



Exposure Assessment and Modelling, NanoFASE– Intentions, Achievements and Outcomes

Claus Svendsen & 65 others
UKRI-CEH, Wallingford, United Kingdom

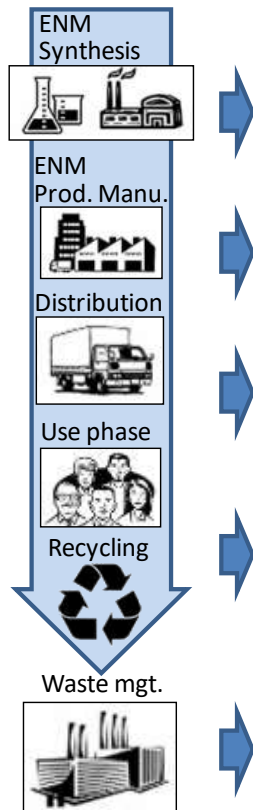


NOTA BENE – *Some slides highlight scientists who presented related papers at ICEEN. Collaborators are recognized! Visit our [online library](#).*

Exposure assessment in the environment:

How much is released and where does it go?

1) ENM enabled
Product value chains
& release pathways



Chapter R.16: Environmental exposure assessment

Version 3.0 – February 2016

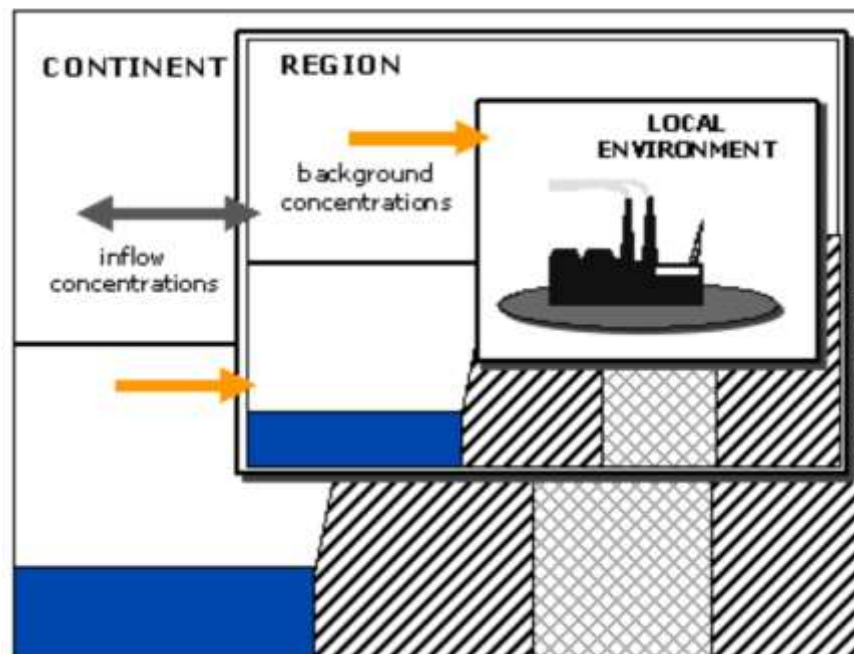
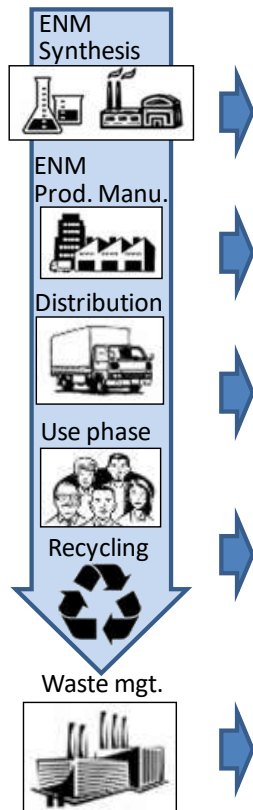


Figure R.16-7: The relationship between the continental, regional, and local scales

Exposure assessment in the environment:

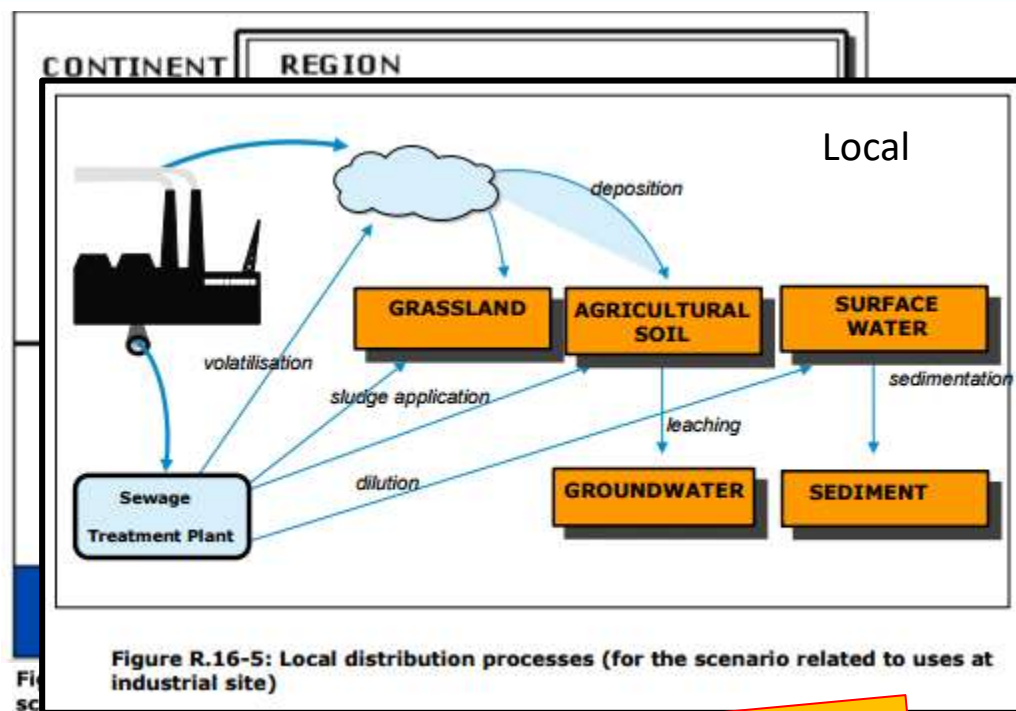
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Chapter R.16: Environmental exposure assessment

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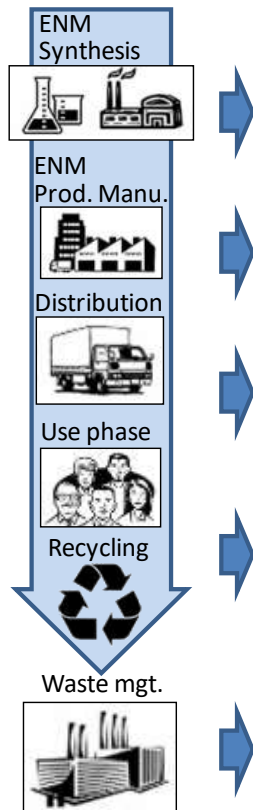


REMEMBER – THIS IS THE GOAL!

Exposure assessment in the environment:

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Chapter R.16: Environmental exposure assessment

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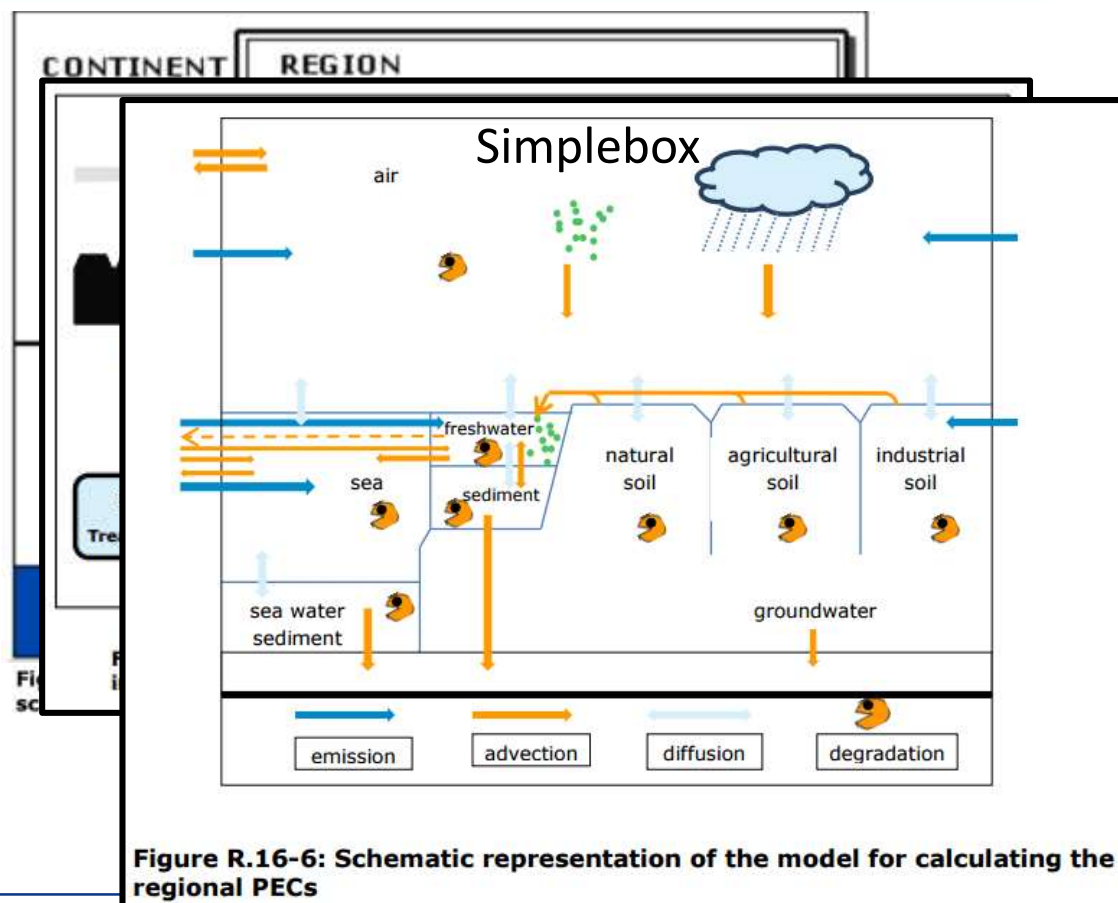
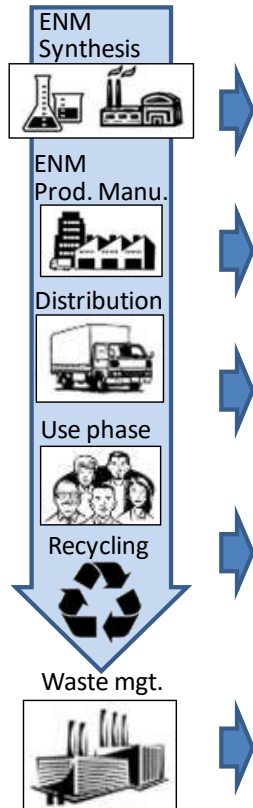


Figure R.16-6: Schematic representation of the model for calculating the regional PECs

Exposure assessment in the environment:

How much is released and where does it go?

1) ENM enabled
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Chapter R.16: Environmental exposure assessment

Version 3.0 – February 2016

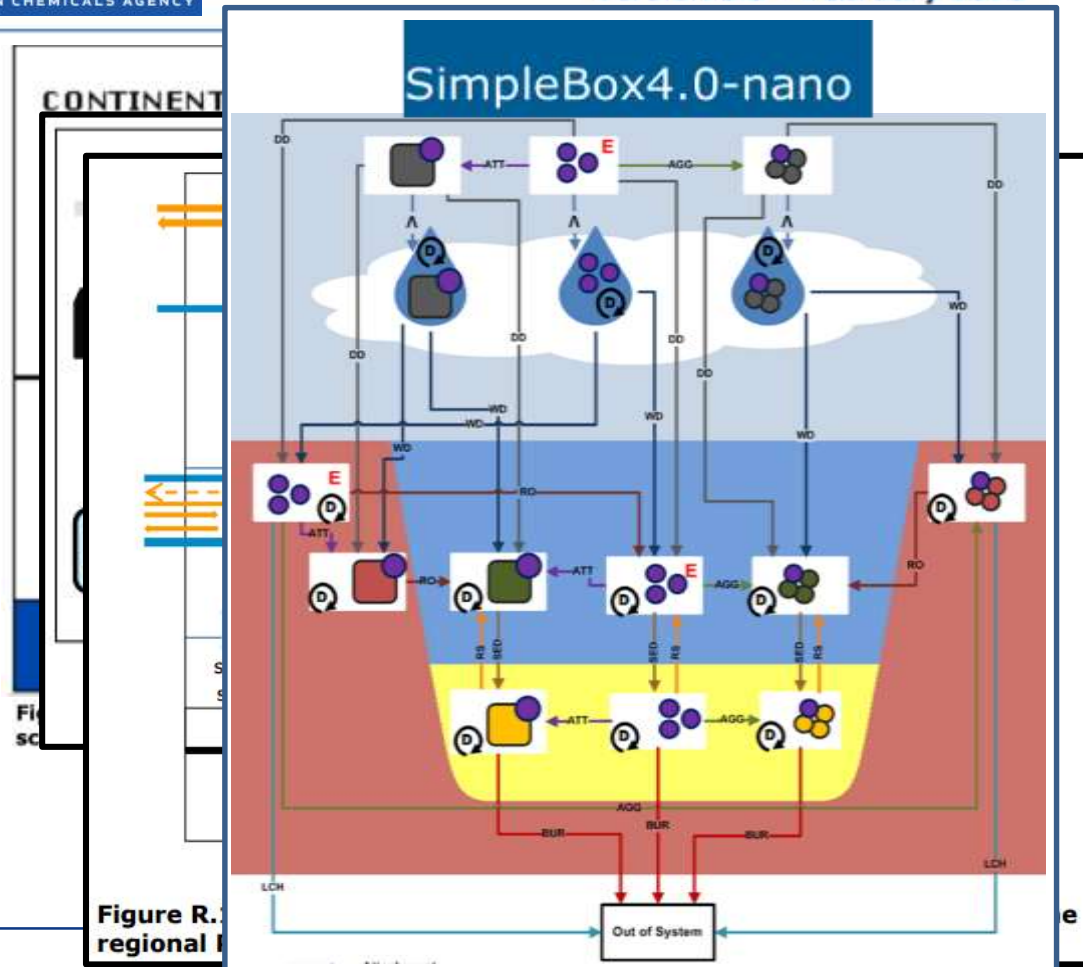
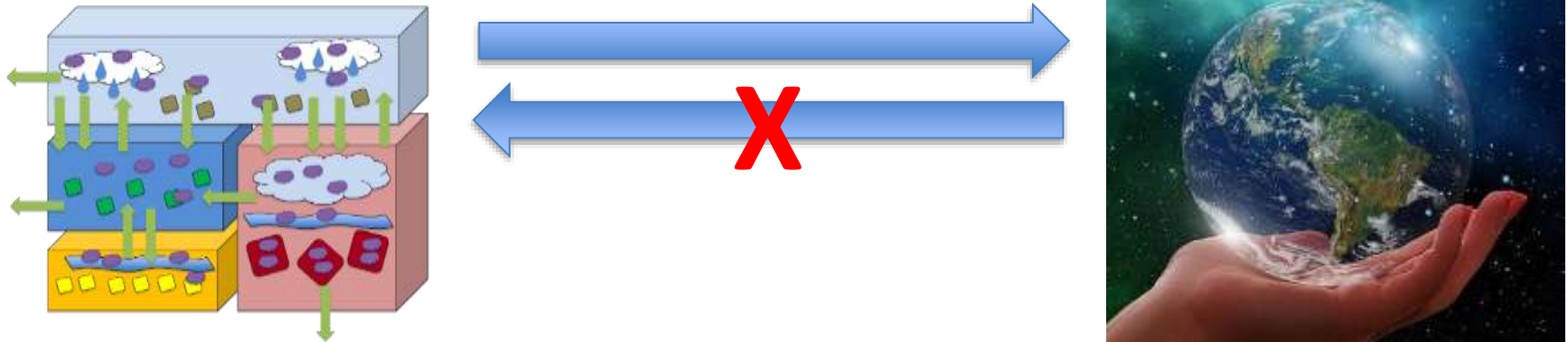


Figure R.16
regional

Putting the models together and comparing

Towards validating nanomaterial PECs from SimpleBox4nano using the NanoFASE-WSO spatiotemporal multimedia fate model



SimpleBox4nano

Screening level

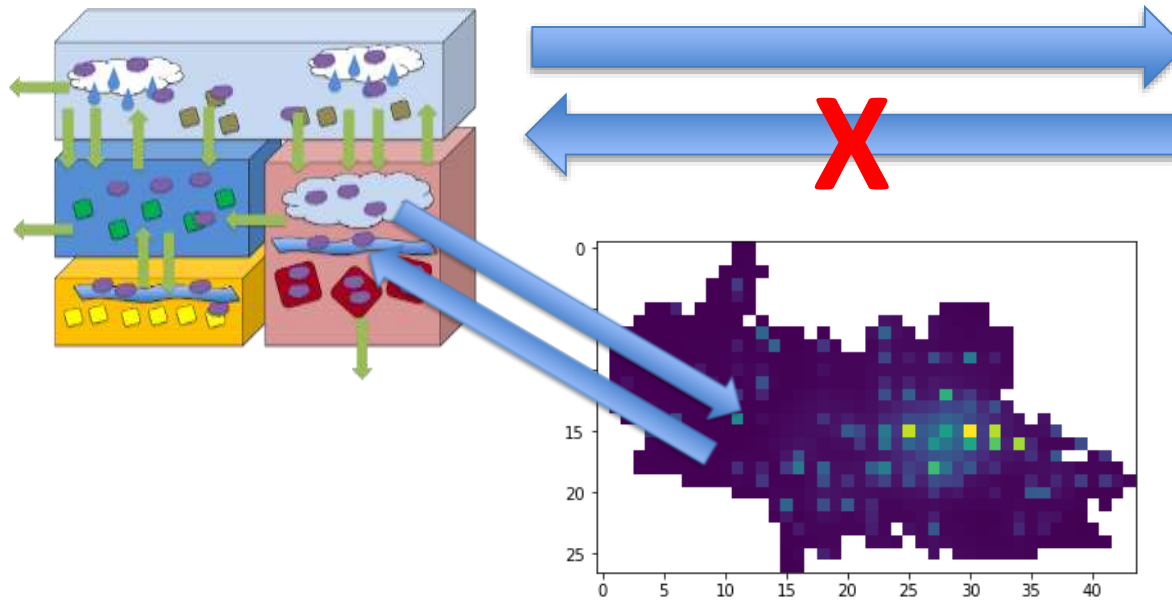
Steady state conditions

Regional to continental scale

Background, regional concentrations

Putting the models together and comparing

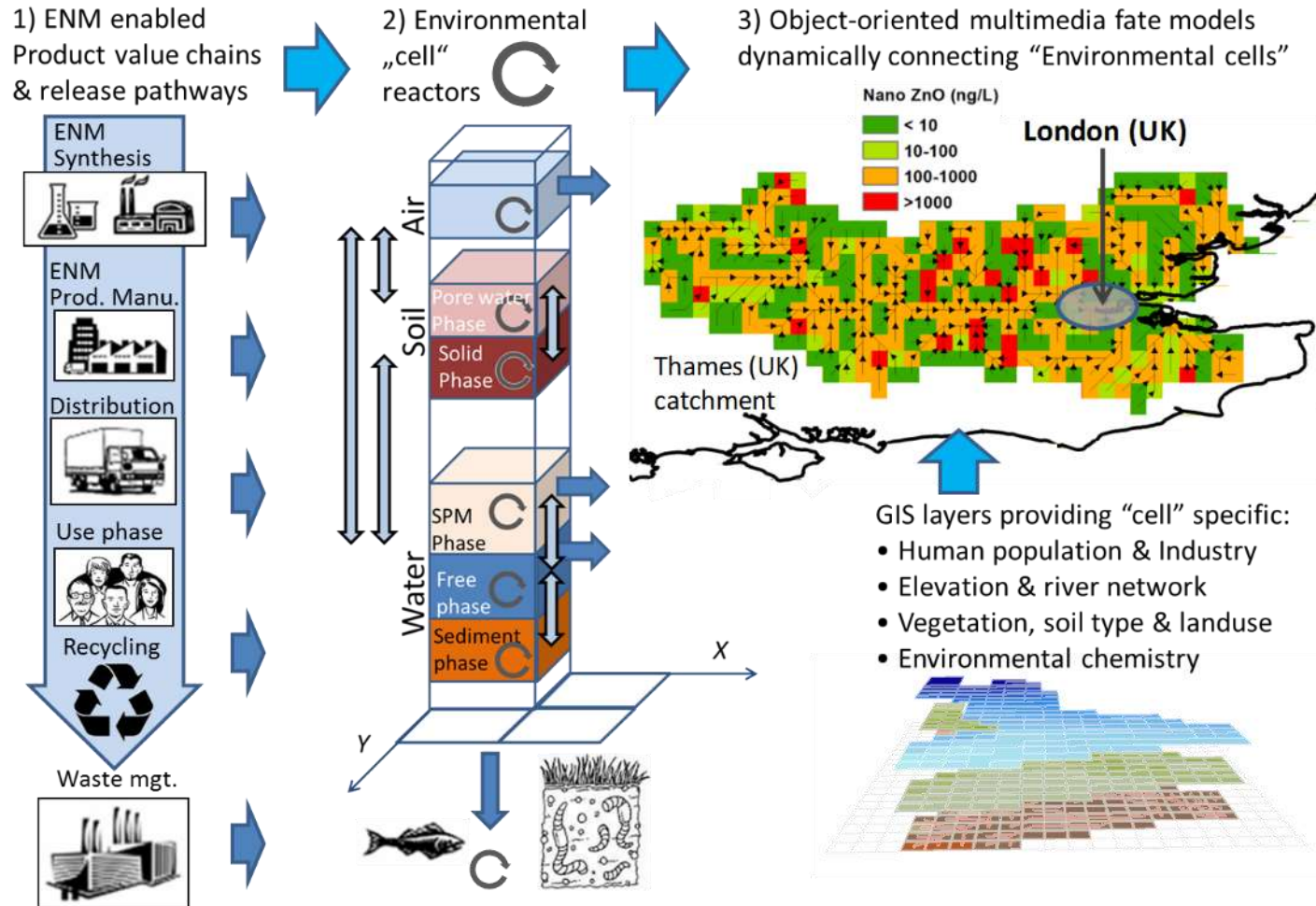
Towards validating nanomaterial PECs from SimpleBox4nano using the NanoFASE-WSO spatiotemporal multimedia fate model



