PRESENTED TO THE STOCKHOLM WATER CONFERENCE, AUGUST, 1995

A RAPID ASSESSMENT MATRIX FOR USE IN WATER RELATED PROJECTS.

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Abstract

The paper describes a rapid matrix method, used in a holistic manner to provide an assessment of possible environmental impacts. The system has been created to provide a means by which qualitative analysis can be expressed in a semi-quantitative manner, and so provide a record of the analysis which is both transparent and permanent. Such a system overcomes the problems of the traditional approach to qualitative assessments, which rely on the expertise and experience of the assessor and the quality of the record left behind. This new method is highly flexible, and useful in cases where the database is poor (for whatever reason), so permitting EIA records to be developed to assess specific project issues, and be re-assessed with time. Because of the open nature of this rapid impact assessment matrix (RIAM) even subjective judgements can be recorded, and full transparency of the EIA is guaranteed.

The system is based on scoring impact components against pre-defined criteria, and transposing scores into ranges describing the degree of positive or negative impacts. The system does not require major changes to the methods used by assessors in present impact assessments; but adds an analysis and presentation component to any existing methods. Each component is evaluated against each criteria and the value recorded in the matrix. Using the RIAM formula, the score for each component is then derived. The matrix thus provides a transparent record of the judgement process.

The RIAM is ideally suited to EIA where a multi-disciplinary team approach is used, as it allows for data from different sectors to be analyzed against common important criteria within a common matrix, thus providing a rapid, clear assessment of the major impacts. The system provides a means by which a profile of an impact condition can be developed, allowing rapid comparisons of development options to be made.

The system has been tested in studies on river and coastal developments, and was found to provide a rapid and reproducible basis for assessment of the conditions by highlighting changes, and in comparing impacts from different planning options.

Introduction

Environmental impact assessments (EIA) of projects are important in securing long-term positive benefits to the projects concerned. For an EIA to be of value, the assessment should be undertaken on relevant aspects of the project, and early in the planning stages (World Bank 1988, Danida 1994). Environmental impact assessment of projects has traditionally relied on subjective conclusions from data analysis of primary field data and secondary data sources. The sources of data may be poor: particularly in areas peripheral to project sites, and in developing countries, where it is often impossible to obtain reliable baseline data on ecological and social aspects.

In conducting any environmental impact assessment where reliance has to be placed on incomplete secondary data, and where no possibility exists for independent confirmation, or for primary data collection, the assessment must tend to be subjective (Gilpin 1995). This subjectivity can provide a competent analysis of the probable changes and effects, but suffers in that it is neither reproducible nor transparent.

It is necessary to ensure some degree of transparency and objectivity in the qualitative assessment and evaluation of the impacts on projects (in particular development projects where data may be scarce and implementation may take a number of years). EIA evaluations need to be re-assessed with the passage of time, and the data contained therein should be open to scrutiny and revision as new data becomes available. Wholly subjective and descriptive systems are not capable of such revision, dependent as they are on the expertise and experience of the original assessors and on the quality of the descriptive record left behind.

This paper describes a system of scoring within a matrix that has been designed to allow subjective judgements to be quantitatively recorded, thus providing both an impact evaluation and a record that can be re-assessed in the future. The system is ideally suited to EIA where a multi-disciplinary team approach is used (Morris & Biggs, 1995), as it allows for data from different components to be analysed against common important criteria within a common matrix, thus providing a rapid, clear assessment of the major impacts.

Material and methods

The system is based on the definition of the important assessment criteria and environmental components within the project area; as well as a means by which values for each of these criteria can be collated to provide an accurate and independent score for each condition. The impacts of project activities are evaluated against the environmental components, on a without/with project basis. For each component a score (using the defined criteria) is determined, which provides a measure of the benefit/dis-benefit of the activity on the component.

The important assessment criteria fall into two groups:

(A) criteria that are of importance to the condition, and which can individually change the score obtained

(B) criteria that are of value to the situation, but individually should not be capable of changing the score obtained

The scoring system requires simple multiplication of the scores given to each of the criteria in group (A). The use of multiplier for group (A) is important for it immediately ensures that the weight of each score is expressed, whereas simple summation of scores could provide identical results for different conditions.

Scores for the value criteria (group (B)) are added together to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all values (group (B)) are fully taken into account.

