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GEDM
GRUPO ESPAÑOL DE DECISIÓN MULTICRITERIO

1st Iberian Conference on Multi-Criteria Decision Making/Analysis

WEB-MAUT-DSS: A web-based DSS based on MAUT to deal with partial/incomplete information

Antonio Jiménez and Alberto Gómez - Universidad Politécnica de Madrid

https://vps155.cesvima.upm.es/web-maut-dss/

WEB-MAUT-DSS

- Improved web-based version of the generic multi-attribute analysis (GMAA) system.
- Based on the **Decision Analysis methodology** (Belton, 1990)
- Decision-making problems with **partial/incomplete information**
  - Uncertainty about the performances of the alternatives under consideration by means of probability distributions or ordinal information
  - Imprecision concerning the quantification of the decision-maker preferences
- Hierarchically elicited weights using different weighting methods
- **Additive multi-attribute utility** model
- **Sensitivity analysis** tools that take advantage of the imprecise available information to provide further insights about the robustness of the results.
- Developed using **Shiny** that allows to build interactive web apps straight from **R**.

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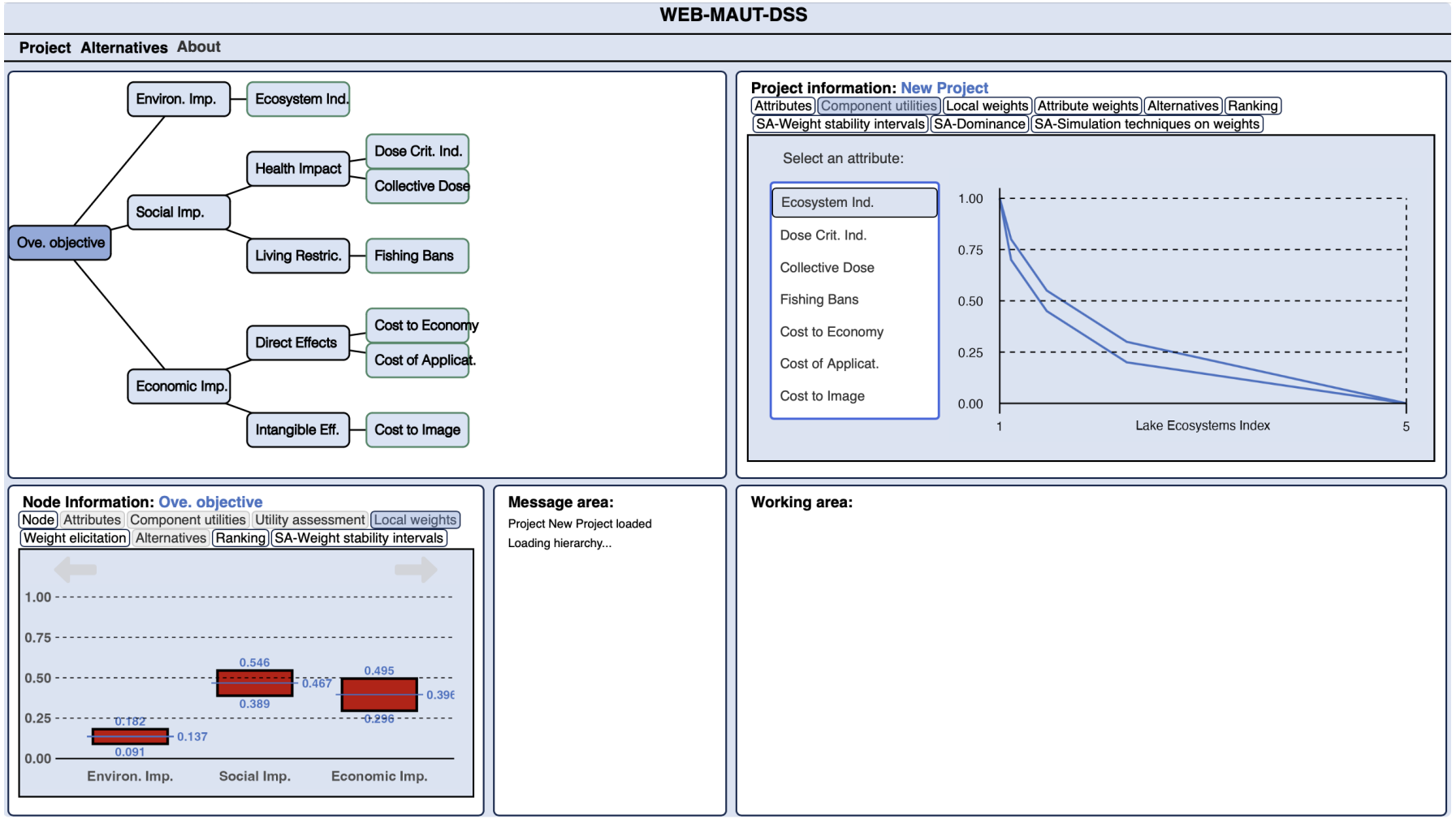
WEB-MAUT-DSS: A web-based DSS based on MAUT to deal with partial/incomplete information

1. Main menu and screen



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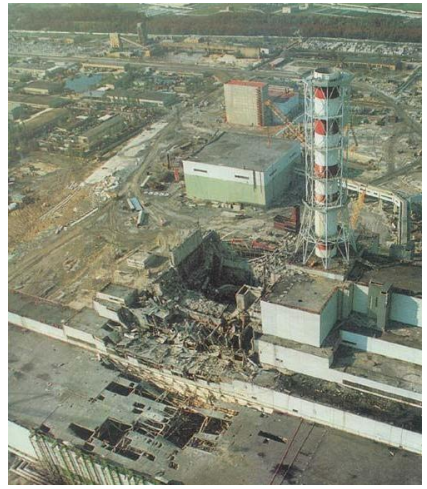
1. Problem identification

Problem scenario: Øvre Heimdalsvatn

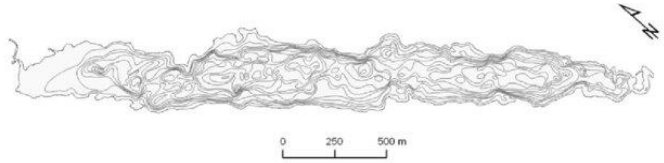


It was contaminated after the Chernobyl accident (1986)

^{137}Cs contamination → 130 kBq/m^2

Lake features:

- small subalpine lake
- mean depth of 4.7 m
- maximum depth of 13 m
- surface area of 0.78 km^2
- catchment area of 23.6 km^2
- highest point of the catchment area is 1843 m above sea level
- mean annual precipitation is 800 mm



Author: Reidar Borsgstrom

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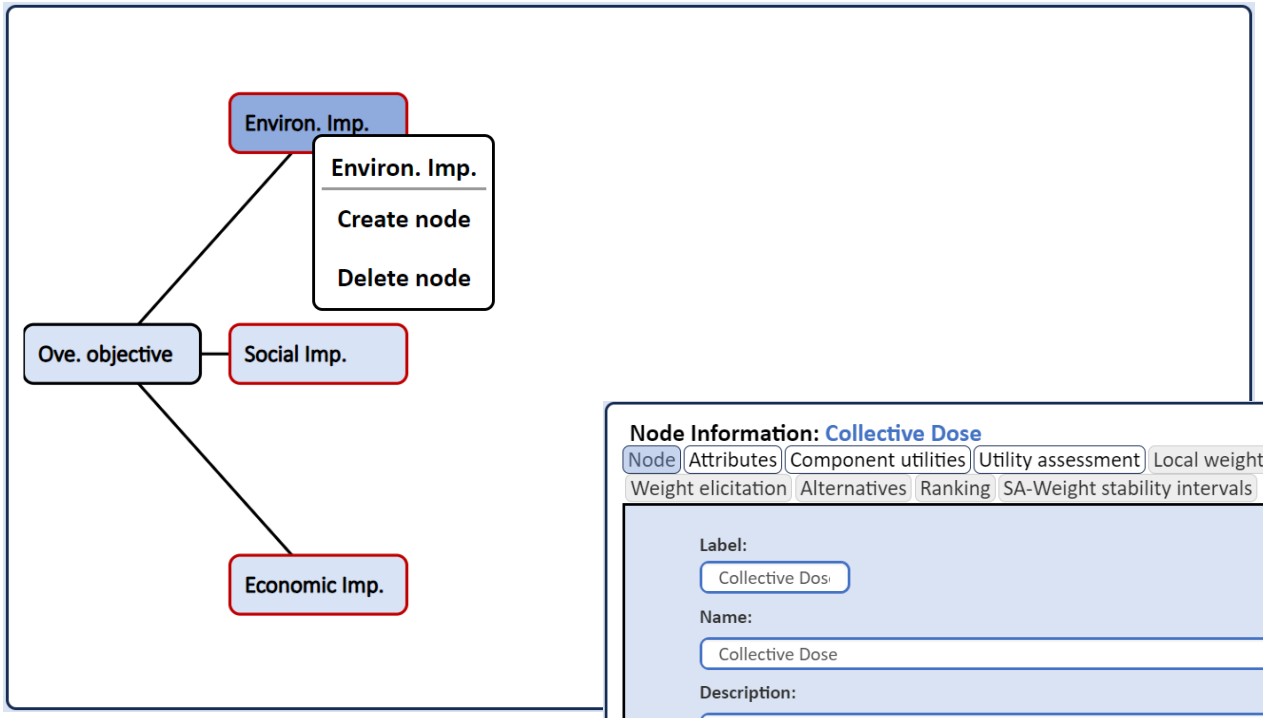
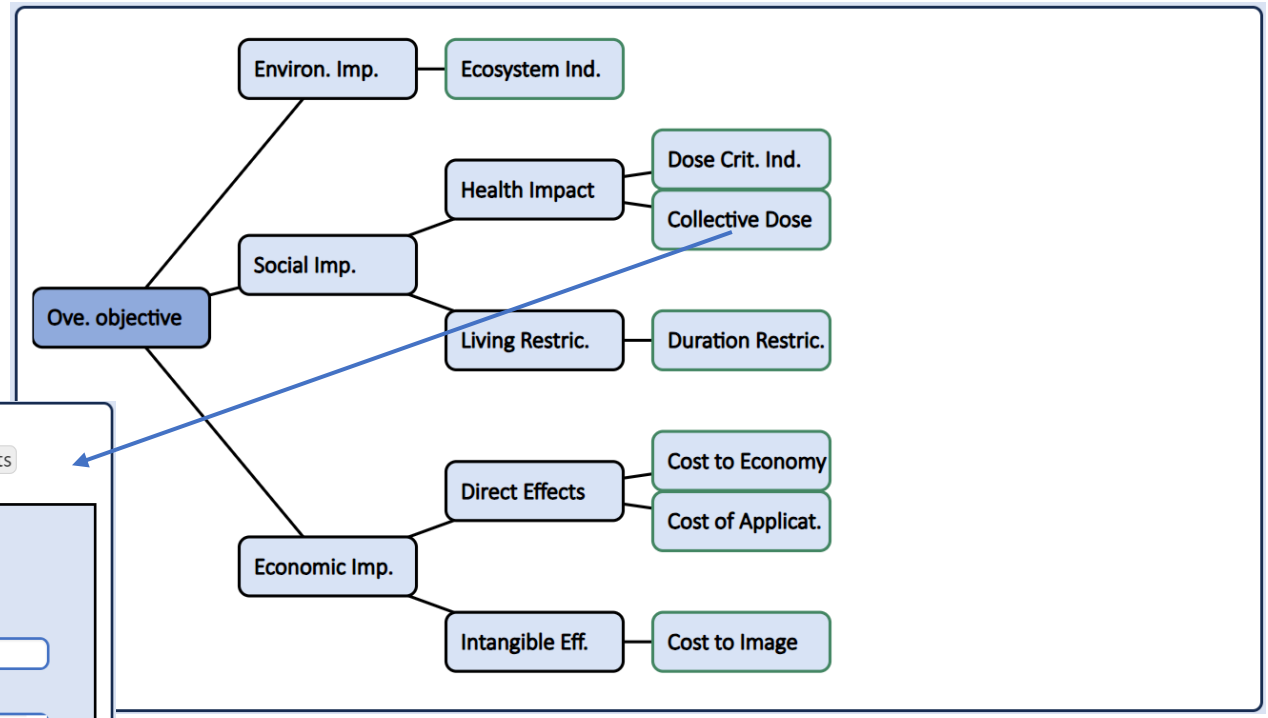
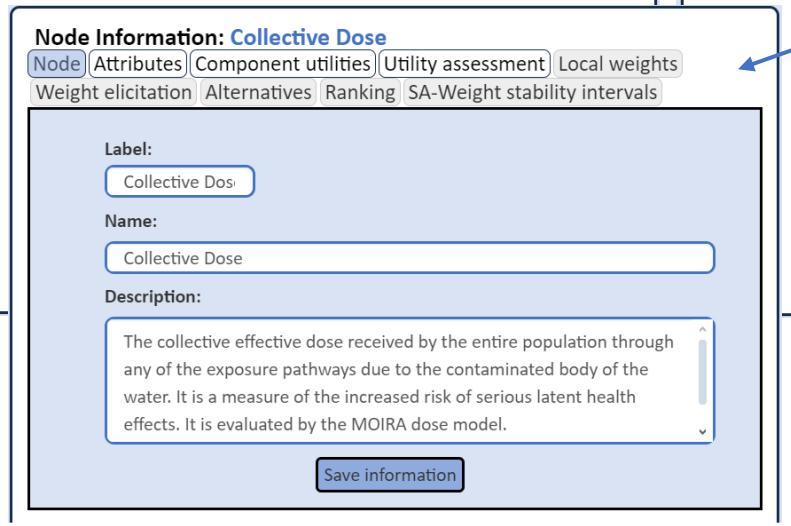
3.1 Problem structuring. Objective hierarchy







