FROM RESOURCES TO THE PRODUCTS: WHICH ENVIRONMENTAL IMPACTS FOR THE ECOSYSTEM?

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Presentation

2016 – now Arts et Métiers Paristech – Bordeaux Talence,
Associate Professor
Researcher in Life Cycle Assessment, Material Flow Analysis and Eco-design
Teaching: Life Cycle Assessment for engineer

2014 - 2016 University of Technology of Troyes,
Assistant professor
Researcher in Life Cycle Assessment, Material Flow Analysis and Eco-design
Responsible of the engineering degree in "Material economics and environment"
Teaching: Life Cycle Assessment and Material Flow Analysis for Master

2010 - 2014 University of Technology of Troyes,
Research engineer
Expertise in Life Cycle Assessment
Eco-design and Life Cycle Assessment teaching in master and engineer degree

2005 - 2010 EVEA,
Responsible for developing the Life Cycle Assessment and Material Flow Analysis expertise

Plan

- Introduction
  - Why do we assess the environmental impact
  - Which tools do we have in order to limit our environmental impacts ?
  - Focus on Life Cycle Assessment
- USEtox model
- Limitations
- Case studies
  - Impact of nano-particules
  - Impact of Chromium
- Conclusion

INTRODUCTION

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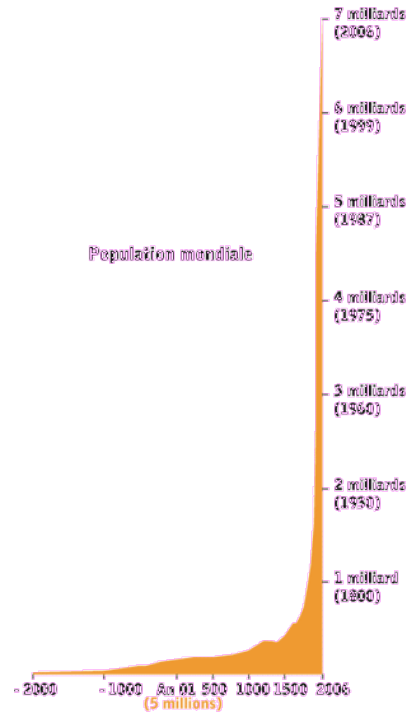
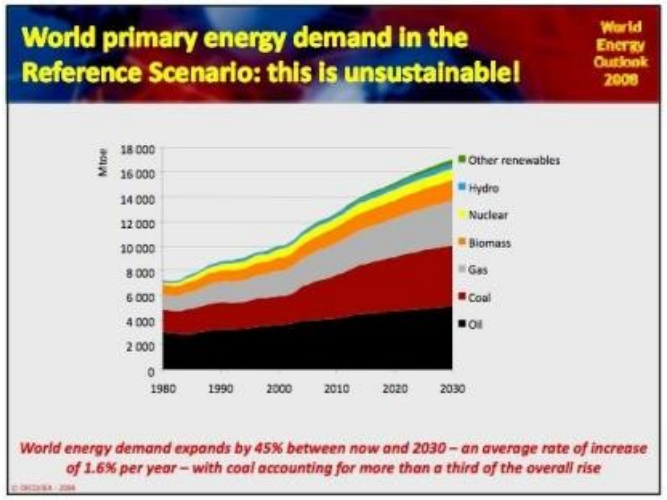
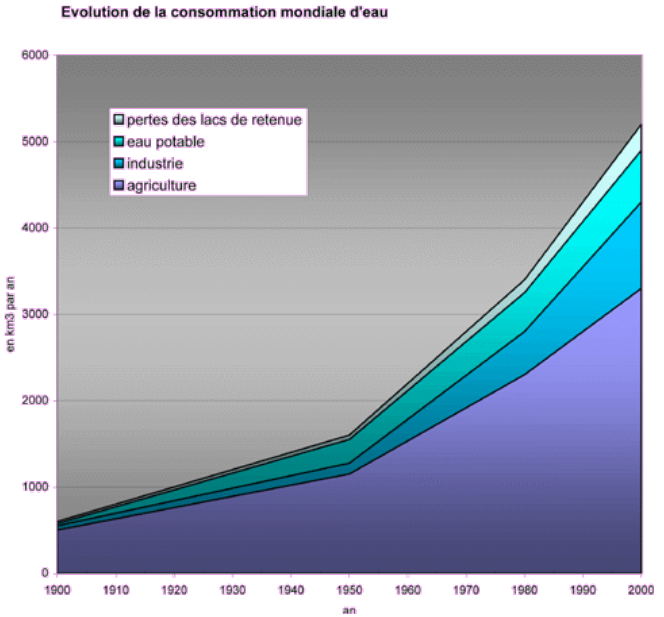
INTRODUCTION

