A two-step global sensitivity analysis of a SWAT model, using simple screening methods and advanced quantitative methods

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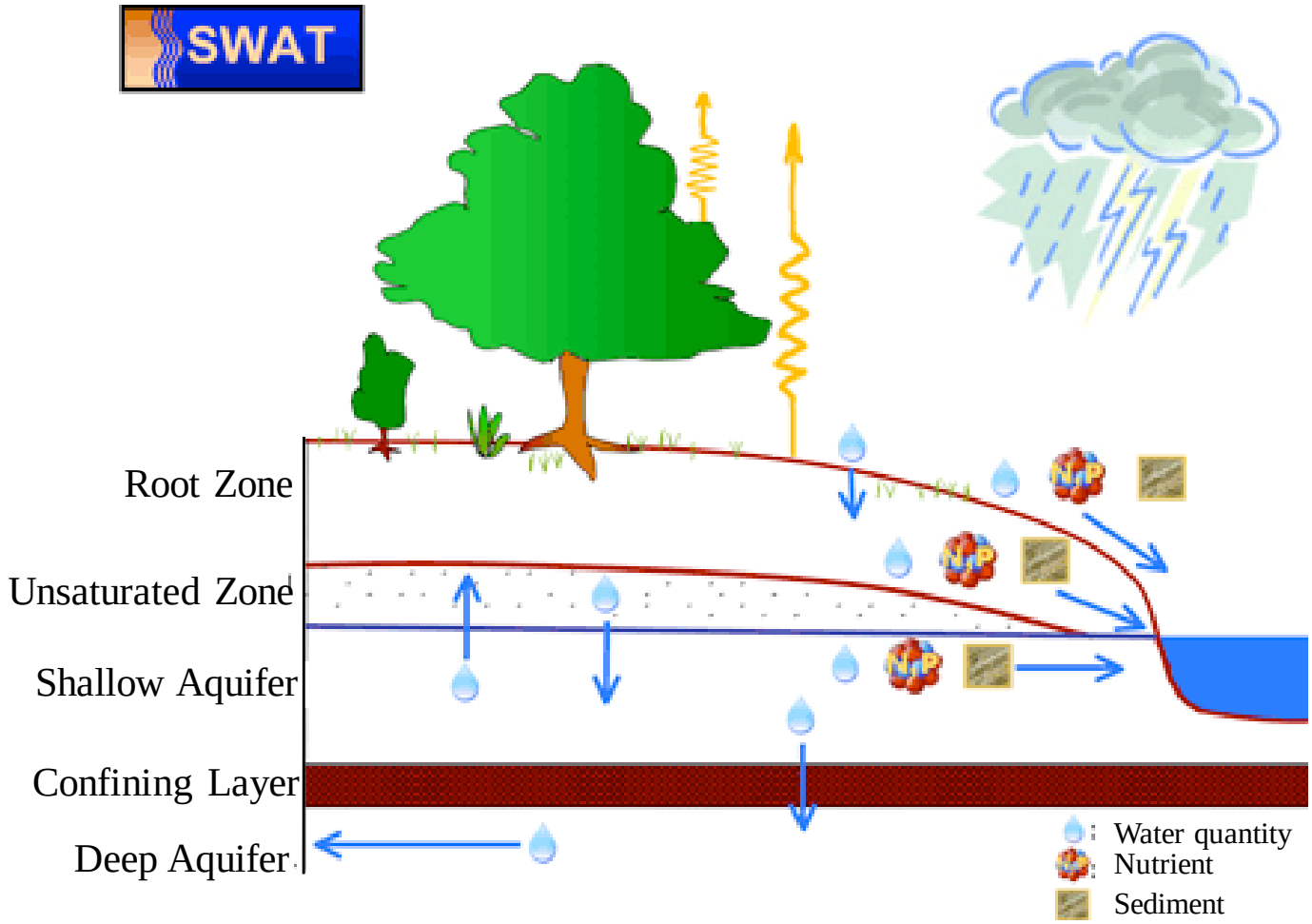
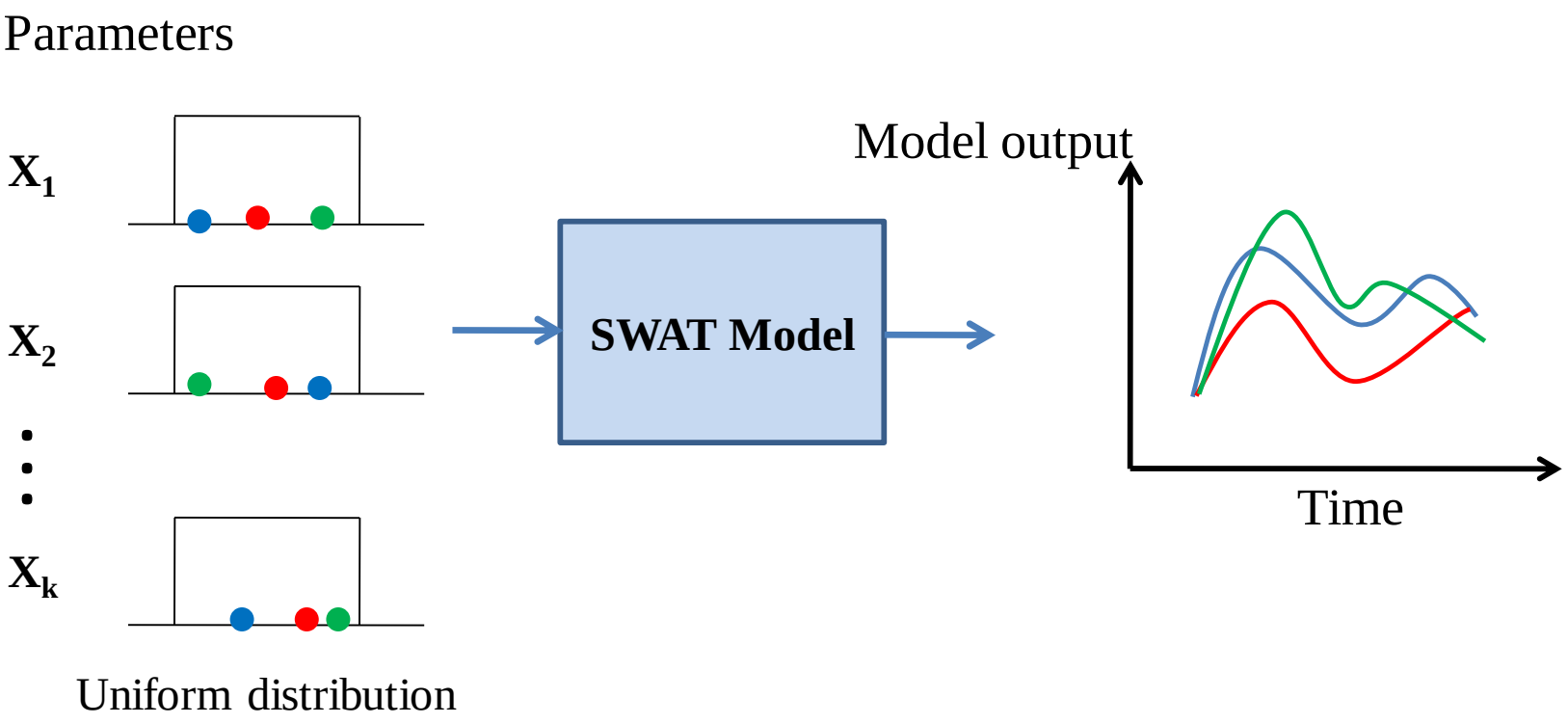
A SWAT model includes a large number of parameters



