MCEWR

Multi-Criteria Evaluation Model for Water Resources

Quick Start

For students and academic colleagues – using MCEWR on the website and on the desktop: the essentials in a few pages

Model developed by Mohamed Rami Mahmoud, 1995-2026

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WAM · PROMETHEE II · CP · ELECTRE II · AHP · EV · RA · TOPSIS · VIKOR · ELECTRE III

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Companion documents: MCEWR_Methods_Explained.pdf (the methods taught with solved examples), MCEWR_Web_Tutorial.pdf (the website step by step, with screenshots), MCEWR_Web_User_Guide.pdf (every control of the website), MCEWR_Method_Reference.pdf (the mathematics). All are on the website under Downloads & documents.

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1. What MCEWR does

You have several **alternatives** – sites for a plant, designs of a dam, technologies for desalination – and several **criteria** by which to judge them – cost, yield, environmental impact, reliability – with a **weight** for each criterion. MCEWR turns that table into a **ranking** of the alternatives, by a method you choose among ten, and tells you how sensitive the ranking is to the weights and to the method. The criteria can form a hierarchy (main criteria with sub-criteria), each with its own weights.

The model was written in 1995 for the Ph.D. dissertation of Mohamed Rami Mahmoud at Colorado State University and applied in four published studies (section 8). The 2026 Python edition reproduces the 1995 program to the last digit on every historical example and adds five methods, five weighting schemes (equal, Best-Worst, entropy, CRITIC, MEREC), reports, and the comparison, sensitivity, robustness and rank-reversal analyses. It exists in two forms that give identical numbers:

- **the website** – nothing to install; open the address in a browser (section 2);
- **the author's desktop edition** – the same engine on the author's computers, with Excel and Word reports and no size limit, used for larger studies (section 5).

What MCEWR does *not* do: it does not decide for you. It makes the consequences of your weights and of your choice of method visible, so that the decision – and the discussion of it – rests on something explicit.

2. The website in ten minutes

Open **https://mcewr.m-rami.org** in any modern browser (Chrome, Edge, Firefox, Safari; a tablet works, a phone is cramped). The front page describes the model; the menu leads to four pages:

Page	What it is for
Evaluate	the evaluator itself – the eleven steps described below
Worked examples	the 26 example problems with their expected results, computed by the same engine – the fastest way to learn what each method does
Methods	one paragraph per method: what it needs, what it returns, its reference, its status
Downloads & documents	this Quick Start, Methods Explained, the Web Tutorial, the Web User Guide and the Method Reference, as PDF

2.1 The eleven steps of the evaluator

The evaluator is a guided workflow: eleven steps in a sidebar, in three groups. Move with the sidebar or the *Next* buttons; a tick marks the steps that are done.

Step	What you do there
1 Project	choose one of the examples, **open your own file** (`.MCE`, `.mcewr` or `.csv`), or start a **new problem** with a chosen number of alternatives and criteria; give it a name, a title and notes; **Save** it later from the toolbar
2 Alternatives	name the alternatives, **add** or **remove** them, switch one off to leave it out
3 Criteria	the criteria table: names, direction (max or min), weights, units, limits and – under *Show thresholds* – the PROMETHEE and ELECTRE III thresholds; add main criteria and sub-criteria. Every cell is **edited in place**: click, type, press Enter or Tab. Every edit is checked at once; a wrong value is refused with a message
4 Decision matrix	the values of every alternative on every criterion; paste a block of numbers from a spreadsheet
5 Weights	how the criteria are weighted: your **given** weights, **equal** weights, the **Best-Worst Method** (name the best and the worst criterion, compare the others with them, the weights are computed by linear programming), or the **objective** weights computed from the data (entropy, CRITIC, MEREC). A table shows the weights every scheme gives
6 Method and settings	choose the **method** and its options (standardization, the method's own parameters – only the relevant ones are shown); a **Ready to run** list flags what does not fit; press **Run**
7 Results	the best alternative, the ranking with its bars, the **report** (PDF, HTML or text) with the ranking, the per-criterion contributions and the method's own tables
8 Compare	run **several methods at once** and see the ranks side by side, with the agreement between methods and the alternatives whose position depends on the method
9 Sensitivity	one input at a time: how far a **weight**, a **value** of the decision matrix or a **setting** of the method can move before the first place changes (a sweep with an exact critical point)
10 Robustness	**Monte Carlo**: the values and the weights are perturbed at random many times; how often each alternative takes each position, and how stable the winner is
11 Rank reversal	the **rank-reversal** diagnostics: does removing an alternative, or adding a copy or a dominated one, change the order of the others? A known property of some methods, made visible

2.2 A worked example: NIJKAMP.MCE

The example from the textbook of Nijkamp, Rietveld and Voogd (1990, p. 68) is also the first verification example of the dissertation, so its answer is known. Do this once and you have seen the whole cycle:

Step 1. **Evaluate** page → step *1 Project* → in the list *Open an example*, choose `NIJKAMP.MCE`. Step 3 shows three criteria with weights 0.4, 0.2, 0.4; step 2 three alternatives; step 4 the raw measurements.

