systematically guided as with RIAM, but the evaluations were merely based on heuristics and the subjective reasoning of the panellists. Also, the features considered and emphasised during the evaluation varied substantially between the different projects. This is often seen as one of the biggest drawbacks of intuition-based evaluation methods, as the overall results of the assessment tell very little about how the significance determinations are actually made and about the main reasons and assumptions lying behind them.

2.2. Modified RIAM method

The environmental impacts of the projects were assessed using a modified version of the RIAM method. In the present study the method was modified by: 1) adding a sixth evaluation criterion (susceptibility of the target environment, B4) to the evaluation framework and 2) extending the ordinal scales used in criteria class B. With the help of criterion B4 the intrinsic values of the target environment of the project can be brought to the evaluation process and this way make the significance determination more realistic. Susceptibility was placed in criteria class B because it influences the overall significance of the assessed impacts only indirectly, either positively or negatively emphasising the changes expected to be caused by the project. Extra values were added to the ordinal scales of criteria B to decrease their dichotomous nature and to make the entire evaluation procedure more comparable to the actual evaluation phase of the EIA. The scoring framework applied in this study is presented in Table 2. Environmental scores (ES) for the environmental components were calculated from the criteria values using Eqs. (1)–(3) (applying Pastakia (1998)).

$$A_T = A1 * A2 \tag{1}$$

$$B_T = B1 + B2 + B3 + B4 \tag{2}$$

$$ES = A_T * B_T. \tag{3}$$

The levels of significance were further defined according to the ES scores using the point ranges presented in Table 3. The scale was constructed following Pastakia's (1998) principles but taking into

Table 2
Assessment criteria (applying Pastakia, 1998; Kuitunen et al., 2008).

Criteria	Scale	Description
A1. Importance of the impact	4	Important to national interests: area of coverage can be defined as the country as a whole, or the impact target has national/international significance.
	3	Important regionally: area of coverage can be defined as a single region of the country with its immediate surroundings, e.g. Central Finland as a whole.
	2	Important to areas outside the local context: area of coverage can be defined as a part of the region, but nevertheless is bigger than in local impacts. For example, a municipality as a whole.
	1	Important only in the local context: area of coverage is small and can be defined as point-formed, for example a single village inside a municipality.
	0	No geographical or other recognised importance.
A2. Magnitude of change	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change in status quo
	−1	Negative change to status quo
	−2	Significant negative disadvantage or change
	−3	Major disadvantage or change
B1. Permanence of the impact-causing activity	4	Permanent or long-term: the impact is intended to be a permanent one or will last for more than 10–15 years.
	3	Temporary and medium-term: the impact will last approximately 1–10 years
	2	Temporary and short-term: the impact will last only for a short period of time (few weeks or months)
	1	No change/not applicable
B2. Reversibility of impact	4	Irreversible impact: impact has changed the environment permanently or the restoration will last at least 10–15 years.
	3	Slowly reversible impact: impact has changed the environment substantially but restoration can be observed. Total recovery will, however, last for many years.
	2	Reversible impact: the original state of the environment will be restored quickly (in weeks or months) after the activity finishes.
	1	No change/not applicable
B3. Cumulativity/synergism of impact	4	Impact has obvious cumulative or synergistic effects with the other projects or activities occurring in the same area.
	3	Cumulative and/or synergistic impacts exist in the project environment, but the significance of these interactions is still uncertain.
	2	Impact can be defined as single (not interacting with other impacts)
	1	No change/not applicable
B4. The susceptibility of the target environment	4	The target area is extremely sensitive to environmental changes and/or it has intrinsic values with regional or national level significance
	3	The target area is sensitive to environmental changes and/or it has locally significant intrinsic values (outside the actual target area)
	2	The area is stable for the environmental changes caused by the planned project and does not have significant environmental values that should be considered during the evaluation process
	1	No change/not applicable

Table 3
Range bands used for the modified RIAM method.