Uncertainty in parameters

is a well-know reason of **model output uncertainty**



Model calibration

to estimate the parameters values

A large number of parameters

Lack of data

→ Low calibration efficiency

Solutions to improve the calibration efficiency:

Identification the most sensitive parameters

Identification the less sensitive parameters

Reduction of the number of parameters

→ **Sensitivity analysis**

Global sensitivity analysis methods

- Simple screening methods
- Advanced quantitative methods

Two-step global sensitivity analysis of a SWAT model

Results and discussion

Conclusion

Global sensitivity analysis methods

analyze the whole parameter space

Simple screening methods

Advanced quantitative methods

Global sensitivity analysis methods

analyze the whole parameter space

Simple screening methods:

Latin-Hypercube – One-factor-At-a-Time (LH-OAT)

Regression-based method

conceptually simple

Easy to implement

Low computational cost

Cannot provide quantitative information about the importance of parameters.

Parameter interactions

Not reliable for highly non-linear systems

Global sensitivity analysis methods

analyze the whole parameter space

Simple screening methods

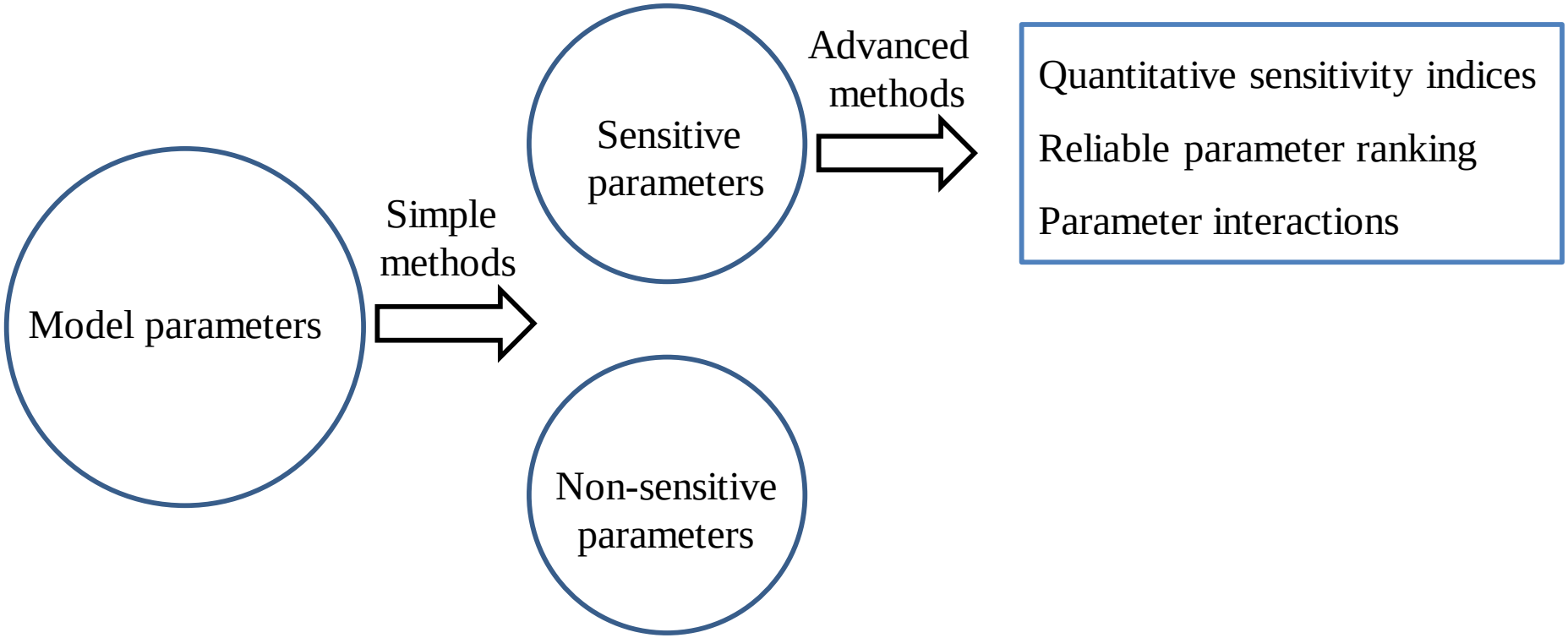
Advanced quantitative methods:

Variance-based method of Sobol’

Density-based method of PAWN

- Sensitivity indices: quantitative importance measures
- Applicable for non-linear systems
- Parameter interactions
- Computationally expensive

Two-step approach for a global sensitivity analysis: simple methods + advanced methods