SimpleBox4nano	NanoFASE Water-Soil-Organism
Screening level	Higher tier
Steady state conditions	Time explicit
Regional to continental scale	Gridded: 5x5 km
Background, regional concentrations	Local concentrations

Exposure assessment (of Nano) in the environment:

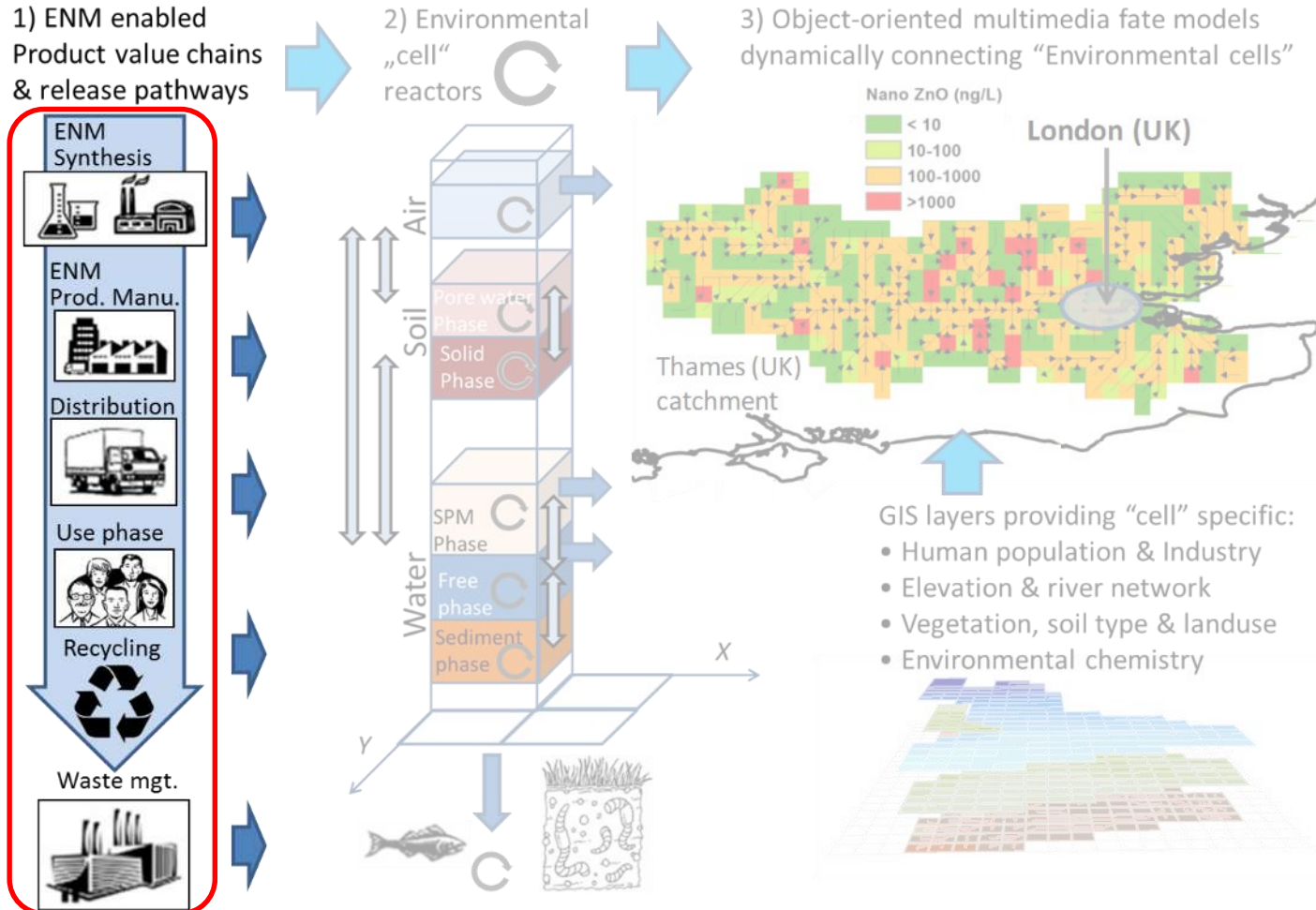
How much is released, and where does **what** go?



The NanoFASE Approach

Exposure assessment (of Nano) in the environment:

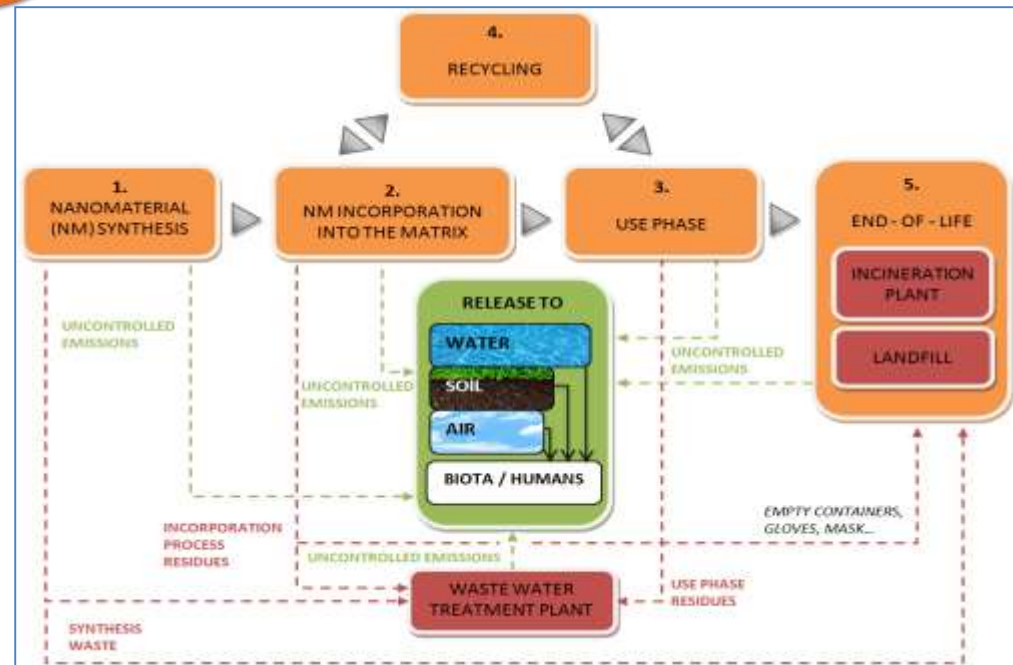
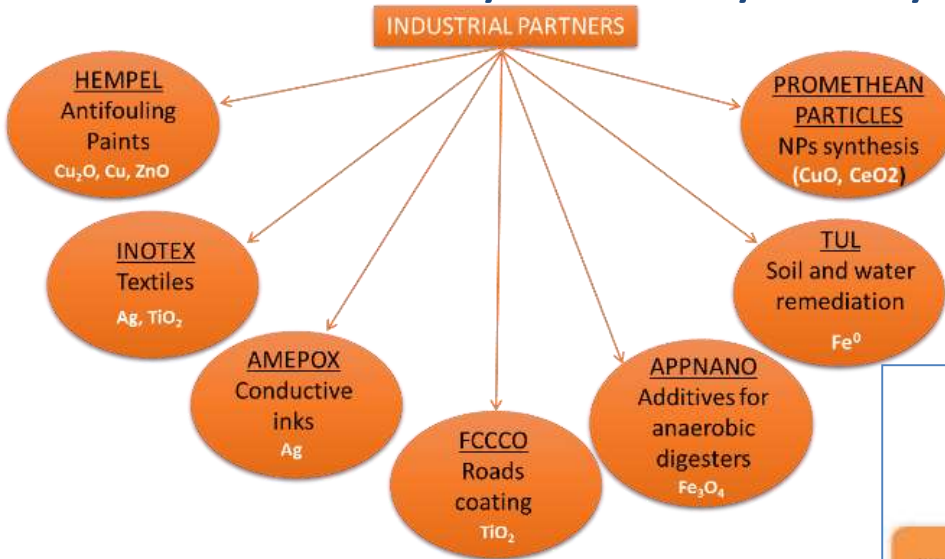
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The NanoFASE Approach

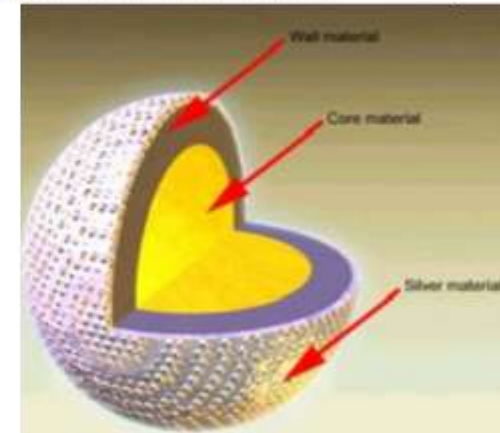
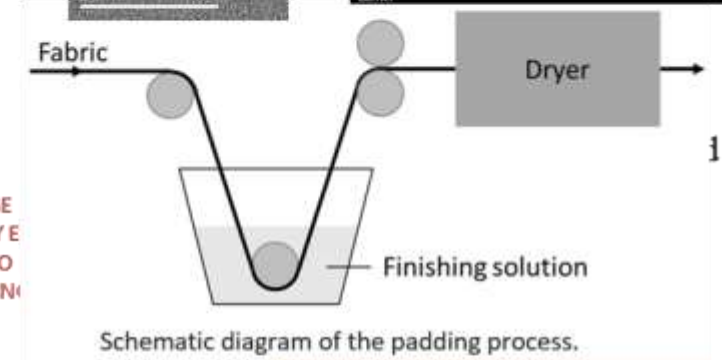
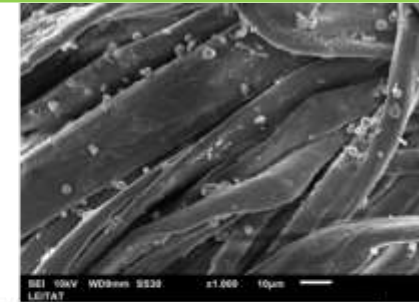
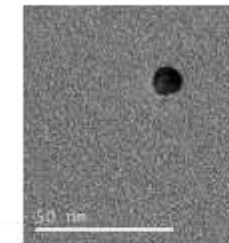
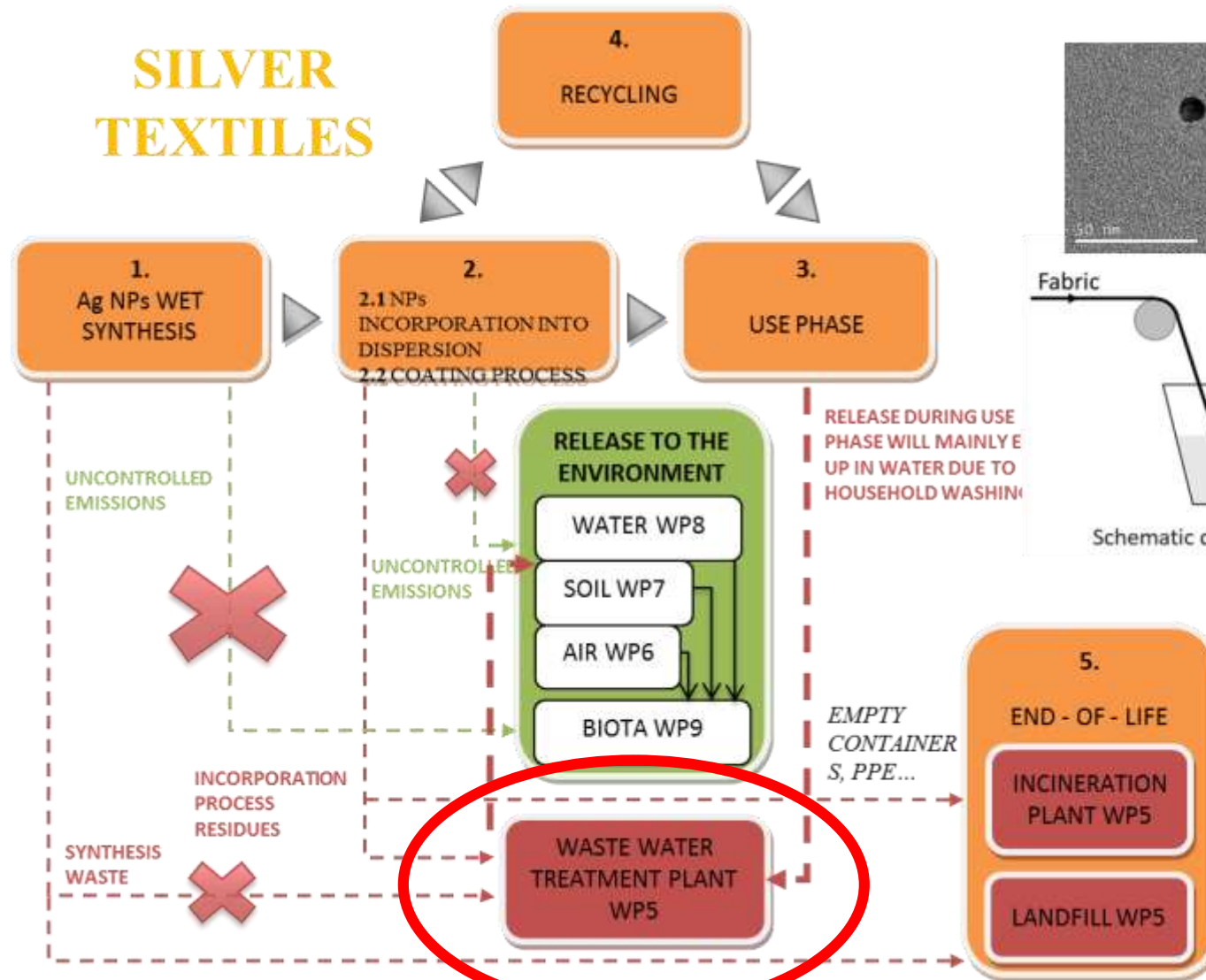
Charting nano releases and forms from products

- Case Study Pathway Analysis to guide experiments



Nano Product value chain and release paths (WP4)

SILVER TEXTILES



Nano Product value chain and release paths (WP4)

SILVER TEXTILES

1.
Ag NPs WET
SYNTHESIS

UNCONTROLLED
EMISSIONS

2.
2.1 NPs
INCORPORATION IN
DISPERSION
2.2 COATING PROC

UNCONTROLLED
EMISSIONS

INCORPORATION
PROCESS
RESIDUES

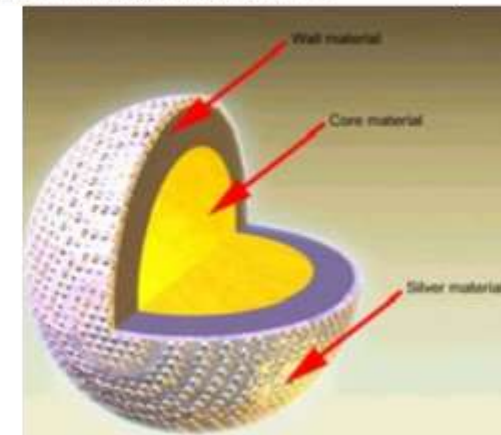
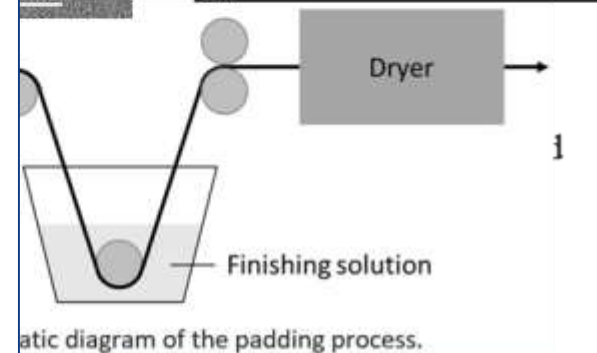
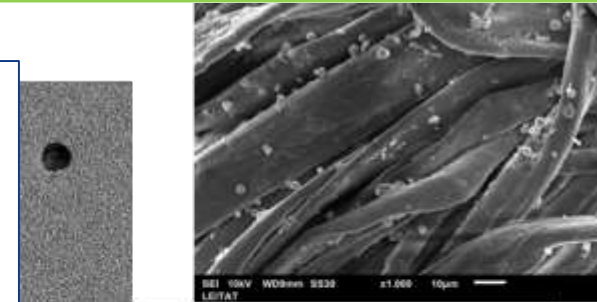
SYNTHESIS
WASTE



Vicenç Pomar

LEITAT Technological Center

Spain



Nano Product value chain and release paths (WPA)

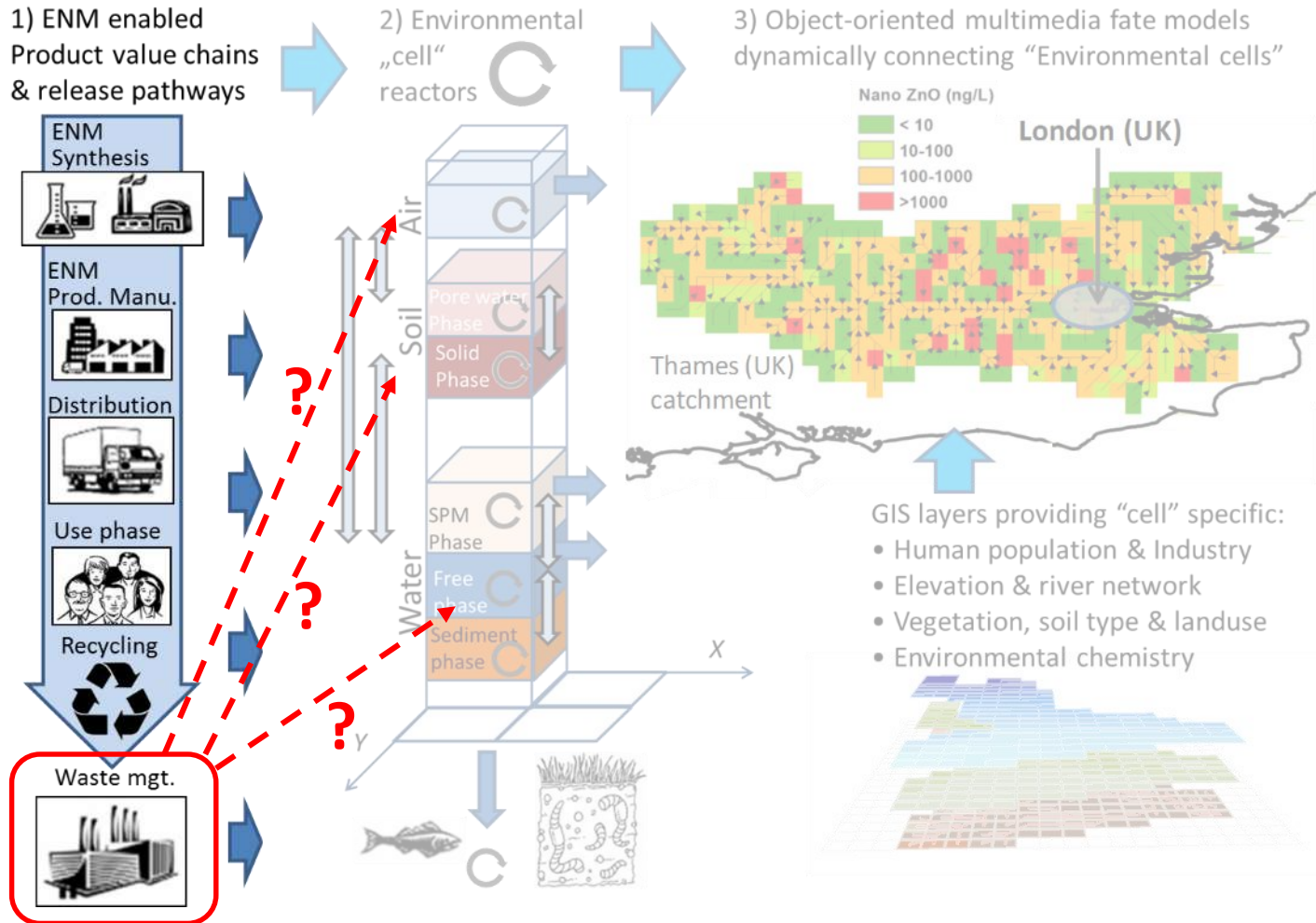
Ag CONDUCTIVE INKS - TO INFINITY AND BEYOND:

"The Golden Fleece" smart sail concept to support space exploration missions. NanoFASE partner AMEPOX's nano silver products used in printed control circuits and application of metallic coatings.