The sum of the group (B) scores are then multiplied by the result of the group (A) scores to provide a final assessment score (ES) for the condition. The process can be expressed:

(1) (al)x(a2)x(a3)x...(aN) = aT

(2) (b1)+(b2)+(b3)+...(bN) = bT

(3) (aT)x(bT) = ES

Where:

(a1)...(aN) are the individual criteria scores for group (A)

(b1)...(bN) are the individual criteria scores for group (B)

aT is the result of multiplication of all (A) scores

bT is the result of summation of all (B) scores

ES is the assessment score for the condition

Benefit and dis-benefit can be obtained by using scales that pass from negative to positive values through zero for the group (A) criteria. Zero thus becomes the 'no-change' or 'no-importance' value. The use of zero in this way in group (A) criteria, allows a single criterion to isolate conditions which show no change or are unimportant to the analysis.

Zero is a value avoided in the group (B) criteria. If all group (b) criteria score zero, the final result of the ES will also be zero. This condition may occur even where the group (A) criteria show a condition of importance that should be recognised. To avoid this, scales for group (B) criteria use '1' as the 'no-change/no-importance' score.

The criteria should be defined for both groups, and should be based on fundamental conditions that may be affected by change, rather than be related to individual projects. Initial criteria identified for use in this assessment system are :

GROUP (A)

IMPORTANCE OF CONDITION (A1)

A measure of the importance of the condition, which is assessed against the spatial boundaries or human interests it will affect. The scales are defined:

4 = important to national/international interests

3 = important to regional/national interests

2 = important to areas immediately outside the local condition

1 = important only to the local condition

0 = no importance

MAGNITUDE OF CHANGE/EFFECT (A2)

Magnitude is defined as a measure of the scale of benefit/dis-benefit of an impact or a condition:

+3 = major positive benefit

+2 = significant improvement in status quo

+1 = improvement in status quo

0 = no change/status quo

-1 = negative change to status quo

-2 = significant negative dis-benefit or change

-3 = major dis-benefit or change

GROUP (B)

PERMANENCE (Bl)

This defines whether a condition is temporary or permanent, and should be seen only as a measure of the temporal status of the condition.(e.g.: an embankment is a permanent condition even if it may one day be breached or abandoned; whilst a coffer dam is a temporary condition, as it will be removed).

1 = no change/not applicable

2 = temporary

3 = permanent

REVERSIBILITY (B2)

This defines whether the condition can be changed and is a measure of the control over the effect of the condition. It should not be confused or equated with permanence. (e.g.: (i) an accidental toxic spillage into a river is a temporary condition (B1) but its effect (death of fish) is irreversible (B2); a town's sewage treatment works is a permanent condition (Bl), *the* effect of its effluent can be changed (reversible condition)(B2)).

1 = no change/not applicable

2 = reversible

3 = irreversible

CUMULATIVE (B3)

This is a measure of whether the effect will have a single direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other conditions. The cumulative criterion is a means of judging the sustain ability of a condition, and is not to be confused with a permanent/irreversible situation. For instance, the death of an old animal is both permanent and irreversible, but noncumulative as the animal can be considered to have already passed its breeding capabilities. The loss of post-larval shrimp in the wild, is also permanent and irreversible, but in this case cumulative, as all subsequent generations that the larvae (as adults) may have initiated will also have been lost.

1 = no change/not applicable

2 = non-cumulative/single

3 = cumulative/synergistic

The system then requires specific assessment components to be defined through a process of scoping. This process is a major requirement in any EIA, defining as it does the components against which the EIA will be assessed, and hence be capable of re-assessment in the future.

The environmental components used can be considered as four primary elements, which are defined as follows:

<u>PHYSICAL/CHEMICAL</u>

Covering all physical and chemical aspects of the environment, including finite (non-biological) natural resources, and degradation of the physical environment by pollution.

<u>BIOLOGICAL/ECOLOGICAL</u>

Covering all biological aspects of the environment, including renewable natural resources, conservation of bio-diversity, species inter-actions, and pollution of the biosphere.

SOCIOLOGICAL/CULTURAL

Covering all human aspects of the environment, including social issues affecting individuals and communities; together with cultural aspects, including conservation of heritage, and human development.