Global sensitivity analysis of a SWAT model using two-step approach

Upstream catchment of the River Zenne, Belgium

26 water quantity related parameters

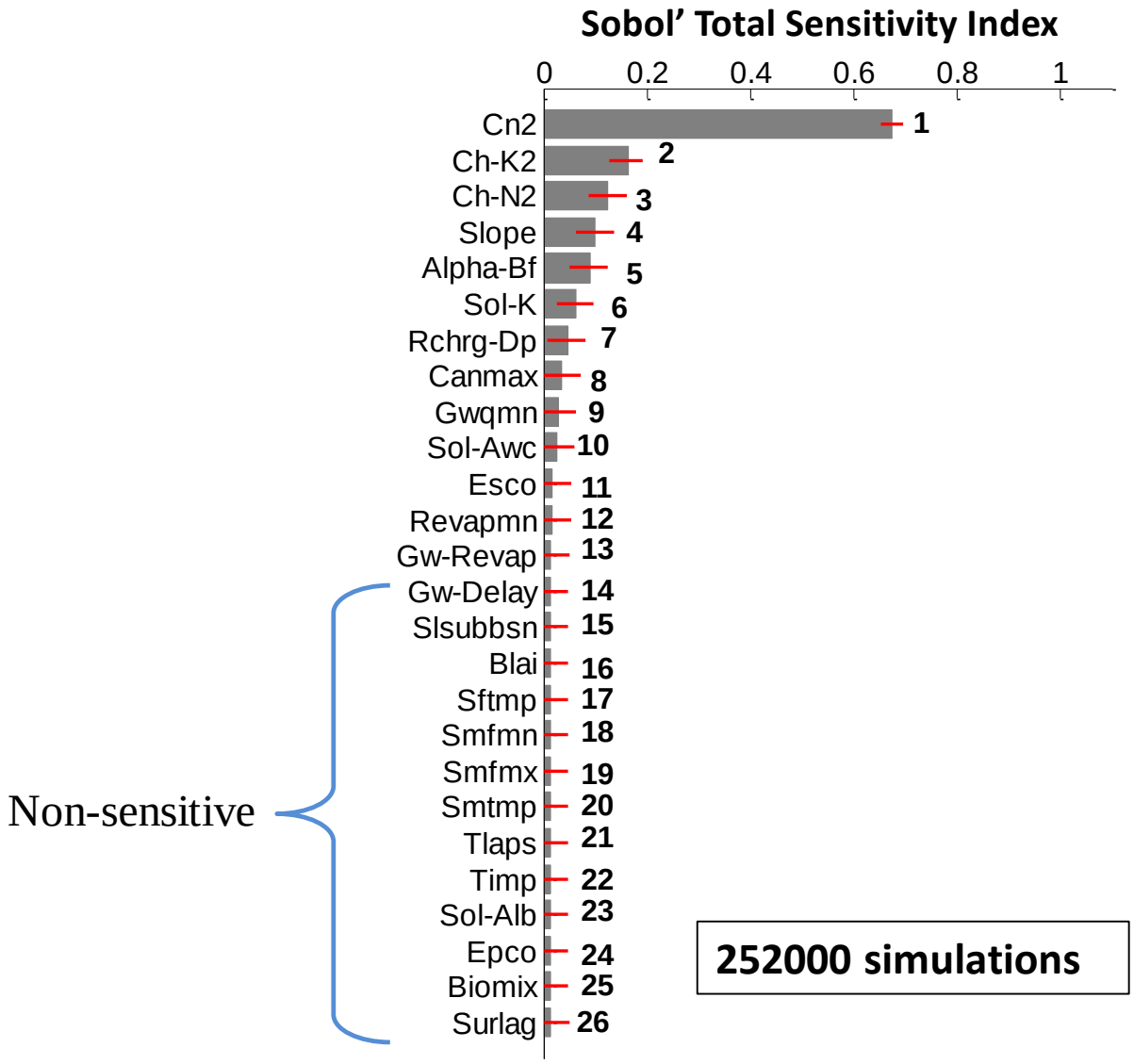
Sample size:

LH-OAT: 75 samples (2025 simulations)

SWAT-CUP: 2000 samples (2000 simulations)

Sobol': 9000 samples (135000 simulations)

