Oecologia
Montana 2000,
9, 29 - 35

Using specialists or stakeholders to select indicators of environmental change for mountain areas in Scotland and Spain

N.G. BAYFIELD[1], G.M. MCGOWAN[1] and F. FILLAT[2]

[1]*Centre for Ecology and Hydrology, Banchory, Aberdeenshire AB31 4BY Scotland;* [2]*Instituto Pyrenaico de Ecologia, Jaca, Spain*

Abstract. A decision tree of possible indicators of environmental change (social, economic and ecological) was prepared for mountain areas in Spain and Scotland. Separate groups of specialists and stakeholders used the decision tree to identify key indicators for three different sizes of sample area in each country. There were many differences in the priority indicators selected by the two groups both within and between countries, reflecting a wide range of local issues and concerns. However, there were some indicators in common between stakeholders and specialists and also between Scotland and Spain.
Key words Decision modelling, key indicators, Pyrenees, Cairngorms

Introduction

Key indicators of environmental change are favoured by the EU and the OECD as a potential means of identifying, integrating and comparing the effects of social, economic and ecological pressures on the environment (UNCED 1992, OECD 1994, EEA 1995). The DPSIR model currently favoured by Statistical Office of the European Communites differentiates between indicators for Driving forces, Pressures, States, Impacts, and Responses (Eurostat 1999). Although these approaches are being enthusiastically adopted by many agencies, there has been little scientific underpinning of the concepts and many practical difficulties remain (Crabtree and Bayfield 1998). Outstanding concerns are that there is

- little agreement on how indicators should be selected; by consensus, by policy makers or by specialists;
- confusion over the most appropriate scale for indicators (local, regional national or international);
- little guidance on how to ensure that indicators are appropriate.

This study explored some of these issues in the context of mountain areas in Scotland (Cairngorms Mountains) and Spain (Pyrenees). The approach was to use a standard protocol for selection of indicators and compare those chosen by groups of specialists and stakeholders. The protocol involved the use of a decision tree of indicators selected in a pilot study. The specialist and stakeholder groups used the decision tree to prioritise the indicators at each level of branching. The same protocol was used in three areas in each country, ranging from about 10-5,000 square kilometres. This provided a comparison of indicators for different size areas, as well as indicators that might be common between Scotland and Spain. The results also identified differences and similarities in the choices of specialists and stakeholders

Methods

The decision tree

The decision tree comprised 80 indicators grouped by four levels of branching (Figure 1). The structure and composition of the tree was the result of three preliminary workshops involving ecologists, hydrologists, statisticians, environmental economists and sociologists. At each workshop the tree was examined, tested against trial areas and modified as necessary. Initially the workshops used the Decision Explorer and VISA software packages (Banxia 1997, Visual Thinking International 1998) but later a paper-based scoring system was developed that permitted individual scoring rather than consensus scores. Scores were written directly onto printouts of the decision tree. This approach was quick to complete and provided information about the variation in opinion between group members. The final tree included a fairly comprehensive list of generic indicators of change suitable for a wide range of mountain area situations. Many other arrangements of the tree could however have been possible and might have been equally effective.

At the first level of branching indicators were classified by social and political, economic and natural capital disciplines. Each of these disciplines was then subdivided into major topics and issues and then into generic indicators of change (Fig.1). A written definition of each level of the hierarchy and of the individual indicators was provided to avoid ambiguity.