ECONOMIC/OPERATIONAL

To qualitatively identify the economic consequences of environmental change, both temporary and permanent, as well as the complexities of project management within the context of the project activities.

The use of these four primary elements is in itself a competent tool, particularly if set against the detailed activities of project engineering, from pre- to post- project implementation, and including the construction phases.

However, each primary element can be further refined to identify specific environmental components that better demonstrate the possible impacts of each primary element. Such further detailed sub-division will require careful consideration of the nature of the impacts in individual projects. The degree of sensitivity and detail of the system can thus be controlled by the selection and definition process for these environmental components.

To use the evaluation system described, a matrix is produced for each project option. The matrix comprises of cells showing the criteria used, set against each defined component. Within each cell the individual criteria scores are set down. From the formulae given above each ES number is calculated and recorded.

No claim is made for the sensitivity of any ES value, and to provide a more certain system of assessment, the individual ES scores are banded together into ranges where they can be compared. Ranges are defined by conditions that act as markers for the change in bands. These conditions would normally reflect the changes in group (A) scores, combined with the upper or lower scores possible with the group (B) criteria.

Conditions have been defined to produce a range covering +/- 5, and the limits of the bands in this range can be defined as follows:

1. Conditions that have neither importance or magnitude will score a zero, and can be banded together. Any condition in this band is either of no importance, or represents the status quo, or a no change situation.

2. A condition that is local in importance (A1=1), and a slight change from the status quo (A2 =1) , yet is permanent (B1=3), irreversible (B2=3) and cumulative (B3=3), represents the upper limit of the 'slight change' condition.

3. A condition of 'change' will occur up to a condition of local importance (Al=1) with significant magnitude (A2=2), that is permanent (Bl =3), irreversible (B2=3) and cumulative (B3=3).

4. A condition of moderate change will lie between the limits of change' and 'significant change'.

5. The lower limits of 'significant change' can be taken as the point when a condition is outside local boundaries (A1=2) but is of major importance (A2=3), yet is temporary (B1=2), reversible (B2=2) and non-cumulative (B3=2).

6. A 'major change' will occur at a point when the condition extends to a regional/national boundary (A1=3) and is of major importance (A2=3). Such a change would also be permanent (B1=3), irreversible (B2=3), though it could be non-cumulative (B3=2).

Once the ES score is set into a range band, these can be shown individually or grouped according to component type and presented in whatever graphical or numeric form that the presentation requires. The full EIA report will detail the criteria used, the components derived after scoping, the RIAM matrix, and the presentation of the RIAM results; together with the normal baseline information, conclusions and suggested mitigation.

Results

Research is continuing to assess the RIAM in different project and environmental situations. The system has already been tested in studies on river and coastal developments; in engineering and tourism projects, and was found to provide a rapid and reproducible basis for assessment of the conditions by highlighting changes, and in comparing impacts from different planning options.

An example of the RIAM matrix is given in Figure 1, which shows the ES results obtained in a tourism project for a Health and Water Amusement Resort in the municipality of Højer in the coastal area of the Wadden Sea. In this particular study no data was available for the Economic/Operational components.

Although the results show a largely negative series of impacts, the range bands used indicate that these are not generally serious; falling mainly (with the exception of Soc./Cult 3) in the bands of Slightly Negative/Negative (Figure 2). In this study the ranges were not expressed as +/- 5, but as +/- A to E (with 'N' representing the zero range). The use of letters rather than numbers can be useful in avoiding confusion between ES values and range numbers.

As a further illustration of how the RIAM results can be used to simply demonstrate the impacts between project options, Figure 3 shows the comparison of RIAM results for three camp-site options in the coastal area of the Wadden Sea. The histograms provide comparative pictures of positive/negative impacts between development options; to identifying important negative components that may require further study or mitigation; and providing a simple, understandable record of the EIA process.

In this instance, although components were identified in the scoping exercise, for some components no data was available from the study. The RIAM was therefore also able to identify areas where more information is needed; which would allow early investigations to be carried out, without undue delays in the planning/project cycle.

Discussion

By setting up a matrix with defined components, it is possible to compare the with- and without-project situation. In most cases this will involve a single matrix representing the with-project situation, as the without-project situation normally represents the status quo, and so would score zero in every case.