- Why do we have to assess the environmental impact ?







INTRODUCTION

- Why do we have to assess the environmental impact ?

INTRODUCTION

- Which tools / actions do we have in order to limit our environmental impacts ?
  - International actions: Kyoto protocol, humanities helps, …
  - Processes in enterprises: ISO 14001, Global Reporting Initiative, …
  - Regulations: EOLV, EUP, …
  - Advertisement: Label, TV show …
  - New Technologies: Renewable energy, tools helping the design, …
  - Tranversal approach : Ecodesign AND **Life Cycle Assessment**

INTRODUCTION

- Focus on Life Cycle Assessment

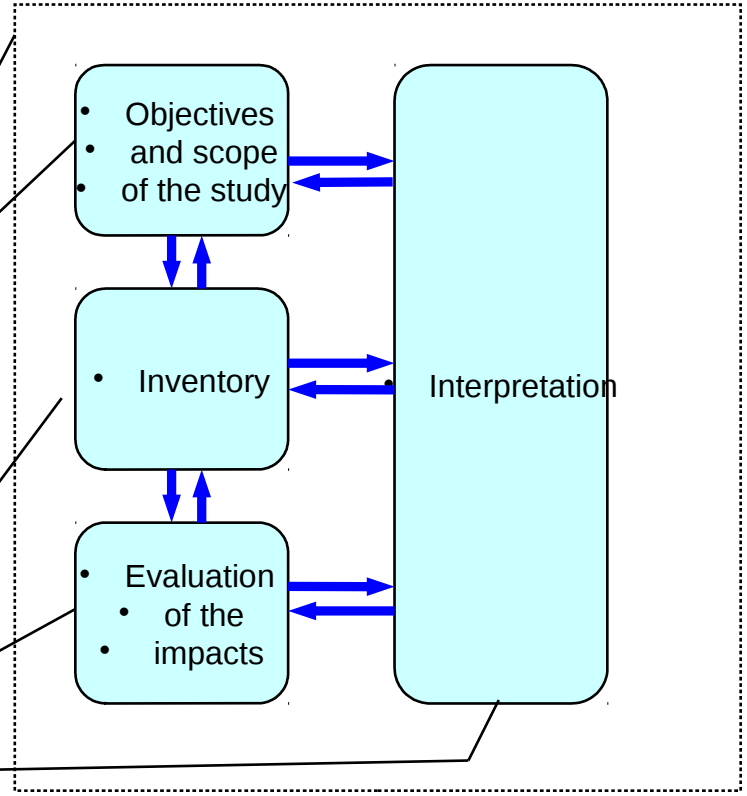
- Based on each phase of the life cycle of the product : from the extraction of the resources to the treatment in end of life
- Follow the standards ISO 14040 & ISO 14044
- Used for research & development, policies and regulations, ecolabel, green marketing, environmental monitoring,...