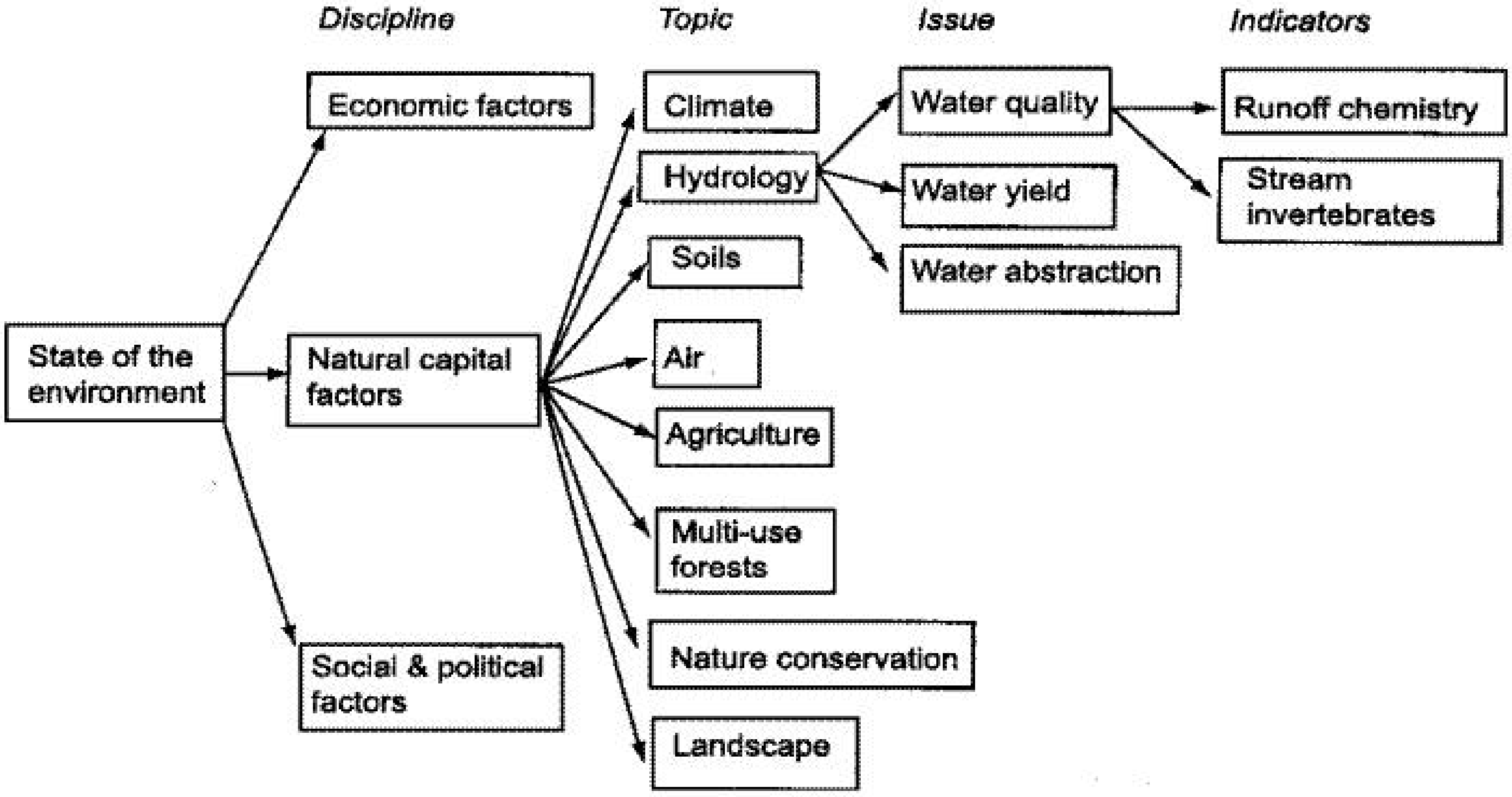

Fig. 1. Part of the decision tree showing the hierarchy leading to indicators for water quality. The complete tree had 80 indicators.