ES scores	Classification	Description
[108, 192]	+4	Major positive impact
[54, 107]	+3	Significant positive impact
[31, 53]	+2	Moderate positive impact
[1, 30]	+1	Slight positive impact
0	0	No change in status quo
[−30, −1]	−1	Slight negative impact
[−53, −31]	−2	Moderate negative impact
[−107, −54]	−3	Significant negative impact
[−192, −108]	−4	Major negative impact

account the changes made in the scoring system. In the study the ranges were defined as follows:

- An impact represents the lower limit of a major change, if it is regionally important (A1 = 3) and causes major changes in its area of influence (A2 = 3). In addition both the duration and reversibility of the impact can be measured in years (B1 = B2 = 3), the impact accumulates over time or has synergistic effects with other environmental impacts (B3 = 3), and it focuses on areas of the environment susceptible to changes (B4 = 3).
- When an impact is significant outside the local context (A1 = 2), causes major changes in this area (A2 = 3) and focuses on sensitive areas of the environment (B4 = 3), but the consequences can still be defined as temporary and short-term (B1 = 2), reversible (B2 = 2) and single/non-cumulative (B3 = 2), it presents the lower limit of significant change.
- A condition is placed on the upper limit of slight change, if it is only locally important (A1 = 1) but causes significant changes (A2 = 2) that are permanent (B1 = 4), irreversible (B2 = 4), highly cumulative/synergistic (B3 = 4) and focus on a sensitive area of the environment (B4 = 3).
- Impacts of moderate significance lie between the limits of slight and significance change.
- Impacts that have no importance (A1 = 0) or do not change the status quo (A2 = 0) are scored zero.

3. Results

Overall the study data consisted of 37 projects, of which 36 were evaluated by the panel. One project was excluded, because the panellists were not able to form a clear impression about the project

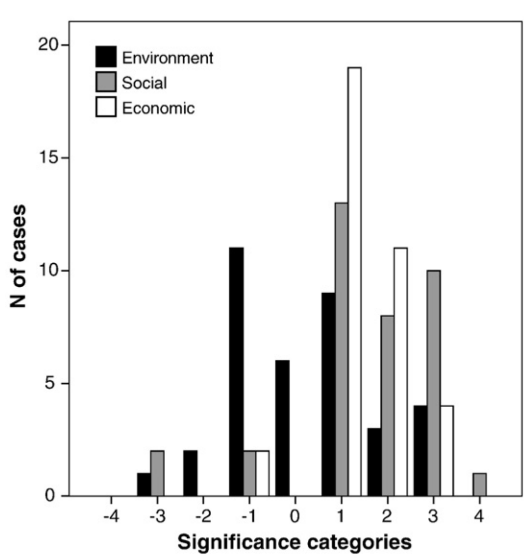

Fig. 1. Significance ratings of the assessed cases using the modified RIAM.

Table 4
Correlations between the impact components in the evaluation data.

		Environment	Social	Economic
Environment	r_s	1.000	0.076	0.024
	P	–	0.661	0.891
	n	36	36	36
Social	r_s		1.000	0.223
	P		–	0.191
	n		36	36

and its main objective on the basis of the background information. The impact significance categories of the projects given by the modified RIAM method are presented in Fig. 1. According to their environmental impacts cases divided rather evenly into the different classes causing both positive and negative impacts in the surrounding area. However, most of the environmental impacts were evaluated as having only low significance and changing the target environment only slightly when compared to the present state. With respect to the social and economic impacts the distribution of cases was clearly different. The great majority of the projects were evaluated as having positive impacts and on average these ratings were also notably higher than the ratings of the environmental impacts. Overall this emphasis on social and socio-economic issues reflects the main aim of RDT, which is especially targeted at increasing the social communality of the local residents and this way enhances the sustainable development in the area. In the study data most of the projects were designed to improve the amenities and social well-being of the local residents, either by taking advantage of the existing social structures and frameworks or via the natural environment and its special characteristics. In turn, the number of projects aiming directly at e.g. nature conservation or restoration was substantially smaller, which explains the low proportion of cases rated as having significant or major environmental benefits. Significant correlations between the impact components were not found in the study data (Table 4), which indicates that the scoring framework of RIAM can reasonably be used to define the importance of these impact types and that they can also be clearly differentiated from each other by the panel.