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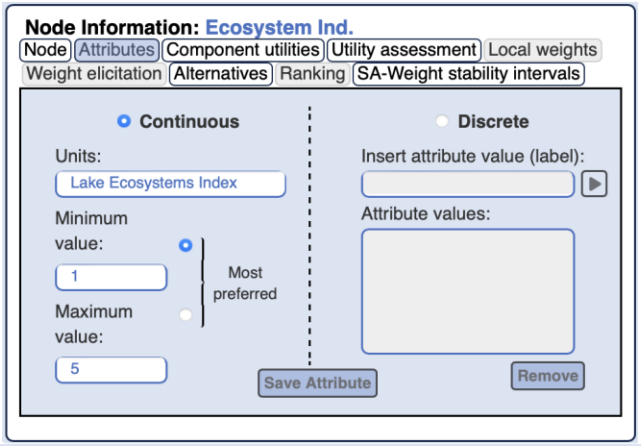
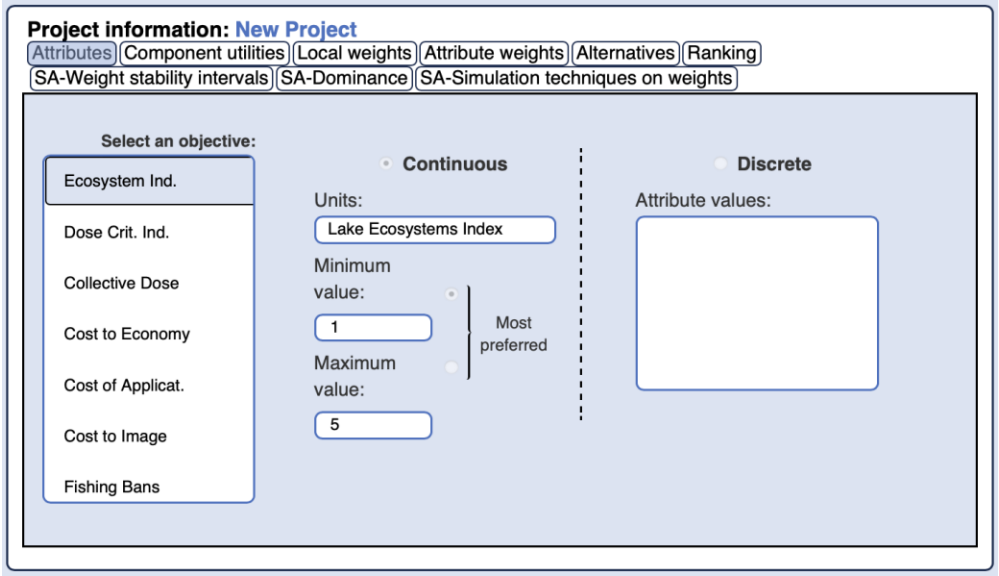
3.2 Problem structuring. Attributes





Attributes for evaluating countermeasures

Attribute	Measure (units)	Level	
		Worst	Best
X_1: Lake ecosystem index	LEI	5.00	1.00
X_2: Radiation dose to critical individuals	milliSv	2.47	0.76
X_3: Collective radiation dose	mSv × person	72.3	20.30
X_4: Duration of restrictions	months	36	0
X_5: Cost to economy	euros × 10^2	426.00	0.00
X_6: Cost of application	euros × 10^2	702.00	0.00
X_7: Cost of image	constructed scale	0.00	1.00

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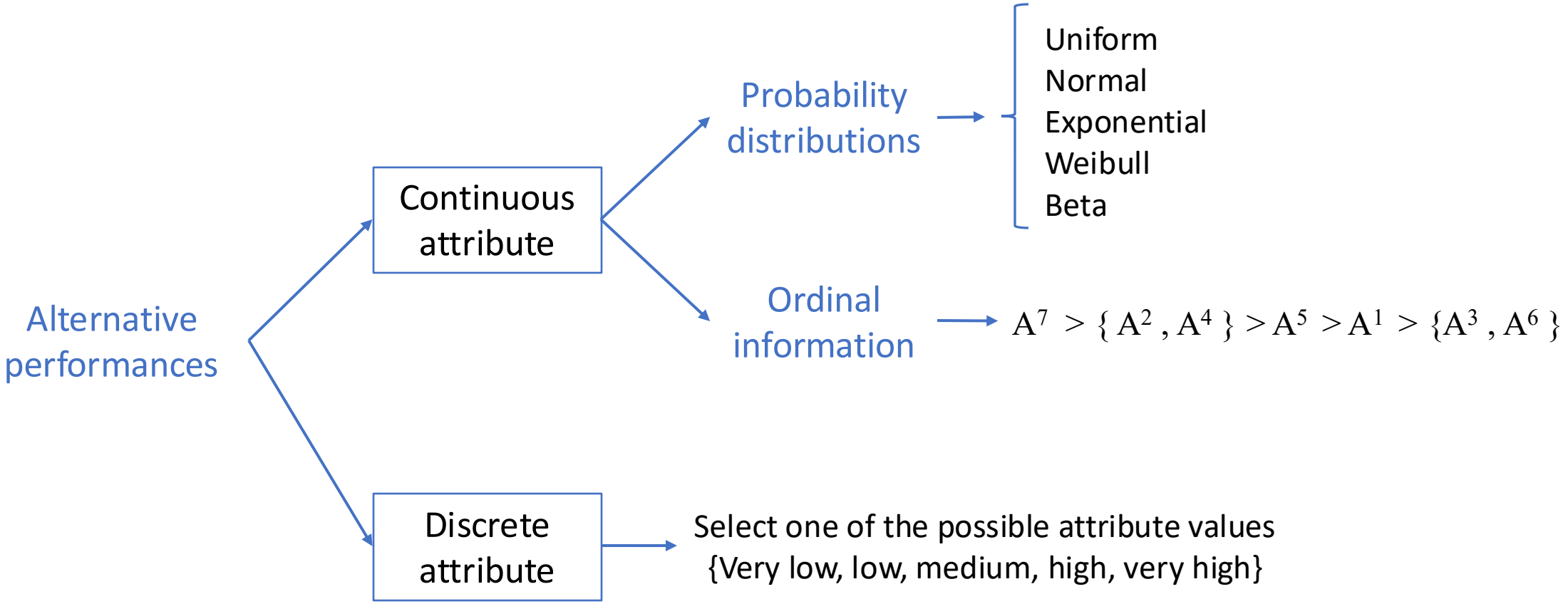
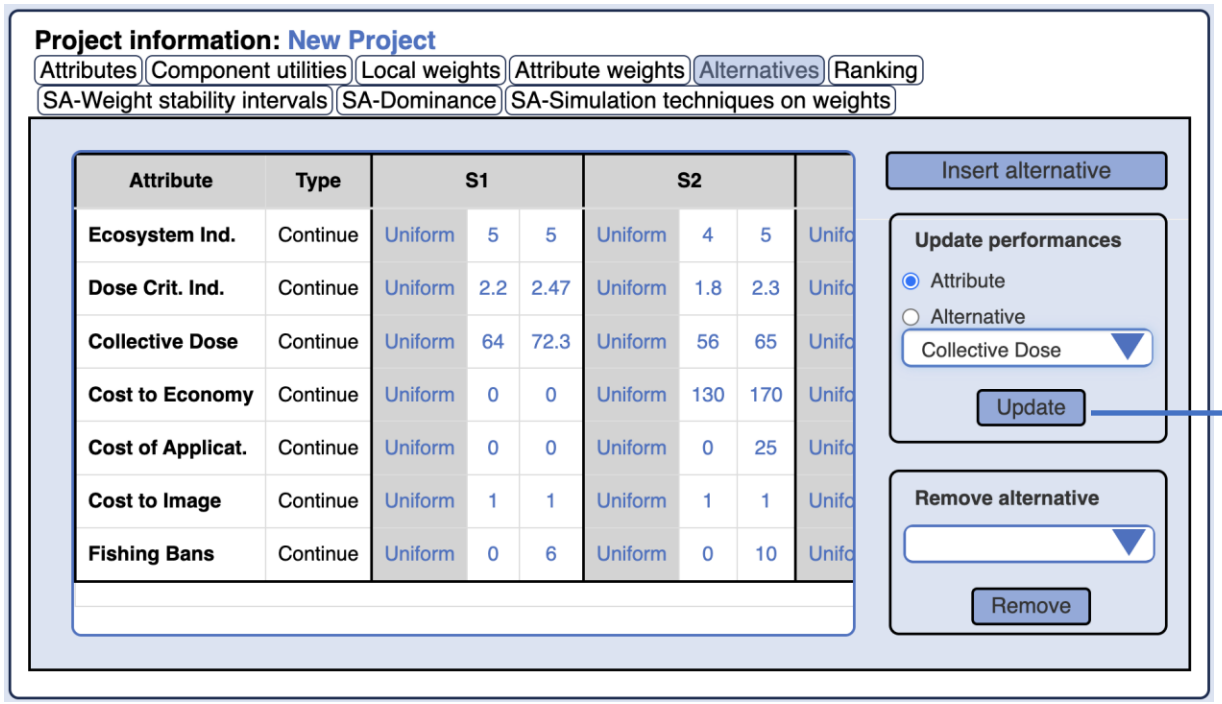
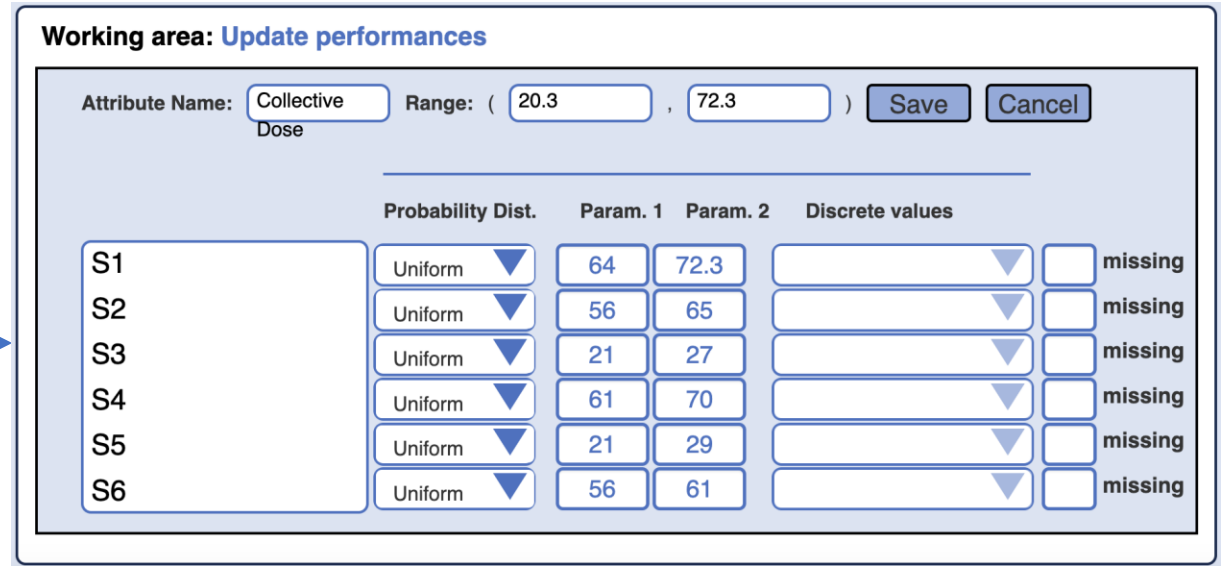
4. Alternatives and performances