Decision conferences

The tree was used in a decision conference setting by groups of 8-10 people, a facilitator and minute taker. The groups were asked to prioritise individual indicators separately for three different scales of area. The smaller areas were nested within the largest. The groups first discussed the areas under consideration to explore the range of perceived impacts and threats. Then each member of the group independently ranked the relative importance of the elements at each level of the decision tree for each of the areas. Scoring started at the level of disciplines and proceeded from there across the tree (Fig. 1). At each branching point every contributing element was ranked against every other element at that point on a scale of 100 (highest priority) to 0 (no priority). One element always had to be scored as highest priority (100) and other elements at that branching point were scored relative to the highest. There could also be more than one element with the top priority score. If there was only one element at a particular branch point it automatically scored 100.

After completing the scoring for the whole tree, the group discussed individual scores, particularly those that differed substantially from the group mean. After this discussion individuals could re-score elements if they wished, but were not obliged to do so. This often resulted in reduced variation between individuals. By use of a spreadsheet and a simple arithmetic normalising procedure the priority of each element of the hierarchy could be compared on a 0-100 scale. The range of opinion could be gauged from individual's scores and the effects of the discussion of scores could be assessed from the changes to individual scores.

Group composition

Workshops were conducted in Spain and Scotland with the same team of 8 specialists from the two countries to provide consistency. The specialists comprised ecologists, hydrologists and environmental economists. Then in each country an identical workshop was conducted with groups of local stakeholders, including planners, farmers, regulators, foresters and recreation managers.

Study areas

In each country there were three sites, small (about 10 km^2) medium (170- 300 km^2) and large (2,000-5,000 km^2) (Table 1). The sites were chosen to provide contrasts in land use as well as in area.

In Scotland, the small area was the Allt a'Mharcaidh catchment where the main land uses were nature conservation and environmental monitoring research, with small numbers of recreationists visiting the site for hiking (Bayfield and Conroy 2000) (Fig. 2). There was no resident population. The medium area was around the large tourist village of Aviemore and included a ski area and both recreational and commercial forests. There was also some agricultural land and some land managed for hunting deer and red grouse and for fishing. The large area was the Cairngorms region corresponding to the boundary of the Cairngorms Partnership Area (Cairngorms Partnership 1999) and including several tourist villages. This larger area included two further ski areas and large tracts of land used for hunting and nature conservation

In Spain the small area was around the tiny village of Fragen, which was used for small-scale tourism, and for agriculture (mainly