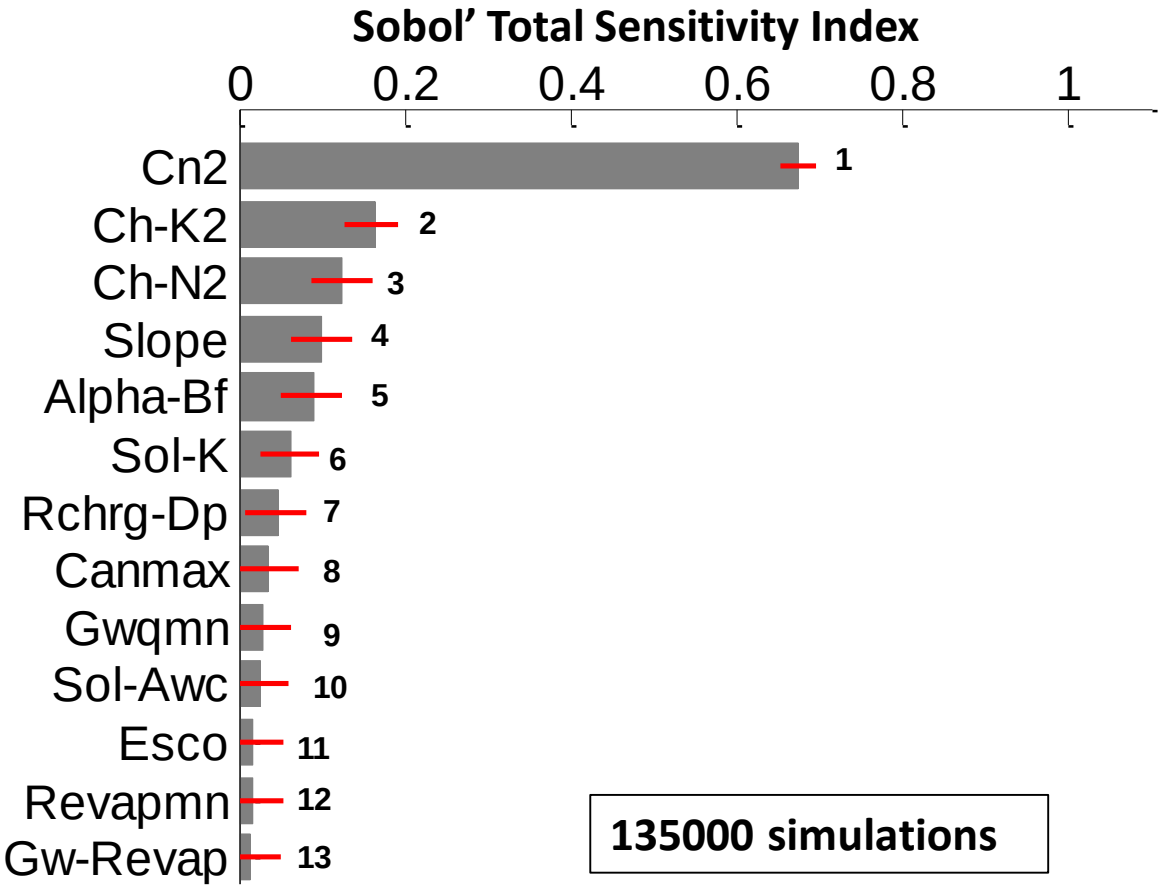
Sobol' method



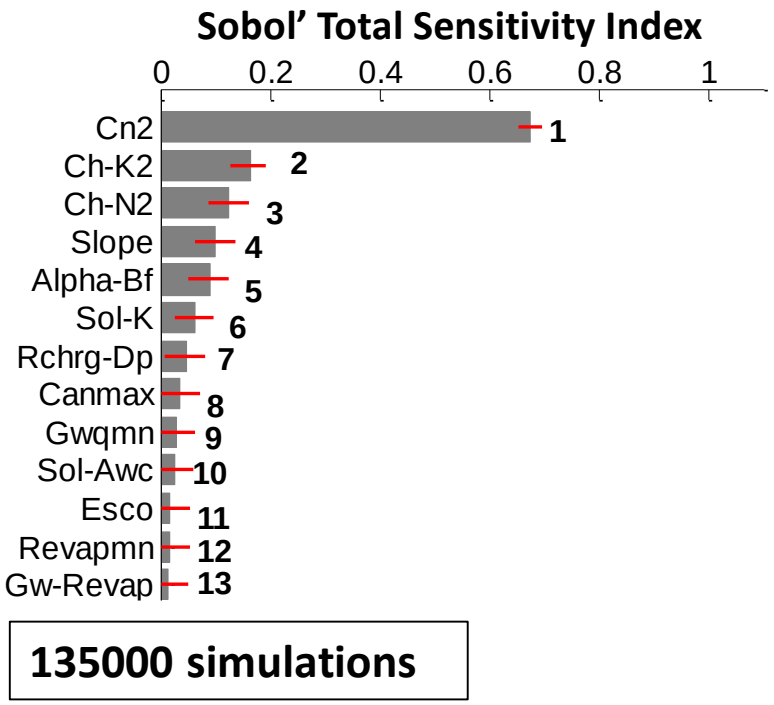
Parameters	Sobol'	LH-OAT	SWAT-CUP
Cn2	1	1	1
Ch_K2	2	2	2
Ch_N2	3	4	7
Slope	4	3	6
Alpha_Bf	5	4	9
Sol_K	6	6	5
Rchrg_Dp	7	9	10
Canmax	8	8	3
Gwqmn	9	11	8
Sol_Awc	10	7	14
Esco	11	10	11
Revapmn	12	12	18
Gw_Revap	13	13	25
Gw_Delay	14	14	17
Slsubbsn	15	18	4
Blai	16	17	19
Sftmp	17	27	13
Smfmn	18	27	21
Smfmx	19	27	24
Smtmp	20	27	12
Tlaps	21	27	16
Timp	22	27	23
Sol_Alb	23	19	20
Epco	24	16	15
Biomix	25	17	22
Surlag	26	15	26