INTRODUCTION

- Focus on Life Cycle Assessment

Normative framework the LCA:

Principles and framework ISO 14040 (2006)



Inventory ISO 14044 (2006)

INTRODUCTION

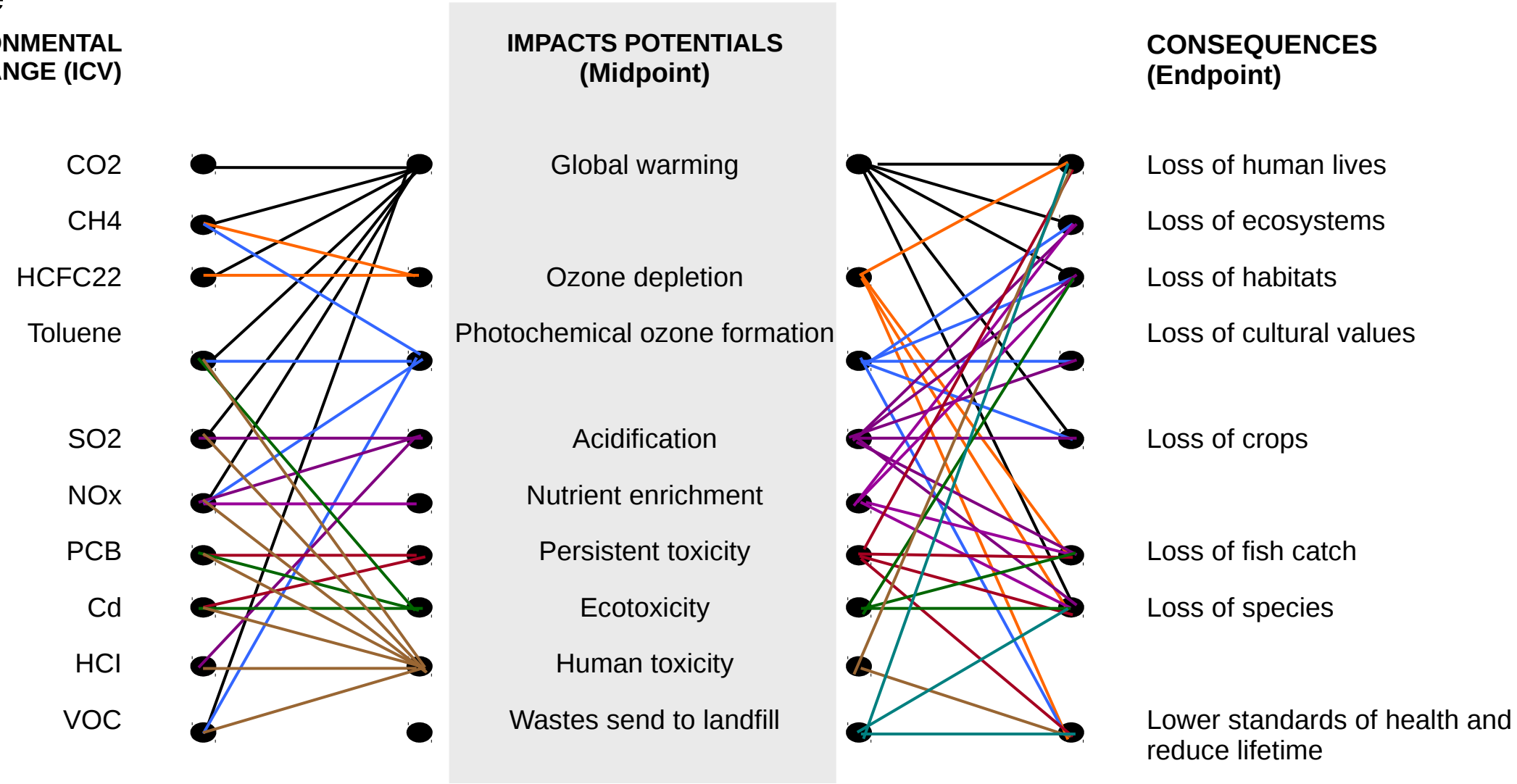
- Focus on Life Cycle Assessment : Life cycle impact assessment

$$Im = \sum Ms \times CFi$$

Im = Impact in the compartment m
Ms = Mass of the substance s
CFi = Characterization Factor

