ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

Laboratoire d'Hydrologie et de Géochimie de Strasbourg

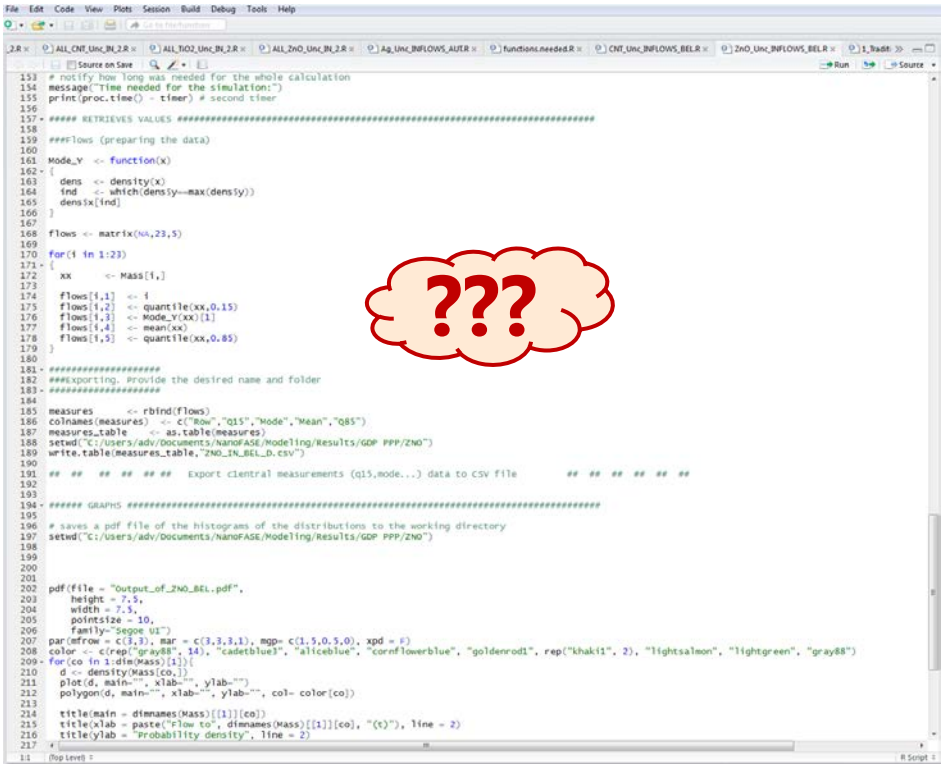
Empa
Materials Science and Technology

A comparison of two methods for probabilistic modelling of ENM emissions during their life cycle