4. Alternatives and performances

Alternative and performance management in the WEB-MAUT-DSS





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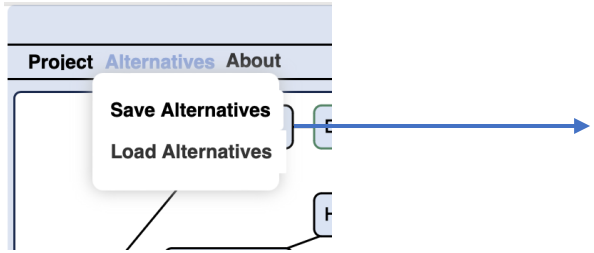

Attribute	category	Attribute values/range	
Ecosystem Ind.	Continuous	1	5
Dose Crit. Ind.	Continuous	0,76	2,47
Collective Dose	Continuous	20,3	72,3
Cost to Economy	Continuous	0	426
Cost of Applicat.	Continuous	0	702
Cost to Image	Continuous	0	1
Fishing Bans	Continuous	0	36

Attribute information | Performances

Attribute	type	S1			S2			S3			S4	
Ecosystem Ind.	Continuous	Uniform	5	5	Uniform	4	5	Uniform	3,5	5	Uniform	1.5
Dose Crit. Ind.	Continuous	Uniform	2,2	2,47	Uniform	1,8	2,3	Uniform	0,8	1,3	Uniform	2.2
Collective Dose	Continuous	Uniform	64	72,3	Uniform	56	65	Uniform	21	27	Uniform	61
Cost to Economy	Continuous	Uniform	0	0	Uniform	130	170	Uniform	380	426	Uniform	0
Cost of Applicat.	Continuous	Uniform	0	0	Uniform	0	25	Uniform	10	50	Uniform	130
Cost to Image	Continuous	Uniform	1	1	Uniform	1	1	Uniform	1	1	Uniform	0.3
Fishing Bans	Continuous	Uniform	0	6	Uniform	0	10	Uniform	30	36	Uniform	0

Attribute information | Performances

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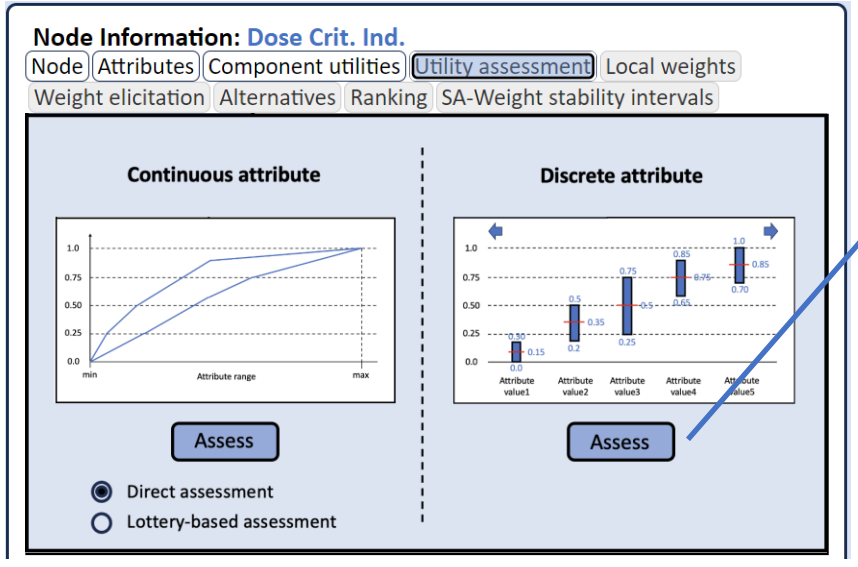
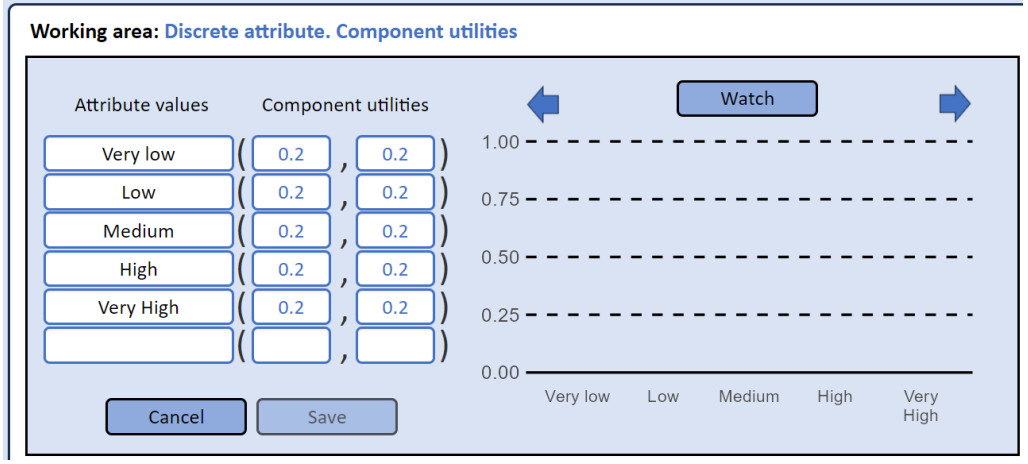
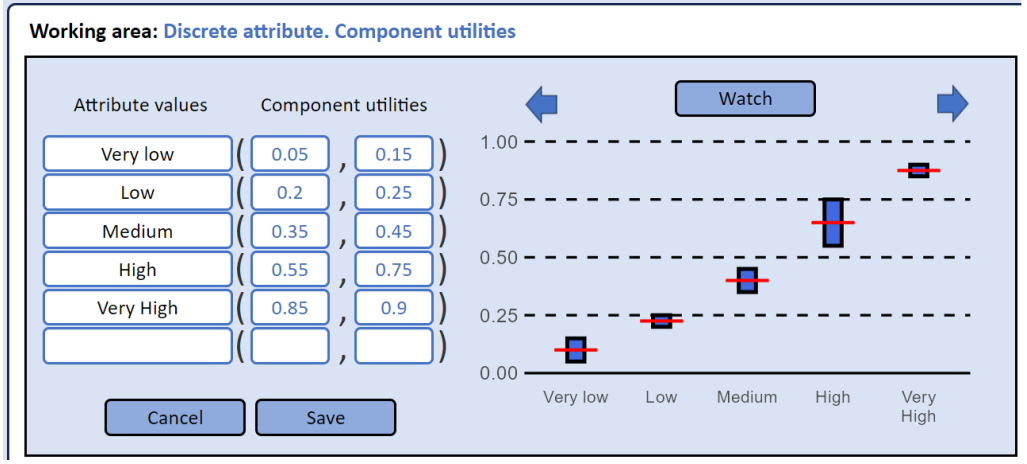
5.1. Quantifying preferences. Component utility assessment

Component utility assessment in the WEB-MAUT-DSS







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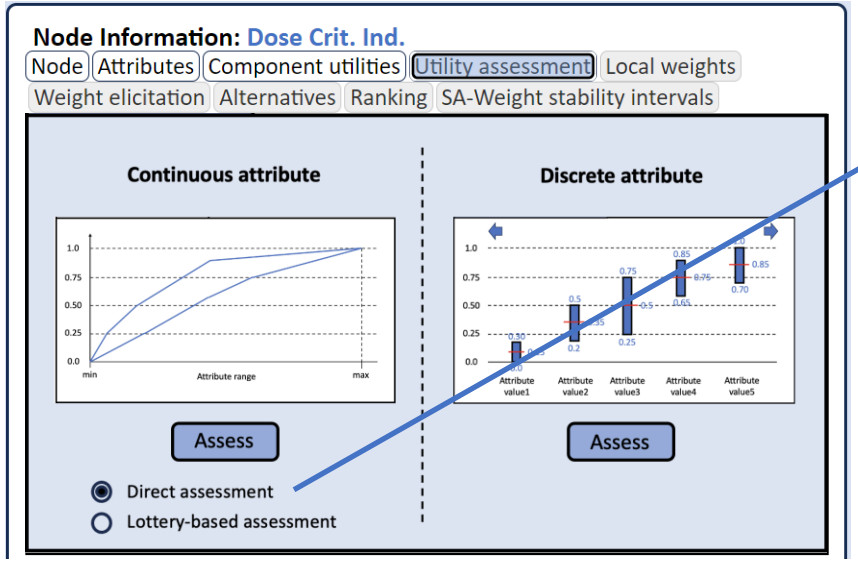
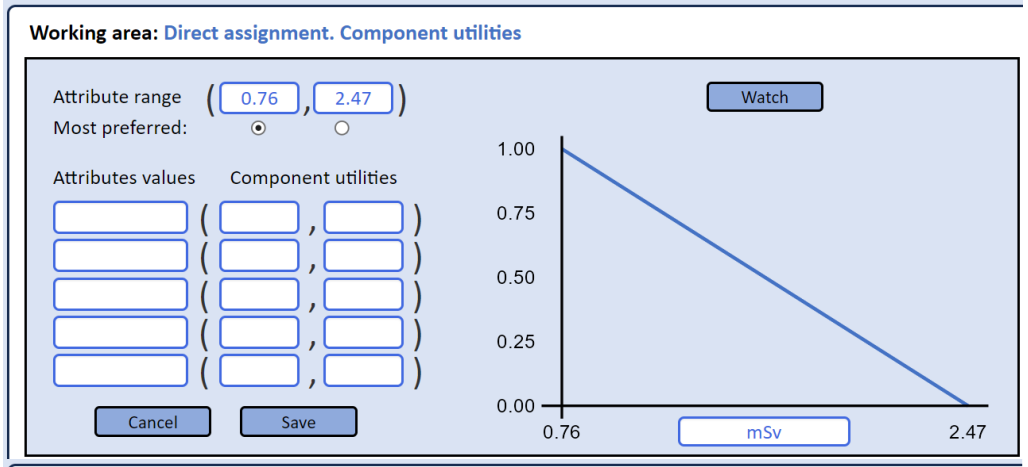
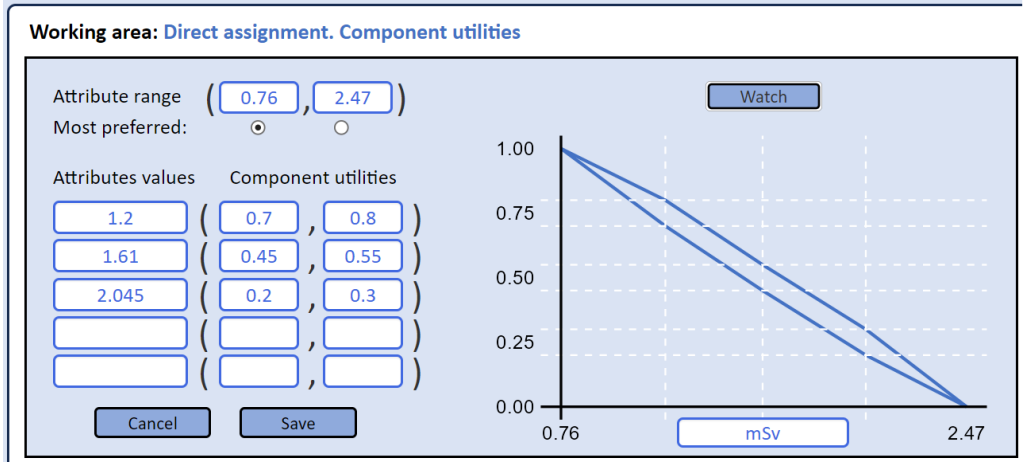
Component utility assessment in the WEB-MAUT-DSS