Assessment methods

Principe



INTRODUCTION

- For the indicators of Human Toxicity and Ecotoxicity, the European Commission and the Environmental Protection Agency (USA), recommend to use USEtox

- It exists several models to assess these impacts, but USEtox includes much more substances than the others methods

USEtox Model

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USEtox Model

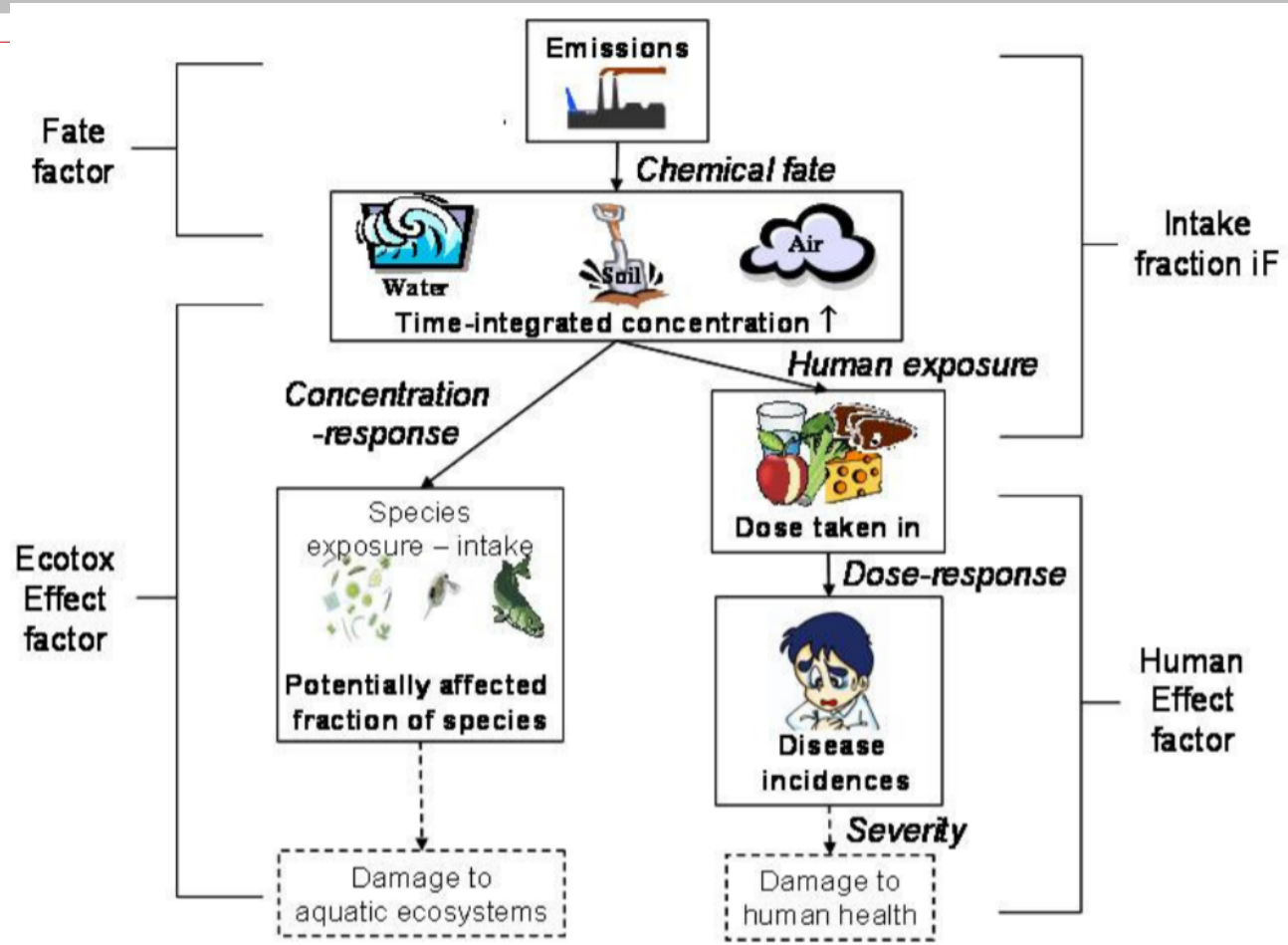
USEtox proposes several Characterization Factors (CF) for organic and non-organic substances for categories of indicators (human toxicity and ecotoxicity). The calculation of CF_e for the ecotoxicity is based on three parameters:

$$CF_e = FF \times XF_e \times EF_e$$

where:

- *FF* (Fate Factor expressed in day) is the residence time of the substance in a compartment (air, water, soil),
- XF_e (Expose Factor, dimensionless) represents the bioavailability of a chemical and can be represented by the fraction of the chemical dissolved in the compartment,
- EF_e (Effect Factor in PAF.m^3.kg^{-1}) reflects the change in the potentially affected fraction (PAF) of species due of the change in substance concentration in the compartment.

USEtox Model



LIMITATIONS

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LIMITATIONS

- Even if the Life Cycle Assessment is reconized, one can identify many limitations :
  - The non-consideration of the temporal resolution
    → Consideration of the lifespan of the substance
  - The non-consideration of the spatial / regional resolution
    → Consideration of the concentration in each region
  - The non-consideration of the local geology
    → Consideration of the transfer in each compartments

CASE STUDIES

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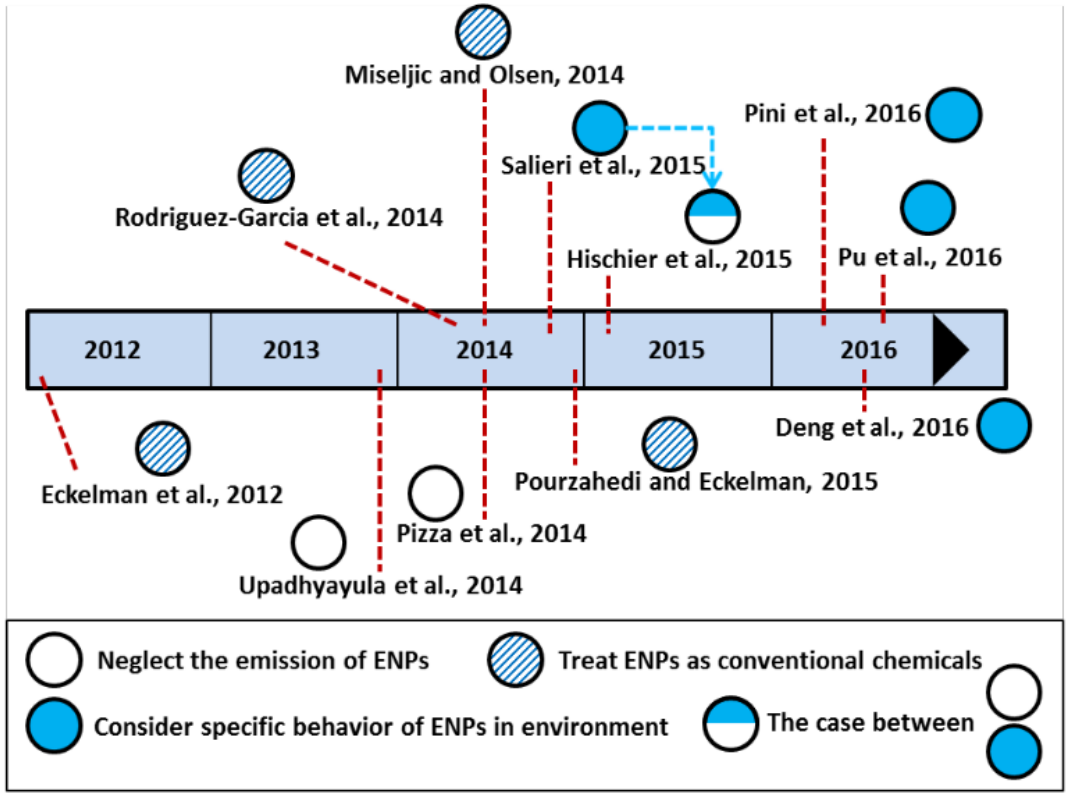
CASE STUDIES