Exposure assessment (of Nano) in the environment:

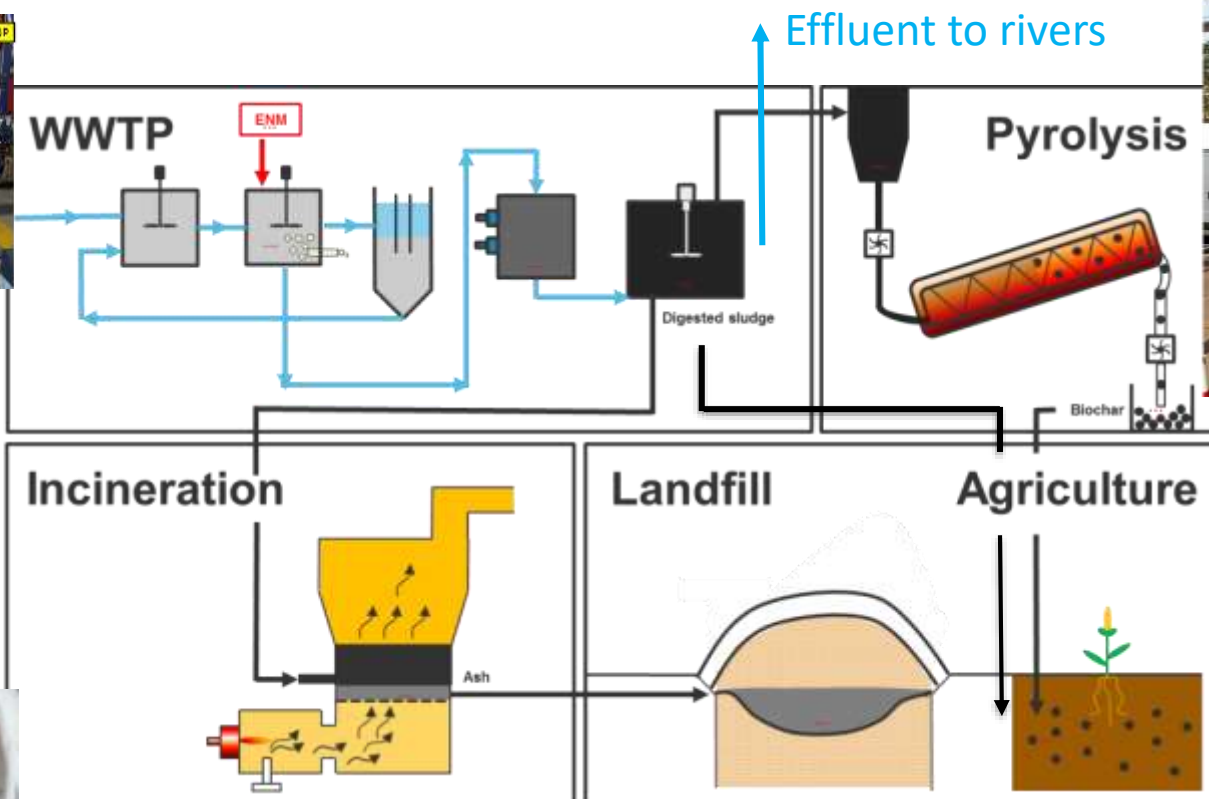
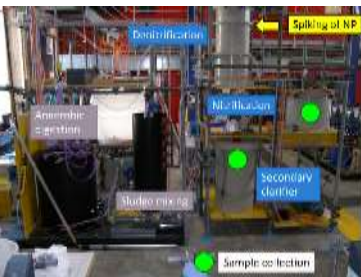
How much is released, and **where** does **what** go?



Waste Water Management

Investigating forms leaving end of life stage (WP5)

Investigate fate and transformation of ENM in major managed waste facilities:



Sewage sludge incineration

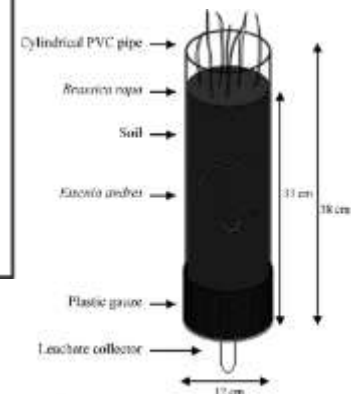
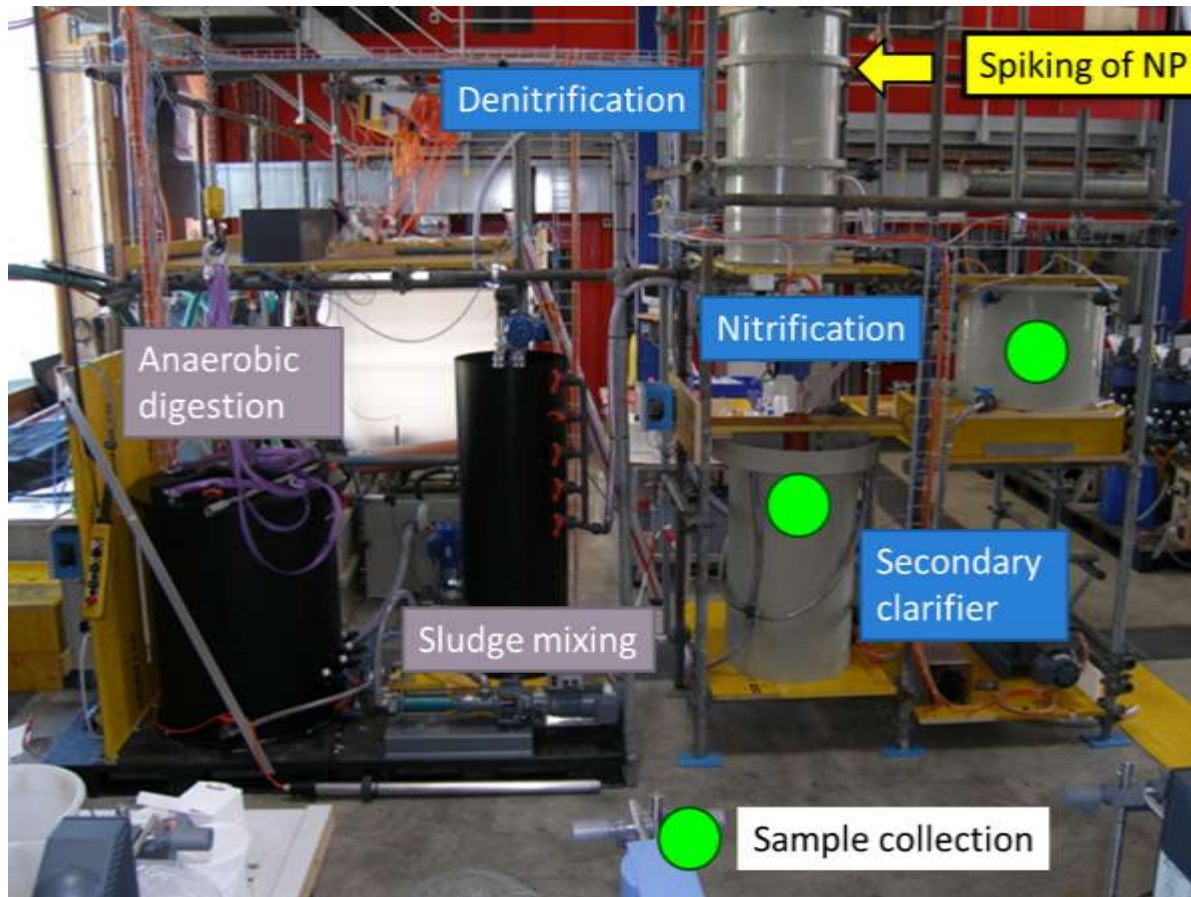


Fig. 2. Small scale test cell for nanomaterial (NM) fate in the experimental procedure.

Exposure assessment (of Nano) in the environment:

How much is released, and where does **what** go?

Waste Water Treatment Plant

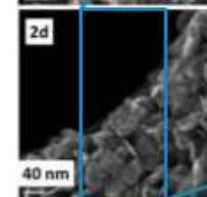
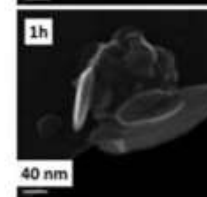
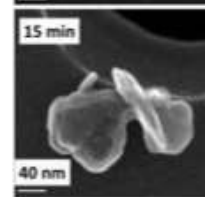
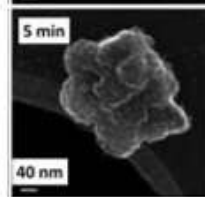
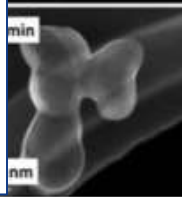
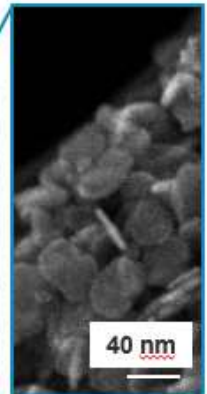
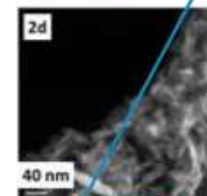
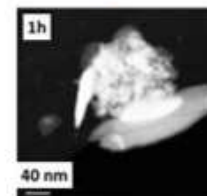
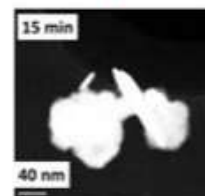
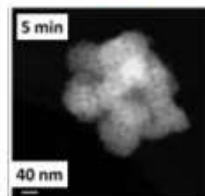
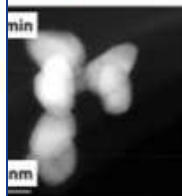
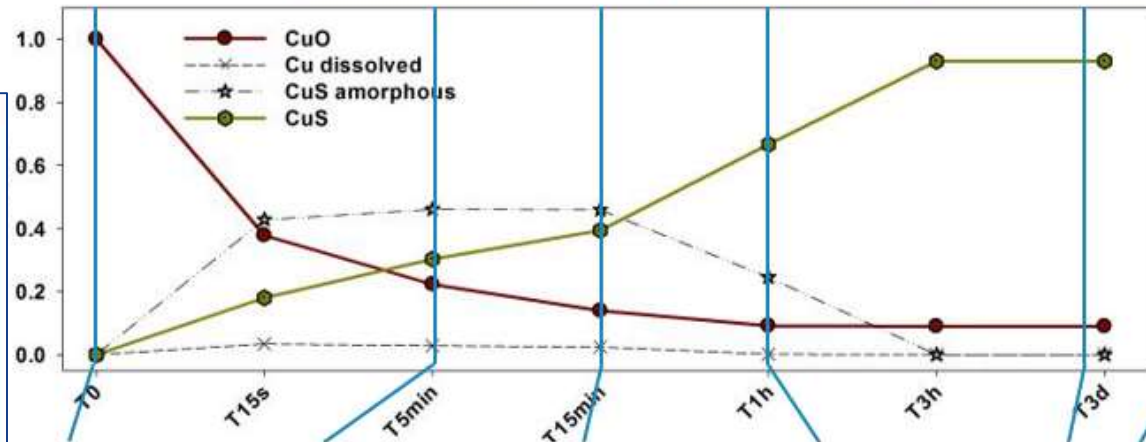


Exposure assessment (of Nano) in the environment:

How much is released, and where does **what** go?

Waste Water Treatment Plant – Ag and CuO NPs

CuO NP - LCF analysis and electron microscopy



Alexander Gogos

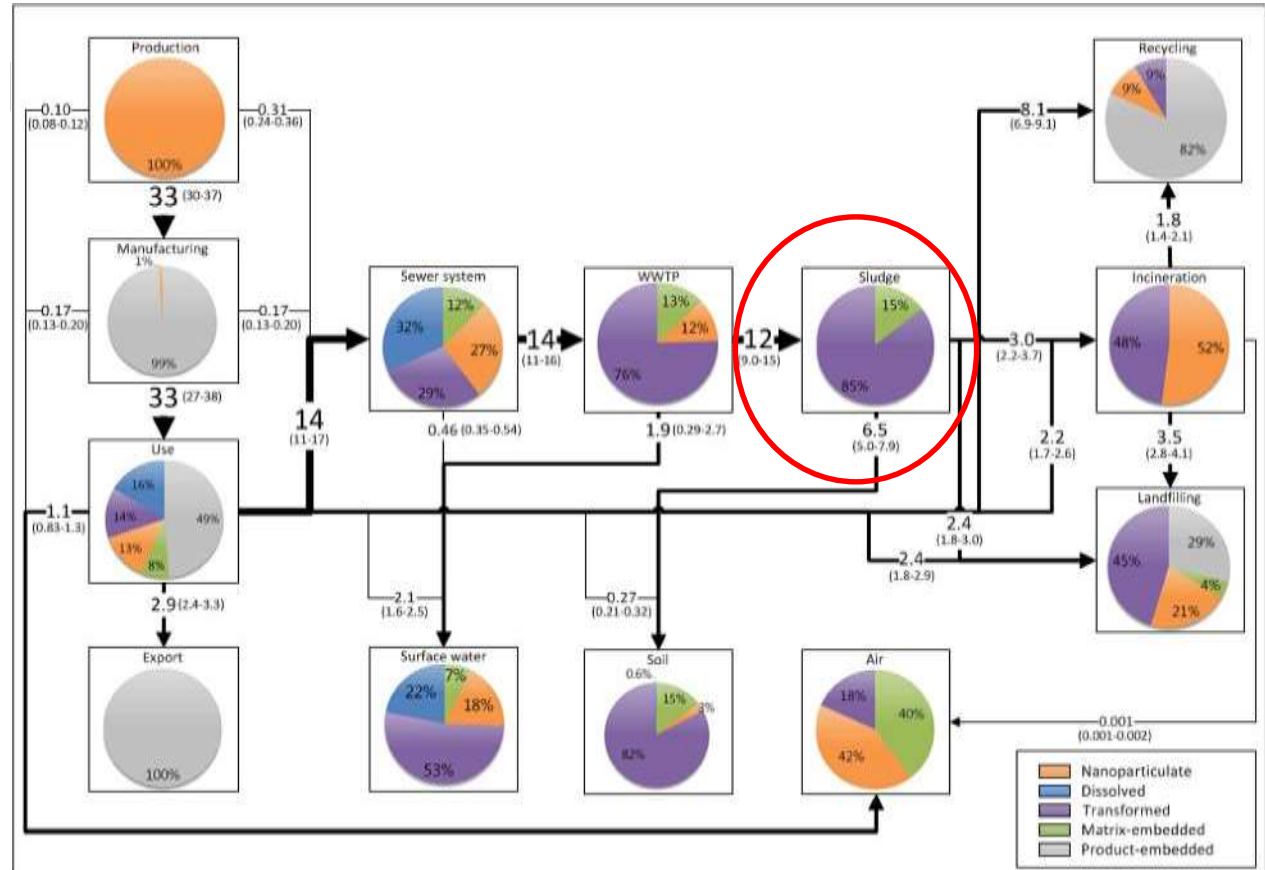
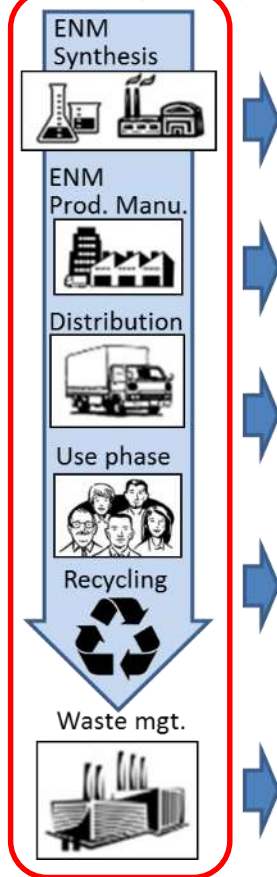
EAWAG

Switzerland

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Product value chains
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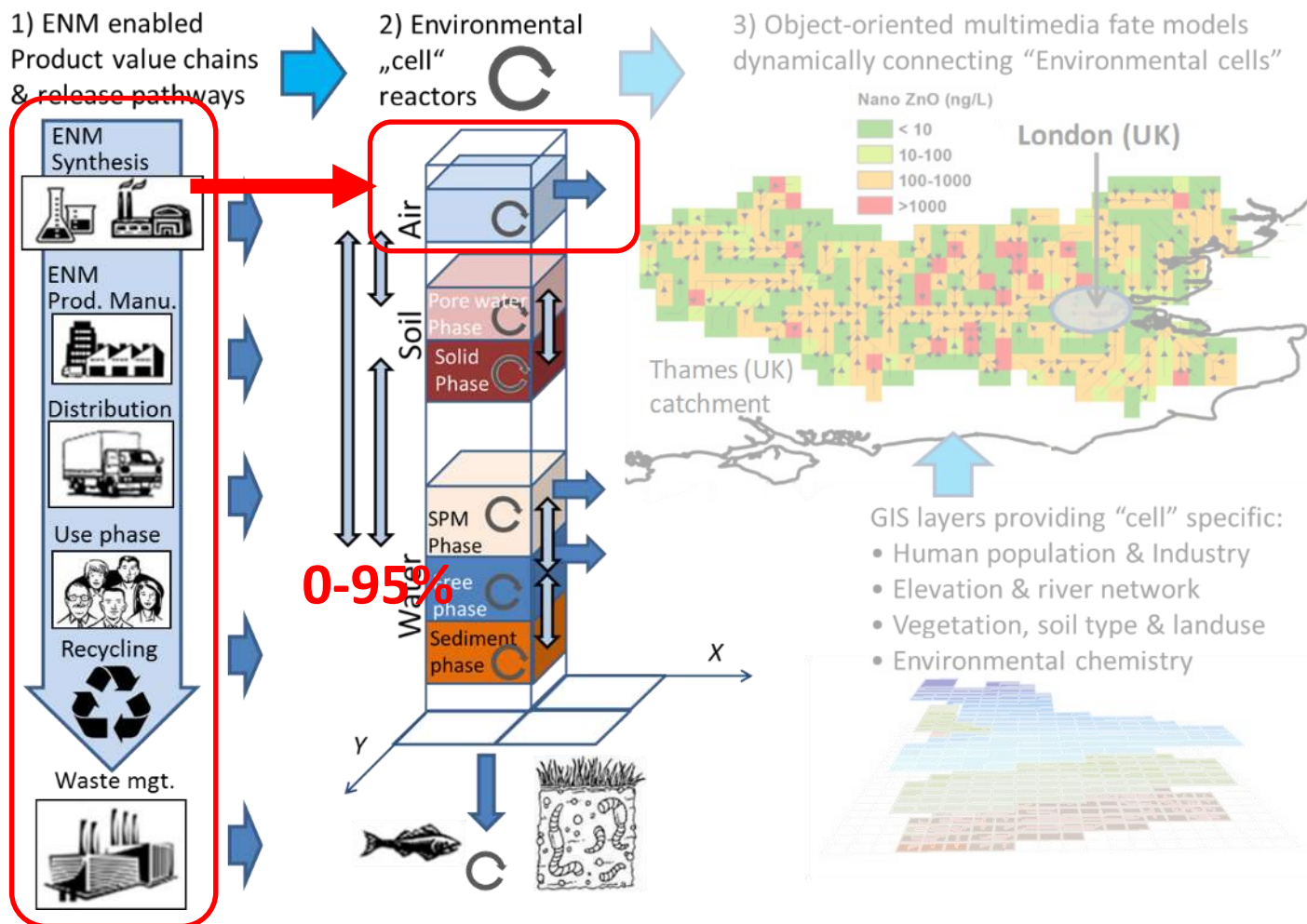


Flows of nano-Ag and distributions among the forms released during its life cycle. All flows are described in tons/year in the European Union with the means of the probability distributions.

Adams, V et al 2018 Environmental Pollution, 243, pp 17-27

Exposure assessment (of Nano) in the environment:

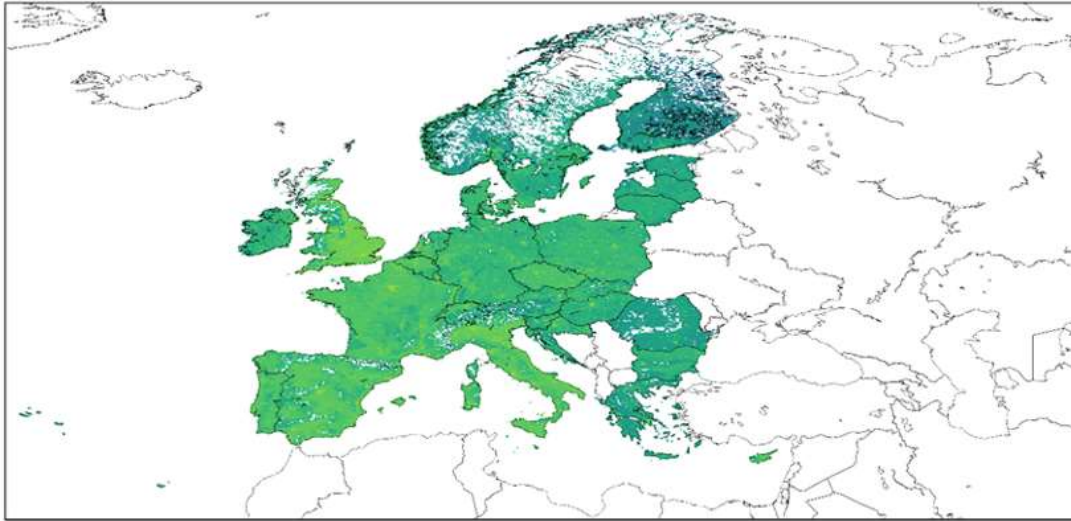
How much is released, and **where** does **what** go?