A methodological examination of RIAM shows the differences in how the different evaluation criteria are expressed in the final significance ratings of the method. In general considerable weight is given to impact magnitude (criterion A2) and areal importance (A1)

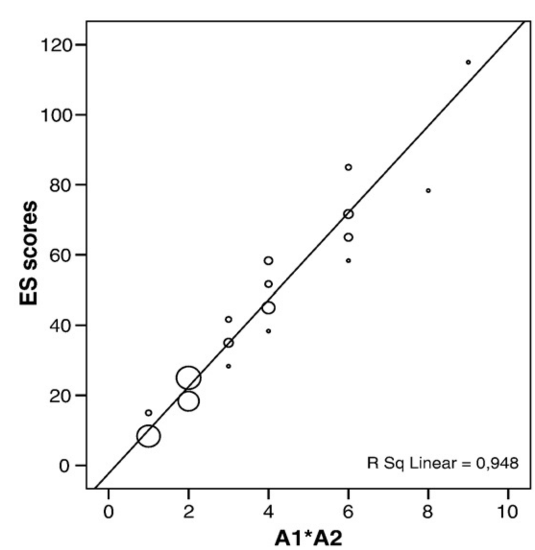

Fig. 2. The dependence between the product of criteria A and the ES scores in the overall study data ($n = 102$). Positive and negative impacts are combined in the figure using absolute values. Cases with no significance (A1 = 0 or A2 = 0) are not included in the figure.

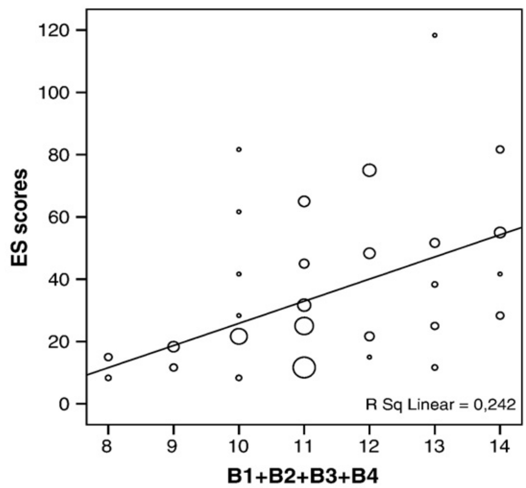

Fig. 3. The dependence between the sum of criteria B and the ES scores in the overall study data ($n = 102$). Positive and negative impacts are combined in the figure using absolute values. Cases with no significance (A1 = 0 or A2 = 0) were not included in the figure.

as the primary determinants of the overall significance of the impact (Pastakia and Jensen, 1998), as can clearly be observed also in the modified RIAM. When the project scores calculated using only these two criteria (following Eq. (1)) and the final ES scores of the method were compared, a very strong positive correlation was found between the case rankings ($r_s = 0.971$, $df = 102$, $p < 0.001$, Fig. 2). With the sum of criteria B (following Eq. (2)) the correlation was notably smaller ($r_s = 0.588$, $df = 102$, $p < 0.001$, Fig. 3) indicating that the values of criteria A1 and A2 explain most of the variation in the final ES scores of RIAM. Thus it can be concluded that the modifications of the RIAM framework did not significantly affect how the different criteria are expressed in the final ratings, but that more drastic changes need to be made to the method framework to alter the relative weights of the criteria groups, i.e. increase the importance of the features assessed in criteria B.

Comparison between the intuitive judgement and the results of RIAM showed marked differences in the significance ratings given to the assessed projects (Fig. 4). As regards their environmental impacts

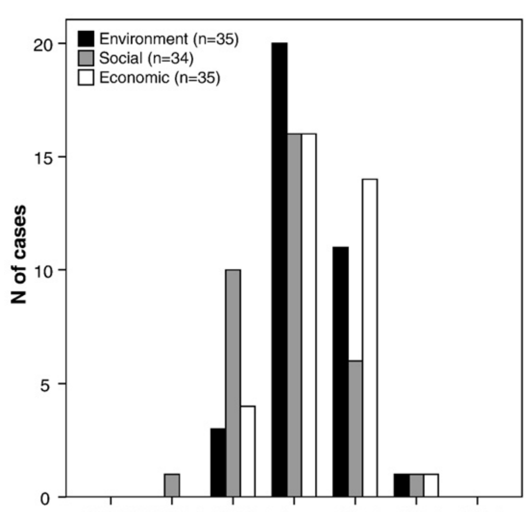

Fig. 4. Case-specific differences in the significance ratings between RIAM and unaided judgement. On the x-axis "Same" indicates that the same classification was given to the impact in both of the methods used, INT+1 significance one class greater was given with unaided judgement than RIAM, RIAM+1 significance one class greater was given with RIAM than unaided judgement etc.