Step 2. Step *6 Method and settings* → method **Weighted Average Method (WAM)**, standardization *1* → **Run the evaluation**.

Step 3. The ranking table appears: alternative 1 first with the value **0.6**, alternative 2 with **0.533333**, alternative 3 with **0.306667**. The *separation* column says how far each alternative is from the next – the first two are close (12.5 %), the third is far behind.

Step 4. Press **Report → PDF**: the same result as a document with the per-criterion contributions – open it and see which criteria made alternative 1 win.

Step 5. Step *9 Sensitivity* → part *Weights* → **Run**: the sweep shows that the first place holds until the weight of criterion 2 rises far above its 0.2 – a robust result. Step *10 Robustness* → **Run**: with the weights uncertain by ±10 %, alternative 1 stays first in 99.5 % of 200 samples. Step *8 Compare* → **Run the comparison**: every method agrees on the winner here; in the Red Bluff example (`REDBLUFF.MCE`, 11 alternatives) they do not, which is the subject of the 2000 paper.

> **Note.** Everything you enter is sent to the MCEWR server for computation and discarded as soon as the answer is returned; nothing is stored, and the site says so on every page. The server accepts problems up to 300 alternatives and 120 criteria; larger studies belong to the desktop application.

2.3 Saving and reopening your work

Toolbar → **Save** → *Project file* `.mcewr` writes a project file (the complete problem with your edits, your notes, the Best-Worst judgments and the settings of the last run, in a readable JSON envelope) to your computer; `.MCE` writes the 1995 format; `.csv` a spreadsheet-friendly form. Open the file again with *Open a file* – on the website or in the desktop application, which read all three. The reports and the result tables are downloaded the same way; there is no account and nothing is kept on the site.

3. Preparing your own problem

Three ways, from the quickest to the most comfortable:

- **In the evaluator**: *New problem* with the numbers of alternatives and criteria, then type names, weights and values into the tables. Good for a classroom exercise of a dozen alternatives.
- **As a CSV file** written in any spreadsheet program: three blocks – `[criteria]`, `[alternatives]`, `[values]` – as in the example below. Save as CSV, open it in tab 1. Good for a study prepared in Excel.
- **From Excel**: prepare the three blocks in a worksheet and *Save as → CSV*; the site reads the CSV directly.

The CSV form of the Nijkamp example – the header row names every column the model understands; only `id`, `name`, `type`, `weight` and the values are needed for a weighted-average or distance method:

```
[criteria]
id,parent,name,type,weight,upper,lower,units,promethee_function,p,q,p_star,p_0,p_minus,q_star,q_0
,saaty_weights,saaty_values
1,,This example for WAM in Nijkamp pg
68,1,0.4,5.0,5.0,agrement,1,10.0,10.0,0.7,0.6,0.55,0.55,0.3,0,0
2,,Criteria 2,1,0.2,5.0,5.0,agrement,1,30.0,0.0,0.7,0.6,0.55,0.55,0.3,0,0
3,,Criteria 3,1,0.4,5.0,5.0,agrement,1,30.0,0.0,0.7,0.6,0.55,0.55,0.3,0,0

[alternatives]
id,name
1,
2,
3,

[values]
alternative,1,2,3
1,50000.0,500.0,80.0
2,100000.0,-100.0,60.0
3,80000.0,100.0,50.0
```

A few rules save most mistakes. **Weights** are relative: the model normalizes them within each group of criteria, so 4, 2, 4 means the same as 0.4, 0.2, 0.4. **Direction**: `type` is 1 for a criterion to maximize (benefit) and -1 for one to minimize (cost). **Hierarchy**: a sub-criterion names its parent in the `parent` column; leave it empty for a main criterion. **Thresholds** (`p`, `q`, the ELECTRE levels) matter only for the outranking methods; the defaults are those of the 1995 program. **Missing values** are refused, not treated as zero. The Web User Guide (chapter 9) describes the formats; the Method Reference gives every option.

4. Choosing a method

The ten methods, with what the best alternative looks like in each. Five are the methods of the 1995 model, reproduced exactly; five were added in 2026 and are **provisional** until a published worked example has been reproduced by the author – use them, compare them, but quote them as such.

No.	Method	Family	Best alternative has the …	Status
1	Weighted Average Method (WAM)	additive value	largest value	audited (1995 model, reproduced exactly)
2	PROMETHEE II	outranking (PROMETHEE family)	largest value	audited (1995 model, reproduced exactly)
3	Compromise Programming (CP)	distance to the ideal	smallest value	audited (1995 model, reproduced exactly)
4	ELECTRE II	outranking (ELECTRE family)	smallest value	audited (1995 model, reproduced exactly)
5	Analytic Hierarchy Process (AHP)	pairwise hierarchy	largest value	audited (1995 model, reproduced exactly)
6	Expected Value (EV)	ordinal / expected values	largest value	provisional (2.0 addition)
7	Regime Analysis (RA)	ordinal / outranking (regime method)	largest value	provisional (2.0 addition)
8	TOPSIS	distance to the ideal and the anti-ideal	largest value	provisional (2.0 addition)
9	VIKOR	compromise ranking (group utility and individual regret)	smallest value	provisional (2.0 addition)
10	ELECTRE III	outranking on pseudo-criteria (credibility and distillations)	smallest value	provisional (2.0 addition)