Exposure assessment (of Nano) in the environment:

Modelling air phase distributions?

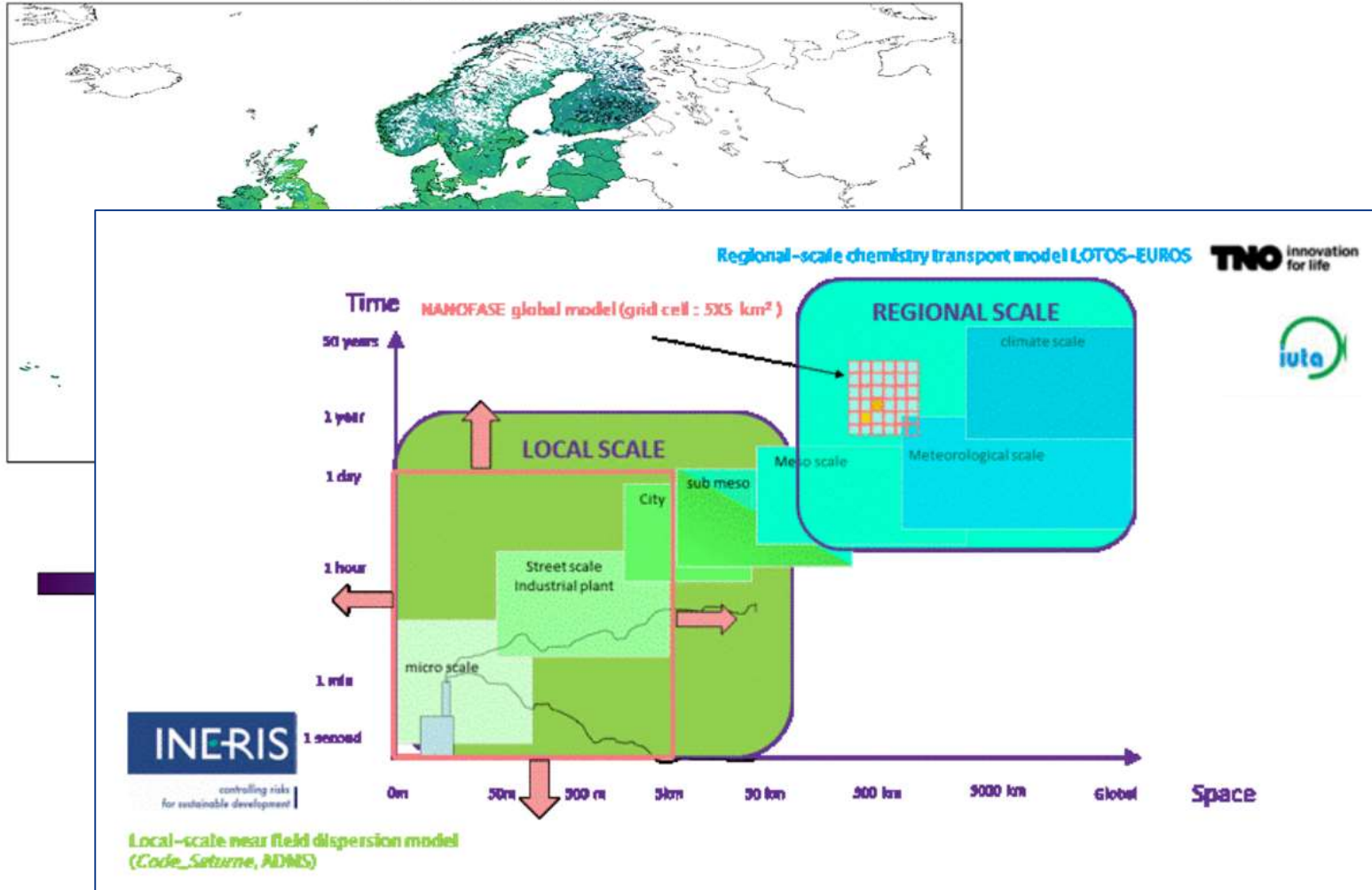
Release nano-TiO₂ Europe 2015



Exposure assessment (of Nano) in the environment:

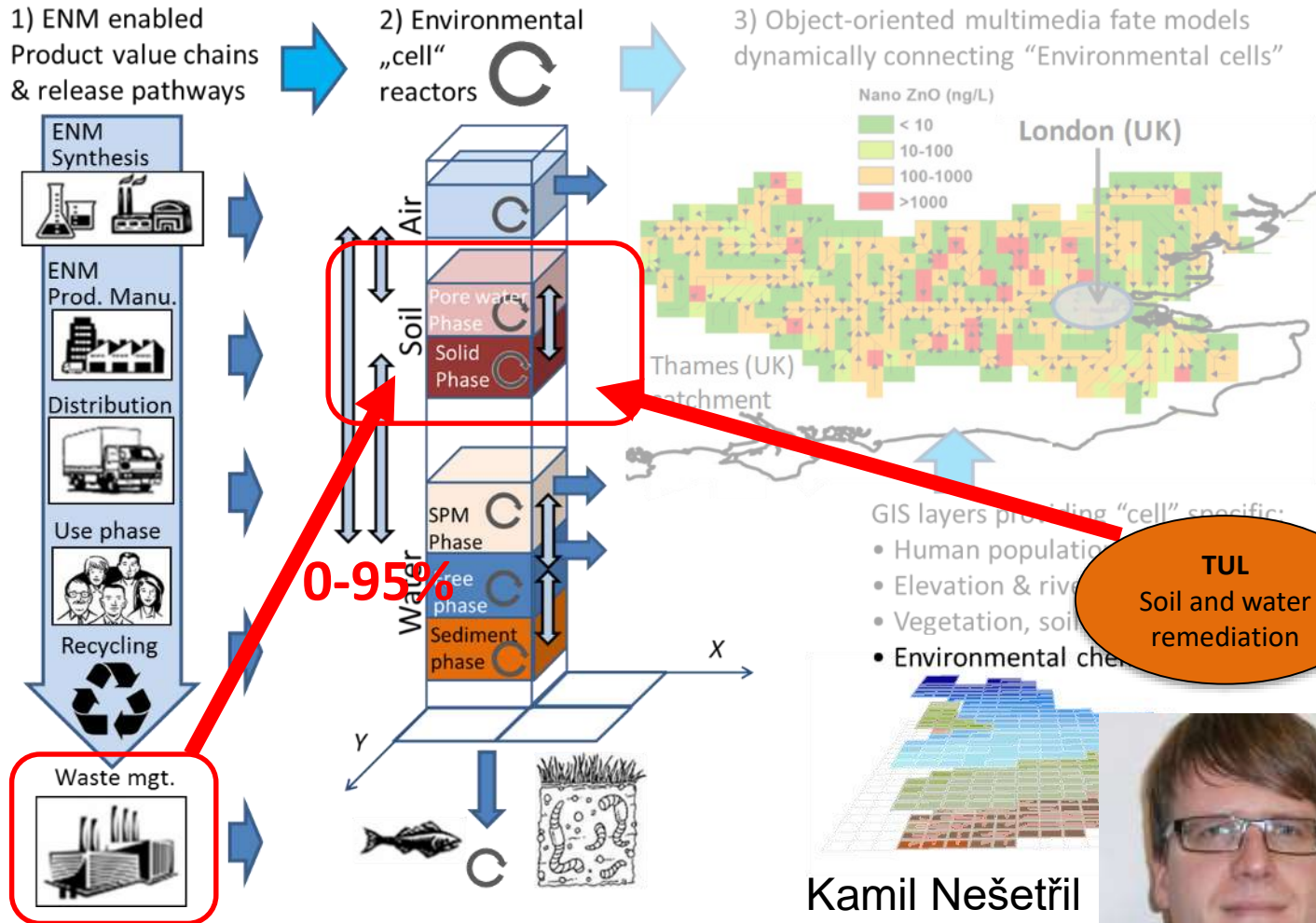
Modelling air phase distributions?

Release nano-TiO₂ Europe 2015



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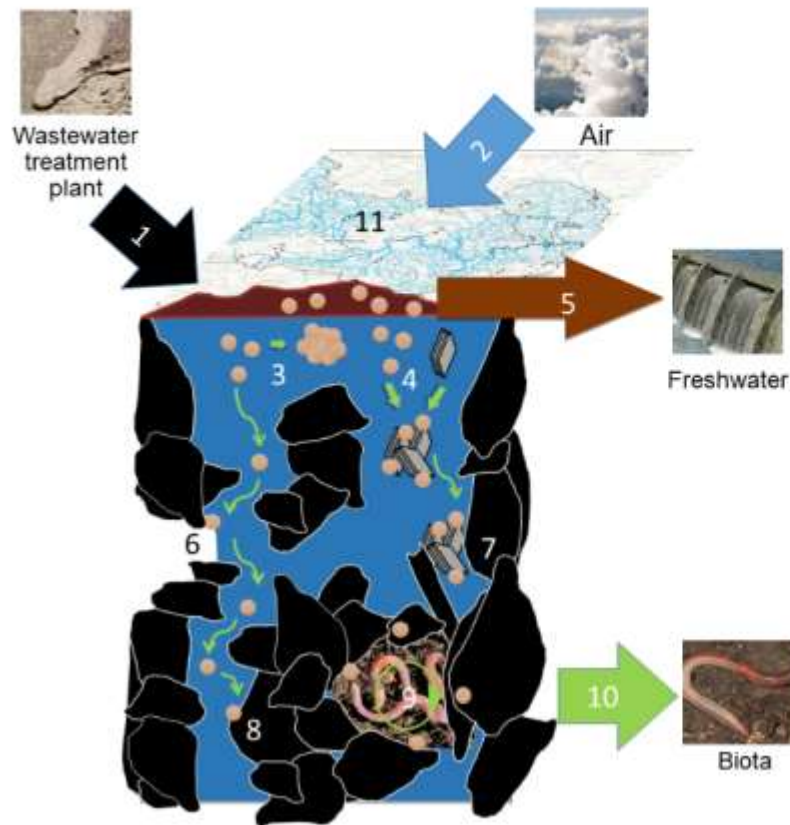
Waste Water Treatment Plant



NanoFASE Soil modelling module

Environmental Fate of ENMs: Soil Compartment

Soils are exposed to ENMs mostly through deposition of sludge on agricultural land. A range of organisms can be exposed and possibly be affected, including food crops, also giving an entry into the human food chains. ENMs are also applied deliberately to soils, e.g. as [zerovalent iron](#) to remediate contaminated soils, as [nanofertilizers](#) or as [nanopesticides](#).

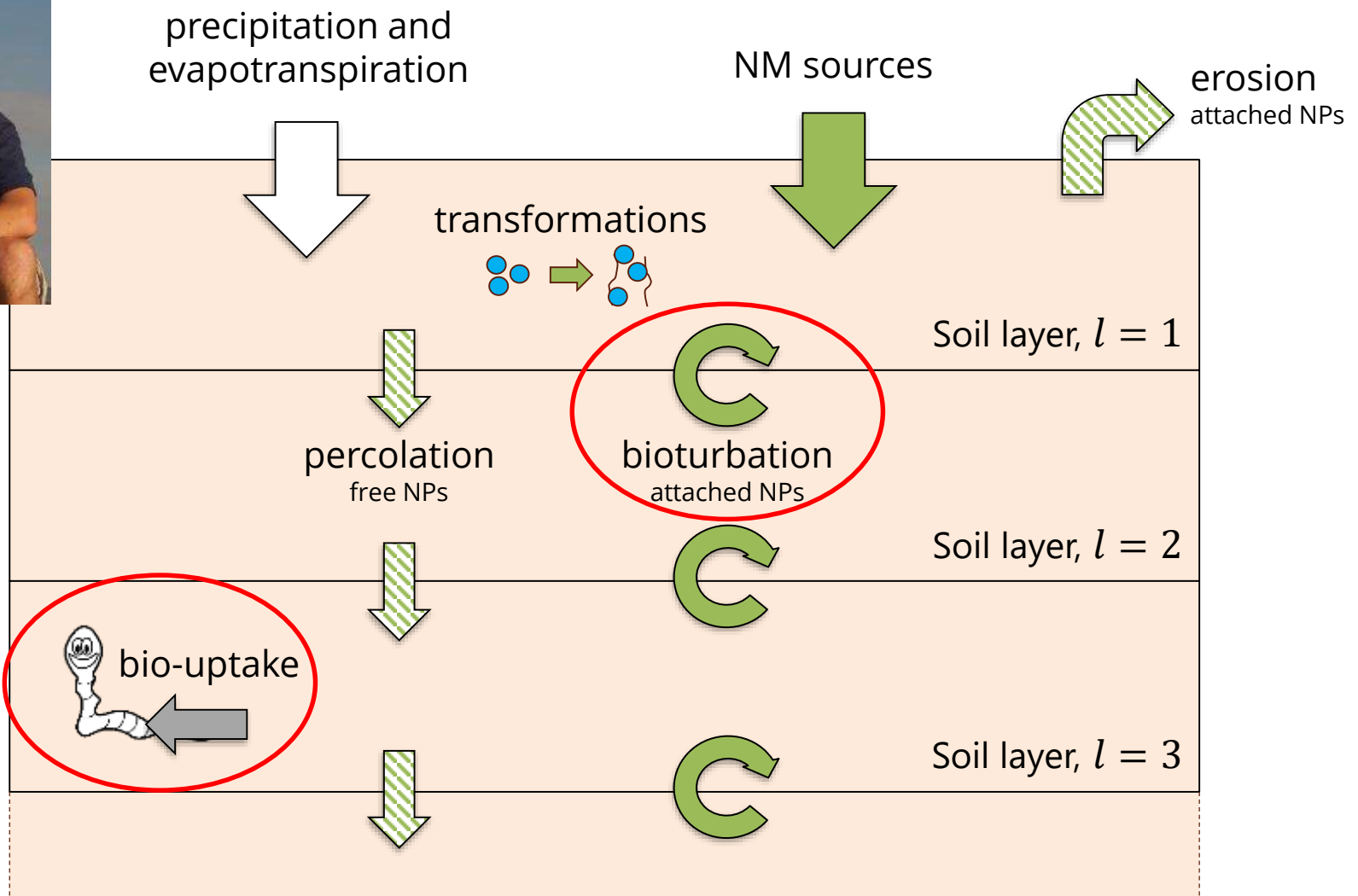


- [1. Sludge deposition](#)
- [2. Atmospheric dry deposition](#)
- [3. Homoaggregation](#)
- [4. Heteroaggregation](#)
- [5. Surface runoff](#)
- [6. Air-water interaction](#)
- [7. Straining](#)
- [8. Attachment](#)
- [9. Bioturbation](#)
- [10. Bio-uptake](#)
- [11. Spatial distribution](#)
- [12. Mass transfer](#)

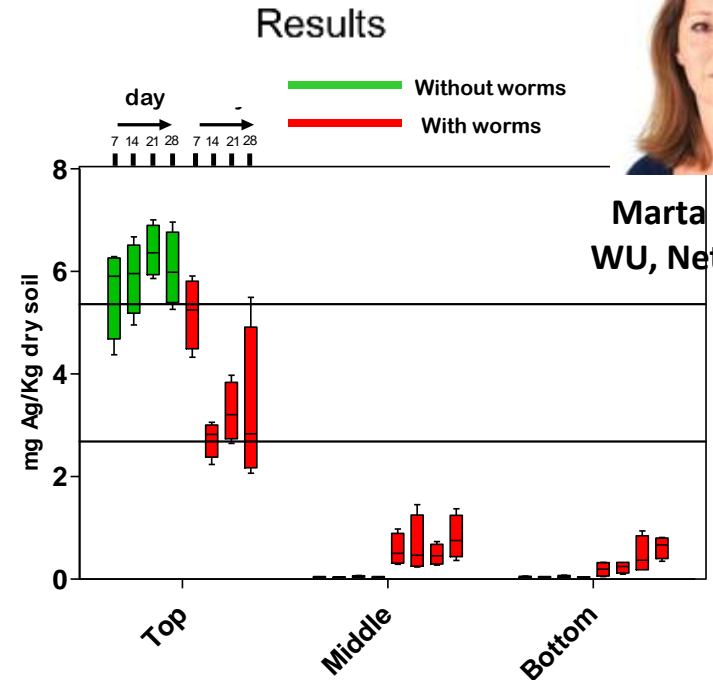
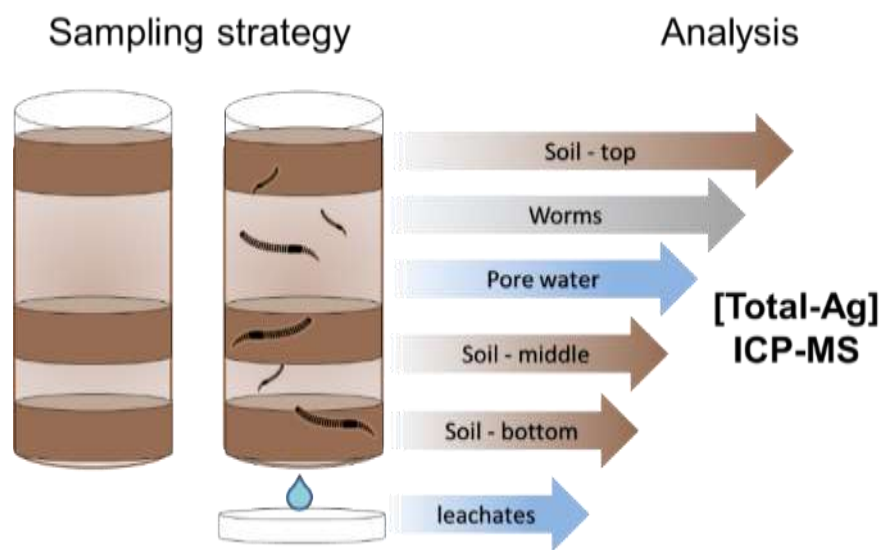
NanoFASE Soil modelling module



