Jesew

Quick user guide

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Introduction

Managing complex systems often requires simultaneous choices regarding essentially incomparable issues. In integrated coastal zone management for instance, socio-economic exploitation of the coastal area has to be weighed against preservation of ecological values and natural resources. The Jesew concept provides a means to perform such weighing in a consistent, reproducible way and it facilitates intercomparison of various combinations of choices on any set of issues.

Jesew was developed originally by Istvan Bogardi and Andras Bardossy within the framework of the UNEP/UNESCO project 'Integrated Environmental Evaluation of water resources development' [1]. The name Jesew refers to this background. It is an acronym of '**J**oint **E**cological and **S**ocio-economic **E**valuation of **W**ater resources development'. Its application is not limited to this particular field, however. It can be used for many types of joint evaluations.

For the IHE/TUD/UU course on Integrated Coastal Zone Management, a spreadsheet version of Jesew has been created [2]. The present quick user guide accompanies this version and it contains:

- a brief explanation of the Jesew concept;
- overview of the program structure;
- step-by-step user assistance.

Jesew concept

In coastal zone management it often happens that stimulating some economic progression has adverse environmental effects and vice versa. Then the question arises to what extend development of the one can be allowed without putting too much strain on the other. In other words, the coastal zone manager is challenged to optimise simultaneously choices regarding essentially incomparable issues. This is impossible without subjective reasoning and weighing. In Jesew, such subjective elements need to be made explicit in a quantitative manner to allow consistent and reproducible comparison of alternative choices. The Jesew principles are outlined hereafter on the basis of a simple example.

Consider a management challenge where a preference needs to be expressed for one out of a series of technically and financially feasible combinations of for instance nature preservation and economic development. Such combinations are called management options. For various reasons, selecting the 'best' option is not straightforward. The two concerned issues may be inter-related in the sense that stimulating the one may adversely affect development of the other. Moreover, preferences of stakeholders may play a noticeable role depending on their authority or influence.

If we, further to the example, focus on the potential for economic development and disregard interaction with nature preservation, we may discriminate two extreme cases. In the one the development is very poor (worst case) whereas in the other it reaches a level from where further improvement is virtually impossible (ideal case). In Jesew, the range from worst to ideal is used to scale the possible economic developments as mentioned in the various management options. In particular, for each option the economic development is translated into a dimensionless quantity in the range from zero to one, indicating its relative deviation from the ideal situation within the range from worst to ideal. In mathematical terms this is reflected by

$$s = \frac{\sigma_{\text{ideal}} - \sigma}{\sigma_{\text{ideal}} - \sigma_{\text{worst}}} \tag{1}$$

[1] Unesco, project FP/5201-85-01, Paris, 1987.
[2] For this purpose, Microsoft Excel has been used.

in which

s	scaled indicator
σ	actual indicator value
σ_{ideal}	indicator value in the ideal situation
σ_{worst}	worst case indicator value

A similar scaling procedure is applied to nature preservation. This way, each management option is written as a pair of scale factors that, as they have identical properties, can be combined (mathematically) into a single value reflecting the quality of the entire management option.

In Jesew, this procedure is taken a little further. Management options are built around so-called indicators (economic development and nature preservation in the above example). Scaled indicators may be combined directly into a qualification of the entire management option (as done is the example), but that may be performed in subsequent stages as well. In the first stage, the set of indicators is split up into a number of subsets[3]. Such subsets are called 'groups of level 1'. In a similar way, level 1 groups are combined in the second stage into groups of level 2, and so on. Although the number of levels is theoretically unlimited, practical applications beyond level 3 are exceptional.

A measure for the quality of a group of level one (henceforth called group value) is computed as

$$L_{j,1} = \left(\sum_{i=1}^{N_{j,1}} w_{i,j} s_{i,j}^{b_{j,1}} \right)^{1/b_{j,1}} \qquad (2)$$

in which

$L_{j,1}$	group value of the j-th group of level 1
$s_{i,j}$	scaled value of the i-th indicator in the j-th group of level 1
$w_{i,j}$	corresponding weight factor
$N_{j,1}$	number of indicators in the j-th group of level 1
$b_{j,1}$	balancing factor for the j-th group of level 1

A similar relation is used to compute values for groups of the levels 2 and 3 (and beyond, if applicable). This procedure is repeated for all of the management options.

The weight factors $w_{i,j}$ are normalised. They satisfy

$$\sum_{i=1}^{N_{j,1}} w_{i,j} = 1 \qquad (3)$$

for all j.