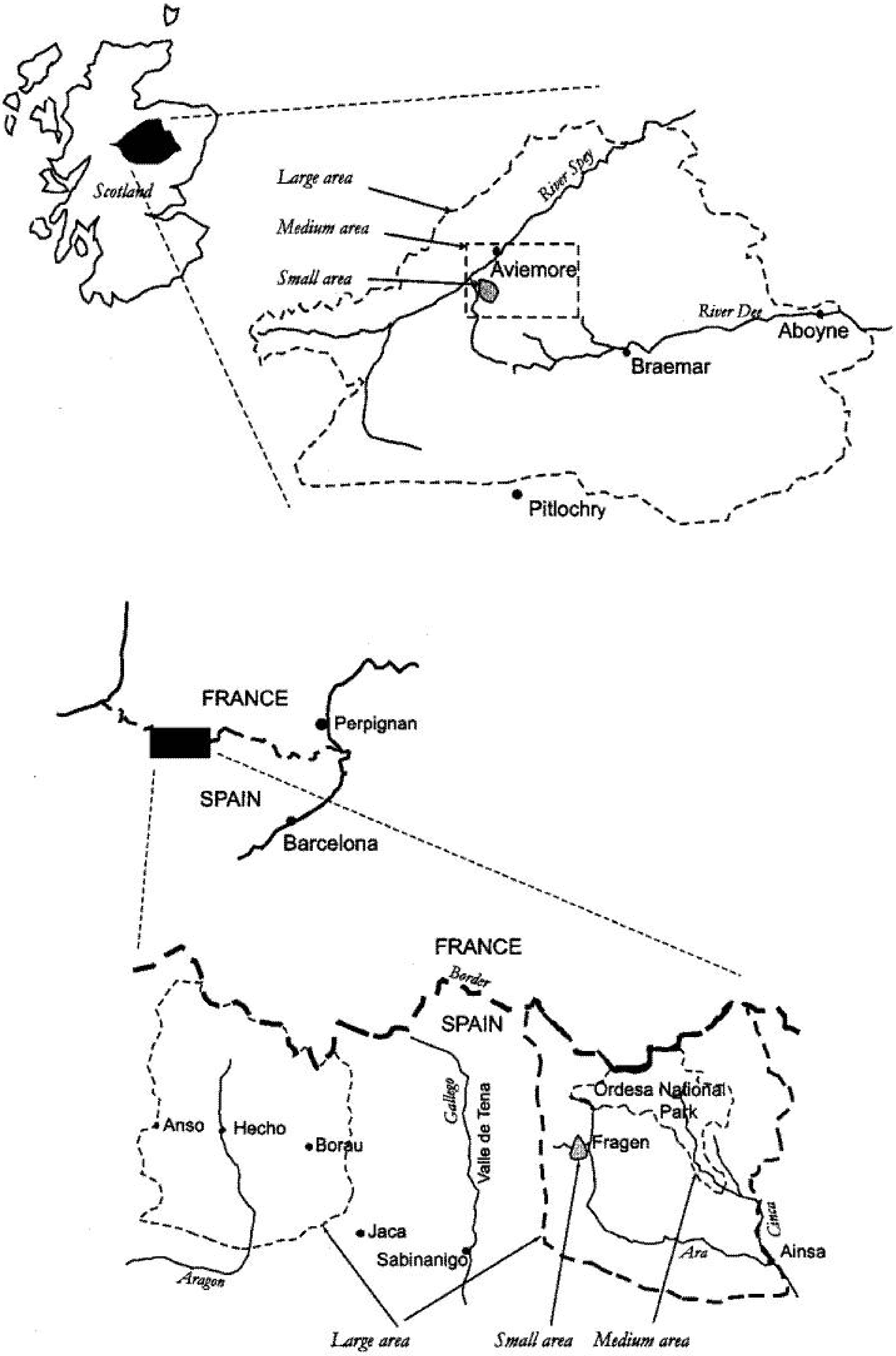

Fig. 2. Location maps for the Scottish (above) and Spanish (below) study sites.

	Scotland area: small	medium	large	Spain area: small	medium	large
Area (km^2)	10	300	5000	12	170	1950
Population density ($/km^2$)	0	100	3	3	<1	3
Land use concerns						
Skiing		*	*			*
Tourism		*	*	*	*	*
Nature conservation	*	*	*		*	*
Forestry		*	*			*
Fishing / hunting		*	*			*
Recreation	*	*	*	*	*	*
Arable agriculture		*	*	*		*
Grazings		*	*	*	*	*
Water abstraction						*
Abandonment				*		*
Traffic					*	

Table 1. Comparison of the size, population density and land use concerns at the sample areas in Scotland and Spain.

cattle). Transhumance was still practised but there was abandonment of much of the terraced land around the village. The medium area comprised the Ordesa National Park where there was tourism, recreation and grazing but no hunting, and strict controls on development. The large area included the National park, a ski area and areas managed for forestry and grazings. This area comprised two parts of about equal size, separated by the Vallé de Tena. It included the Hecho, Aragüés, Anso, Aisa, Puertolas, Añisolo,