Sam
Harrison
UKRI-
CEH, UK

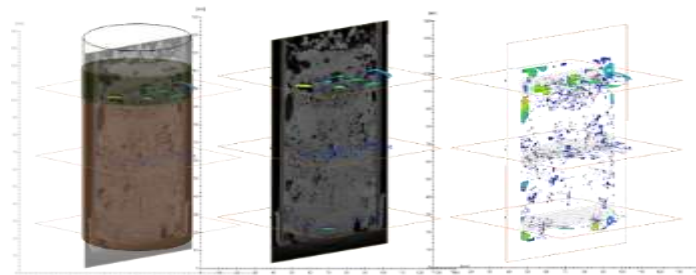


NP mobility in Soil vs Earthworm driven bioturbation



Marta Baccaro
WU, Netherlands

x ray computed tomography

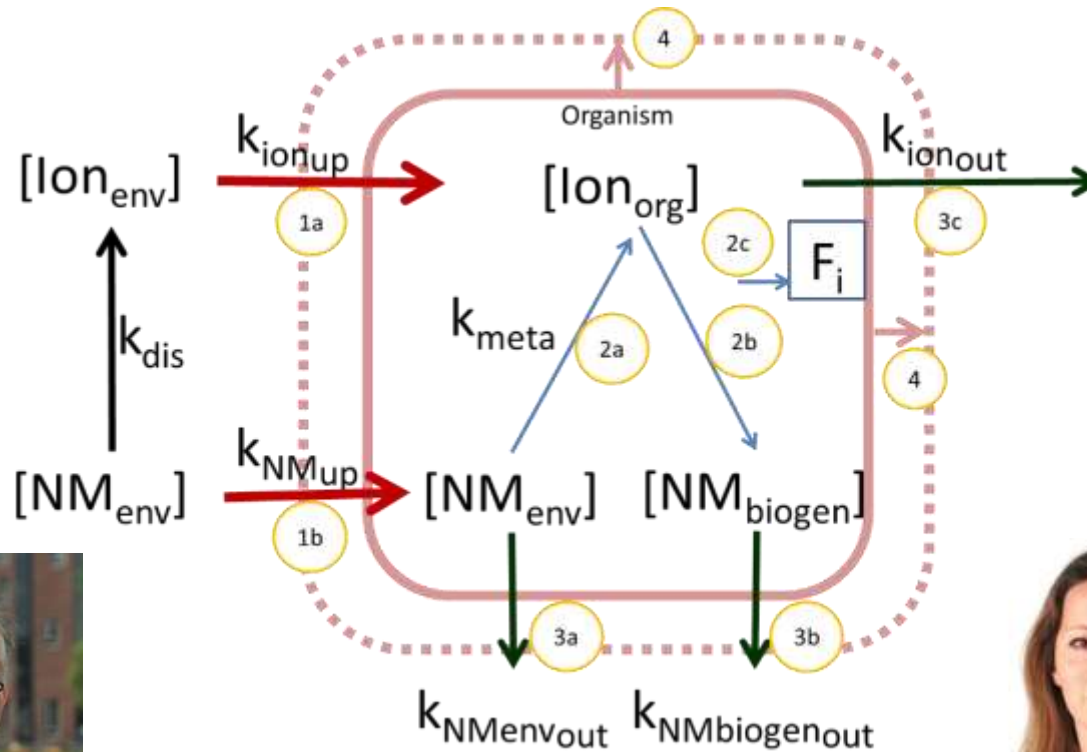


Consequences
for leaching
and for run-off

Baccaro, M. et al, Environmental Pollution, 2019

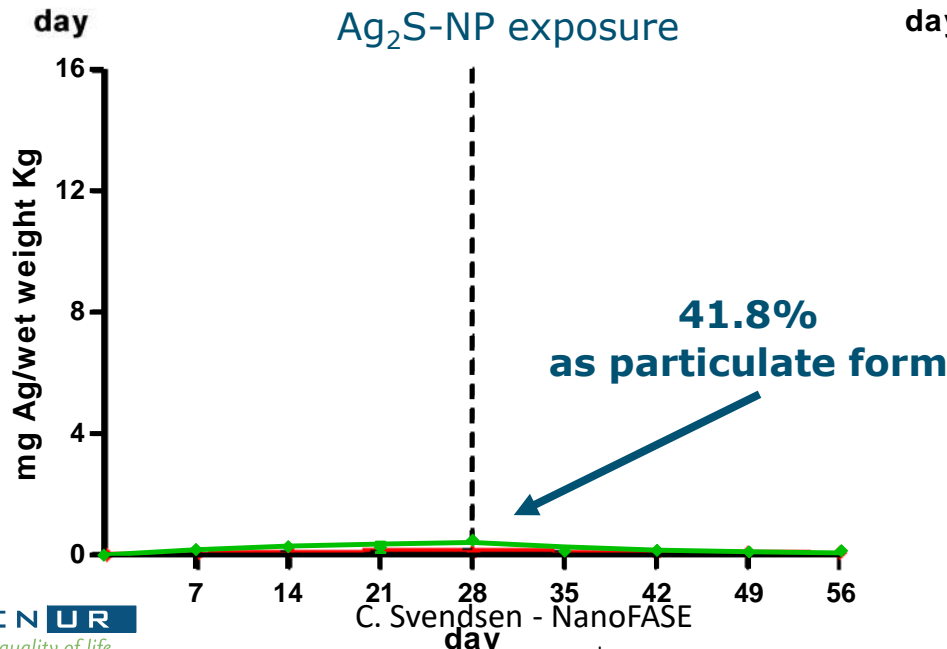
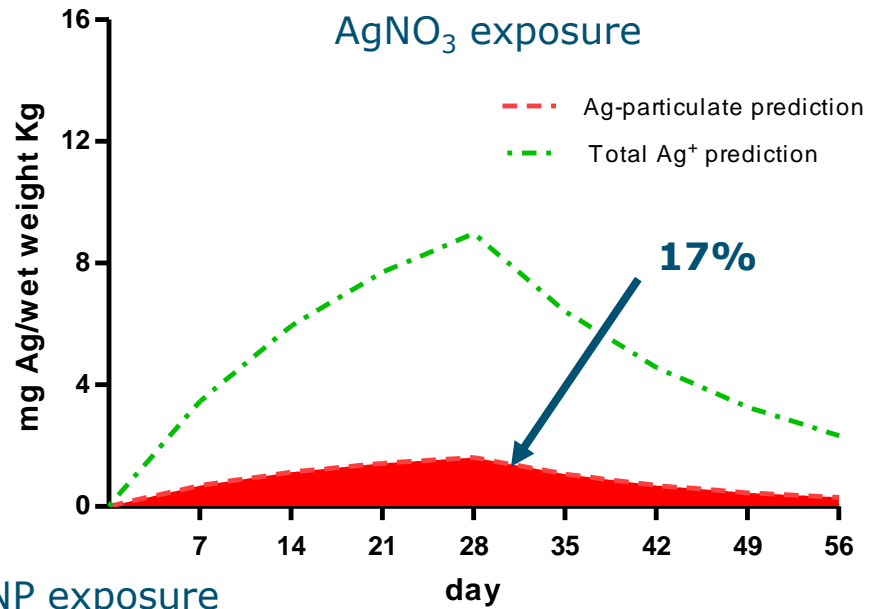
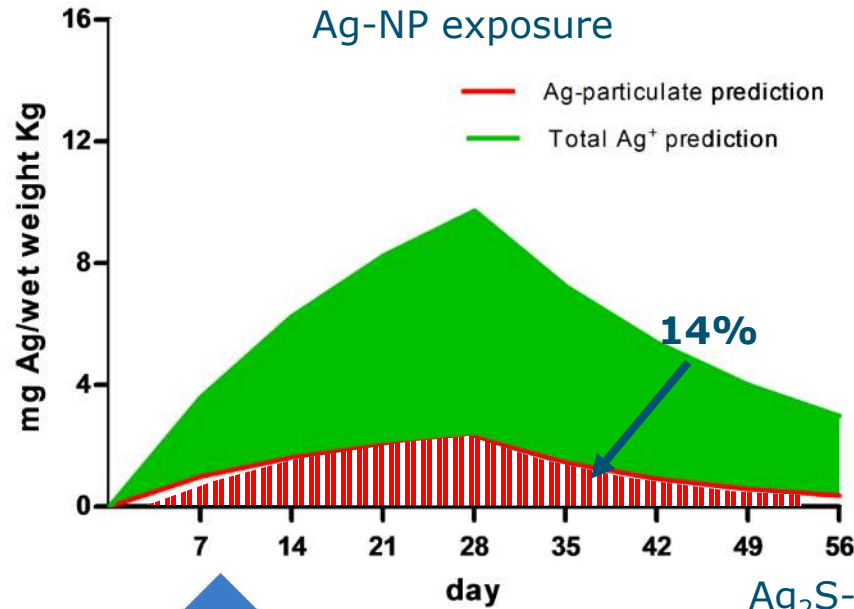
Accumulation kinetics in different biota

Conceptual model



Nico van den Brink, and Marta Baccaro, WU, Netherlands

Earthworm uptake (ions vs particulate)



10x less when aged



Marta Baccaro
WU, Netherlands

Tracking Uptake In Organisms (Pristine Vs Aged NM)

Kinetics of uptake of Ag and Ag₂S-NPs by wheat in different soils

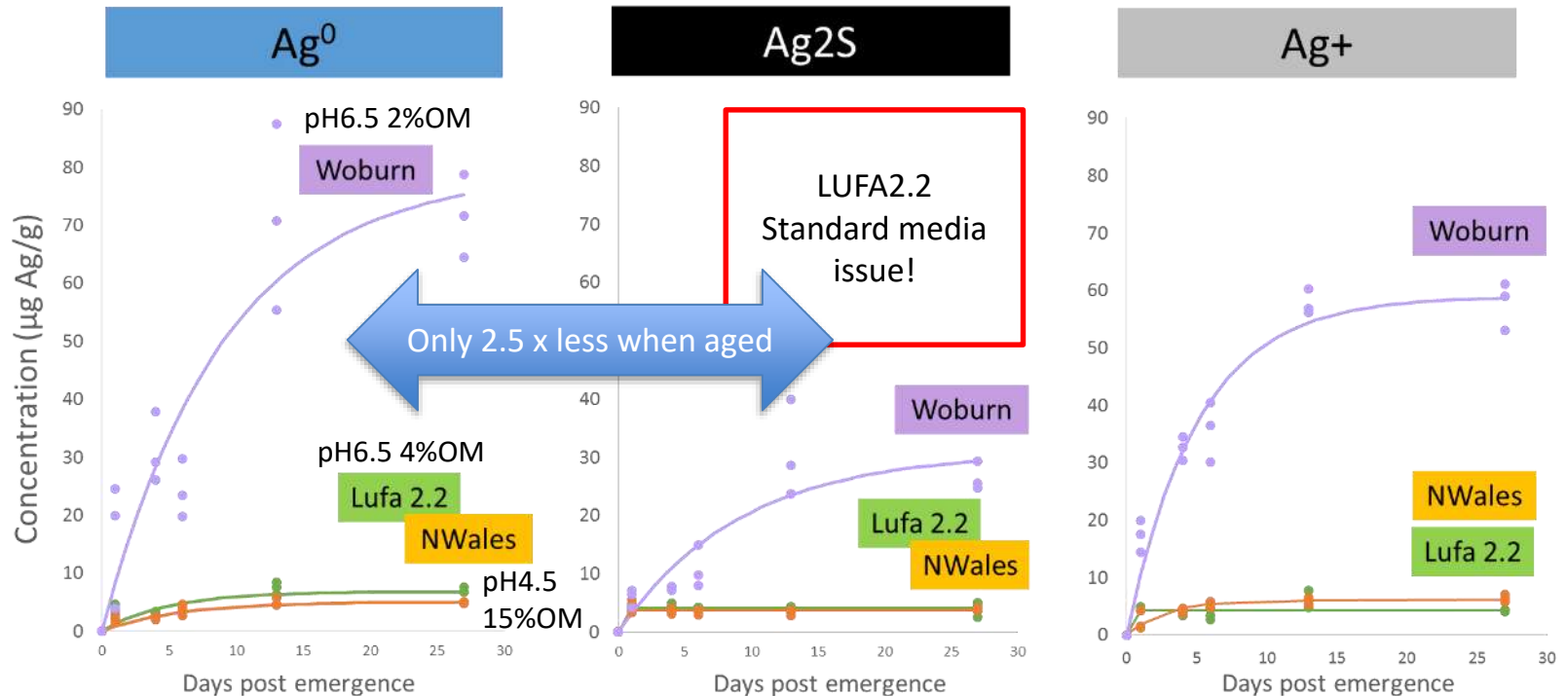
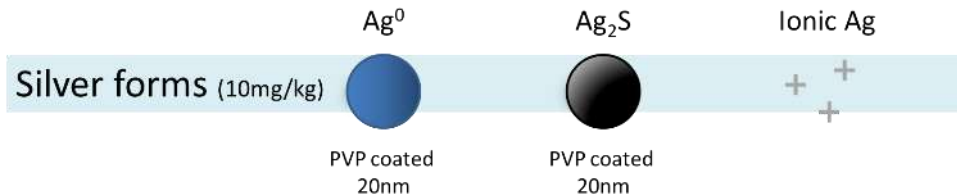


Amaia
Etxabe
Green



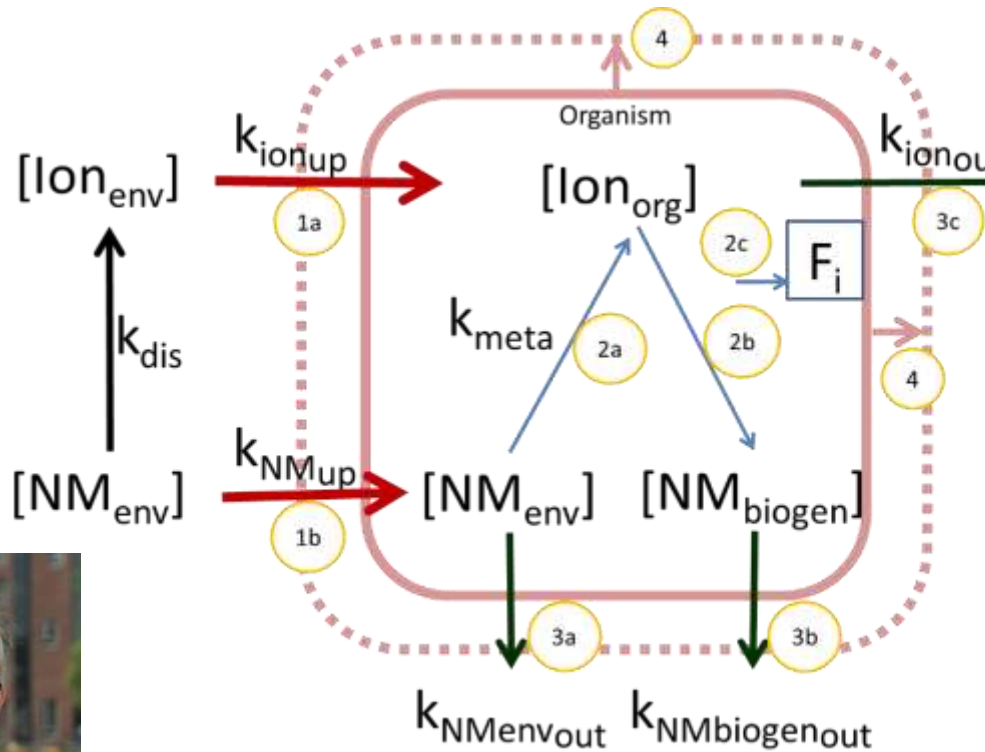
Elma
Lahive

UKRI-CEH, UK



Accumulation kinetics in different biota

Conceptual model



Detailed study of:

Snails;



Patricia Silva
Uni. of Aveiro.
Portugal

Mealworms;



Zahra
Khodaparast
Uni. of Aveiro,
Portugal

Fish;



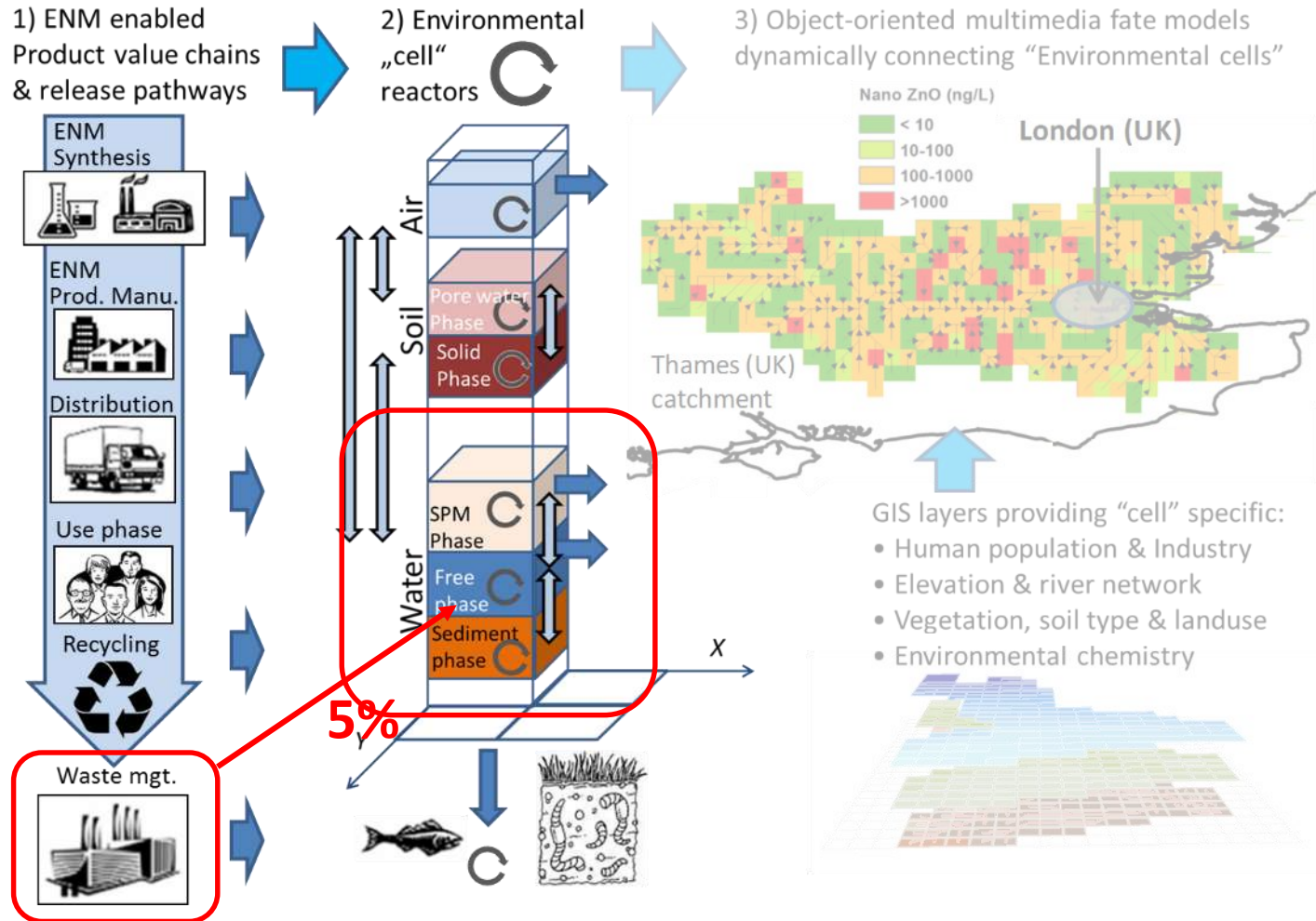
Nathanial Clark & Richard Handy
Uni. of Plymouth, UK



Nico van den Brink, WU, Netherlands

Exposure assessment (of Nano) in the environment:

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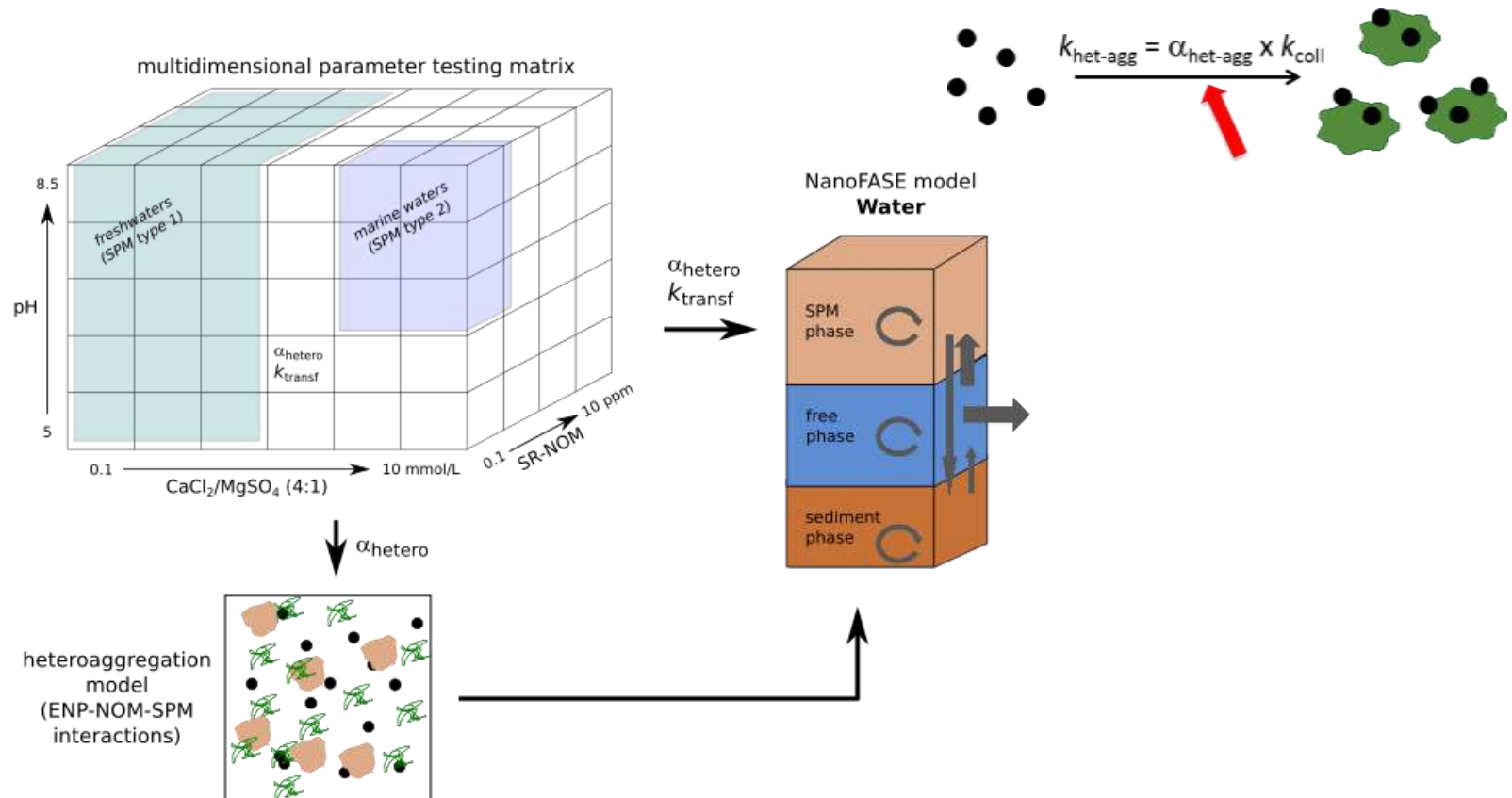