As the scaled indicators vary between 0 and 1 and with the normalisation (3), group values L range from 0 (ideal case) to 1 (worst case) as well. Higher-level groups bear the same property.

In general, indicators will be associated to a specific aspect of a complex system and they are grouped by nature. This way, a group represents a particular sub-system. Each level up corresponds to a larger degree of aggregation. It is not uncommon that the characteristics of a sub-system show substantial variations if one of its constituents (indicator or lower level group) becomes close to an extreme value, whereas variation of the constituent around a more average value yields a comparatively mild response of the sub-system. The balancing factor b is used to simulate such behaviour. When it is set to 1, expression (2) reduces to a regular weighted mean. Varying b around 1 determines the sensitivity of the group value to extreme indicators or lower level group values. Increasing b yields an ever-larger sensitivity. For smoothly responding sub-systems, b=1..2. On the other hand, when exceedance of some critical value by one of the indicators has dramatic consequences for the sub-system, b=3 or even larger.

[3] Each subset contains one or more indicators, but an indicator can be part of one subset only.

To obtain an impression of how the group value $L_{j,1}$ is composed, imagine an $N_{j,1}$-dimensional space (as many dimensions as the number of indicators in the group). Each management option can be reflected by a point in this space with co-ordinates ($1-s_{i,j}$). In other words, the scaled indicator values indicate the location of the management option relative to the point that reflects the ideal situation (all co-ordinates equal to 1). In this ideal point, L is equal to zero.

To visualise the scatter of this collection of points, a projection can be made on a plane perpendicular to one of the axes that define the space. This boils down to drawing a scatter diagram for a selection of two of the indicators in the j-th group.

As scaled indicator values and group values are by definition within the range 0..1, the scatter diagram always fits in a unit square. The lower left corner of this square coincides with the origin of the axis system and it represents the worst possible combination of indicators (or group values) that have been plotted along the two axes of the diagram. The upper right corner with co-ordinates (1,1) on the other hand, reflects the best possible combination. The closer a management option is to this corner, the better it is at least with respect to the plotted indicators (or group values).

The distance to the upper right corner of the scatter plot may be used to rank the various management options. The lower the group value, the closer the corresponding point is to the upper right corner of the unit square. We use this property and in particular the definition of group values (expression (2)) to define curves of constant 'distance' β to the ideal point. They are given by

$$\beta^b = w_x \left(1-x\right)^b + w_y \left(1-y\right)^b \tag{4}$$

in which w_x and w_y are the normalised weight factors of the indicators (or groups) that are plotted along the horizontal axis (x) and vertical axis (y) of the diagram, respectively. Furthermore, $\beta = 0$ if (x,y) coincides with the ideal point and in the worst case, β reaches its maximum which equals $(w_x+w_y)^{1/b}$.

In many Jesew applications, two of such curves are drawn. One reflects the transition from poor to acceptable group values and the other discriminates between acceptable and sound group values. These two curves are called domain boundaries as they separate the domains of sound, acceptable and poor group values (see figure 1 below). Ranking groups within a domain is not common practice. All groups in the same domain are considered to be of comparable quality.

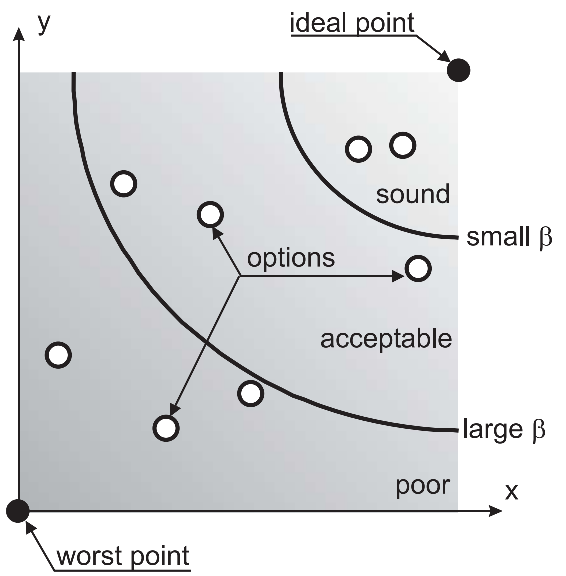

Figure 1

Example of graphic presentation of Jesew results. The small circles reflect management options and the two curves are domain boundaries**.**

Structure

The Excel version of the Jesew evaluation tool contains 11 worksheets:

1	title page
2	definition of indicators
3-5	specification of groups and corresponding balancing factors
6	specification of weight factors
7	management options
8	selection of composite indicators for evaluating management options
9	graph of evaluation results
10	table with results
11	computations.