If the without project situation does not have a zero value for any component, or the intention is to explore situations on a 'what if...' basis, two matrices will be required. Multiple matrices can be set up to compare alternative strategies and development options, isolate the major positive/negative impacts, define the temporary and permanent impacts, and show where mitigation can be effective in reducing negative impacts. The detail of the analysis may require that matrices are set up of single (or grouped sets of) environmental components.

Once the criteria and components have been selected and the matrix has been developed it is possible to assess individual phases and parts of a project as well as the overall options and strategies, very rapidly; providing data for design modifications (within multidisciplinary teams) as well meeting the EIA requirements for the project. Objectivity is ensured by means of the defined criteria set on scales which provide a figure on the judgement made.

The system is ideally suited to EIA where a multi-disciplinary team approach is used, as it allows for data from different sectors to be analyzed against common important criteria within a common matrix, thus providing a clear assessment of the major impacts. The discipline imposed by using the matrix allows the assessors to rapidly record their judgments.

As the definition of components is the initial step in the system, and such definition is related to the project specific conditions, the RIAM can be used both as a screening tool for project options, as well as method of detailed impact assessment in specific stages in the development process. Because of its simple nature, and the ability to use the matrix even where data is poor (by defining assumptions beforehand), the RIAM is an ideal tool for Initial Environmental Evaluations (IEE) as well as recording the results of a full EIA.

The system has proved effective when used for site-specific EIA's on engineering projects or other forms of physical interventions. The value f the RIAM for on-physical impact assessments in regional or strategic planning is less certain; and this aspect requires further research.

The sensitivity of the ranges, though adequate for use in engineering interventions, are still based on subjective definition of range bands. This does not permit more sensitive bands to be easily formed, and the present system may not be sensitive enough for use in marginal or fragile environments. To overcome this problem, studies are being undertaken to try and develop an algorithm that will allow an objective definition of range bands and permit changes in sensitivity to be made, thus increasing the flexibility of the system.

The RIAM is described on a theoretical basis, though it has been has been tested in a number of different projects, in Denmark, Vietnam, and Bangladesh. All projects so far are water-related, although it is hoped to further test the system using existing EIA data from the forestry sector in Nepal. The system was found to provide a rapid and reproducible basis for assessment of the conditions by highlighting changes between a without- and with- project situation. Further development and refinement of the system will demonstrate its value under other conditions where impact assessments are required.

References cited

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3. Gilpin, A. 1995. Environmental Impact Assessment. Cambridge University Press 1995.
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This paper was presented at the Stockholm Water Conference, Stockholm, Sweden in August 1995.