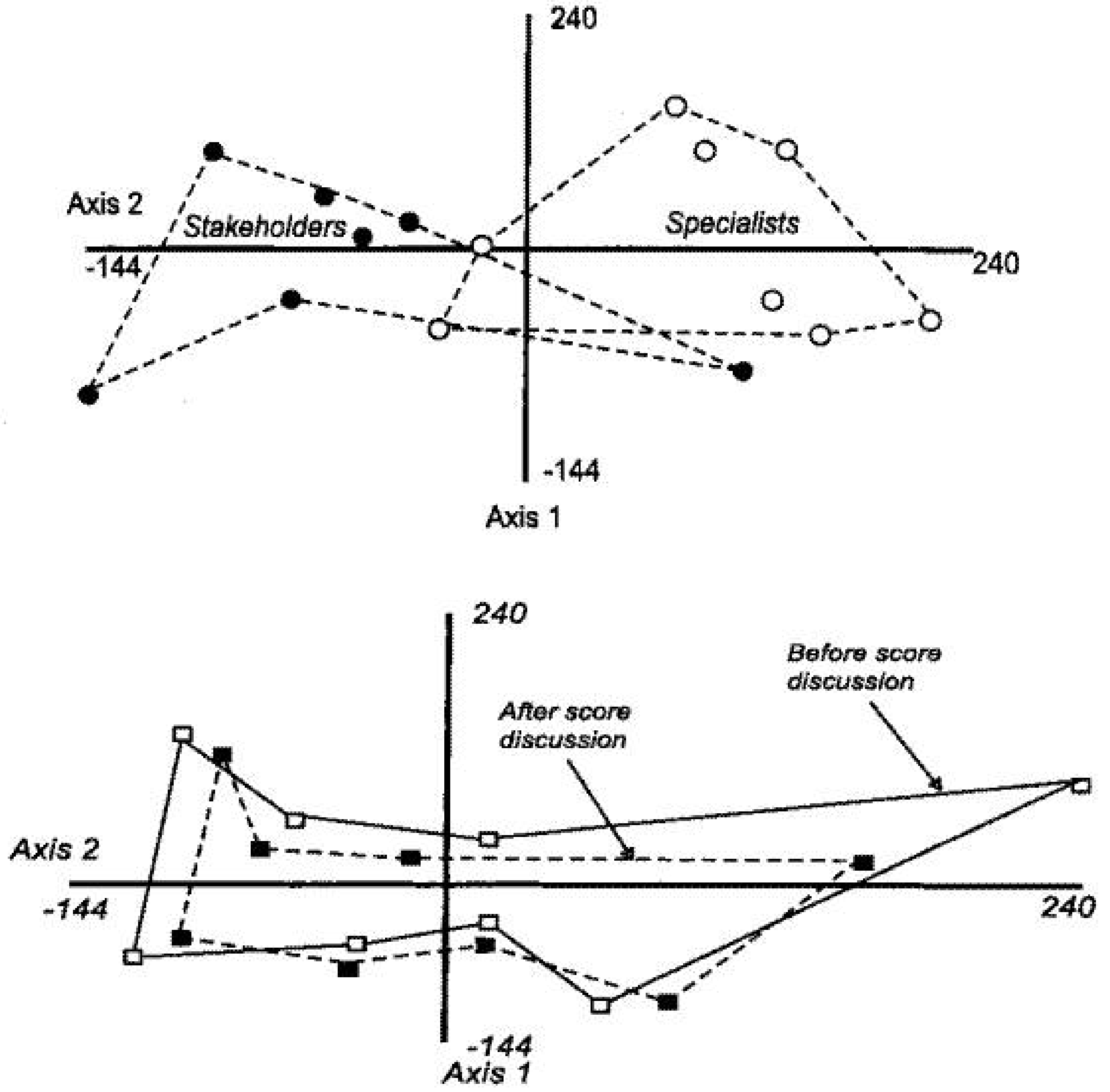

Fig. 3. (Above) Principal coordinates analysis plots of stakeholder and specialist scores for the medium areas in Scotland and Spain. Each point is based on all the scores for one individual. (Below) Plots for specialists before and after the final discussion of scores for the medium area in Scotland. Solid lines demarcate points before, and dotted lines after the final discussion.

Broto and Pineta valleys and both tourist and agricultural villages. Some arable agriculture was also practised and some hunting. Parts of the area were used for water abstraction for irrigation and for domestic and industrial use in lowland areas.