Waste Water
95% Sludge
5% Effluent

Waste Water Treatment Plant

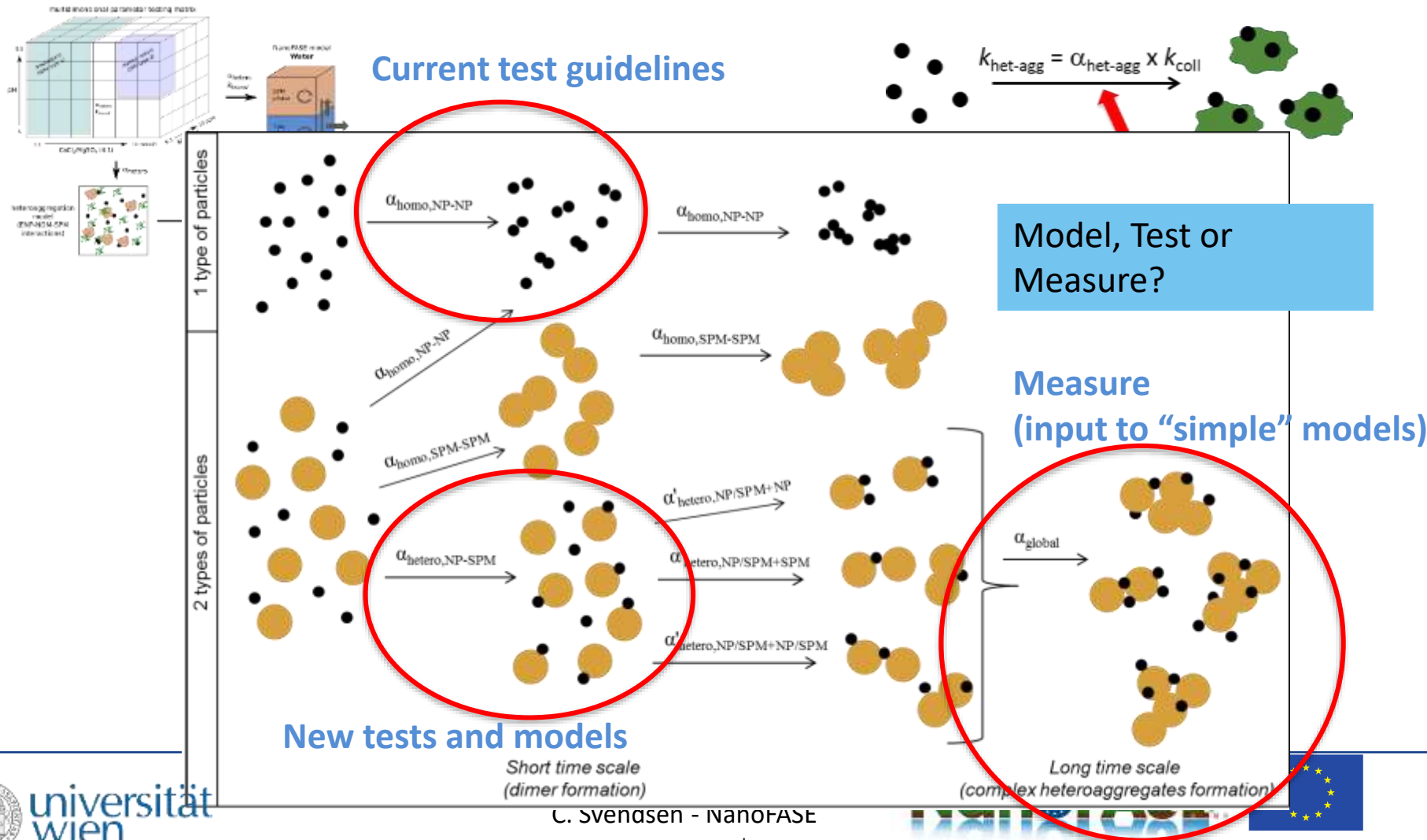
Assessing NM behaviour in Surface Waters and Sediments

Cover fate in realistic natural water chemistries



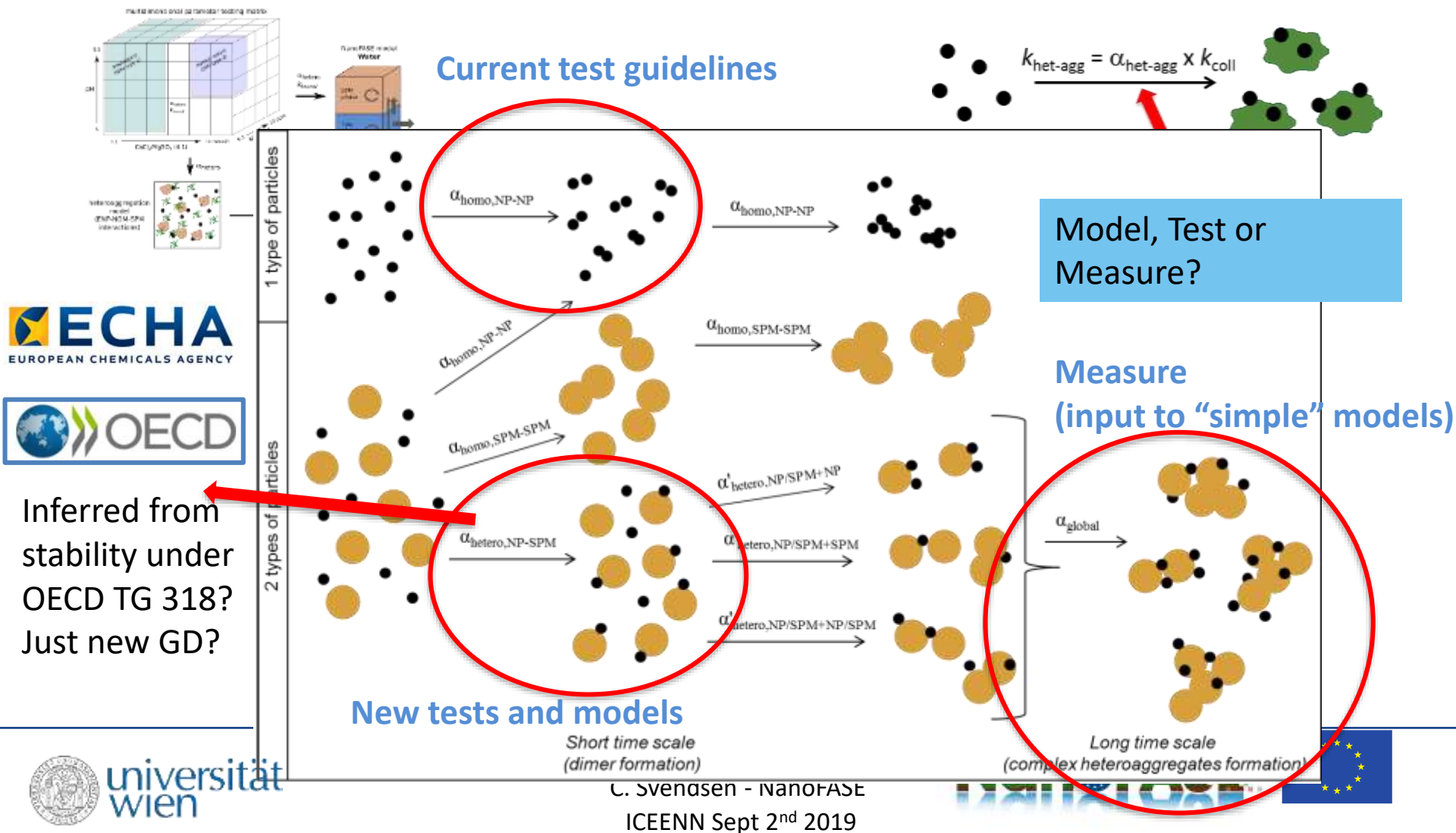
Assessing NM behaviour in Surface Waters and Sediments

Cover fate in realistic natural water chemistries



Assessing NM behaviour in Surface Waters and Sediments

Cover fate in realistic natural water chemistries



Assessing NM behaviour in Surface Waters and Sediments

Cover fate in realistic natural environments

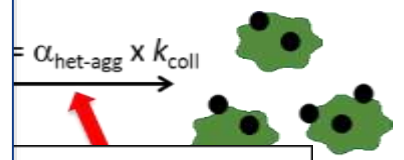
Helene Walch, Uni of Vienna
Experimental work



Modelling from:
Serge Stoll &

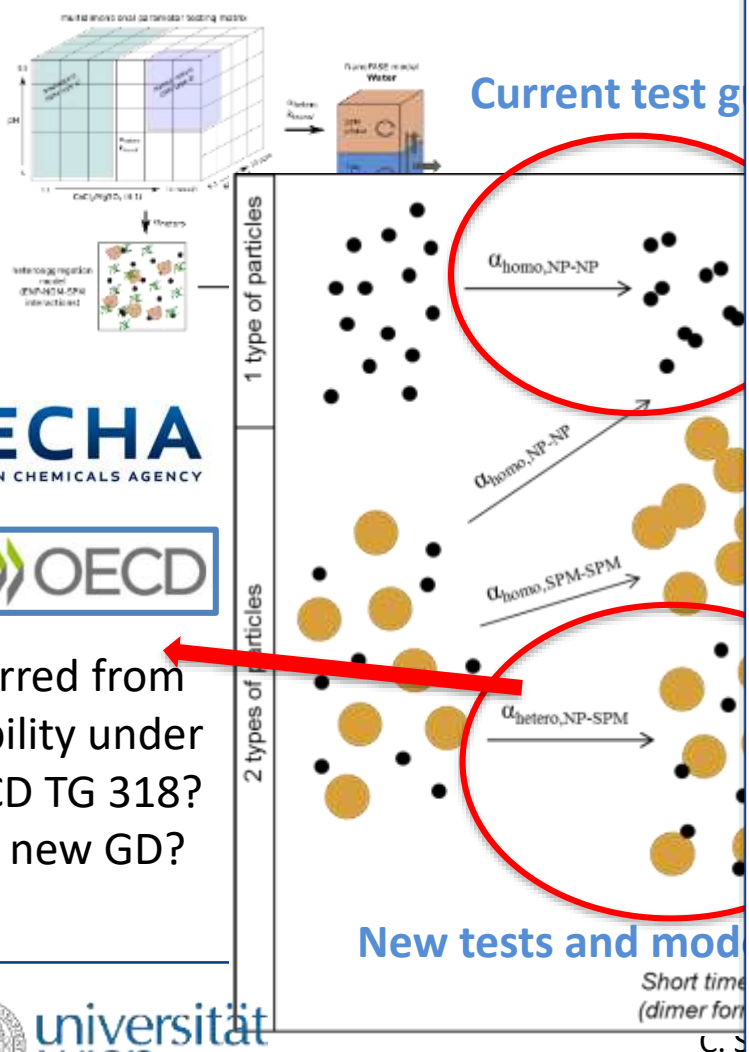
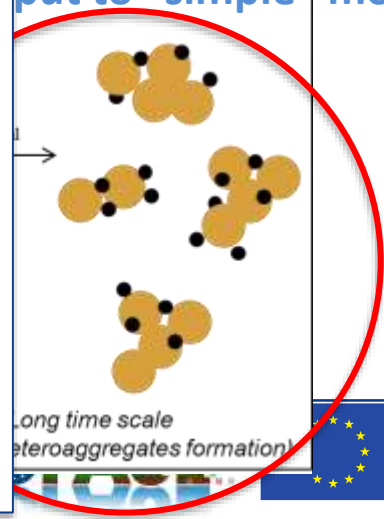


Marianne Seijo



Model, Test or
Measure?

Measure
input to "simple" models)

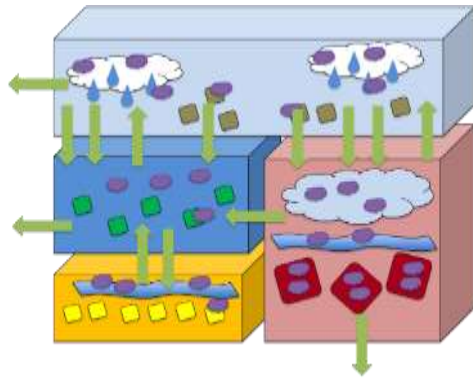


Inferred from
stability under
OECD TG 318?
Just new GD?

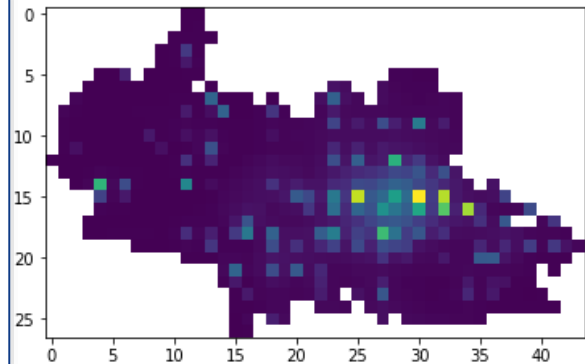


Putting the models together and comparing

Towards validating nanomaterial PECs from SimpleBox4nano using the NanoFASE-WSO spatiotemporal multimedia fate model



Steve Lofts, UKRI-
CEH, UK



SimpleBox4nano

Screening level

Steady state conditions

Regional to continental scale

Background, regional concentrations

NanoFASE Water-Soil-Organism

Time explicit

Time explicit

Gridded: 5x5 km

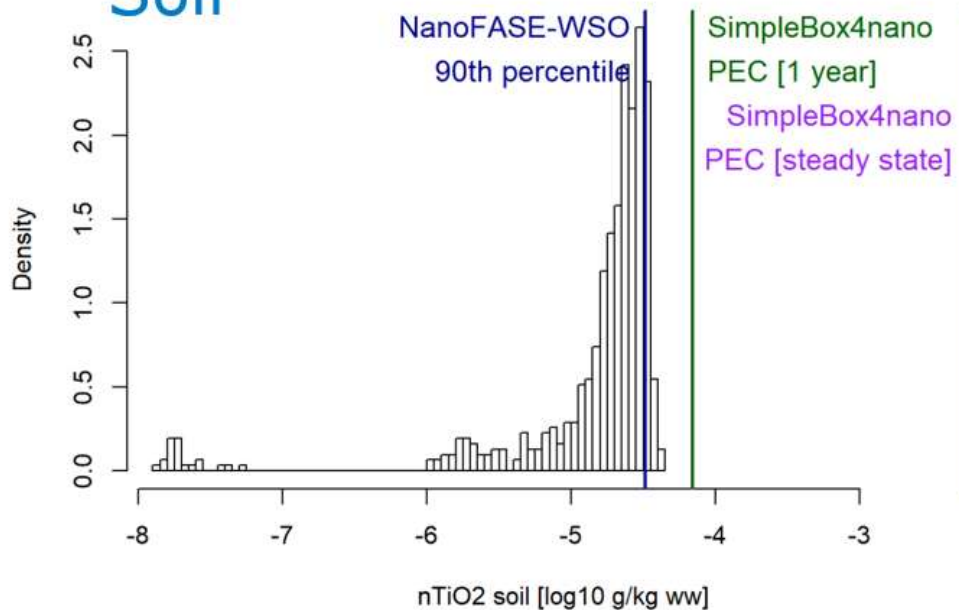
Local concentrations

Putting the model together and comparing

Scenario

- TiO_2 in the Thames catchment
- Concentrations from NF-WSO is after 1 year.

Soil

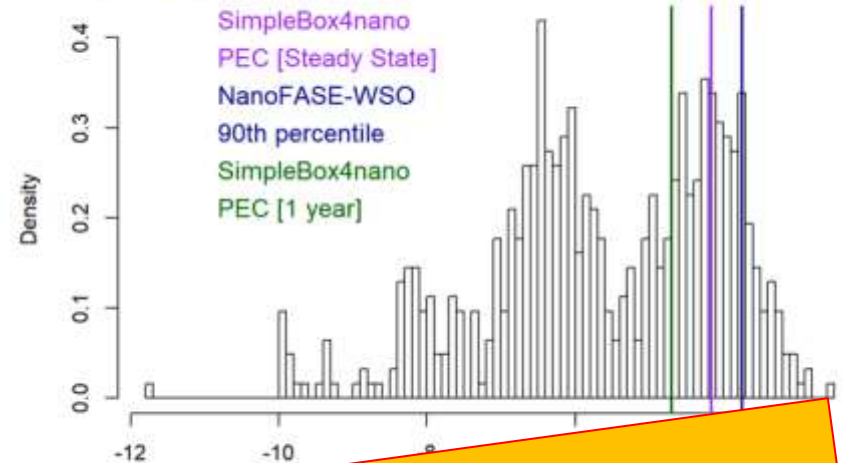


Putting the model together and comparing

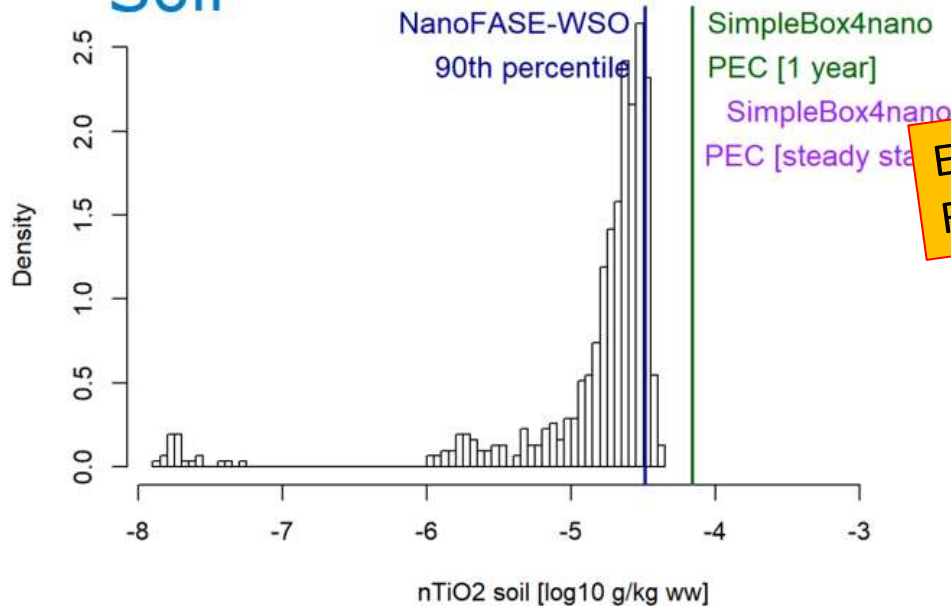
Scenario

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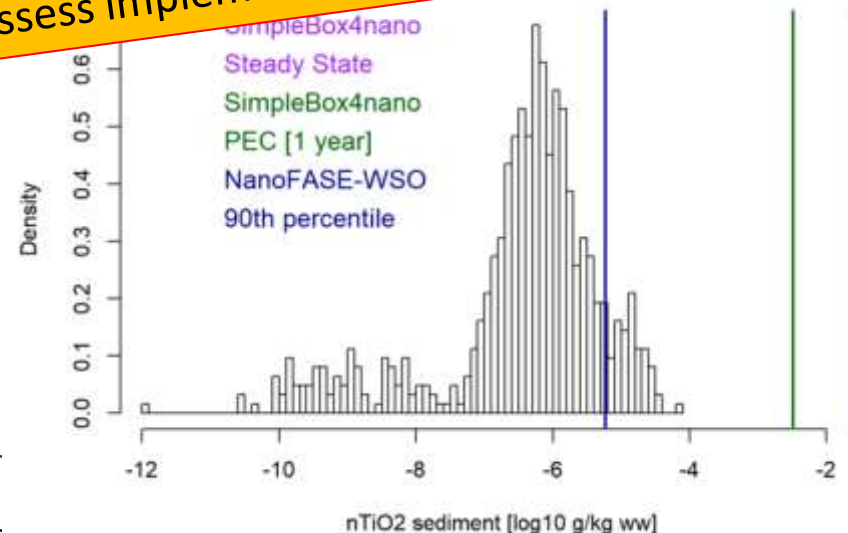
Fresh Water



Soil



Evaluation suggests:
Reassess implementation of resuspension rate



Putting the model together and comparing

Sensitivity



PEC insensitive



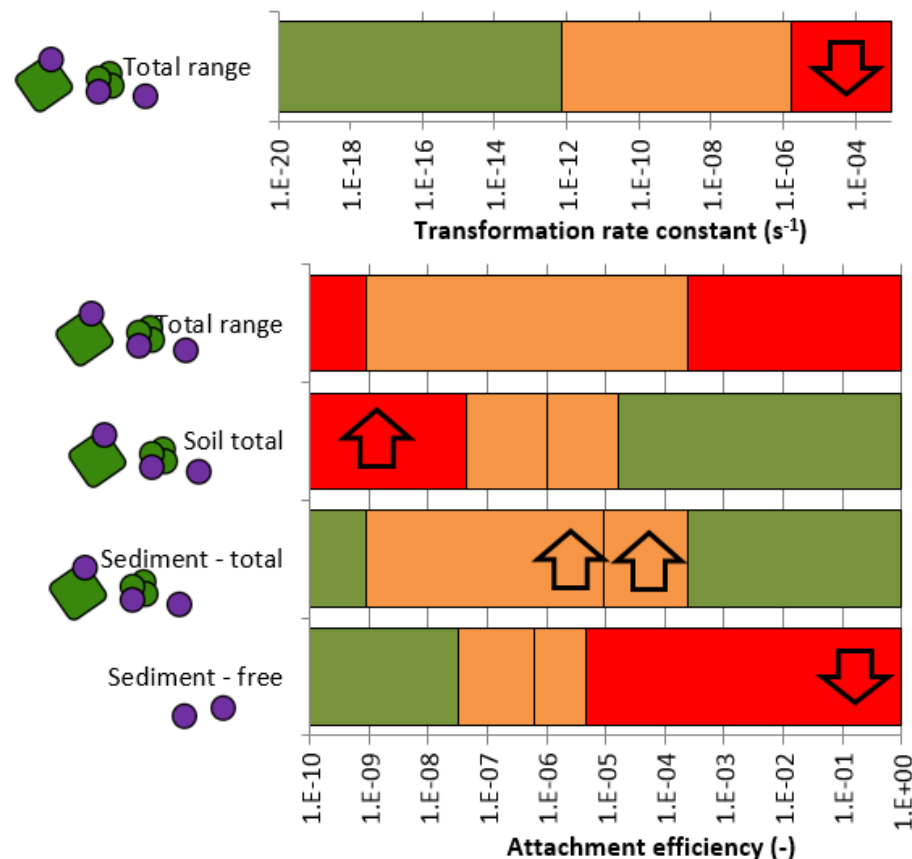
Critical range
2.5-97.5th percentile



PEC sensitive

- PEC sensitive to transformation rates above approx. 10^{-12} s^{-1}
- PEC sensitive to attachment efficiency for heteroaggregation
 - Varied sensitivity between compartments.