The first sheet is a title page only. All input and output takes place on sheets 2 up to and including 10, whereas sheet 11 is reserved for input processing and most of it is hidden for the user. Sheets 2-10 share the following features:

- user input is restricted to cells with a yellow background (all other cells are protected against changing their contents to prevent malfunction of the spreadsheet due to erroneous input);
- cells with a light green background are used to echo previous user input;
- indications for use of a sheet are presented as yellow text on a dark blue background;
- error messages are shown in red in cells with a white background and a blue border;
- the sixth and following sheets also contain a summary of error messages generated in previous sheets.

Avoid the use of spaces in yellow cells where it is sufficient to enter a single character. Spaces are invisible to the user, but nevertheless they are interpreted as meaningful input and treated accordingly.

Application

How to use the Excel version of Jesew is outlined hereafter sheet-by sheet.

Sheet 2: Indicators

The user may specify the names of up to 15 indicators in the cells with a yellow background. The order of the list of indicators is irrelevant and it may be interrupted by empty lines. Note that entering a single invisible character on a line (like a space) is interpreted as a valid indicator name and it will be treated accordingly.

Sheet 3: Group 1

The indicators defined on the previous sheet are echoed in the light green cells on top of the sheet. In Jesew, indicators are combined into groups of level 1. The names of these groups need to be typed in the yellow column with 'groups of level 1' in its heading. Corresponding balancing factors can de specified in the column on the left, entitled 'b.f.'. If no balancing factor is given, 1 is assumed. Other than in specifying indicator names, the list of group names may not be interrupted by empty lines.

Use the yellow matrix to indicate which indicators belong to a group. Each row in this matrix concerns the group of which the name is on the same row under 'groups of level 1'. Similarly, each column of the matrix belongs to the indicator given in the green cell above the column. This way, each mesh in the matrix refers to the combination of an indicator and a group of level 1. To indicate that an indicator belongs to a certain group of level 1, type any character in the corresponding mesh (avoid typing spaces in this respect, as they are invisible but nevertheless interpreted as a valid specification of a relation). Groups may contain multiple indicators, but an indicator can be assigned to a single group only.

If no indicators are assigned to a group of level 1, the message 'not used' will appear in the column 'diagnostics' on the right hand side of the sheet. In the diagnostics frame at the bottom of the sheet, four types of messages may occur:

not assigned	an indicator that is not assigned to any group will generate this message in the corresponding column of the diagnostics frame
no reference	a relation has been defined between an indicator and an (as yet) undefined group
no indicator	for one of the constituents of a group, an indicator has been selected that has not

	been defined.
too many	an indicator has been assigned to more than one group

If no indicators are assigned to a group, the message '*not used*' will appear on the right hand side of the matrix at the same line of the concerned group.

Sheet 4: Group 2

Groups of level 1 are combined into groups of level 2. This is done similar to joining indicators into groups of level 1 (see 'Sheet 3').

Sheet 5: Group 3

See 'Sheet 4'.

Sheet 6: Scheme

When indicators and groups of levels 1 up to and including 3 have been defined, a scheme is produced showing their mutual relations as specified on previous sheets. This scheme more or less has the form of a tree, building from level 3 groups on the right hand side of the sheet (rightmost green column) through groups of lower levels down to indicators (leftmost green column). In vertical direction, empty lines separate groups.

Roughly, the scheme consists of four vertical blocks, each containing three columns as indicated below:

reference one level up (white background)	weight factor (yellow background)	name of indicator or group (green background)

Weight factors of indicators and groups can be specified in the yellow cells directly left of the name of the concerned indicator or group. Any positive value may be assigned to a weight factor. They will be normalised automatically to satisfy relation (3). A zero weight may be convenient to exclude (temporarily) an individual indicator or group from the analysis, provided that not all weights in a group are set to zero as this leads to an undefined normalisation.

The blue diagnostics frame at the bottom of each column may show:

complete	all weight factors have been specified (if a group contains only one sub-group or indicator, its weight is set automatically to 1)
zero sum of weights	within one or more of the groups all weights are set to zero with an undefined weight normalisation as a result
negative weight factor(s)	at least one of the weight factors specified is less than zero
# weight factor(s) to be specified	the number # of (as yet) unspecified weight factors

For indicators, the 'reference one level up' is the serial number of the group of level 1 the concerned indicator belongs to. The serial number refers to the list of group names as defined on sheet 3 'Group 1'. Similar references are given for groups of levels 1 and 2. They are presented in the scheme to easily see which indicators or groups are joined in a group of higher level.