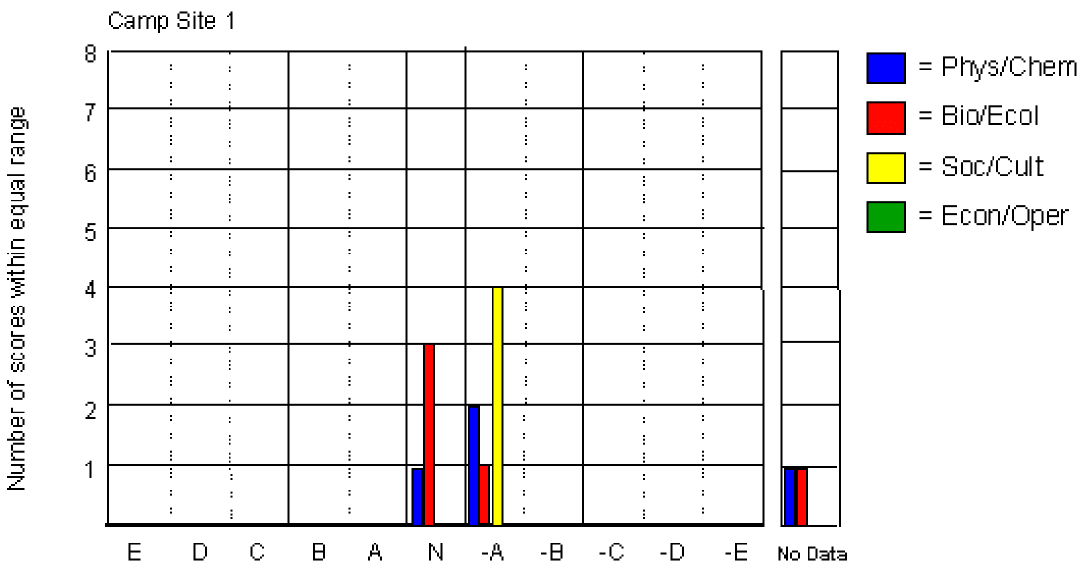
Figure 1: RIAM Matrix

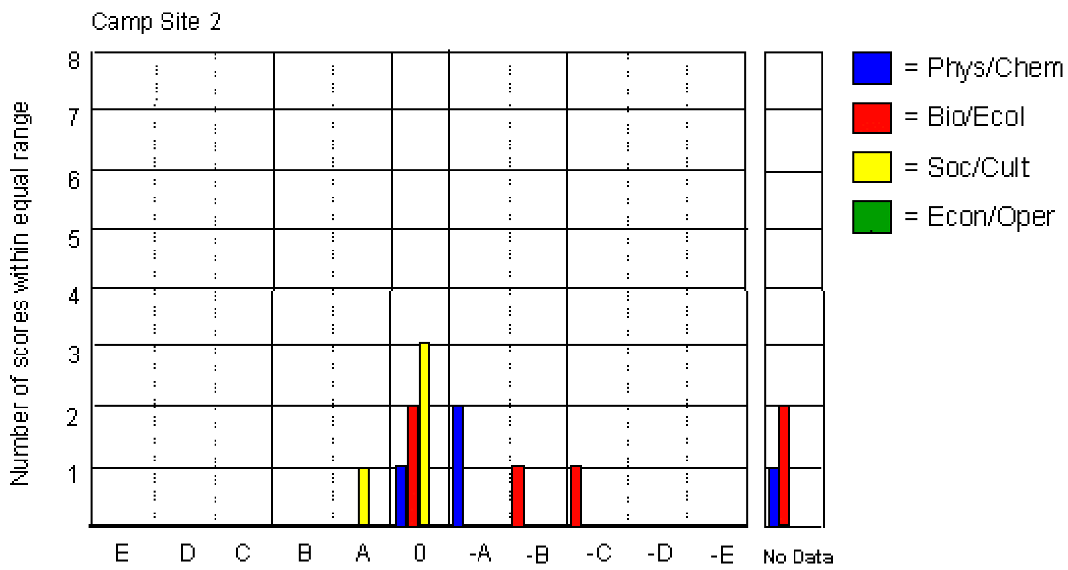
Phys/Chem 1			**Phys/Chem 2**			**Phys/Chem 3**			**Phys/Chem 4**			**Phys/Chem 5**		
A1	**1**	ES	**A1**	1	ES	A1	**1**	ES	A1	**No**	ES	A1		ES
A2	**-2**		**A2**	-2		A2	**0**		A2	**Da-ta**		A2		
B1	**2**		**B1**	2		B1	**3**		B1			B1		
B2	**1**		**B2**	1		B2	**2**		B2			B2		
B3	**1**		**B3**	1		B3	**1**		B3			B3		
		-8			**-8**			**0**			**ND**			
Bio/Ecol 1			**Bio/Ecol 2**			**Bio/Ecol 3**			**Bio/Ecol 4**			**Bio/Ecol 5**		
A1	**1**	ES	A1	**2**	ES	A1	**1**	ES	A1	**2**	ES	A1	**No**	ES
A2	**0**		A2	**0**		A2	**-1**		A2	**0**		A2	**Da-ta**	
B1	**3**		B1	**2**		B1	**2**		B1	**1**		B1		
B2	**2**		B2	**2**		B2	**2**		B2	**1**		B2		
B3	**1**		B3	**2**		B3	**3**		B3	**1**		B3		
		0			**0**			**-7**			**0**			**ND**
Soc/Cult 1			**Soc/Cult 2**			**Soc/Cult 3**			**Soc/Cult 4**			**Soc/Cult 5**		
A1	**2**	ES	A1	**1**	ES	A1	**1**	ES	A1	**1**	ES	A1		ES
A2	**-1**		A2	**-2**		A2	**-2**		A2	**-1**		A2		
B1	**3**		B1	**2**		B1	**2**		B1	**2**		B1		
B2	**1**		B2	**2**		B2	**2**		B2	**2**		B2		
B3	**1**		B3	**2**		B3	**2**		B3	**3**		B3		
		-8			**-6**			**-8**			**-7**			
Econ/Oper 1			**Econ/Oper 2**			**Econ/Oper 3**			**Econ/Oper 4**			**Econ/Oper 5**		
A1	**No**	ES	A1		ES	A1		ES	A1		ES	A1		ES
A2			A2			A2			A2			A2		
B1	**Da-ta**		B1			B1			B1			B1		
B2			B2			B2			B2			B2		
B3			B3			B3			B3			B3		
		ND												