Véronique Adam
Bernd Nowack
Gaetana Quaranta
Stéphanie Loyaux-Lawniczak

65th LCA Discussion Forum
ETH Zürich - 24 May 2017

Background

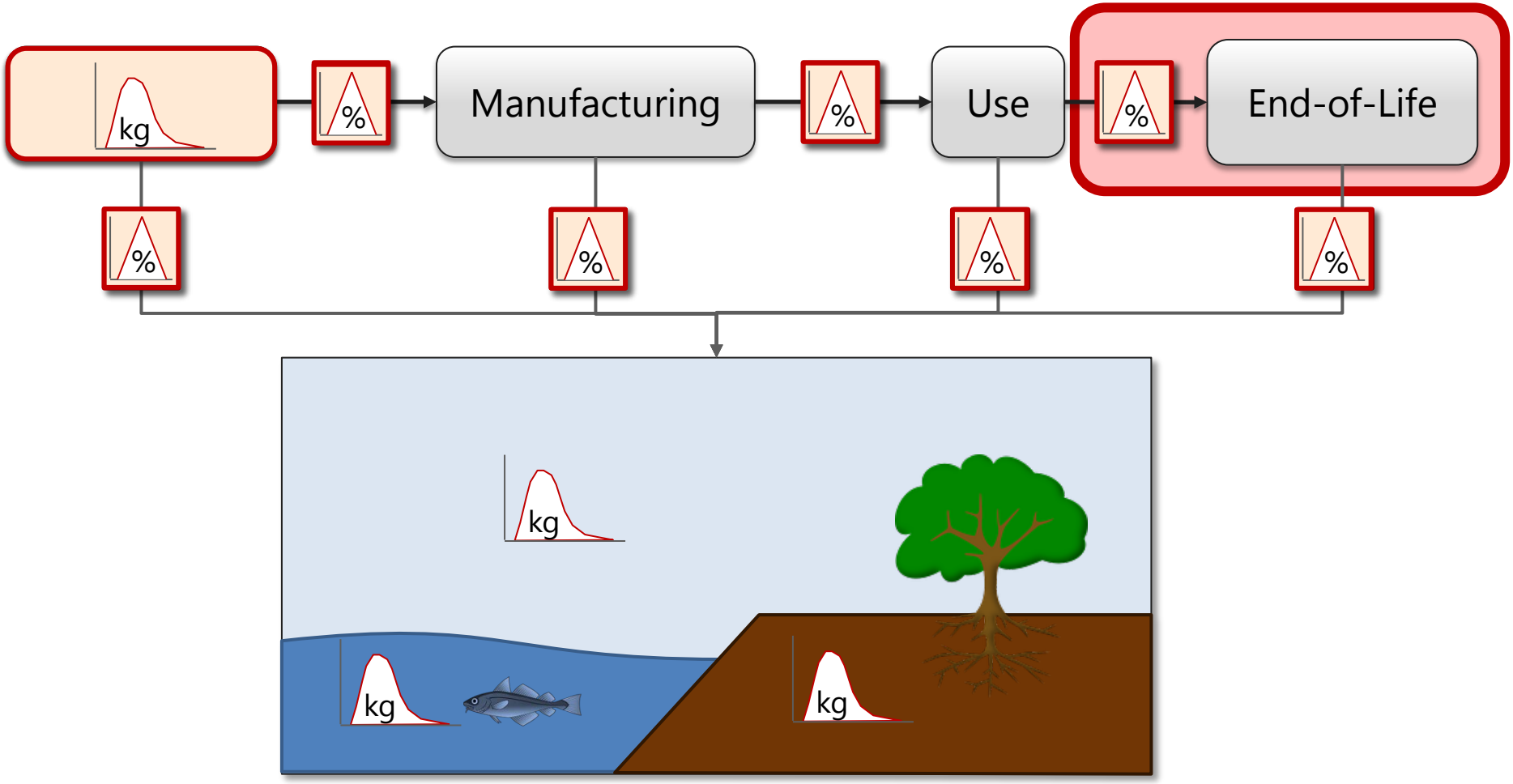


WE NEED A PROBABILISTIC APPROACH!

Outline

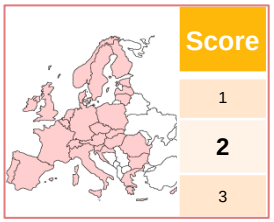
- Method A: Probabilistic Material Flow Analysis
  - General methodology
  - Example of application
- Method B: Bayesian Networks
  - General methodology
  - Example of application
- Points for comparison

Probabilistic Material Flow Analysis
General methodology



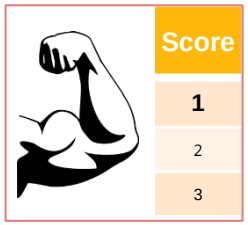
Probabilistic Material Flow Analysis
Assessing the probability distributions

- Various data sources used (Reports, papers, Eurostat)
- Uncertainty assessment for each value (i.e. each reference):