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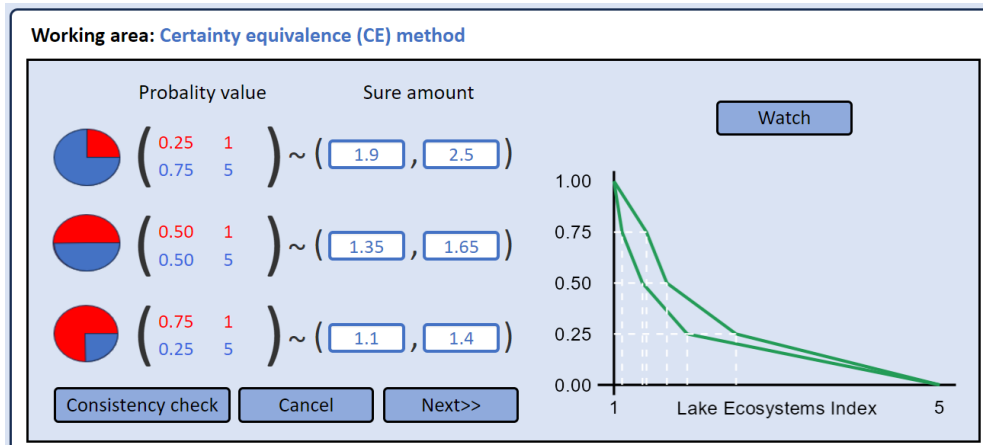
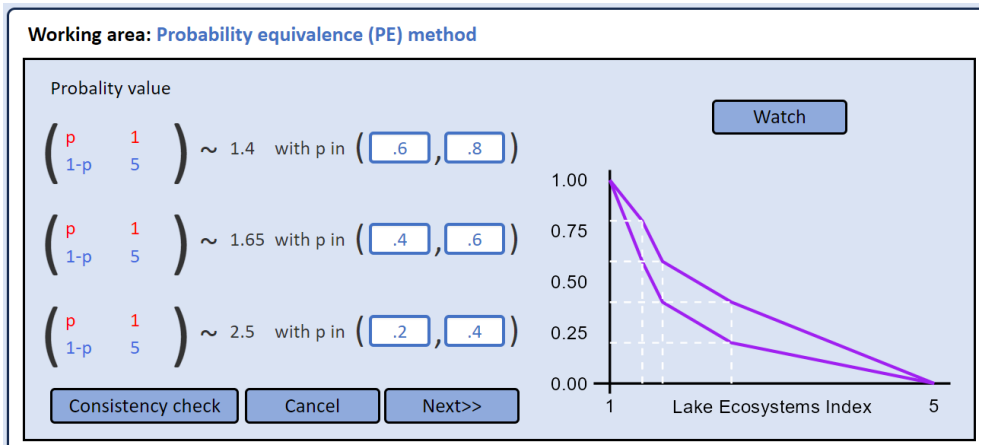
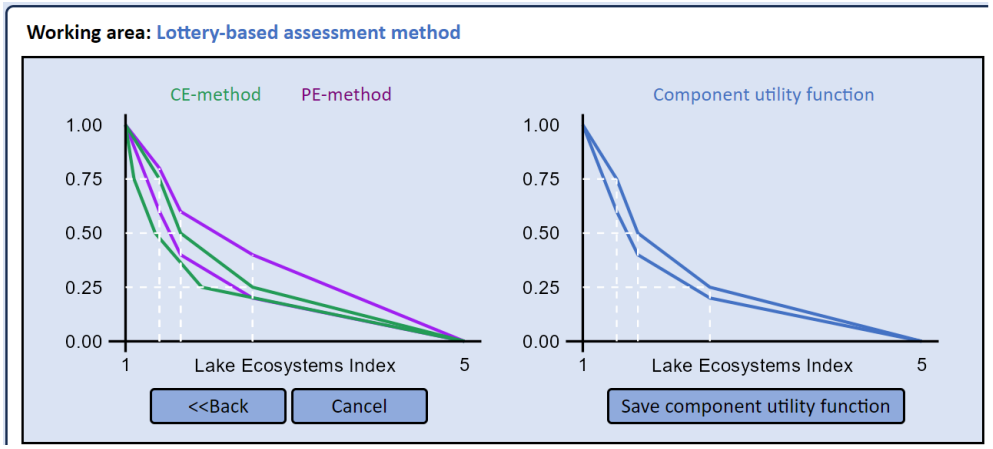
Component utility assessment in the WEB-MAUT-DSS







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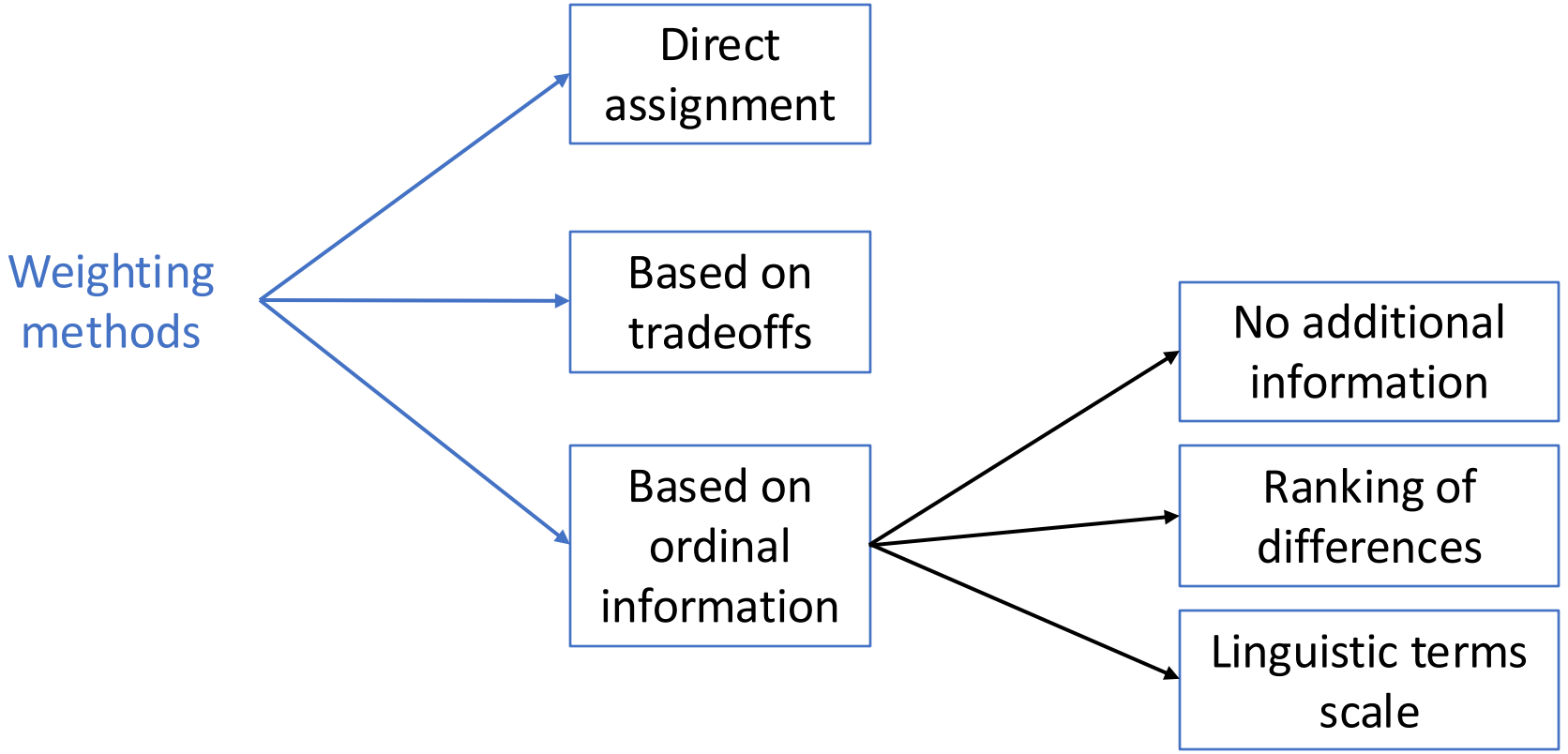
5.2. Quantifying preferences. Weight elicitation

Weight elicitation in the WEB-MAUT-DSS



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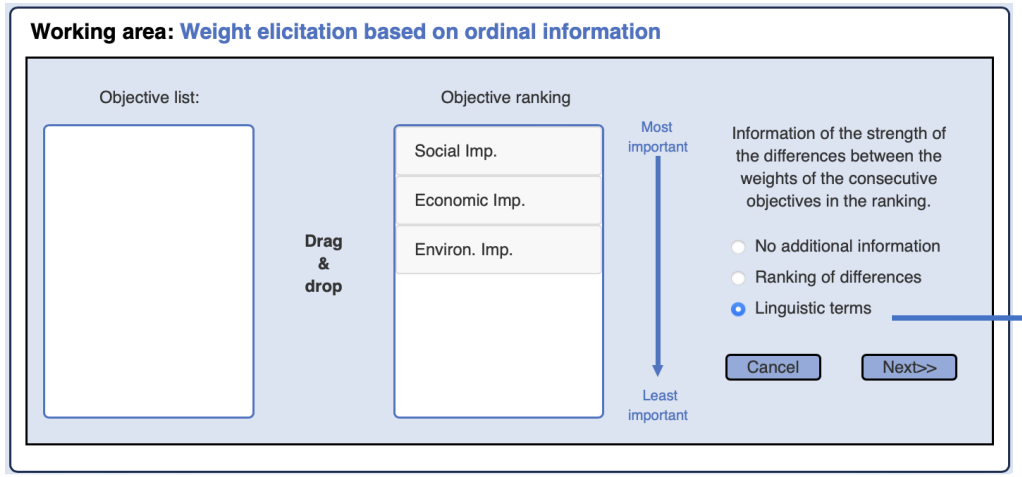
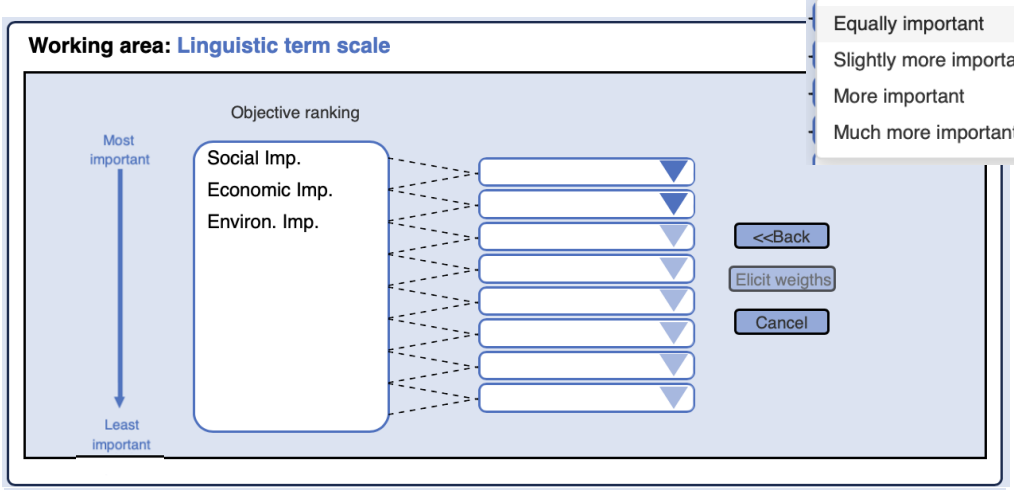
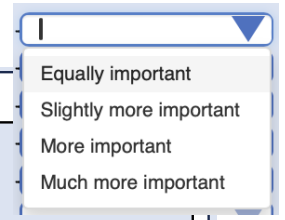
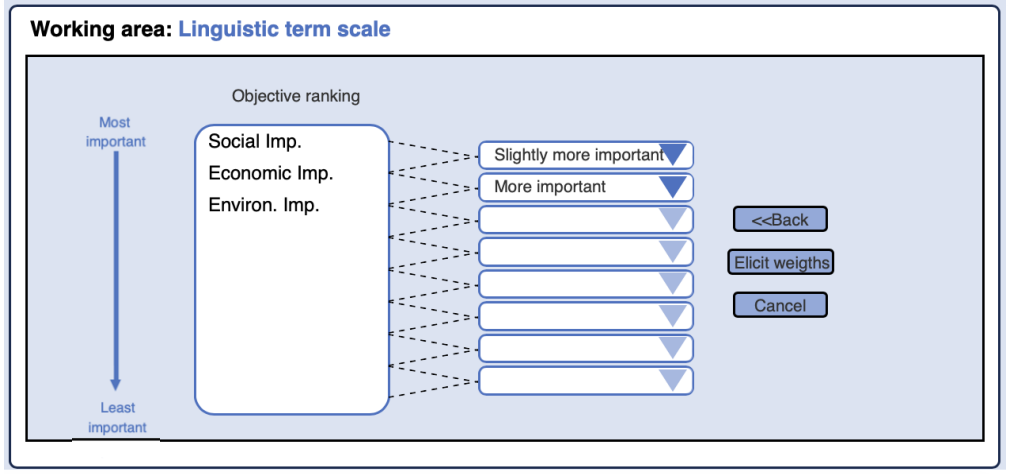
Weight elicitation in the WEB-MAUT-DSS