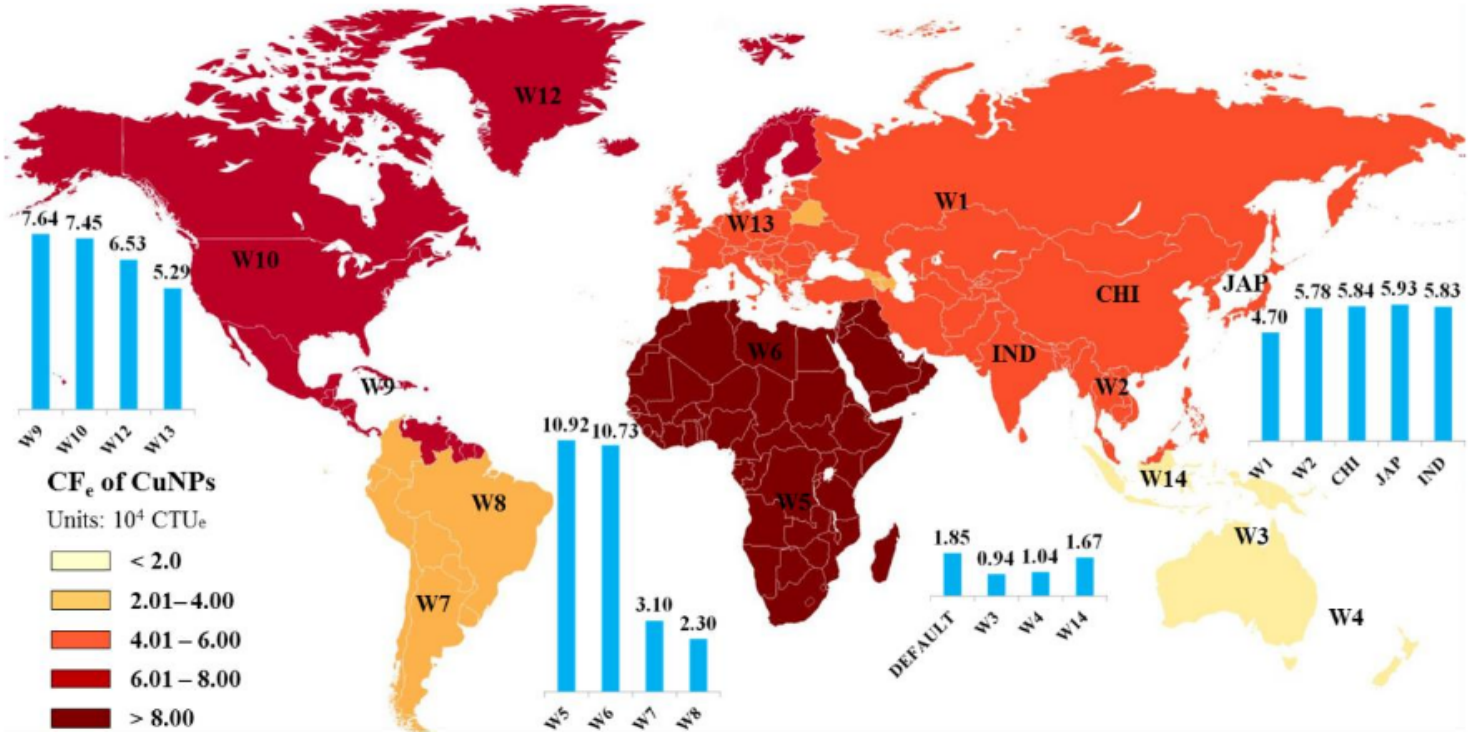
- Regional impact of nanoparticules :
  - Nano-components are not included yet in USEtox
    → New technology