Critical ranges of parameters that need quantification/measurement.



Meesters, J.A.J. 2019. "A Model Sensitivity Analysis to Determine the Most Important Physicochemical Properties Driving Environmental Fate and Exposure of Engineered Nanoparticles."

ES nano 10.1039/C9EN00117D

Implications for ERA considerations, approaches and tools

Environmental fate

- Very different - rules if and where there may be possible Nano Exposures
=> should inform what Nano-form(s) are “exposure relevant”
- Long time scales => Current standard hazard tests may not be “worst case”
=> Pre-aging of test media?

Biodegradation/ accumulation/ biomagnification

- Tested exposure forms must be the exposure relevant ones
- Form (size and speciation) of internalised material ideally identified

Technical / Analytical needs + Test Guidance (match question with precision)

- New analytical and testing techniques needed (kept simple and repeatable)
- Move from “Solute based” to “kinetic” tests



ICPMS to
spICPMS

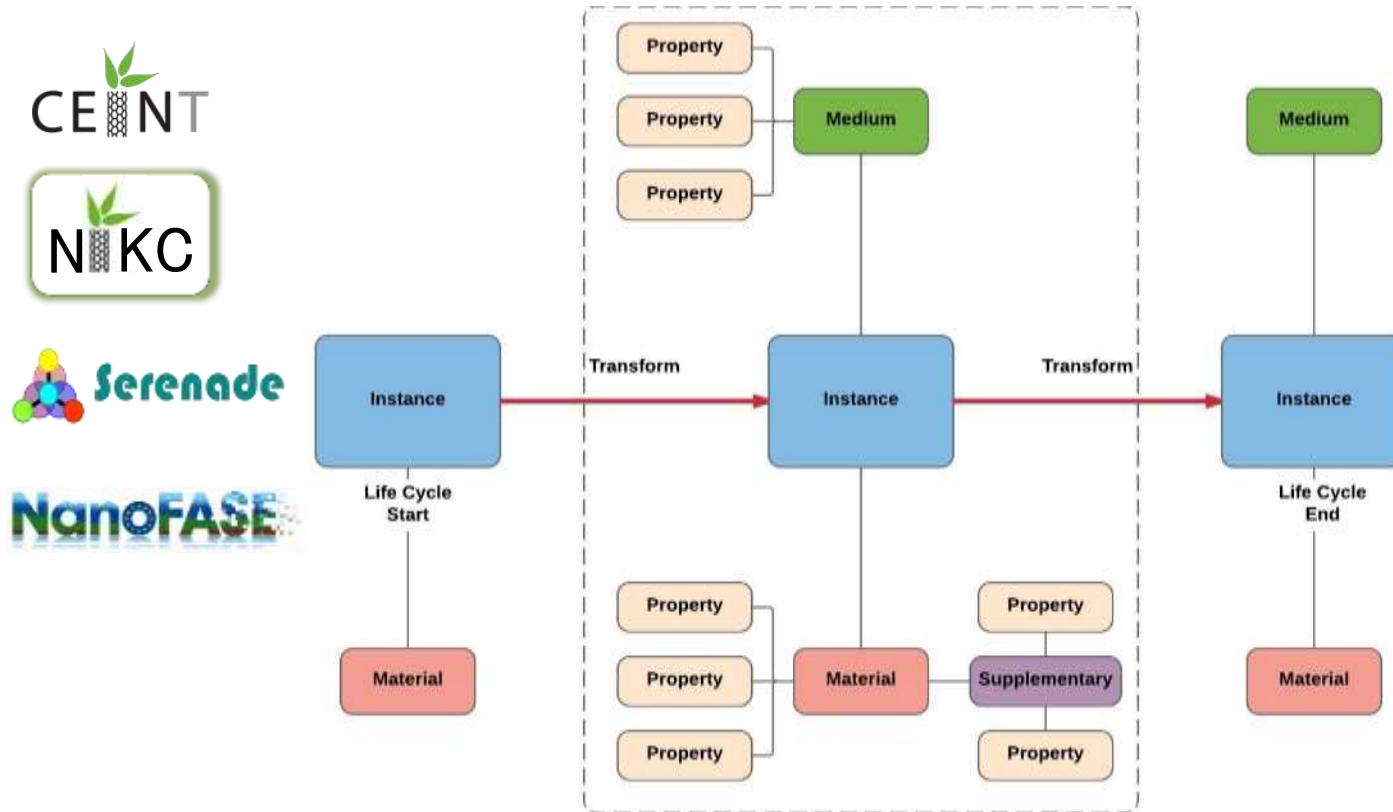
New analytics
for organic NMs

X-ray based
for speciation



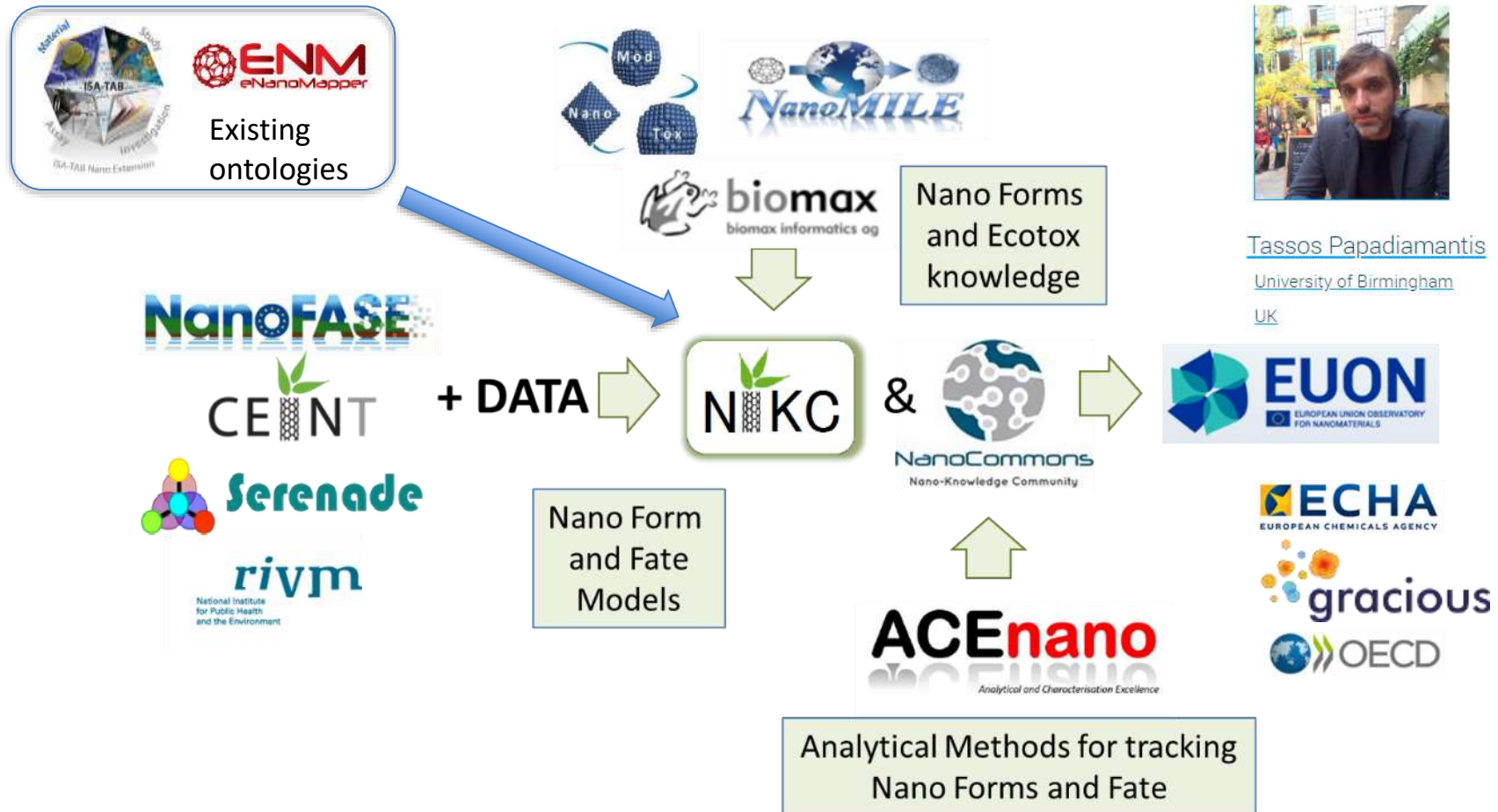
Exposure - Nanomaterial fate in the environment:

How are we are handling, storing, and sharing the data?



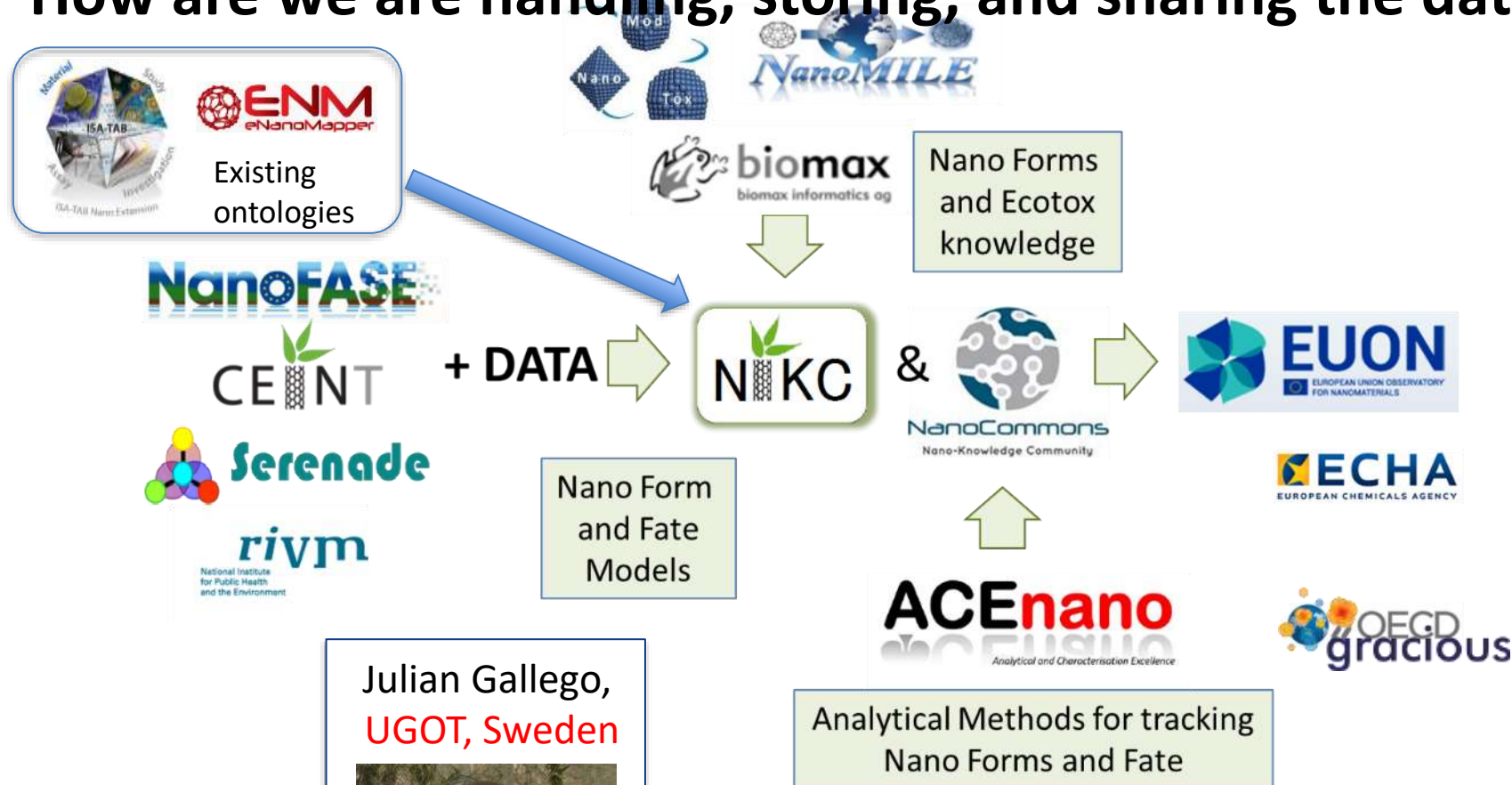
Exposure - Nanomaterial fate in the environment:

How are we are handling, storing, and sharing the data?



Exposure - Nanomaterial fate in the environment:

How are we handling, storing, and sharing the data?



Julian Gallego,
UGOT, Sweden



Exposure - Nanomaterial fate in the environment:

In what format will we deliver it to you all?



www.NanoFASE.eu (EU H2020 Proj. 646002)



Exposure - Nanomaterial fate in the environment:

In what format will we deliver it to you all?

Young NanoScientists



[Véronique Adam](#)
EMPA
Switzerland



[Jessica Adams](#)
NERC CEH
United Kingdom



[Marta Baccaro](#)
Wageningen University
Netherlands



[Sam Harrison](#)
NERC
UK



[Alice Horton](#)
NERC CEH
United Kingdom



[Anja Jemec](#)
Ljubljana University
Slovenia



[Tassos Papadimitriou](#)
University of Birmingham
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[Vicenç Pomar](#)
LEITAT Technological Center
Spain



[Antonia Praetorius](#)
University of Vienna
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[Andrea Brunelli](#)
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Italy



[Nathaniel Clark](#)
University of Plymouth
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[Richard Cross](#)
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Germany



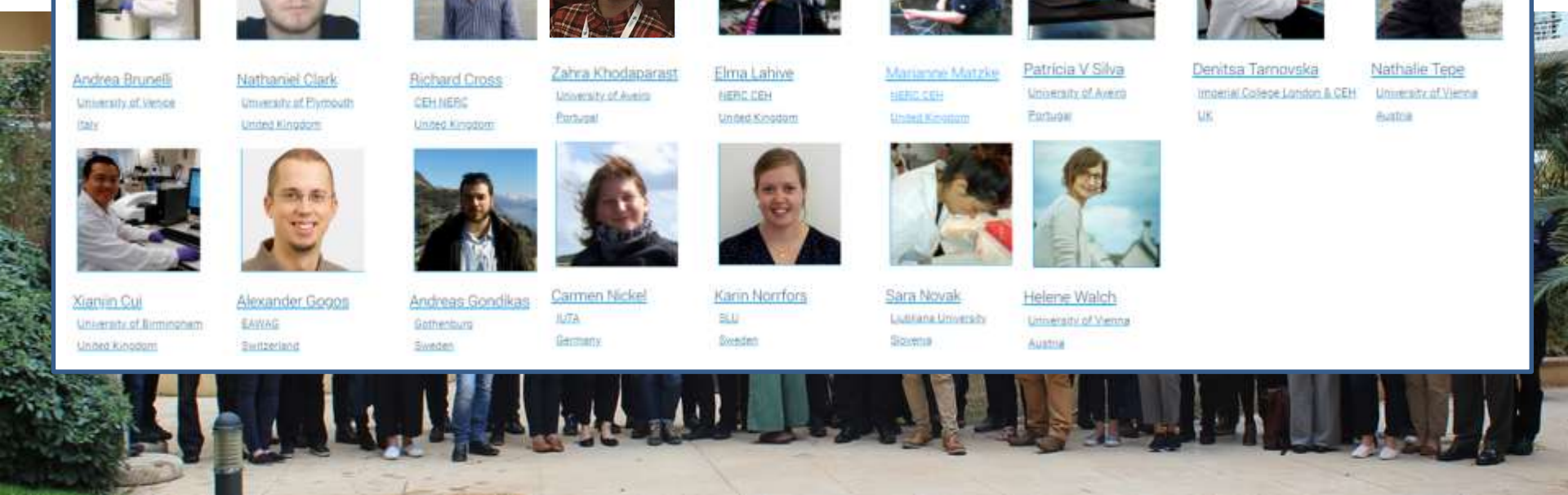
[Karin Norrfor](#)
BLU
Sweden



[Sara Novak](#)
Ljubljana University
Slovenia



[Helene Walch](#)
University of Vienna
Austria



How will we deliver it to you all?

1. The new knowledge in Papers and Presentations:

<http://www.nanofase.eu/documents>



2. Accessible Online resources and tiered Exposure Assessment Framework:

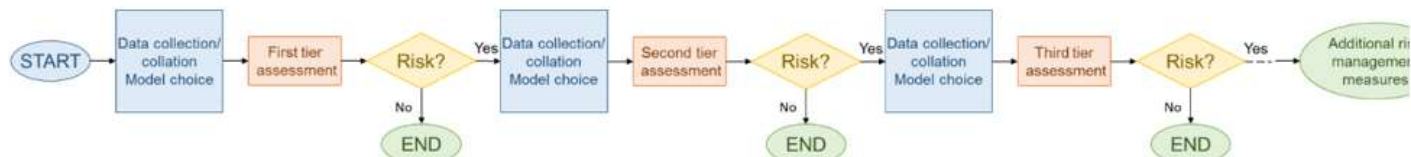


Figure 2: Schematic of tiered approach to environmental assessment using models of increasing complexity.

3. Fantastically well trained people: The (NanoFASE) “Young Nano Scientists”

4. Efforts made to translate our New Knowledge into International Standards:



ICPMS to
spICPMS

New analytics
for organic NMs

X-ray based
for speciation



Exposure - Nanomaterial fate in the environment:

In what format will we deliver it to you all?



www.NanoFASE.eu (EU H2020 Proj. 646002)



NanoFASE “Clickable Framework” modules

The screenshot displays the NanoFASE website with the following elements:

- Header:** NanoFASE logo, a search bar, social media icons (Twitter, Facebook, LinkedIn), and a 'Login' button.
- Navigation Bar:** Links for HOME, PROJECT, FRAMEWORK, TEAM, LIBRARY, NEWS, EVENTS, DOWNLOADS, and CONTACTS. A yellow arrow labeled 'CLICK' points to the 'FRAMEWORK' link.
- Main Content Area:**
 - Recent news:** Two articles are listed, including one about a NanoFASE publication selected as a 'HOT article' and another about a small company's impact at the CHEMUK 2019 Expo.
 - Highlights:** A large image of a conference hall with rows of chairs. Below it, a banner for the 'Joint Event - ICEENN 2019 and NanoFASE Concluding Conference' is shown, with a 'Read more' link.
 - Tweets:** A section showing tweets from @NanoFASE_EU.
 - Calendar:** A section for the '2019 NanoEHS COR Workshop' held from 15 OCT 2019 to 16 OCT 2019.
- Footer:** Three modules are displayed with a yellow arrow labeled 'CLICK' pointing to the first one:
 - Exposure Assessment Framework:** A diagram showing the flow of information in an exposure assessment.
 - EUON: EU Observatory for Nanomaterials:** The logo for the European Union Observatory for Nanomaterials.
 - Brochure:** A thumbnail image of a brochure titled 'Nanomaterial Fate and Speciation in the Environment'.

NanoFASE Exposure Assessment Framework

Welcome to the **NanoFASE Clickable Exposure Assessment Framework** for engineered nanomaterials (ENMs)! Find a message to stakeholders [here](#)

Click below to explore transformation and transport processes in manufacture, use, waste streams, air, soil or water / sediment, as well as uptake and accumulation in biota. Access protocols, characterisation data, and algorithms underlying the NanoFASE water-soil-organism dynamic environmental exposure model. [Click here](#) to access brief NanoFASE case studies, or to view the [workflow for a tiered exposure assessment](#).