Second step: advanced quantitative method

Sobol' total sensitivity index: total contribution of the parameters to the output variance

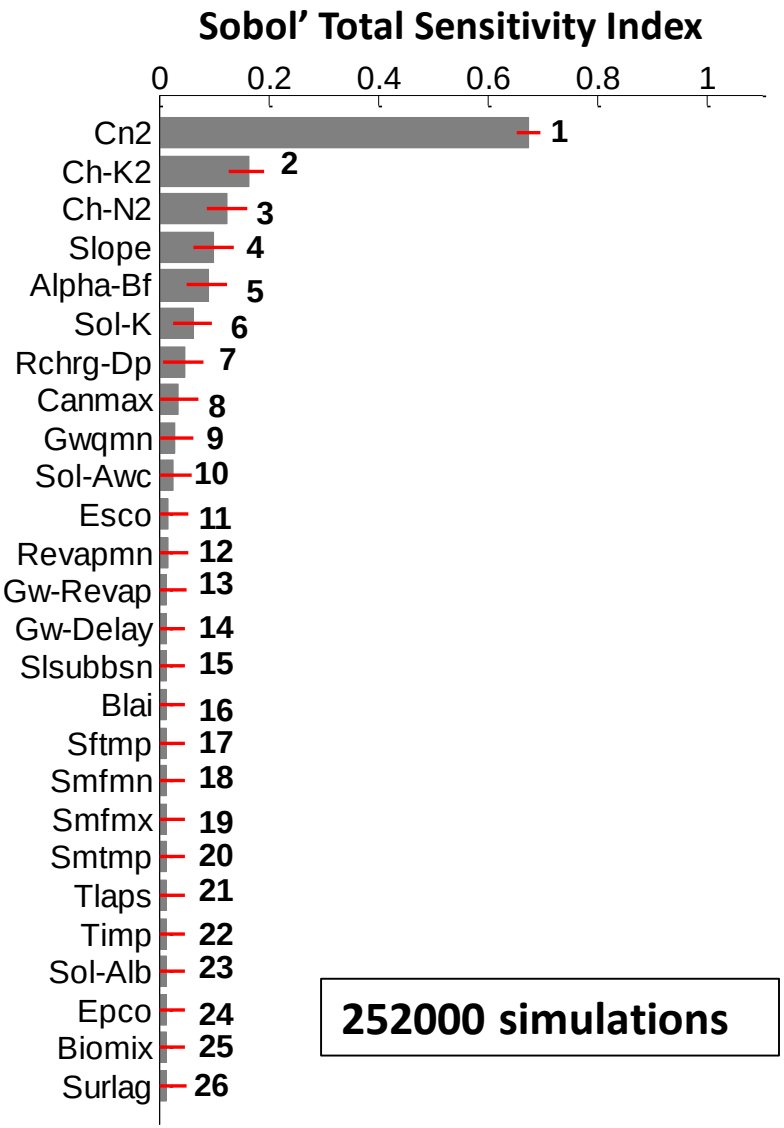


Two-step approach reduces the required computational cost of the Sobol' method



135000 simulations

Non-sensitive



252000 simulations

Conclusions:

- Advanced sensitivity analysis need many simulations

- SWAT-CUP uncertainty analysis gave different ranking but LH-OAT gives similar ranking.

- LH-OAT can be used or a two step process using LH-OAT in a first step

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