Results

Scoring consistency

The analysis method adopted identified the scores allocated by each member of the group, and the extent to which scores were modified after the second discussion period. The results showed that there was often quite large variation in scoring between individuals. The variation can be illustrated by Principal Coordinates Analysis (Kovach 1999) diagrams of the scores for each individual in the group. Figure 3 shows plots for both specialists and stakeholders for the medium size area in Scotland. There was considerable variation between individuals, although the distributions for specialists and stakeholders were quite distinct. The plot for the scientists group before and after discussion of the final scores illustrates how individuals adjusted their scores. Some showed more change than others. The overall positions of the clusters were little affected but most individual points tended to move slightly closer together, indicating greater agreement.

Numbers of indicators selected

Clearly it would be possible to select a fixed number of priority indicators for each site. However, this would have the disadvantage that at some sites indicators could be included with quite low scores. Instead it was decided to select all indicators above a certain score, even though this meant that some sites had more indicators than others. The number of indicators of course increased as the score cutoff level was reduced (Table 3). For example, for the large area in Scotland the specialists only selected 13 indicators with scores of > 70 but 44 had scores of >50.

Most of the comparisons that follow were based on a cutoff score of >60, but this was largely an arbitrary decision.

	Area:								
	small			**medium**			**large**		
Score >	70	60	50	70	60	50	70	60	50
Cairngorms									
specialists	4	6	8	14	28	47	13	27	44
stakehold.	3	4	7	7	11	20	8	16	25
Pyrenees									
specialists	15	23	37	26	40	53	28	44	54
stakehold.	19	33	47	36	52	62	34	55	68

Table 2. Numbers of indicators for the small, medium and large areas in Scotland and Spain with scores of >70, >60 or >50.

For all cutoff values, substantially more key indicators were identified at the Spanish sites than in Scotland irrespective of the group making the assessment. Interestingly the stakeholders in Scotland identified fewer indicators than the specialists in Scotland but in Spain the opposite was true.

The range of indicators scoring >60 for the large areas in Scotland and Spain is given in Table 3. This shows that there were many indicators that only had a high score for one of the groups or sites. However, there were a number that scored highly for both countries and sites.

Agreement between specialists and stakeholders

Within country comparisons

Within Scotland between about a third and a half of the indicators scoring >60 in the three areas were selected by both specialists and stakeholders (Table 4). In Spain the range of agreement was from about 40% for the small area to nearly 70% for the large area.

Between countries comparison

The numbers of indicators >60 common to specialists in Scotland and Spain varied with the size of area (Table 5). There were few in common for the small areas, but 20-21 for the medium and large areas. The stakeholders also identified considerably more for the medium and large areas.

There were also a number of indicators which were common to both groups. These varied from one for the small areas to 12 for the large areas (Table 6). There were more such indicators for natural capital than for economic or social and political factors. This presumably reflected the perceived importance of natural capital factors in these mountain areas by both groups.

Reducing the priority score cutoff to >50 would, however, add a number of mainly economic and social and political indicators including Employment statistics, Traffic flows, Planning applications, Grant uptake by sector, Primary sector, River invertebrates and Agricultural areas.

Discussion

In both countries the specialists chose proportionately more natural capital than economic or social and political indicators. This could possibly have reflected the high proportion of natural scientists in the assessment group (6 out of 8 were hydrologists or ecologists). However, a higher proportion of natural capital indicators were also selected by the stakeholders, who had more varied interests and backgrounds. The possibility of bias amongst groups is, however, a serious concern and may warrant further investigation.