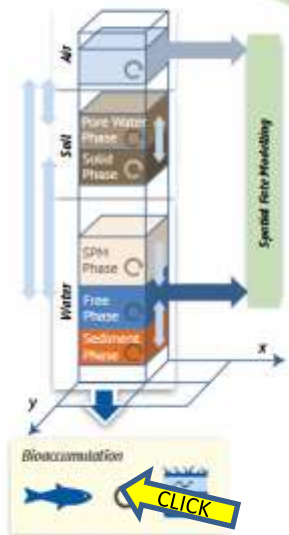


e.g. WP9 - Accumulation kinetics in different biota

ENM Enabled
Product Value
Chains and Release
Pathways

Environmental Reactors
and ENM Fate &
Transformations

Dynamic Fate and
Exposure Modelling for
ENM Forms Entering the
Environment



NanoFASE ENMs Experimental Toolbox



NanoFASE Exposure Assessment Framework

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ENM Enabled
Product Value
Chains and Release
Pathways

Environmental Reactors
and ENM Fate &
Transformations

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NanoFASE

Search



Login

Nanomaterial Fate and Speciation in the Environment

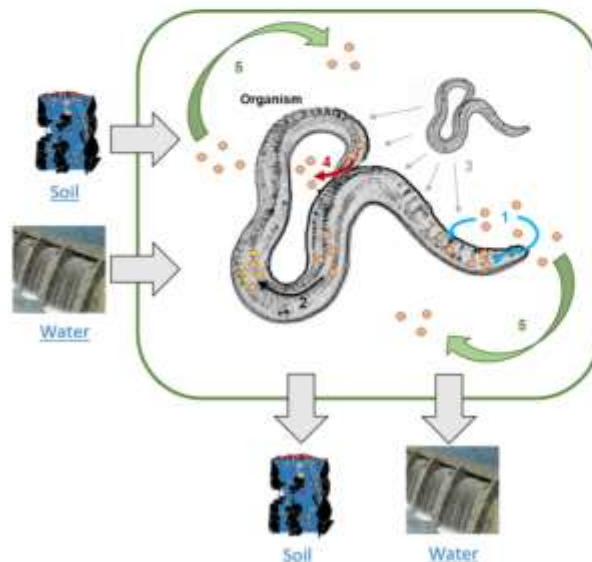
HOME PROJECT TEAM FRAMEWORK LIBRARY NEWS EVENTS DOWNLOADS CONTACTS

Effect of ENM Form on Environmental Fate in Biota

Biota are the final environmental receptors of ENMs that are released into the environment. As such they are considered by NanoFASE to be a compartment.

Different species may accumulate ENMs from soil, water and/or sediment. Furthermore, biota may act as a reactor by transforming the properties of the ENMs during their residence in the organisms or by altering the environment by their activities (e.g. bioturbation) or by excretion of e.g. biomolecules (as in the case of plants).

Assessment of accumulation of ENMs in biota is essential for proper assessment and management of risks that ENMs may pose to the environment.



1. Bio-uptake
2. Biogenic transformation
3. Growth dilution
4. Bio-elimination
5. Bioturbation

Tweets

Tweets by @NanoFASE_EU

NanoFASE Network

Summary: #NANOFASE participate 3rd International Forum of Young Scientists. 1 poster by Carlos Pinheiro on Ag NP effects in snails. 1 platform by @concepcion_silva on multigenerational effects of Cu nanocatalysts in *Poecilia* carpio, and a keynote by @Giovanna_LMUC @NanoFASE_EU

Retweet View on Twitter

Calendar

NanoFASE AGM Autumn 2018

15 OCT 2018 - 18 OCT 2018

The NanoFASE Annual General Meeting will take place from 15-18 October, 2018 in Sofia, Bulgaria. The consortium...

Innovative industries for smart growth

30 OCT 2018 - 31 OCT 2018

The organisation team of the European conference "INDUSTRIAL TECHNOLOGIES 2018 - Innovative industries fo..."

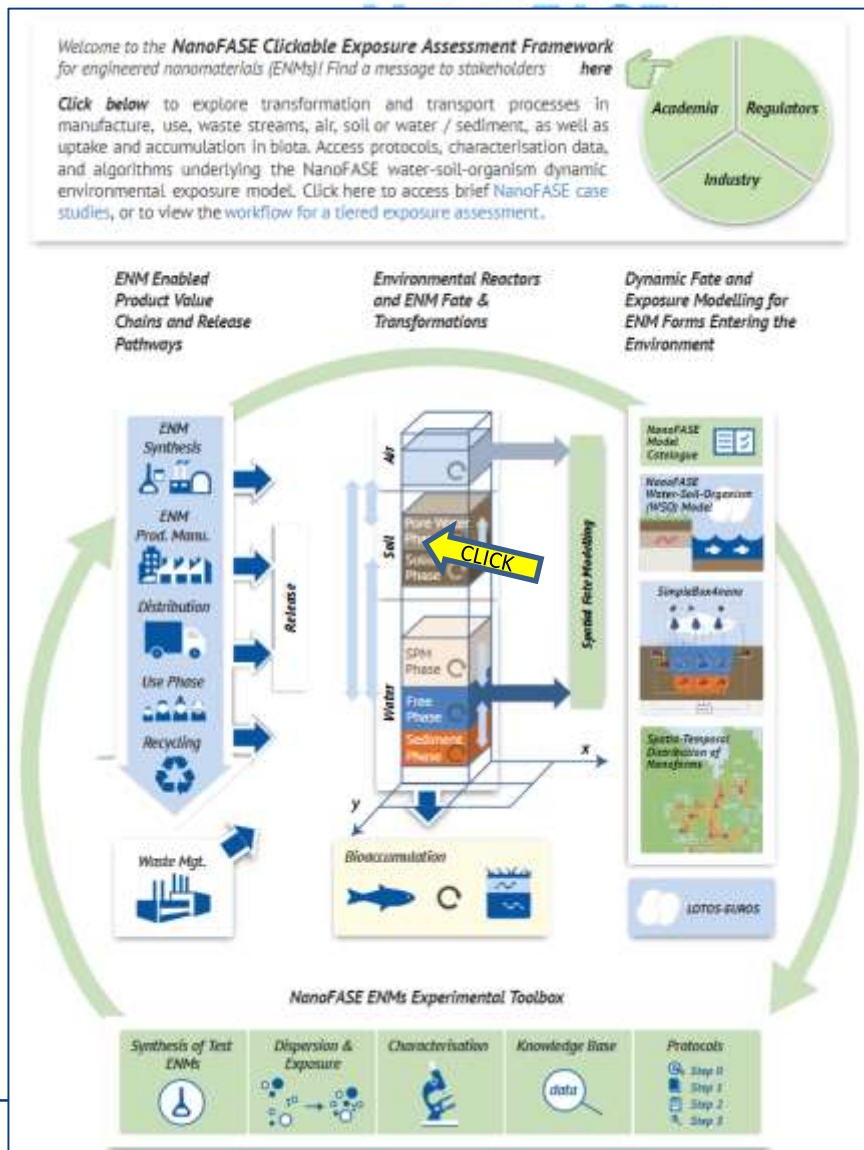
See all

NanoFASE ENMs Experimental Toolbox

Synthesis of Test ENMs Dispersion & Exposure Characterisation Knowledge Base

data

NanoFASE Soil modelling module



NanoFASE Soil modelling module

Welcome to the **NanoFASE Clickable Exposure Assessment Framework** for engineered nanomaterials (ENMs)! Find a message to stakeholders [here](#)

Click here to learn more about the framework, its uptake, and its application in environmental studies.

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Environmental Fate of ENMs: Soil Compartment

Soils are exposed to ENMs mostly through deposition of sludge on agricultural land. A range of organisms can be exposed and possibly be affected, including food crops, also giving an entry into the human food chains. ENMs are also applied deliberately to soils, e.g. as [zerovalent iron](#) to remediate contaminated soils, as [nanofertilizers](#) or as [nanopesticides](#).

- [1. Sludge deposition](#)
- [2. Deposition](#)
- [3. Homoaggregation](#)
- [4. Heteroaggregation](#)
- [5. Surface run-off](#)
- [6. Air-water interaction](#)
- [7. Straining](#)
- [8. Attachment](#)
- [9. Bioturbation](#)
- [10. Bio-uptake](#)
- [11. Spatial distribution](#)

Case studies

- [Zerovalent iron](#)
- [Nanopesticides](#)

Read also

Cornelis G, et al. (2014) Fate and Bioavailability of Engineered Nanoparticles in Soils: A Review. Crit. Rev. Environ. Sci. Technol. 44: 2720–2764. <https://doi.org/10.1080/10643389.2013.829767>

Environment

DOWNLOADS CONTACTS

Tweets

Tweets by [@NanoFASE_EU](#)

NanoFASE
@NanoFASE_EU
Summer 2018 issue of the
@EUEnvPolicy newsletter is out!
a PDF for all news from visit:
[zenodo.org/record/2362003](#)
Scroll down to read about the
joint #ICEENN2019 @EuroEnv &
NanoFASE Concluding
Conference#nanosafety
#nanoscience#nanomaterials

Embed View on Twitter

Calendar

2019 NanoEHS COR Workshop
15 OCT 2019 - 16 OCT 2019
The 2019 EU-JS NanoEHS CORs Workshop will take place October 15-16, 2019, at the Europe de l'Arbois ...
[See all](#)

NanoFASE Soil modelling module

Welcome to the **NanoFASE** for engineered nanomaterials

Click here to learn more about the uptake, distribution and effects of nanomaterials in the environment.

HOME PROJECT TEAM FRAMEWORK LIBRARY NEWS EVENTS DO

Heteroaggregation

Heteroaggregation is an aggregation process between 'particles' of different types (chemistry, size, shape, surface properties). One example is the heteroaggregation between ENPs and [suspended particulate matter](#) (SPM) such as inorganic colloids or/and natural organic matter in aquatic systems or in soils. Heteroaggregation can also occur in air between ENPs and aerosols. Upon collision, particles stick together with a probability expressed by an [attachment efficiency](#) (α) and they form heteroaggregates. In the environment, heteroaggregation is expected to be more frequent than homoaggregation and to occur in [soils](#), [freshwaters](#) and [air](#).

Occurs in

[Soil](#) [Air](#) [Water](#)

Fate descriptors

[Attachment efficiency](#)

Algorithms

[Heteroaggregation rate calculation](#)

Wastewater treatment plant

Environment

Soils are exposed to various contaminants including food and pharmaceutical residues, heavy metals, and pesticides. Contaminated soil can lead to the release of these substances into the environment.

Case studies

- [Zerovalent](#)
- [Nanopesticides](#)

Tweets

Tweets by [@NanoFASE_EU](#)

NanoFASE
@NanoFASE_EU
The 2018 issue of the
Environmental Science & Technology
journal is out!
For all news from this
journal visit:
[http://www.rsc.org/journals](#)
Scroll down to read about the
NANOFASE 2018 @Eurochem &
NANOFASE 2018
NANOFASE 2018
NANOFASE 2018

Calendar

2019 NanoEHS COR
Workshop
OCT 2019 - 16 OCT 2019
The 2019 EHS COR NanoEHS
Workshop will take place
from 15-16, 2019, at the
Maison de l'Arbois ...
[See all](#)

CLICK

NanoFASE Soil modelling module

Welcome to the **NanoFASE** for engineered nanomaterials

Click to manufacture uptake and alg environ studies.

HOME **PROJECT**

HOME

Environment

Soils are exposed including food and contaminated soil

Wastewater treatment plant

Heteroaggregation

Heteroaggregation is an aggregation heteroaggregation between ENPs and systems or in soils. Heteroaggregation expressed by an [attachment efficiency](#) than homoaggregation and to occur in

Fate descriptors

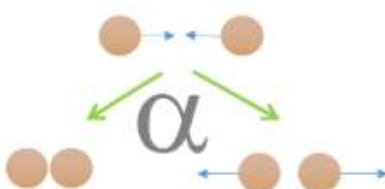
Case studies

- [Zerovalent](#)
- [Nanopesticides](#)


Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Attachment efficiency

Attachment efficiency (α) expresses the probability that upon collision of a particle with another surface or another particle, the two particles will stick to each other. In the case of favorable [attachment](#), α equals 1, i.e. all collisions are successful. This is the case e.g. when the particles are oppositely charged or when the ionic strength is relatively high. In most cases, however, $\alpha < 1$, e.g. because of dissolved organic matter adsorption leading to steric hindrance or charges on the particle surfaces resulting in electrostatic repulsion. Attachment efficiency, together with hydrodynamics, determines the [attachment rates](#) in porous media such as [soils](#) or [sediments](#) as well as the [homoaggregation](#) and [heteroaggregation rates](#) in [rivers](#) and [wastewater treatment plants](#).



Used for



[Attachment](#) [Heteroaggregation](#) [Homoaggregation](#)

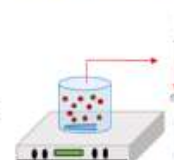
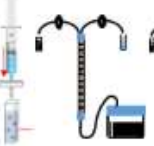

Algorithms

$$k_{att} = \alpha \frac{3(1-\theta)v}{2d_c} \eta_0$$

$$v = \alpha \beta n^2$$

[Attachment rate calculation](#) [Homoaggregation rate calculation](#) [Heteroaggregation rate calculation](#)

Protocols

[Batch test](#) [Saturated column test](#) [Unsaturated column test](#)

Read more

[NanoFASE Report D7.2 Soil property - NM fate relationships](#)

[NanoFASE Report D8.1 Alignment between model requirements and experimental procedures](#)

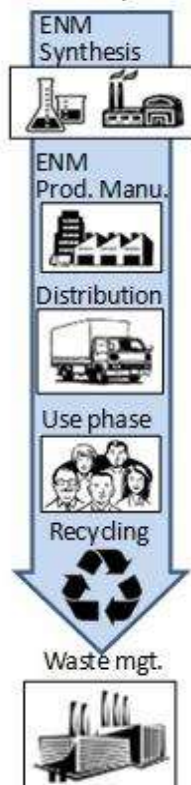
Read also

Petosa, A. R.; Jaisi, D. P.; Quevedo, I. R.; Elimelech, M.; Tufenkji, N.: Aggregation and Deposition of Engineered Nanomaterials in Aquatic Environments: Role of Physicochemical Interactions. Environ. Sci. Tech. 2010, 44 (17), 6532-6549.

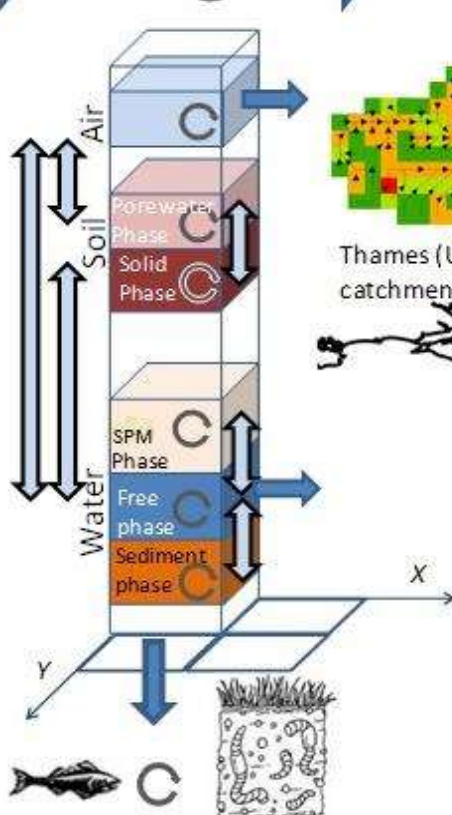
Exposure - Nanomaterial fate in the environment:

In what format will we deliver it to you all?

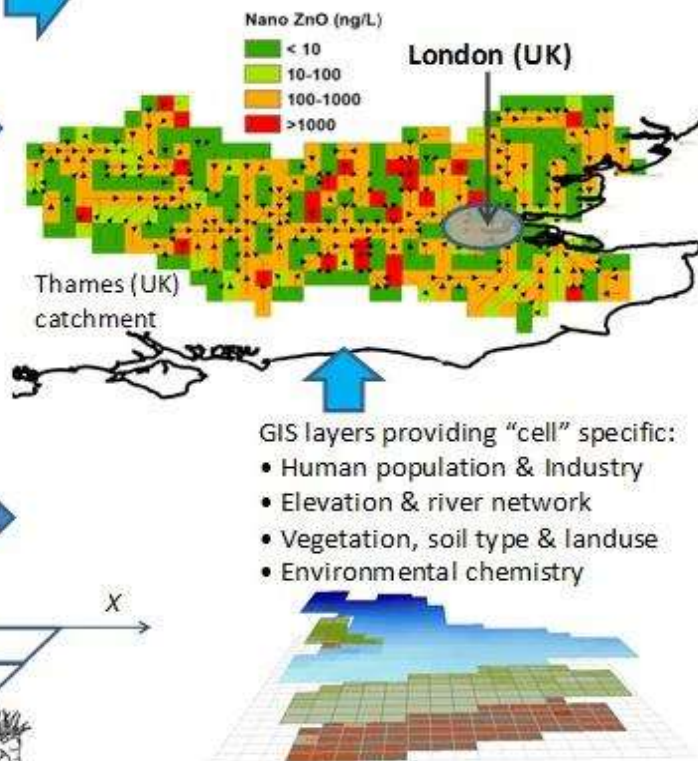
1) ENM enabled
Product value chains
& release pathways



2) Environmental
„cell“
reactors



3) Object-oriented multimedia fate models
dynamically connecting “Environmental cells”



FOCUS ON:

“Reactors” and relevant ENMs (Focus on *relevant materials at each RA step*)

DELIVER:

Functional fate groups
a tool to understand *and reduce* complexity



Exposure assessment framework catalogue of models, parameters and methods



Multimedia fate models
simplified to feed regulatory models (SimpleBox 4 Nano)



DATA +



=>



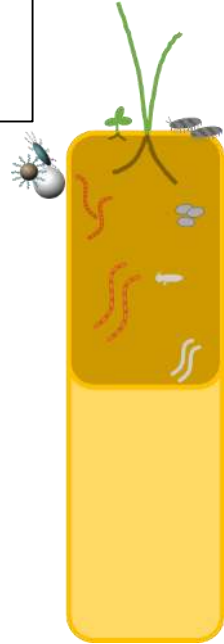
=>



Putting it all together for exposure relevant NPs

Mesocosm kinetic tests (Long term, Low dose, High complexity)

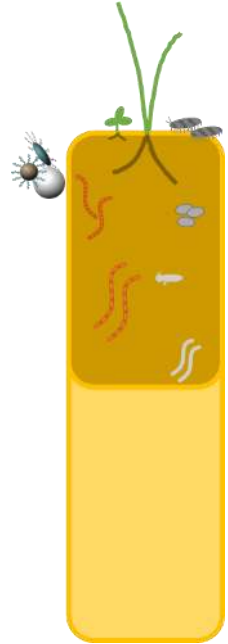
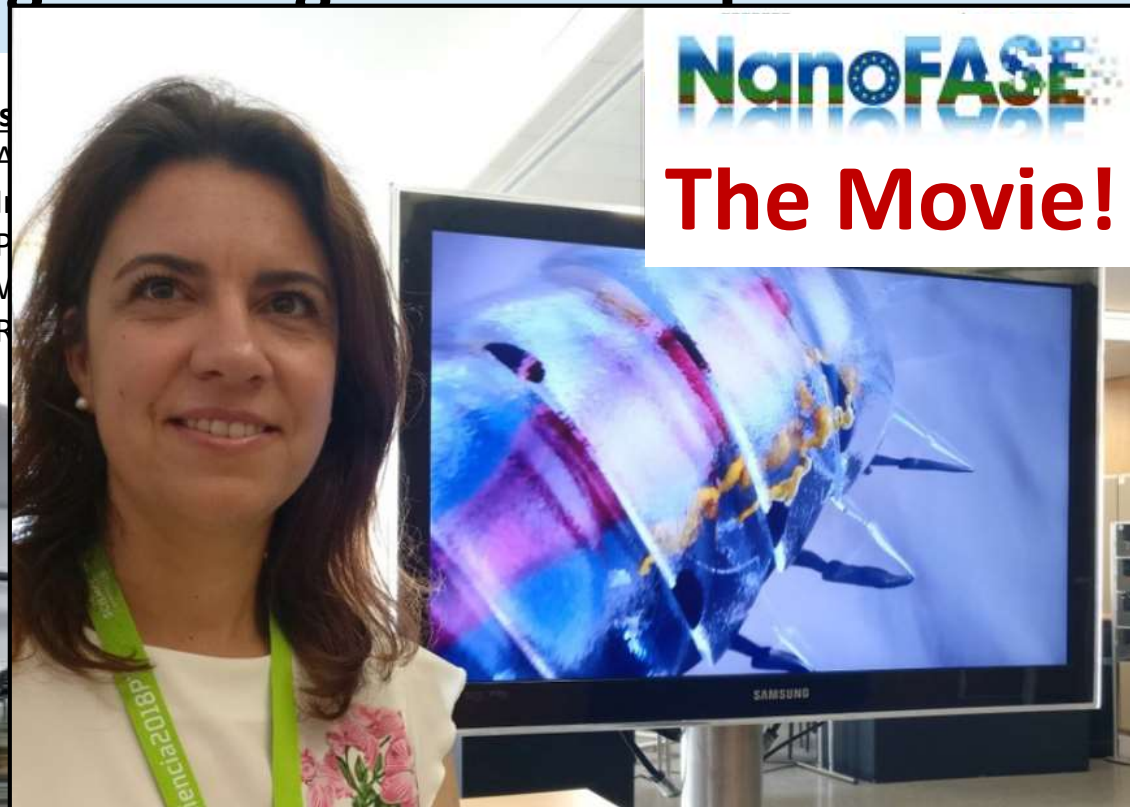
- Aquatic and terrestrial
- Include most species from earlier single species tests
- Performed in Aveiro (Portugal) Summer 2018
- Will validate the single species experiments
- Results to be expected early 2019.



Putting it all together for exposure relevant NPs

Mes

- A
- I
- P
- V
- R



“NanoFASE THE MOVIE!” is out – search “NanoFASE and Mesocosm”

Exposure - Nanomaterial fate in the environment:



Thank you! Onwards and upwards!