drop-down list





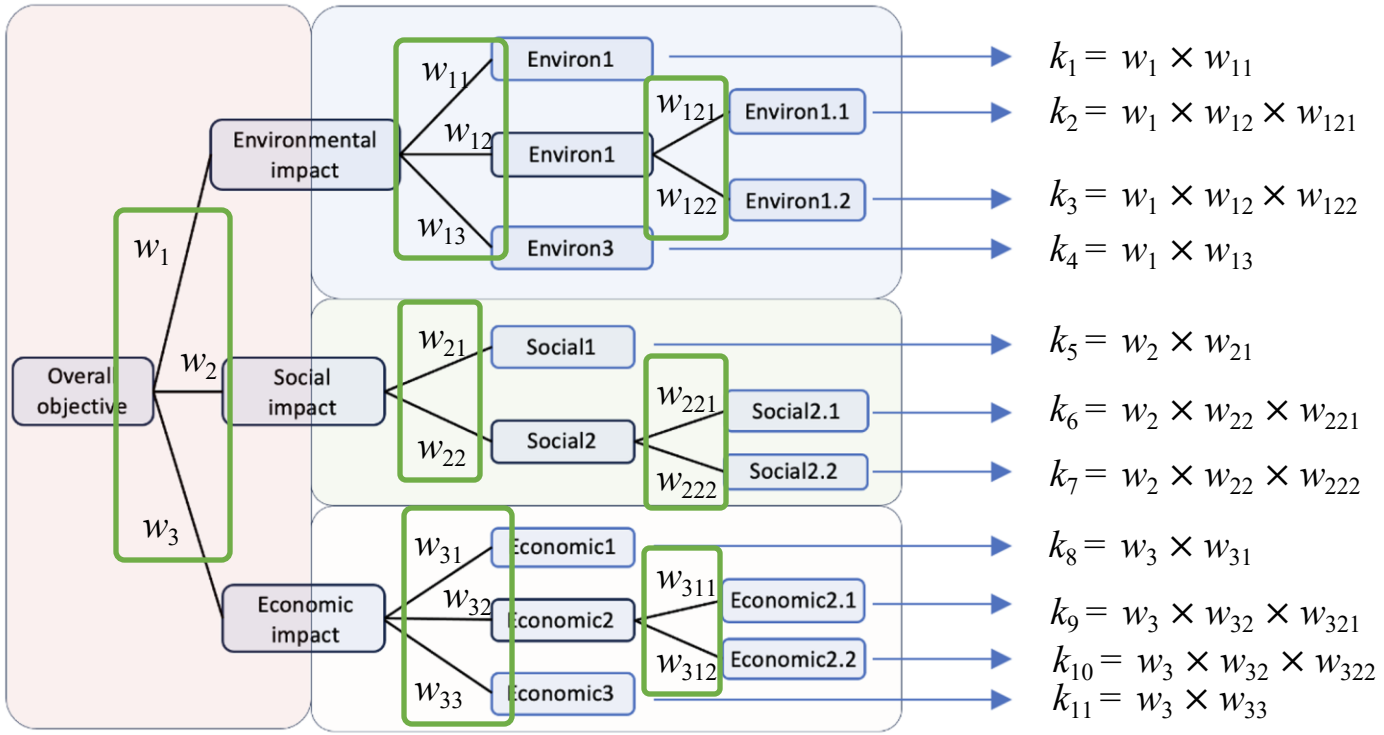
w_2 (Social) > w_3 (Economic) > w_1 (Environmental)

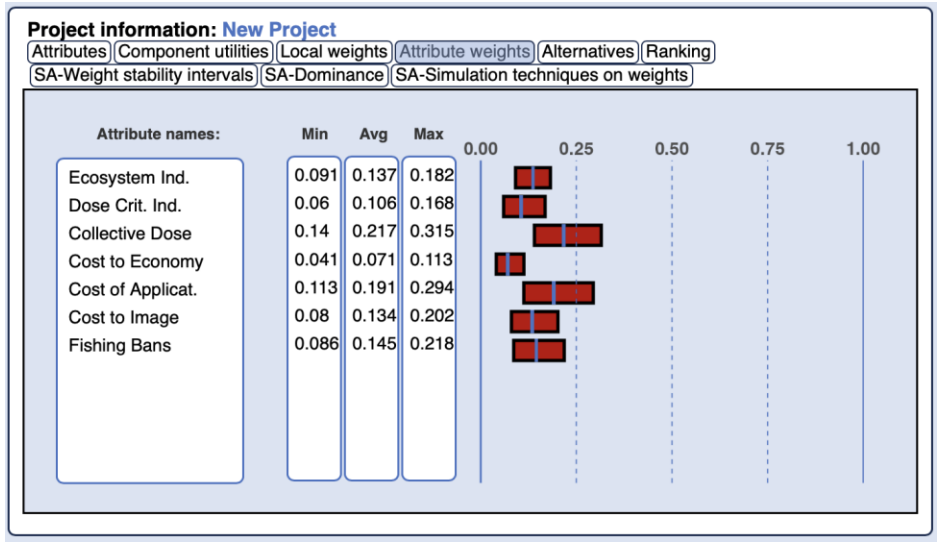
w_2 slightly more important than w_3
w_3 more important than w_1

Cardinal sum reciprocal method
Danielson & Ekenberg (2017)

5.2. Quantifying preferences. Weight elicitation

Hierarchically eliciting weights:





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6. Evaluating alternatives

Uniform distribution and discrete attributes

Alternative performances

Other distributions or ordinal information

$$u(A^j) = \sum_{i=1}^{n} k_i u_i(x_i^j)$$

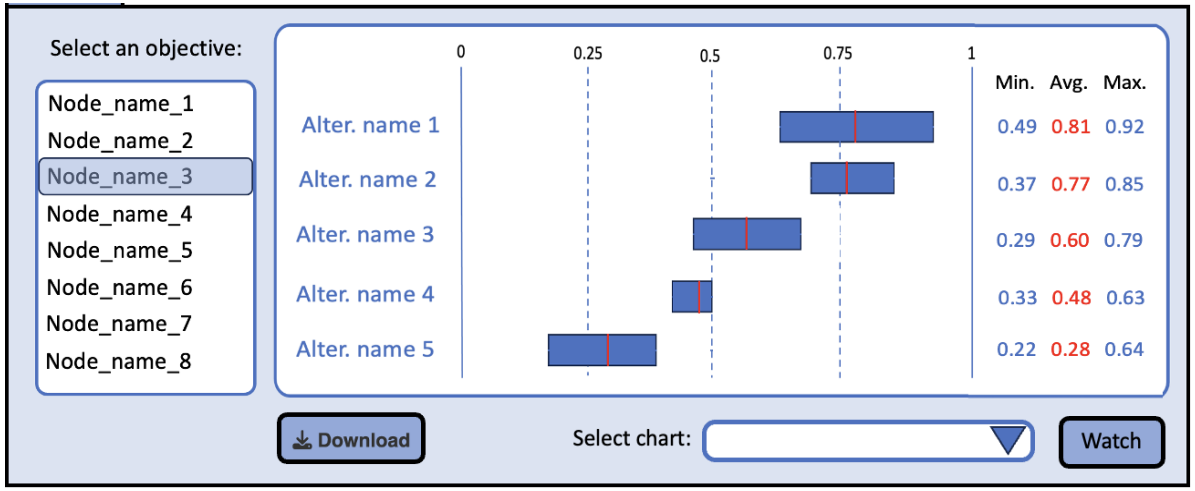
Minimum, average and maximum global utilities