The applications of USEtox model in evaluation the toxicity of nanoproducts according to the year published

CASE STUDIES

- Regional impact of nanoparticules :



It is demonstrated that the fate of ENPs in freshwater has important influences on the toxicity of ENPs and should be considered in the toxicity assessment of ENPs.

The proposed CF values fill the gaps between toxicity testing and environmental modeling. These regionalized CFs values can be used in the future LCA, when assessing the impacts of products containing ENPs to human and ecosystem.

CASE STUDIES

- Regional impact of nanoparticules :
  - Application of the USEtox model for nano-copper

    → PhD thesis of Yubing PU

    → Y. Pu, B. Laratte, R. S. Marks, and R. E. Ionescu, “Impact of copper nanoparticles on porcine neutrophils: ultrasensitive characterization factor combining chemiluminescence information and USEtox assessment model,” *Materials Today Communications*, vol. 11, pp. 68–75, 2017.

    → Y. Pu, F. Tang, P.-M. Adam, B. Laratte, and R. E. Ionescu, “Fate and Characterization Factors of Nanoparticles in Seventeen Subcontinental Freshwaters: A Case Study on Copper Nanoparticles,” *Environmental Science & Technology*, vol. 50, no. 17, pp. 9370–9379, 2016.

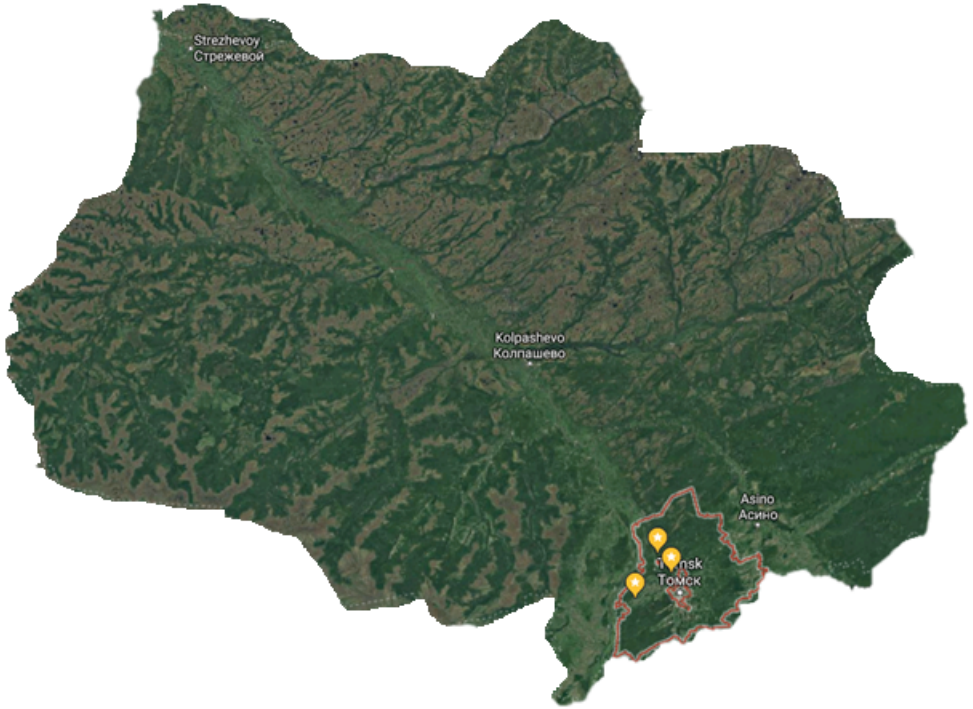
CASE STUDIES

- Regional impact of chromium in Tomsk Oblast

  • Among all areas of the Tomsk oblast of interest is the Tomsk district. The negative influence on population in Tomsk district is being studied during the years.