A practical guide to the choice – and remember that running several and comparing (step 8) is itself a result:

Your situation	Start with
measured values, weights you trust, no strong feeling about compensation	**WAM** – the simplest; every other method is best read against it
you want distances from an ideal, or dislike that a weak criterion is bought off by a strong one	**Compromise Programming** (s = 1 or 2), **TOPSIS**, **VIKOR**
the weights come from pairwise judgements (this criterion is *moderately more important* than that one)	**AHP** – with its consistency ratio as the check on the judgements
differences below a threshold should not count, very large differences should veto	**PROMETHEE II** (complete order; PROMETHEE I for the partial one), **ELECTRE II**, **ELECTRE III**
the scores are ranks or verbal classes, not numbers	**Regime Analysis** (ordinal scores and ordinal weights)
you can only say which criterion matters more than which	**Expected Value** (turns an order of importance into weights)
no expert weights at all	step 5, **objective weights** (or the **Best-Worst Method** when one expert can compare the criteria), then WAM

Two methods rank by the *smallest* value (CP, ELECTRE, VIKOR): the tables say so in their heading, and the reports print the direction of preference above every ranking, so a table cannot be misread.

5. The desktop edition

The same engine also exists as a desktop application, used by the author for his own studies: the same functions in six tabs and the same numbers, plus **Excel, Word and PDF reports** with charts, **Excel input** workbooks, GIS import and export, problems of any size, and files that never leave the computer. It is not distributed through the website. Colleagues who need it for a study can write to the author (rami@m-rami.org); everything a student needs for learning and for ordinary problems is on the website.

6. Reading the results correctly

- **Ranking value**: the number the method produces for each alternative; comparable within one run, not across methods. The **rank** is what to quote.
- **Separation**: how far an alternative is from the next one, as a percentage of the spread; two alternatives a fraction of a percent apart are, for practical purposes, tied – say so.
- **Direction of preference**: printed above every table; larger is better for WAM, PROMETHEE, AHP, EV, RA, TOPSIS; smaller is better for CP, ELECTRE II, ELECTRE III, VIKOR.
- **Warnings**: the evaluator reports them under the result (a weight of zero, a threshold that never bites, a Saaty matrix with a consistency ratio above 0.10). They do not stop the run; they belong in your write-up.
- **Provisional methods**: EV, RA, TOPSIS, VIKOR and ELECTRE III follow the primary literature and pass independent checks, but the author has not yet reproduced a published worked example with them; cite them as *provisional implementation*.
- **Agreement between methods** (step 8) is a finding in itself: an alternative that wins under every method is a robust choice; one whose position depends on the method calls for a look at the criteria that decide it.

7. Where to read more

Document	Read it when
MCEWR_Quick_Start.pdf (this one)	you want the essentials in a few pages
MCEWR_Methods_Explained.pdf	you want to understand a method: each one with a solved example computed by hand, plus the objective weights and the analyses
MCEWR_Web_Tutorial.pdf	you use the website – every step, with screenshots and expected results
MCEWR_Web_User_Guide.pdf	you want every control, setting, message and limit of the website explained
MCEWR_Method_Reference.pdf	you need the equations of a method, its options, its verification and its references

8. Citing MCEWR

Please cite the model and, where relevant, the published application closest to your use:

- Mahmoud, M.R., December 1995. *Multi-criteria Location and Sizing of Water Resources Projects by GIS and Dynamic Programming*. Ph.D. dissertation, Water Resources Planning and Management, Civil Engineering, Colorado State University, Fort Collins, Colorado, USA.
- Mahmoud, M.R., and Garcia, L.A., 1995. MultiCriteria Decision Support System Implementation and Application. First International Conference on Multiple Objective Decision Support Systems for Land, Water, and Environmental Management: Concepts, Approaches, and Applications, Honolulu, Hawaii, July 23–29, 1995.
- Mahmoud, M.R., April 1999. Integrated Mathematical Models for Evaluating Desalination Technology. *Water Science Journal*, National Water Research Center, Cairo, Egypt, Issue 25, pp. 21–32.
- Mahmoud, M.R., and Garcia, L.A., May 2000. Comparison of Different Multi-Criteria Evaluation Methods for the Red Bluff Diversion Dam. *Environmental Modelling & Software*, Elsevier, 15(5), pp. 471–478. https://doi.org/10.1016/S1364-8152(00)00025-6
- Mahmoud, M.R., Fahmy, H., and Labadie, J.W., March 2002. Multicriteria Siting and Sizing of Desalination Facilities with Geographic Information System. *Journal of Water Resources Planning and Management*, ASCE, 128(2), pp. 113–120. https://doi.org/10.1061/(ASCE)0733-9496(2002)128:2(113)
- Software: Mahmoud, M.R., 1995–2026. MCEWR – Multi-Criteria Evaluation Model for Water Resources, Python edition 2.0. https://mcewr.m-rami.org

Questions, corrections and worked examples that could promote a provisional method are welcome at rami@m-rami.org.