→ Ranking based on average global utilities

Simulation process

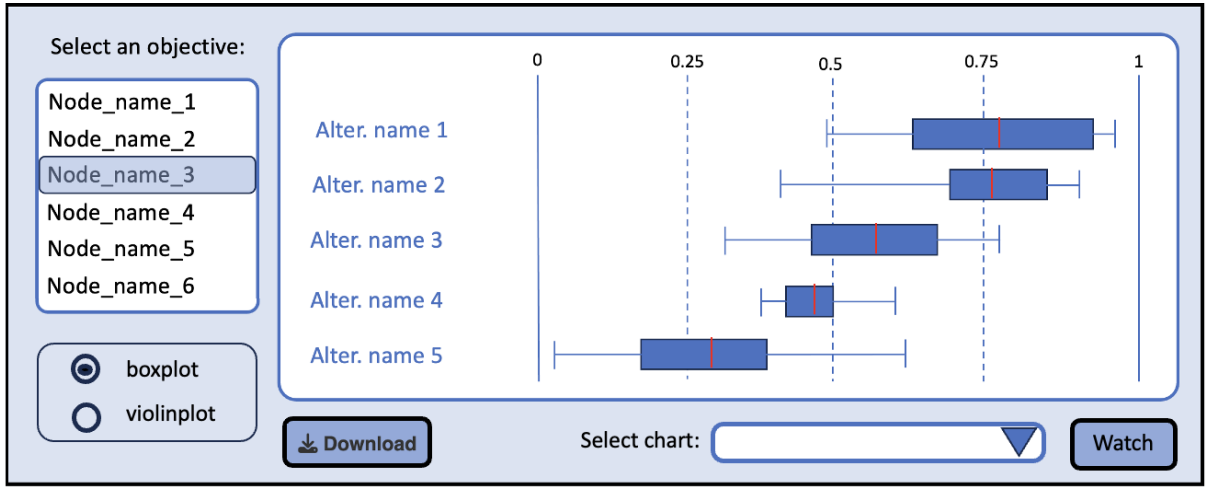
→ Multiple box/violin plot

6. Evaluating alternatives

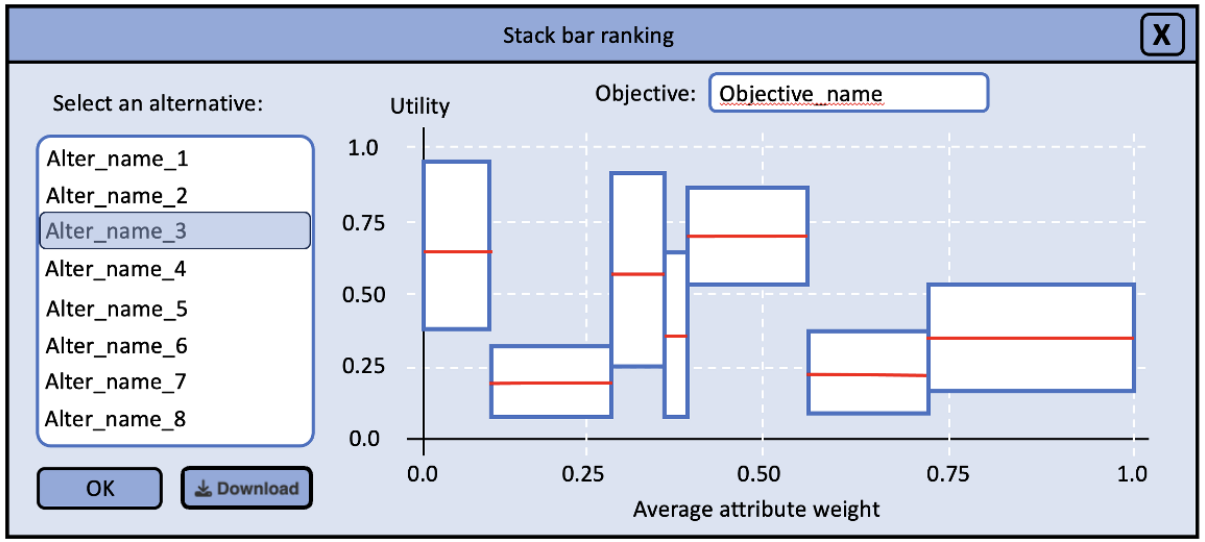


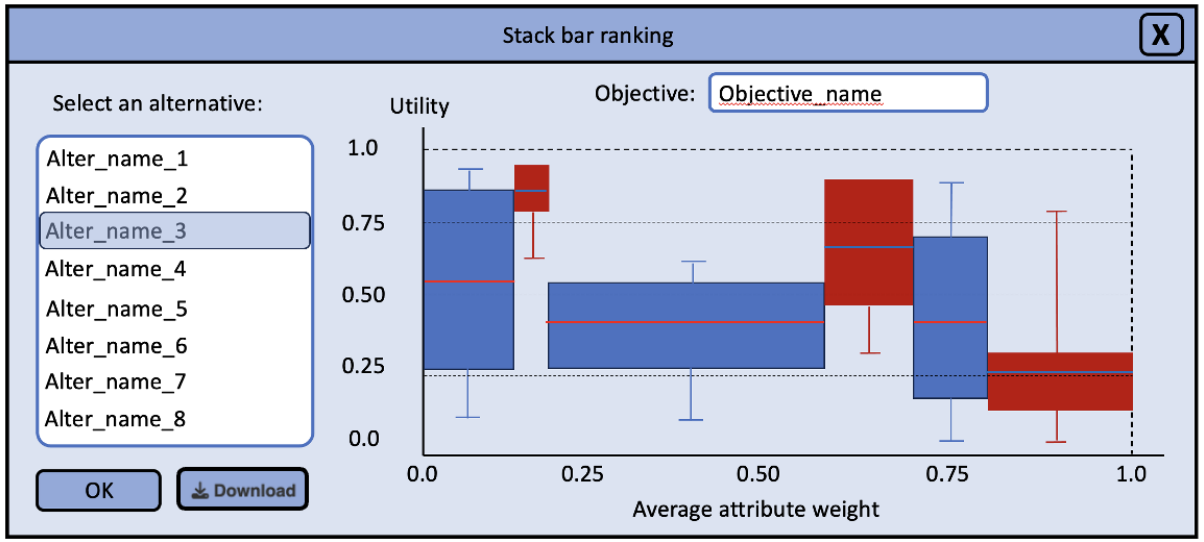
Ranking based on average global utilities

Simulation process



6. Evaluating alternatives





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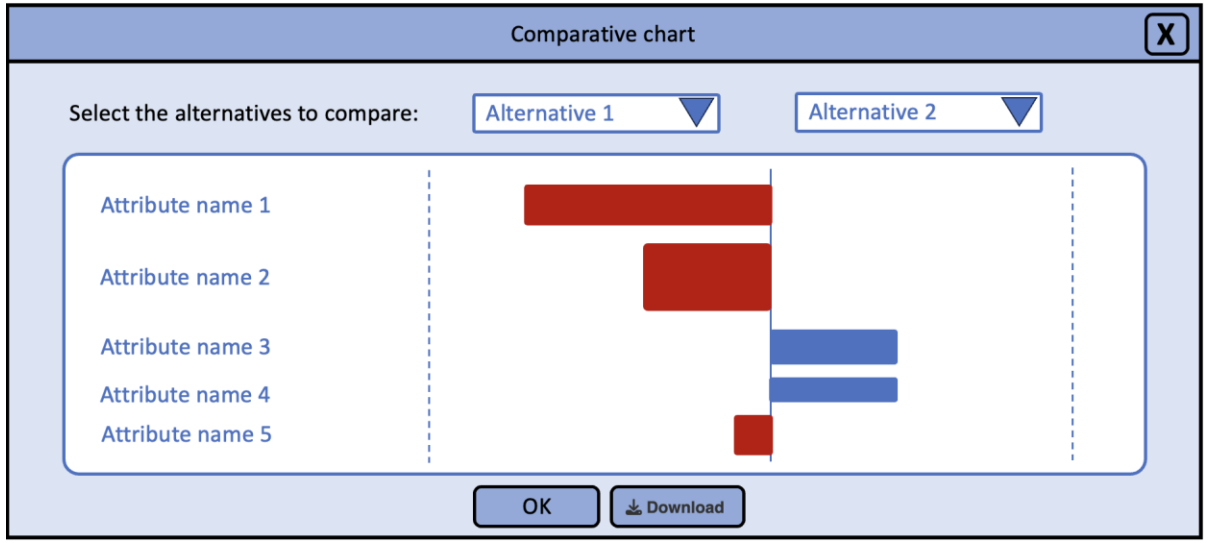

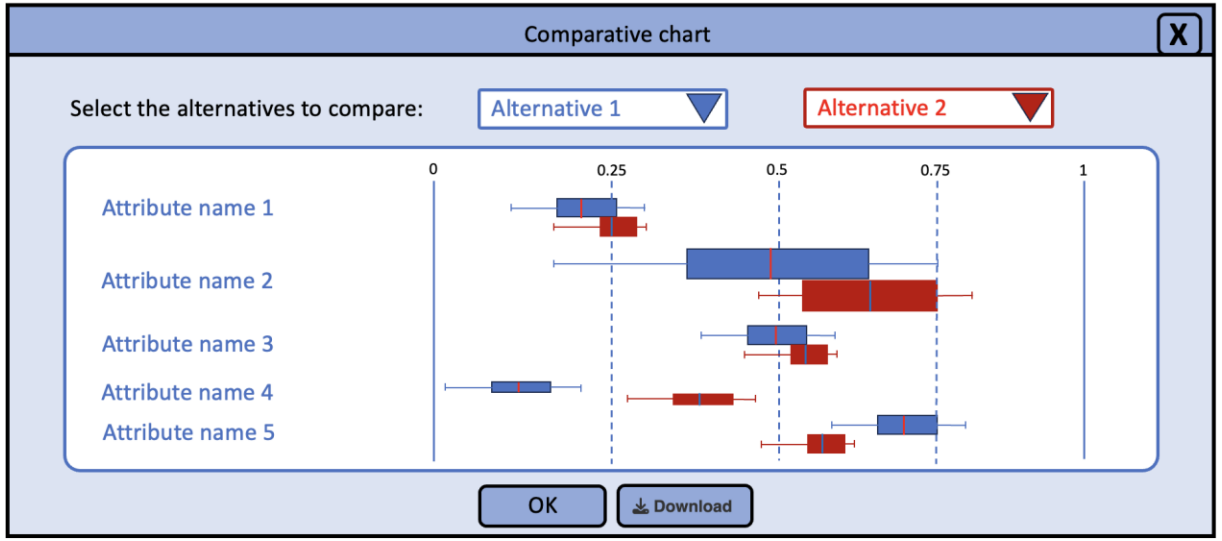

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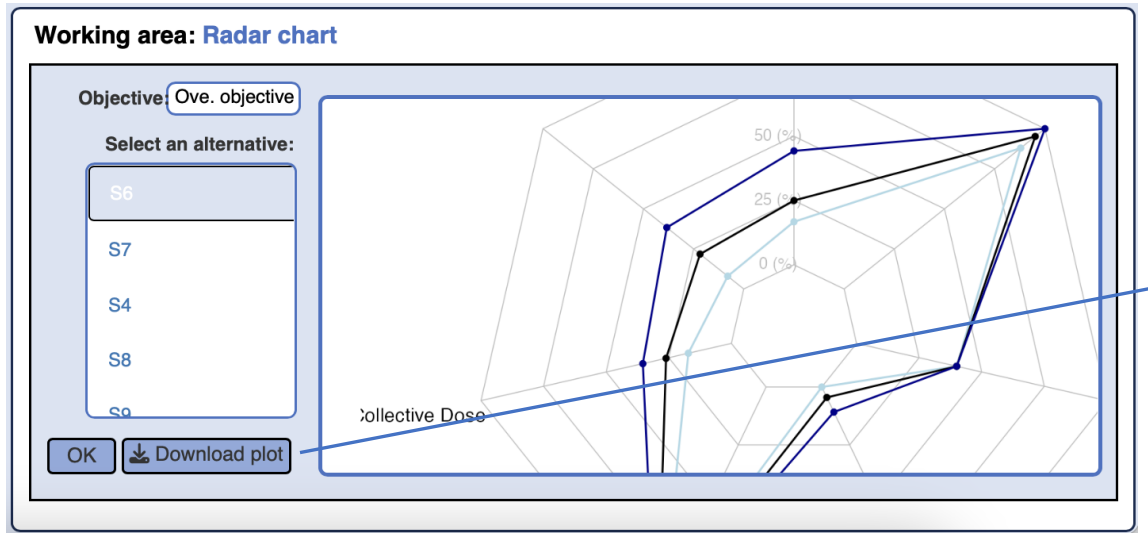