Geographical correlation

Temporal correlation

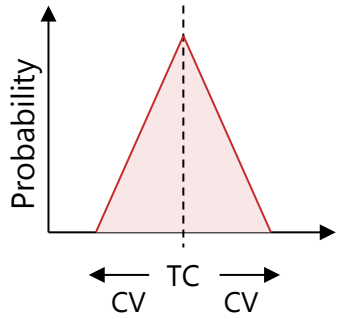


Reliability

$$DQR = \frac{Geo + Temp + Rel + W_i \times 4}{i + 4}$$

$W_i = weakest\ score$
$i = number\ of\ indicators$

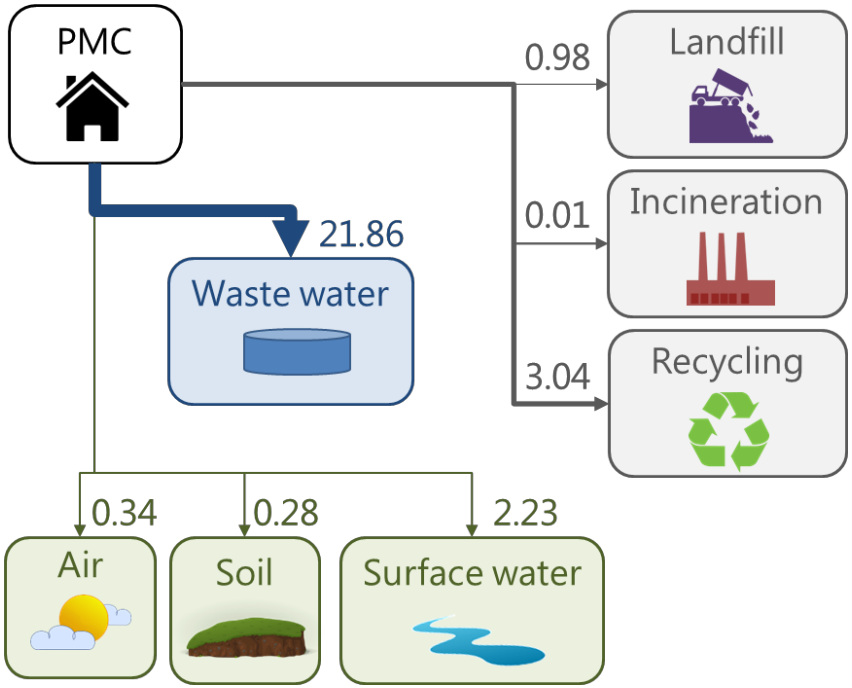
(EC, 2010)



Data Quality Rating	Coefficient of Variation
1 ≤ DQR < 1.5	4.5%
1.5 ≤ DQR < 2.5	13.75%
2.5 ≤ DQR ≤ 3	41.5%

(adapted from Laner et al., 2015)