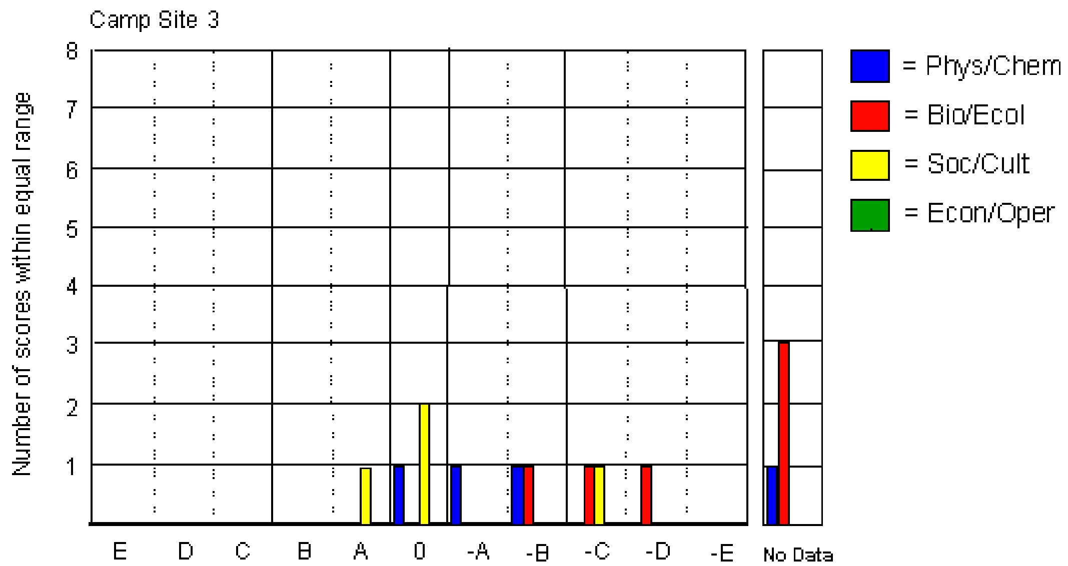
Figure 2: Ranges Bands used for RIAM

RIAM Environmental Score (ES)	**Range Value (RS) (Alphabetic)**	**Range Value (RS) (Numeric)**	**Description of Range Band**
108 to 72	E	5	Major Positive Change/Impact
71 to 36	D	4	Significant Positive Change/Impact
35 to 19	C	3	Moderate Positive Change/Impact
10 to 18	B	2	Positive Change/Impact
1 to 9	A	1	Slight Positive Change/Impact
0	N	0	No Change/Status quo/Not Applicable
-1 to -9	-A	-1	Slight Negative Change/Impact
-10 to -18	-B	-2	Negative Change/Impact
-19 to -35	-C	-3	Moderate Negative Change/Impact
-36 to -71	-D	-4	Significant Negative Change/Impact
-72 to -108	-E	-5	Major Negative Change/Impact

Figure 3 : RIAM Results for Wiedingharde Camp Site


Camp Site 1
Number of scores within equal range
8
7
6
5
4
3
2
1
E
D
C
B
A
N
-A
-B
-C
-D
-E
No Data
= Phys/Chem
= Bio/Ecol
= Soc/Cult
= Econ/Oper


Camp Site 2
Number of scores within equal range
8
7
6
5
4
3
2
1
E
D
C
B
A
0
-A
-B
-C
-D
-E
No Data
= Phys/Chem
= Bio/Ecol
= Soc/Cult
= Econ/Oper


Camp Site 3
Number of scores within equal range
8
7
6
5
4
3
2
1
E
D
C
B
A
0
-A
-B
-C
-D
-E
No Data
= Phys/Chem
= Bio/Ecol
= Soc/Cult
= Econ/Oper