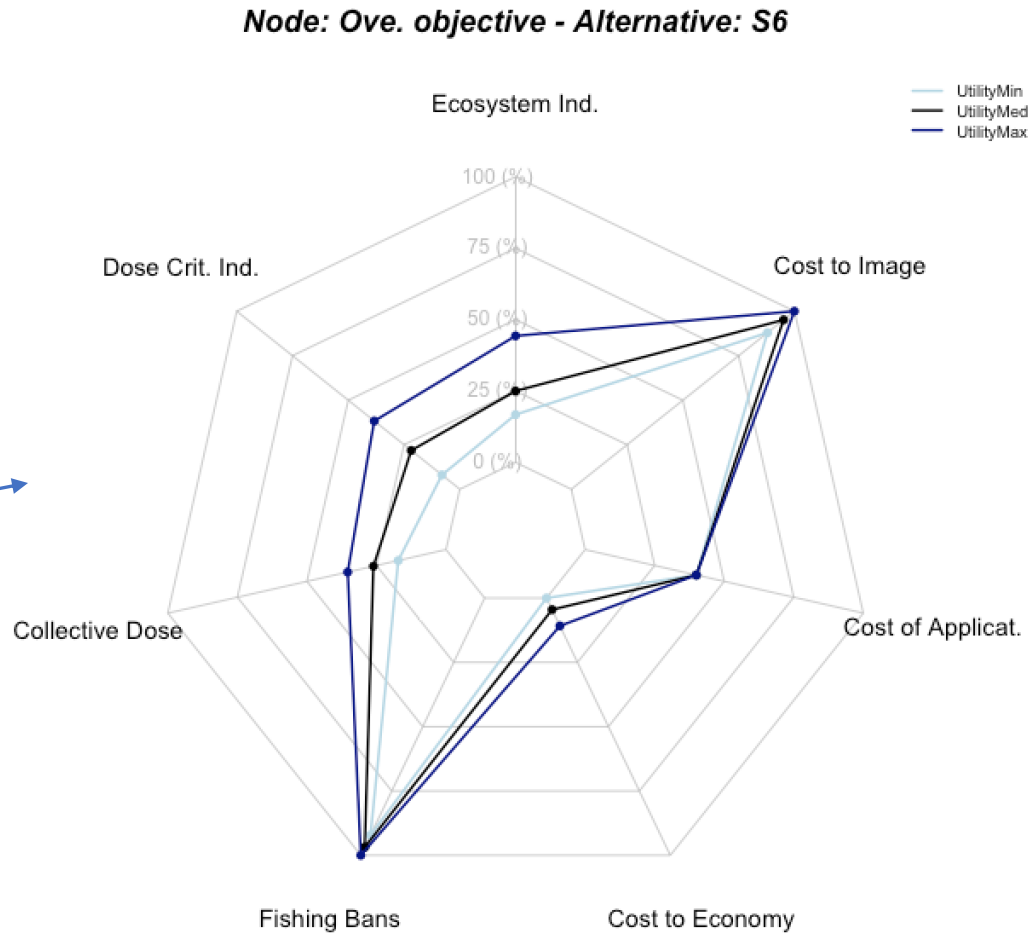

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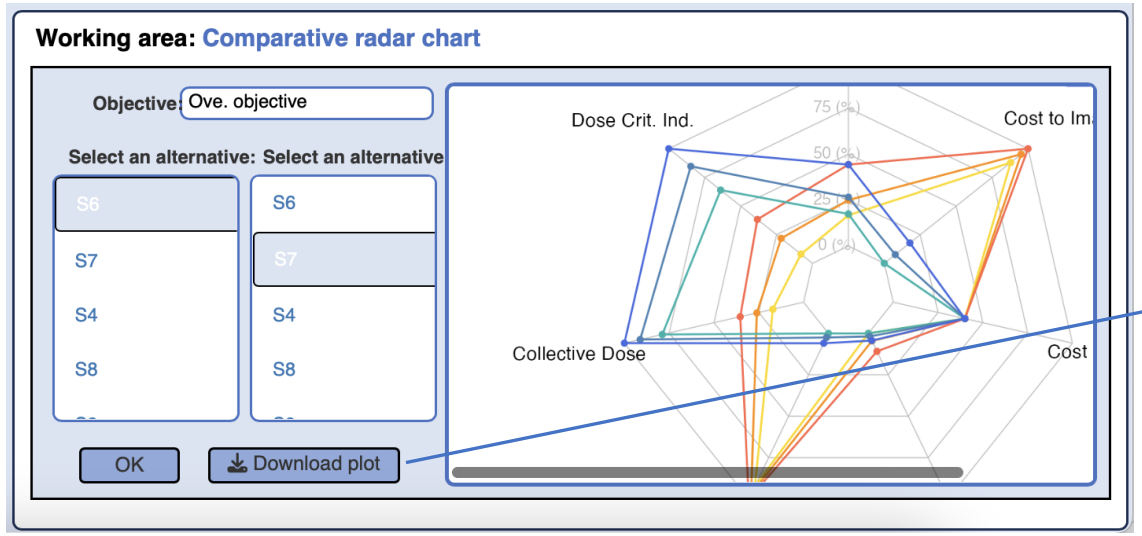

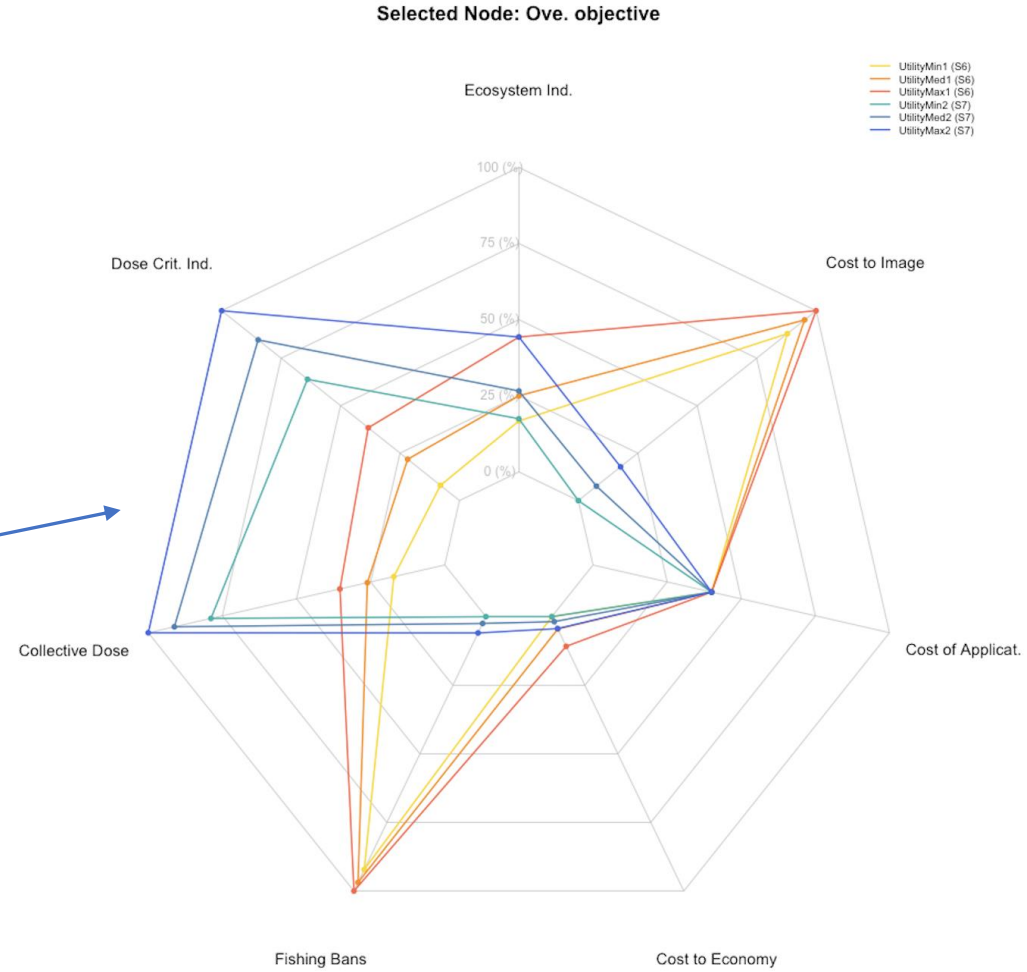

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7.1. Sensitivity analysis. Non-dominated and potentially optimal alternatives

Project information: New Project

Attributes | Component utilities | Local weights | Attribute weights | Alternatives | Ranking | SA-Weight stability intervals | SA-Dominance | SA-Simulation techniques on weights

Non-dominated alternatives

S1
S2
S3
S4
S5
S8
S9

Potentially optimal alternatives

S1
S2
S3
S4
S5
S8
S9

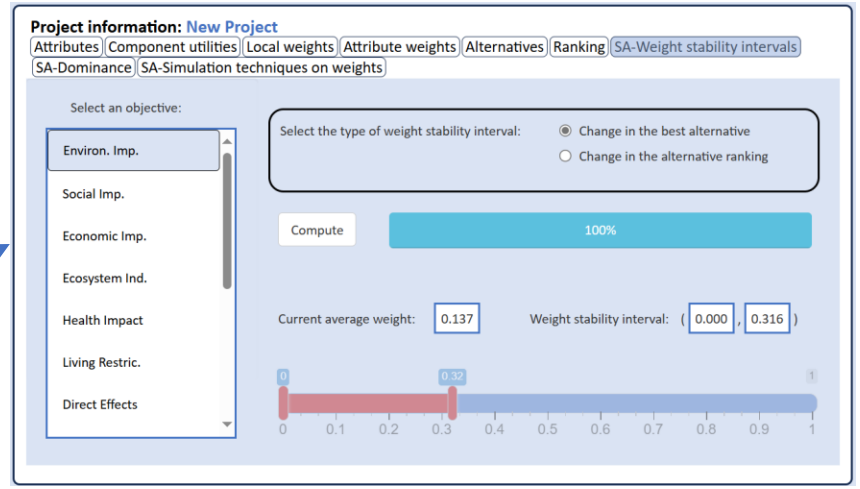
Pairwise dominance values

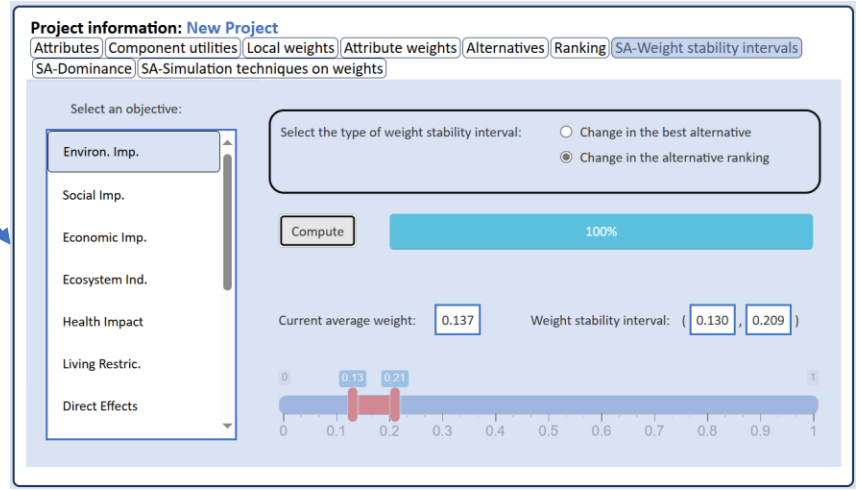
	S1	S2	S3	S4	S5
S1	X	-0.14	-0.173	-0.07	-0.
S2	-0.105	X	-0.197	-0.094	-0.
S3	-0.066	-0.126	X	-0.055	-0.
S4	-0.212	-0.271	-0.304	X	-0.
S5	-0.173	-0.233	-0.265	-0.162	X
S6	-0.285	-0.345	-0.377	-0.274	-0.
S7	-0.3	-0.36	-0.393	-0.29	-0.
S8	-0.192	-0.252	-0.285	-0.182	-0.

Assess

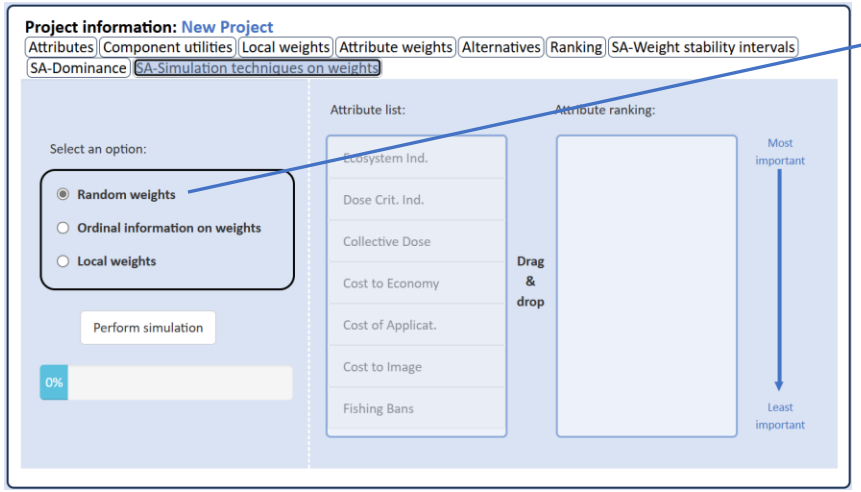
100%

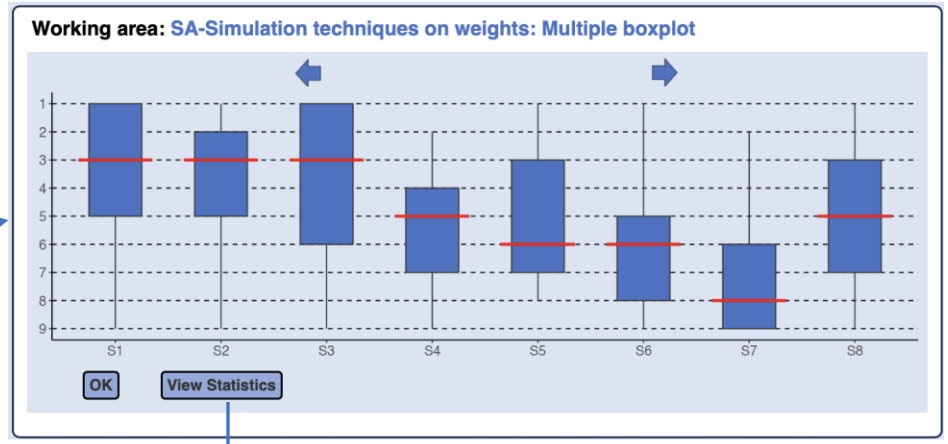
7.2. Sensitivity analysis. Weight stability intervals