Probabilistic Material Flow Analysis
Results visualisation



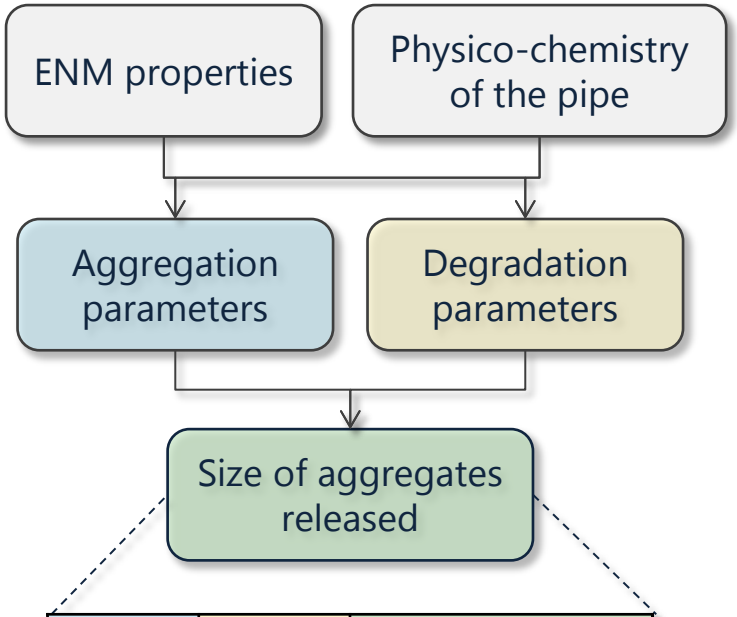
Nano-ZnO (tonnes) in Romania

Difficult to represent the whole distributions…

Bayesian networks
General methodology

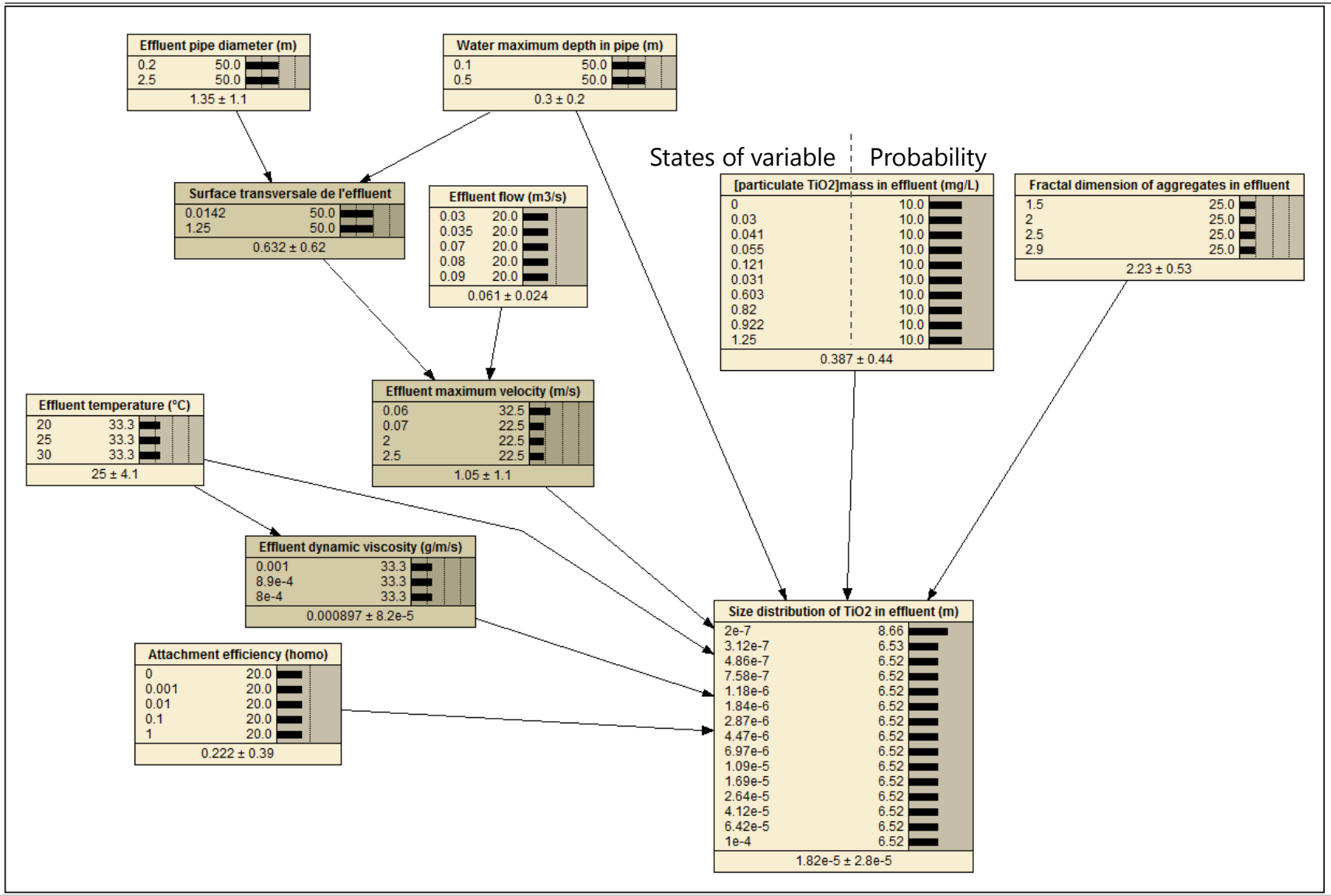
1. Define the **parameters** needed and their **relationships** (models, lab,…)