Sheet 7: Options

Up to 10 management options (alternatives) can be specified for each indicator. The yellow matrix on the right hand side of the sheet can be used for this purpose. Each column of this matrix reflects a single management option. A management option is introduced as soon as to one of the indicators a value has been assigned. For each option, the number of indicators for which no value has been entered yet is shown in the diagnostics frame at the bottom of the concerned column of the options matrix. When all values have been entered, 'o.k.' will appear in this frame.

Management options vary between a worst and an ideal case. These can be specified per indicator in the yellow columns with headings 'worst' and 'ideal' respectively. If left unspecified, the smallest management option will be assumed for 'worst' and the largest one for 'ideal'. Note that this automatic definition of extreme cases neglects the possibility that worst may be represented by a larger value than ideal (in the case of concentration of toxic substances, for instance). In such cases, 'worst' and 'ideal' must specified manually by typing the concerned values in the designated cells.

Management options beyond the manually specified extreme values generate an error message.

Messages that may occur in the diagnostics frames at the bottom of the table:

o.k.	option has been specified completely and correctly
too many	the option specification is incomplete (not all indicators have been assigned a value) and at the same time values have been entered for non-existing indicators (empty lines)
incorrect	values have been assigned to all indicators, but also to one or more non-existing ones.
# remain	the number of (as yet) unspecified indicators

When specification of a management option has been completed and ‘o.k.’ appears at the bottom of the concerned column on the table, it is checked whether all values are within the range between worst and ideal. If not, a message will occur at the right hand side of the line in which a deviation has been encountered. This message shows the number of completed management options for which the concerned indicator has been assigned a value outside the range from worst to ideal.

Sheet 8: Evaluation

An evaluation of management options specified on the previous sheet can be performed for a single group at the time and in particular for a set of two sub-groups or indicators that belong to this group. To specify the group for which an evaluation is desired, first select its level (type the level number in the yellow cell next to 'Select level') and then its name (place an arbitrary character in the yellow column at 'Select group' in the cell next to the name of the group to be selected). When this is finished the names of sub-groups or indicators within the selected group will appear in the green column below 'Select sub-groups'. The yellow cells on either side of this green column can be used to define for which indicators or sub-groups a scatter plot needs to be produced.

The tree structure of the relations between groups and indicators is shown on the top half of the present sheet. It is a mirror image of what is presented on sheet 6 'Scheme' and it is also slightly condensed in the sense that there are no empty lines to separate groups. This tree is meant to help selecting items for evaluating the management options.

Diagnostics concerning ‘select level’:

no level selected	scatter diagrams concern groups of level 1 or higher. this message occurs when no level has been selected
incorrect level selected	selecting a level less than 1 or larger than 3, triggers this message to be displayed

Diagnostics concerning ‘select group’:

no group selected	this message is visible until the group (within the selected level) for which a diagram must be produced, has been selected by placing an arbitrary character in the yellow column left of the list of groups.
incorrect group selected	selecting a group that does not exist results in this message
too many groups selected	more than one group has been selected

Diagnostics concerning ‘select sub-group x/y’:

(hor/vert) no sub-group selected	from the group for which a scatter diagram needs to be produced, the two sub-groups (or indicators) need to be chosen that will be plotted along the axes. this message indicated that such a choice has not been made (yet).
(hor/vert)	a non-existing sub-group (or indicator) has been chosen to be plotted along one of

incorrect sub-group selected	the axes of the scatter diagram.
too many sub-groups selected	only one sub-group or indicator can be plotted along an axis. this message occurs if more than one have been chosen for a single axis.
same (hor) and (vert) selected	for different axes, different sub-groups or indicators should be chosen.
single sub-group	scatter diagrams cannot be plotted for groups that contain only one sub-group or indicator.

Sheet 9: Graph

This sheet shows a scatter diagram according to the specifications given on the previous sheet. To identify individual options, use the yellow column under 'highlight options' (type an arbitrary character in yellow cell next to the number of the option to be identified). Selected options will be marked in the graph with a large '+'.

Boundaries of the domain of acceptable management options can be added by specifying their 'distances' β to the point (1,1) in the yellow cells next to 'boundary 1' and 'boundary 2' (also see expression (4) and figure 1).

A graph appears only if all previous sheets have been completed and errors have been resolved (indicated by a zero in the diagnostics frame in the lower left corner of the sheet). In addition, scatter diagrams can be plotted only for groups that consist of at least two sub-groups or indicators.

Sheet 10: Table

The table is a copy of the ‘Scheme’ presented in sheet 6, including the scaled indicators and group values corresponding to the management option specified in the yellow bar at the bottom of the sheet. Only one option can be called at the time.