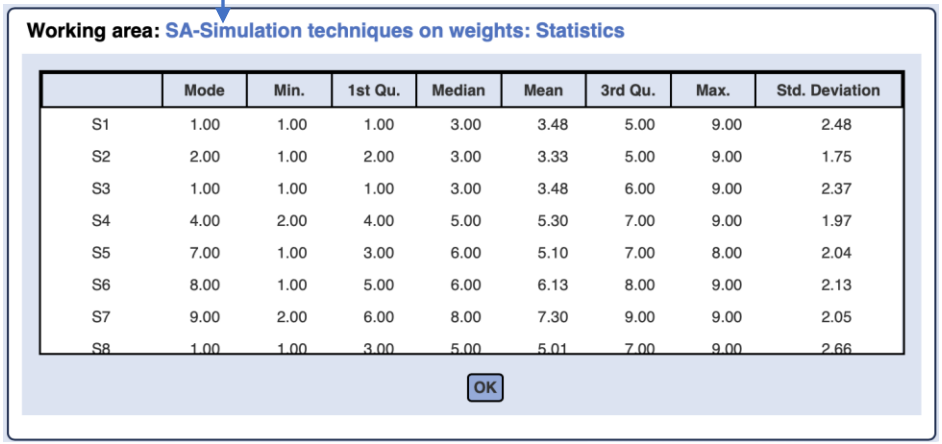




7.3. Sensitivity analysis. Monte Carlo simulation techniques on weights

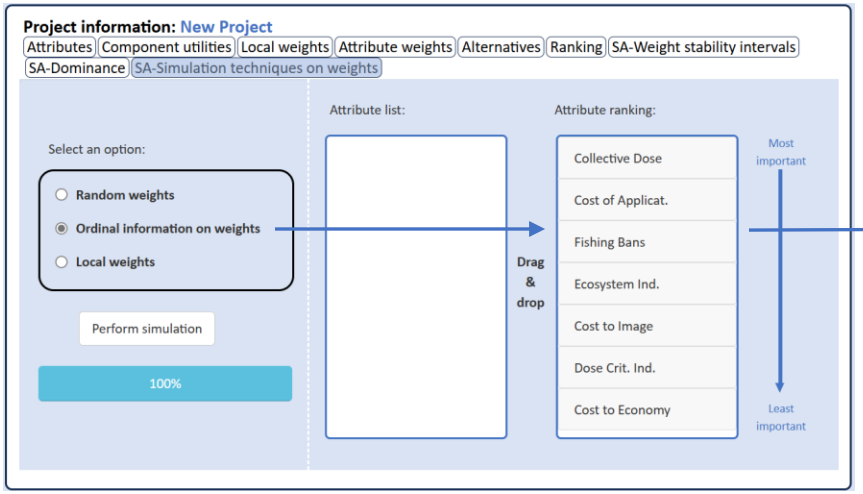


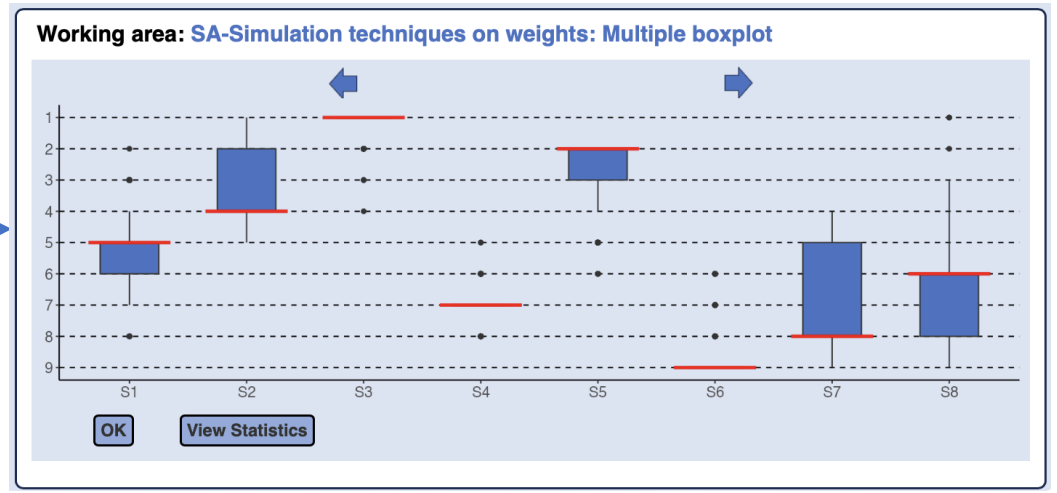




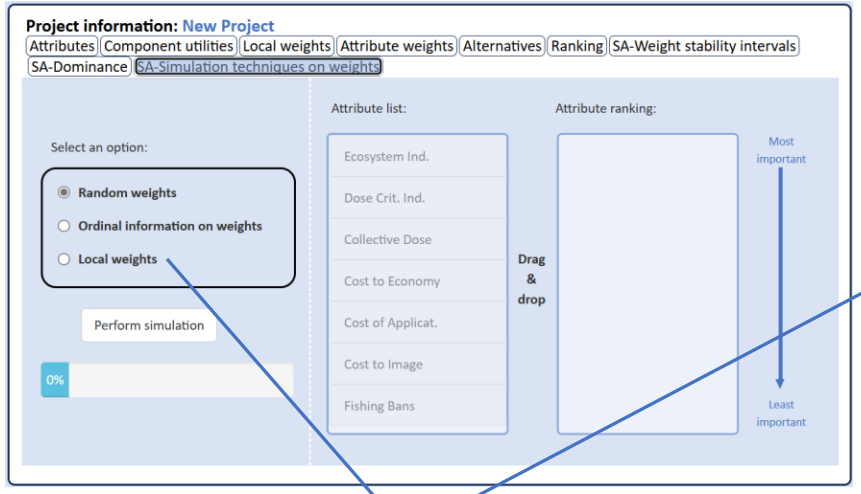
	Mode	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Std. Deviation
S1	1.00	1.00	1.00	3.00	3.48	5.00	9.00	2.48
S2	2.00	1.00	2.00	3.00	3.33	5.00	9.00	1.75
S3	1.00	1.00	1.00	3.00	3.48	6.00	9.00	2.37
S4	4.00	2.00	4.00	5.00	5.30	7.00	9.00	1.97
S5	7.00	1.00	3.00	6.00	5.10	7.00	8.00	2.04
S6	8.00	1.00	5.00	6.00	6.13	8.00	9.00	2.13
S7	9.00	2.00	6.00	8.00	7.30	9.00	9.00	2.05
S8	1.00	1.00	3.00	5.00	5.01	7.00	9.00	2.66

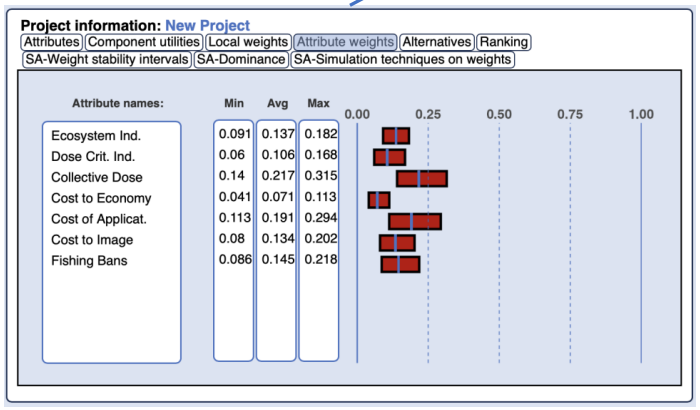
7.3. Sensitivity analysis. Monte Carlo simulation techniques on weights

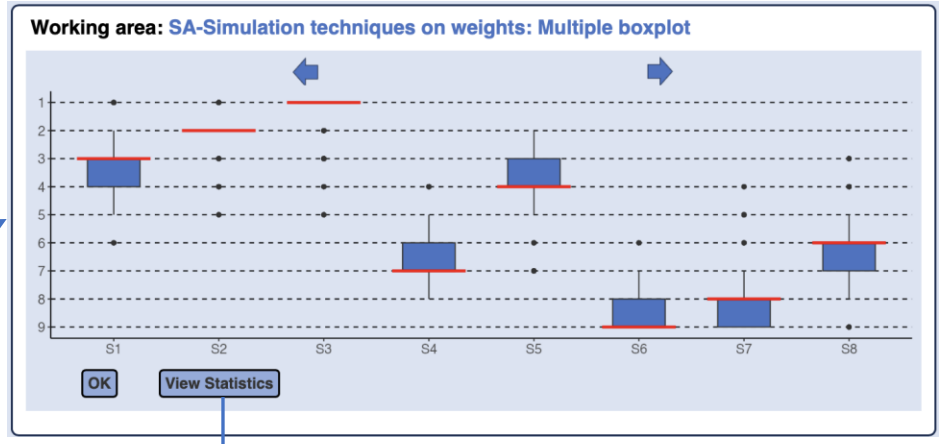


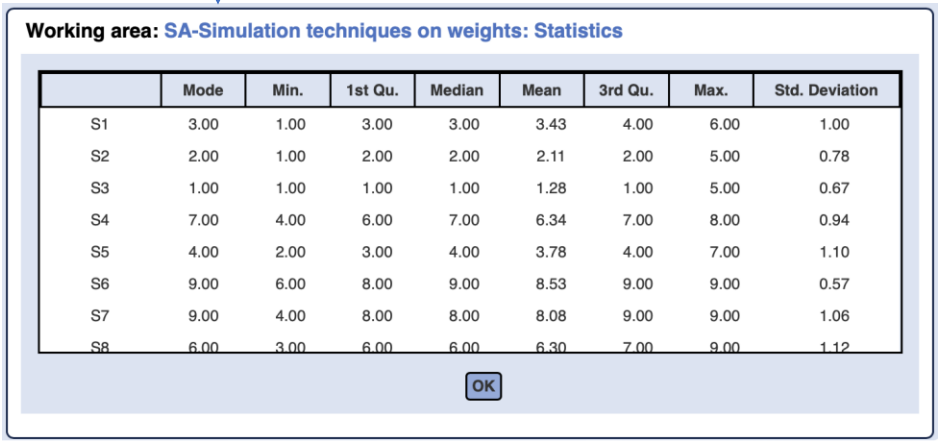


7.3. Sensitivity analysis. Monte Carlo simulation techniques on weights









	Mode	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Std. Deviation
S1	3.00	1.00	3.00	3.00	3.43	4.00	6.00	1.00
S2	2.00	1.00	2.00	2.00	2.11	2.00	5.00	0.78
S3	1.00	1.00	1.00	1.00	1.28	1.00	5.00	0.67
S4	7.00	4.00	6.00	7.00	6.34	7.00	8.00	0.94
S5	4.00	2.00	3.00	4.00	3.78	4.00	7.00	1.10
S6	9.00	6.00	8.00	9.00	8.53	9.00	9.00	0.57
S7	9.00	4.00	8.00	8.00	8.08	9.00	9.00	1.06
S8	6.00	3.00	6.00	6.00	6.30	7.00	9.00	1.12