It was clear that stakeholders and specialists had different priorities. The group making the decision about indicators can therefore have

	Specialists		Stakeholders	
	Scotland	Spain	Scotland	Spain
Natural capital				
Meteorological data	60			
Run-off chemistry				79
River invertebrates		65		68
Hydrographic data				81
Abstraction rates				69
Sediment loadings				62
Erosion events				74
Avalanche records				63
Agricultural land use		90	64	61
Agricultural stock		67		72
Agri-envir. scheme uptake		73		81
Agri-envir. scheme impacts		78		73
Forest types, areas	75	61	74	85
Biodiversity funding	62			65
Timber production			61	65
Areas of habitats	90	95	66	75
Habitat condition	98	100	84	96
Key species data	91	93	88	81
Key groups	90	85	91	88
Damage to habitats		63		72
Walkers on key routes		69		72
Other recreation use				75
Path & site condition		64		69
Landscape fabric	68	98	87	91
Landscape visual impacts	76	98	98	87
Economic factors				
Primary sector		95		
Secondary sector		73		
Tertiary sector		98		70
Per capita income		66		
Income support numbers	61			
Employment statistics	73			
Cost/job	65			73
Agri-envir. grant uptake		85		80
Grant impacts		73		77
Other grant uptake	70	92		69
Regional budget		76		76
Local development funding	66	68		
New business starts	71		69	
Capital sources/levels		67	67	61
Use of walking routes		62		75
Public transport data		81		79
Property occupancy	75	87		83
Visitor numbers	68	78	65	89
Traffic flows		86		76
Tourist activities	78	80	70	67
Game/fishing kills				64
Social and political factors				
Organisation memberships				72
Stakeholders views	74	95	78	87
Planning applications	65	71		75
Regulation compliance	71	84	61	86
Property register	84	68	63	62
Employment statistics	66	70		
Cost of housing				82
Housing plan applications				63
Local services	71	80		69
Cost of living	64	65		63
Population size	61			83
Population structure	68	69		78
Population distribution	62			
Damage to sites		70	75	80
Cultural funding	69			62
Cultural events attendance				64

Table 3. Lists of indicators with scores of >60 for the large areas in Spain and Scotland.

	Area: Small	Medium	Large
Scotland	3(43%)	9 (37%)	12 (48%)
Spain	15(38%)	33 (57%)	38 (66%)

Table 4. Numbers of indicators with scores >60 common to both specialists and stakeholders. Figures in parentheses are % agreement.

Area:	small	medium	large
Specialists	1	21	20
Stakeholders	4	10	16
Both groups	1	8	12

Table 5. Indicators for Scotland and Spain with scores of >60 from both specialists and stakeholders.

Indicator	Area: small	medium	large
Natural capital factors			
Areas and types of forest		*	*
Areas of habitats		*	*
Habitat condition		*	*
Key species		*	*
Key groups	*	*	*
Landscape fabric		*	*
Landscape visual analysis		*	*
Economic factors			
Visitor numbers		*	*
Tourist activities			*
Social & political factors			
Survey of views		*	*
Regulation compliance			*
Property register			*

Table 6. Indicators scoring >60 common to both countries and assessment groups.

a substantial influence on the outcome and this could have both political and resource implications for implementation of environmental monitoring.

Each of the areas had different characteristics so it is not surprising that each had a distinct set of priority indicators. Nevertheless there may be scope for some limited comparisons between areas and even between countries on the basis of the common indicators. It appears that such indicators are more likely to be appropriate to large areas rather than small ones. The usefulness of such indicators requires testing at other sites. There were quite a few similarities between the Scottish and Spanish sites (such as skiing, forestry, hunting and tourism) as well as their differences. Mountain areas in other countries might have much less in common.

Overall the study has tested a methodology that might be further developed to identify indicators of environmental change for mountain areas. It is likely that most mountain areas will probably need a specific set of indicators as well as a general purpose set that could permit comparisons with other areas.

Acknowledgements

We thank colleagues Jim Conroy, Atul Haria and Carolyn Sullivan for helping develop the decision tree, Daniel Gómez,, Begoña Alvarez, Bernardo Alvera, Ricardo Garcia-González and the two groups of stakeholders for contributing to the workshops, and the Centre for Ecology and Hydrology for funding the study as a contribution to the CHASM programme.

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Received 7 August 2000; accepted 22 August 2000