Table 5
Variation in the significance classes between RIAM and unaided evaluation to a) environmental, b) social, and c) economic impact components.

a)

		Unaided evaluation							Total
		−3	−2	−1	0	1	2	3	
RIAM	−3	1	0	0	0	0	0	0	1
	−2	0	2	0	0	0	0	0	2
	−1	0	5	4	2	0	0	0	11
	0	0	0	0	6	0	0	0	6
	1	0	0	0	0	3	4	1	8
	2	0	0	0	0	0	1	2	3
	3	0	0	0	0	0	1	3	4
Total		1	7	4	8	3	6	6	35

b)

		Unaided evaluation				Total
		−2	1	2	3	
RIAM	−3	2	0	0	0	2
	1	0	8	5	1	14
	2	0	1	5	1	7
	3	0	1	6	3	10
	4	0	0	0	1	1
Total		2	10	16	6	34

c)

		Unaided evaluation				Total
		−3	1	2	3	
RIAM	−1	1	0	0	0	1
	1	0	10	9	0	19
	2	0	3	3	5	11
	3	0	0	1	3	4
Total		1	13	13	8	35

Cases of inconsistent evaluation are not included in the table.

the same classification was given in 56% (20 projects out of the total of 36) and 44% (16/36) of cases to both social and economic impacts, respectively. A pairwise comparison test showed statistically significant differences in both the environmental (Wilcoxon $Z = -2.357$, $n = 35$, $P = 0.018$, Table 5a) and economic impacts ($Z = -2.558$, $n = 35$, $P = 0.011$, Table 5c). In these components the significance classes obtained by using RIAM were significantly smaller than those of intuitive judgement. For social impacts an obvious pattern was not found, but the ratings diverged more between the two methods tested ($Z = -0.808$, $n = 34$, $P = 0.419$, Table 5b). Based on these results RIAM seems to be a fairly conservative method, which rather underestimates than emphasises the significance of impacts when compared to intuitive judgement. However, with individual projects significance ratings seldom varied by more than one class one way or another, which suggests that the two evaluation methods were markedly consistent about the assessed impacts and their significance.

4. Discussion

4.1. Application potential of the RIAM method

In this study one new evaluation criterion and extended ordinal scales were introduced into the RIAM framework to increase the application potential of the method. The apparent influence of the changes, however, remained rather small. This is mainly due to the different expression of the criteria categories, which weights the impact characteristics defined in criteria class A substantially higher than in class B. Despite the predominance of criteria A in RIAM it should not be explicitly concluded that the other criteria used in the assessment are insignificant for the assessment process. When the significance determinations are made, the relevance of the actual assessment process assumes an important role, as the evaluations have to be grounded and justified to the stakeholders involved in the EIA. When considered in this light, the criteria B bring depth to the assessment and force the project executives or environmental authorities to evaluate the environmental impacts with reference to many different features which might otherwise be excluded from the assessment. In addition the impact magnitude and its area of coverage often form the basis for the overall characterisation of impact and the determination of its significance, which also justifies their heavier weighting in the evaluation process.

With the help of criterion B4 (susceptibility of the target environment) the intrinsic values of the target area, which among the general public are often one of the most essential elements when judging the predicted impacts and their significance, can be more explicitly brought to the evaluation process. In the assessment panel criterion B4 proved to work well in the assessment situation, in which the impacts were evaluated in a holistic way using large impact entities, such as overall environmental or social impacts. Despite the subjective elements of the criterion clear arguments and examples could be found for each of the criteria values, which in turn helped the panellists to define the basic guidelines for the evaluation of the criteria. The principles used in the assessment panel with respect to criterion B4 can be expressed as follows. With environmental impacts the susceptibility of the target area was mainly assessed by considering how the project is going to affect the natural values of the target area. Roughly the basic principle was that if a planned project could be estimated to affect, either directly or indirectly, an area having nationally or regionally significant natural values (national parks or other nature conservations areas, occurrence of nationally endangered species, environmental habitats conserved by law etc.) larger values (3 or 4) were given to criterion B4. For the social impacts a similar guideline was formed by defining how the costs and benefits of the project are going to divide among different population segments. In this study segments defined as particularly susceptible to the changes were e.g. families with children, old people and the unemployed. For the economic impacts, the determination of susceptibility was mainly based on the development status of the area. If the area had or was lacking a technical infrastructure or e.g. basic social structures, which might emphasise the impacts of the project, larger values were given to the criterion. The principles used in social impact assessment were also applied to the economic impacts, if clear connections could be found between the social and economic impacts of the project (e.g. projects aiming mainly at the employment of the long-term unemployed).