2. Define the **conditional probability tables**

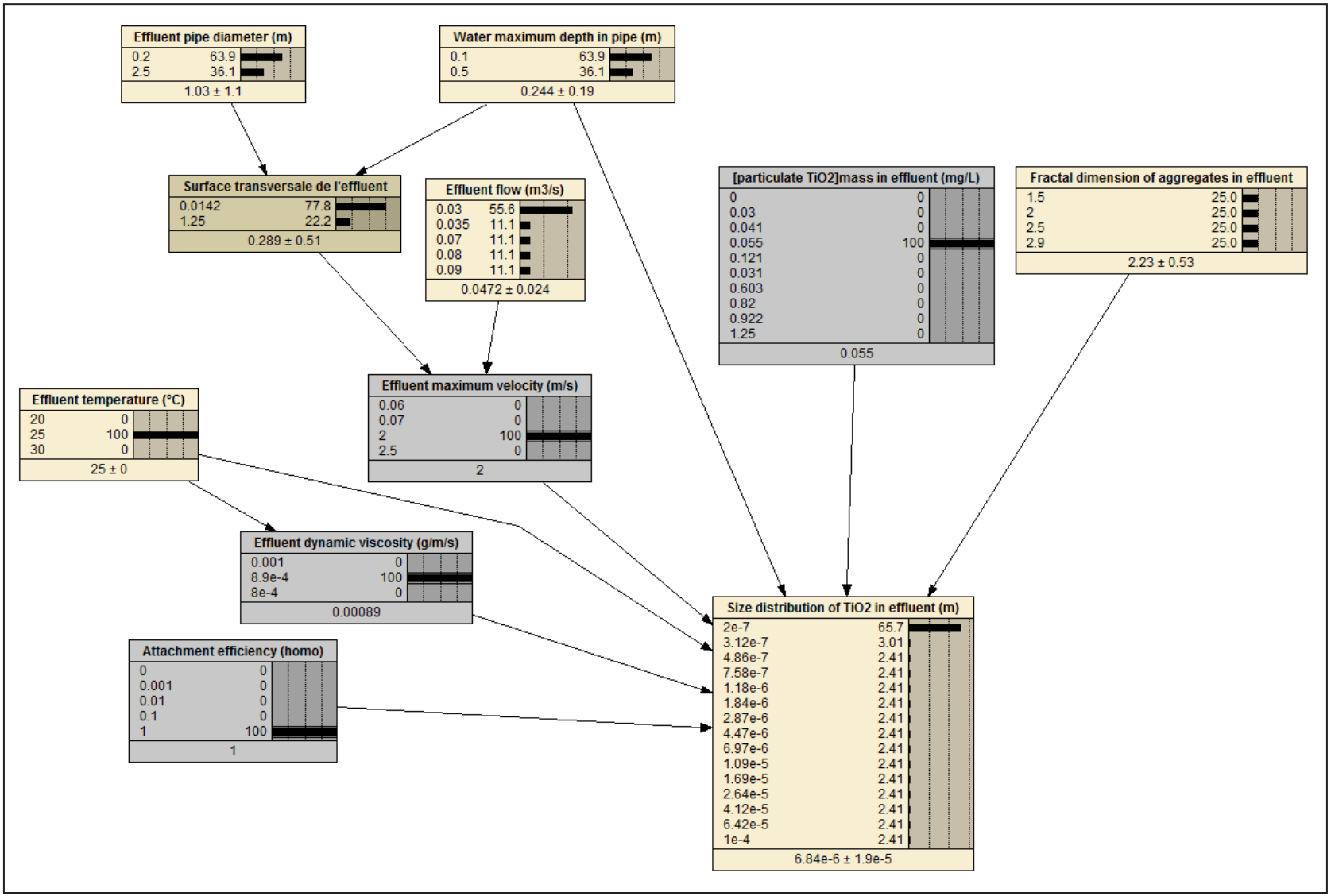


V1	V2	V3		
		1	2	3
[0;5[	0.1	**0**	**0**	**100**
[0;5[	0.01	**0**	**100**	**0**
[5;10[	0.1	**25**	**50**	**25**
[5;10[	0.01	**20**	**60**	**20**
[10;15[	0.1	**100**	**0**	**0**
[10;15[	0.01	**100**	**0**	**0**

Bayesian networks
Example of application



Bayesian networks
Example of application

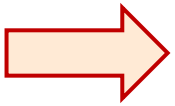


Conclusion

- Two powerful and flexible tools
  - Mechanistic or «black box» models
  - Local to global scales
  - Can include temporal dynamics

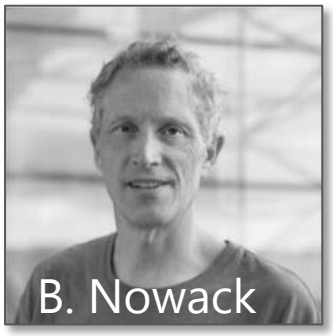
So which should we use?

- Current probabilistic MFA for ENM
  - National to continental scales
  - (Over)simplified probabilistic modelling(?)
- Bayesian networks
  - Easier track of the uncertainty propagation
  - Can become very complex



It depends on the purpose!

Thank you!



ADEME
Agence de l'Environnement et de la Maîtrise de l'Énergie

Région Alsace

EOST
Ecole et Observatoire des Sciences de la Terre

UNIVERSITÉ DE STRASBOURG

Laboratoire d'Hydrologie et de Géochimie de Strasbourg

CENT

CRISTAL Global

Empa
Materials Science and Technology

NanoFASE
Fate and Exposure models for you - www.nanofase.eu

Appendix: Uncertainty in waste management

Score			
1	Country considered	≥ 2014	Reports, communications, papers
2	Local data	2010 ≤ x < 2014	Eurostat
3	Different country	< 2010	Expert estimation