  • This area places many enterprises, as for example the Northern industrial unit are located close to Seversk city.

  • More than thirty industrial complexes are located within the Northern industrial unit, including the world's largest nuclear fuel cycle enterprise - the Siberian Chemical Plant, and the largest in Russia oil and gas processing plant - Sibur (formerly Tomsk Petrochemical Plant).



CASE STUDIES

- Regional impact of chromium in Tomsk Oblast

  - One of the limitations connected with metals is lack of experimental data expressing the bioaccumulation of chemicals into the substrate as meat and milk.

  - In USEtox model the metals accumulation is provided by plenty of literature references, but these references nowadays are not representable (e.g. old data, non human media,...). Plus, the model for calculation of transfer factor from environmental media to substrate in case of metals assessment is irrelevant.

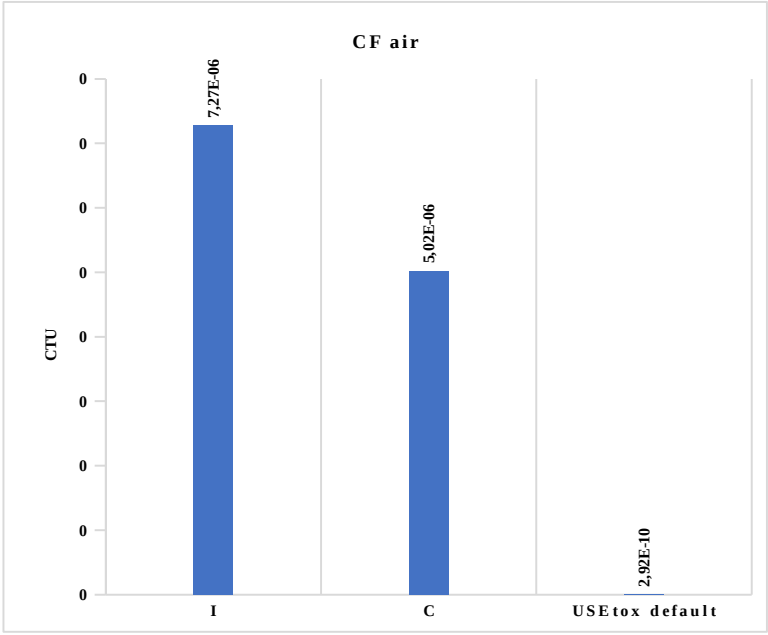
  - Thus, is purposed that using the measured by chemical analysis (INAA, ICP-MS, etc.) concentrations of metals in the “polluted medium” as meat and milk, provides the same information as transfer factor about metals content in the organs but in the more accurate way.

CASE STUDIES

- Regional impact of chromium in Tomsk Oblast

→ PhD thesis of Alexandra BELYANOVSKAYA, cotutelle between Arts et Métiers ParisTech and Tomsk Polytechnic University

→ Publication submitted



Intermediate results: The Characterization factor of chromium in pork meat via soils

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CONCLUSION

- Necessity to connect different fields of research:
  → in order to improve science
  → in order to open new doors in research

- Necessity to work in collaboration:
  → in order to learn each others: in my personal experience, second PhD thesis in cotutelle with Tomsk Polytechnic University

- Necessity, to connect Risk assessment and Impact assessment:
  → in order to help companies
  → in order to improve regulations

Thank you for your attention

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