In general the assessment context and the amount of applicable data significantly affect how complex a scoring system can be used and how many attributes can reasonably be included in the evaluation process. This was also noticed in the present study. When only limited background data exist to support the evaluation process, the scoring framework should not be applied at too detailed a level to ensure that the scores can be clearly grounded in specific criteria values. However, when more comprehensive data can be used and it is therefore possible to define the impacts in more detail, more exact criteria, e.g. describing an impact probability or its temporal variation, can be added into the RIAM framework to increase the comprehensiveness of the assessment in general. Overall this aspect shows the flexibility of the method, as the evaluation process can easily be modified by the decision-maker in accordance with the characteristics of the project at hand. The same applies to the ordinal scales used with the different criteria, i.e. the breadth and accuracy of the range values should always be related to the overall level of the assessment to ensure clear and transparent results; nevertheless with more closely defined criteria the method can better be used to distinguish impacts and to offer more accurate evaluations.

Technically the modification of RIAM encountered difficulties especially in defining the range scale used to classify the final ES scores, an issue that may significantly hinder the applicability of the method. Because the range values depend on the contents of the criteria, the value scale has to be reconstructed every time the scoring framework is changed. This problem was also noticed by Pastakia and Madsen (1995). In the present study a solution to this problem was not attempted, but the ranges were constructed subjectively as in the original RIAM method. However, when the number of evaluation criteria and the point scales used in different criterion are more substantially extended, this comes significantly harder. More explicit and straightforward methods of classifying the ES scores thus need to be developed to enhance the applicability of RIAM and its ease of use.

4.2. Comparison of intuitive judgement and RIAM

Notable differences were discovered between the significance evaluations conducted using the RIAM method and those relying more on the intuitive judgement of the panellists. In the present study context the reasons lying behind these differences are hard to explicitly define because of the subjective nature of the evaluation process. In general, however, two complementary explanations for the results can be given. As stated by Bell et al. (2001), there is a risk that rational methods either oversimplify the subjective elements of a sophisticated decision-making process or, alternatively, produce a more systematic and balanced assessment because different issues can more equally be taken into consideration when compared to an unaided judgement. In both cases the rationale behind the reasoning is somewhat different between the methods, which in turn gives rise to differences in the final judgements as well. In this study the evaluations were mainly based on rather cursory and approximate project data, which made an explicit impact characterisation harder to achieve and tended to place much emphasis on the subjective reasoning of the panellists. This can also be seen as an important factor behind the variation observed in the results. The simple nature of the projects, however, enabled a clear definition of the most important single impact to be used in evaluating the significance of the impact component as a whole, which kept the amount of substantial differences at a rather low level in the evaluation data. In addition the assessment process was further systematised by relating the panel judgements to the statements by the Central Finland EIA team, in which impact significance was also considered. In this way variation caused by misinterpretation of project features could be minimised, making it possible to examine the differences between the actual methods tested. In many cases the statements however lacked aspects considered in the assessment panel, which is why the subjective judgement of the panellists was also needed.

Although the differences between the two methods can partially be explained by inconsistent impact definition and thus by case-specific random variation, the systematic patterns observed in the data, however, indicate that more technical issues may also lie behind them. One feature which is often acknowledged to significantly affect impact evaluations is the scale of the impacts. Impact definition and significance determination are generally seen as highly scale-dependent features and thus their characteristics may also vary depending on the scale on which the assessment is performed (João, 2007). Problems especially arise if impacts with different levels of coverage need to be simultaneously compared. Typical errors at this stage are either an exacerbation of impacts with national or global significance, which may cause underestimations or even negligence of impacts important locally, or vice versa when all the possible alternatives to a nationally important project might be rejected due to the significant negative impacts perceived on the local scale (Antunes et al., 2001). In RIAM, impacts are scaled mainly via criterion A1, which defines the coverage of the impact. The ordinal scale of the criterion is widened from point-level impacts to issues of global significance, which may in principle lead to the first problem presented above, i.e. in the RIAM framework, and to achieve ratings with a bigger overall significance at least regional level importance is demanded. In the present study most of the assessed projects concerned small-scale actions, e.g. how the social amenities of a single village and their residents could be improved. Regionally or globally their impacts are clearly a lot smaller. With projects that are important only in a clearly defined area there is a risk for underestimations of impact significance if a large evaluation scale is used. In its original form the RIAM method takes scale-dependence rather poorly into consideration, which may in certain circumstances notably distort the evaluations made.

Overall the variation in the study data shows how difficult it actually is to rationalise a complex decision-making process, where many aspects have simultaneously to be taken into consideration. This was observed also by Hajkowicz (2007) who compared the project rankings of 16 MCA methods to the intuitive judgement of the decision-makers. The results showed marked differences in the project rankings with rational models having a significant impact on the final results of the evaluation. Despite the observed differences Hajkowicz's study also found rather high consistency between the rankings obtained from the methods, a result which shows that many of the essential aspects in environmental decision-making can be to some degree formalised using explicitly defined assessment frameworks. This conclusion is also supported by the present results. However, owing to the variation in the results between different methods, it has been widely acknowledged (Cloquell-Ballester et al., 2007; Hajkowicz and Higgins, 2008; Hobbs et al., 1992; Vreeker, 2006) that the application of a single method may not offer a sufficient solution to a complex decision-making task. Therefore it is often recommended that many different methods and frameworks should be applied in the same problem context not only for the purpose of finding a consensus between the participating stakeholders but also to identify the main elements causing conflicts (Kangas et al., 2001). In practical decision-making it should also be remembered that rational methods present only a simplified picture of the real world, which is why the final results of these methods should always be carefully reviewed by the participants to evaluate their reasonability and how they relate to the participants' personal values. Considered this way the use of MCA methods could be interpreted not as giving absolute answers, but as offering a framework on which the discussion about the environmental impacts of a proposed project can be based (Bazerman, 1986; Hajkowicz, 2007).

5. Conclusions

Impact evaluation and significance determination pose substantial challenges to many environmental professionals both those working with EIA and those in other areas of environmental management. Often a central question in these processes is to maximise assessment accuracy while simultaneously ensuring that the results obtained remain understandable. RIAM is one of the methods that have been developed to find a balance between these issues. Although the RIAM method is technically simple when compared to many other MCA methods presented in the literature, this does not significantly hinder RIAM's application potential in the field of environmental management. As both Janssen (2001) and Hajkowicz (2008) have concluded even the simpler evaluation methods usually offer an adequate basis for the decision-making process, as long as the formulation of the problem and justification of the decisions can be clearly presented together with the final results. When evaluating impact significance this conclusion is further emphasised by the value-based nature of the concept. In this study the RIAM method was applied to a problem context, where impact evaluations need to be made only with an approximate and inaccurate baseline data and much emphasis is therefore laid on the judgement of the evaluators. In practical EIA work this situation is rather common especially in the early stages of the process when decisions often need to be made before the actual data collection phase relying thus heavily on the expertise of environmental professionals. In these situations transparent methods like RIAM can have notable advantages as expert judgements can be explicitly recorded and used, if needed, to justify the decisions made.

The study exemplified how the RIAM method can be modified with respect to the assessment situation at hand and thus be made more responsive to the demands of the evaluation process itself. With a more flexible scoring framework and evaluation criteria it is possible for an evaluator to more closely define the aspects he wants to bring to the analysis while taking advantage of the transparent basic structure of the method. The comparison of the RIAM method and unaided judgement showed that the essential conceptual characteristics of impact significance can be captured and assessed with RIAM, although some differences were also observed in the results. In particular, the conservative character of RIAM observed here should be better confirmed in the future. Technically the study highlighted the need for developing more explicit ways of classifying the ES scores given by RIAM, which would in turn ease the application of the method on a practical level.

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