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School of Engineering
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Assessing health impacts of hazardous waste: the exposome paradigm

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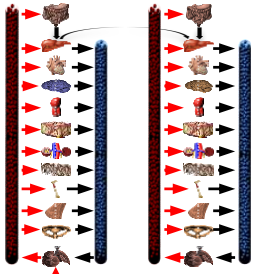
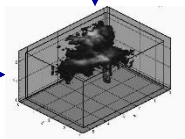
Connectivity-based workflow for exposome studies

Environmental sensors

Remote sensing

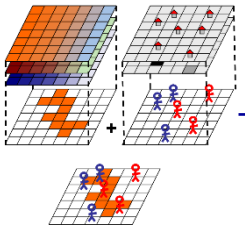
Exposure modelling





Environmental modeling / data management

Environmental analysis



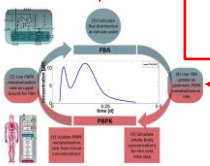
Agent based modelling

Ubiquitous personal sensors

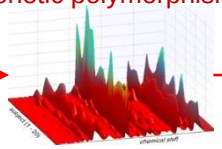
Human biosampling

Epigenetics

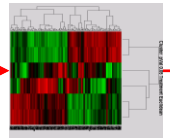
Genetic polymorphisms



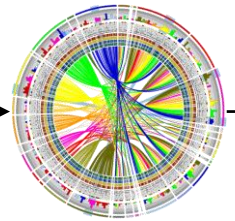
Fluxomics (dynamic flux balance analysis)



Metabolomics



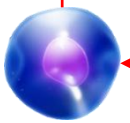
Transcriptomics



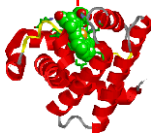
EWAS

Systems Effects / Individual exposome

Community Effects / Cohorts

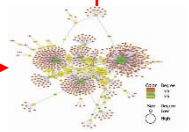


Cellular/tissue effects



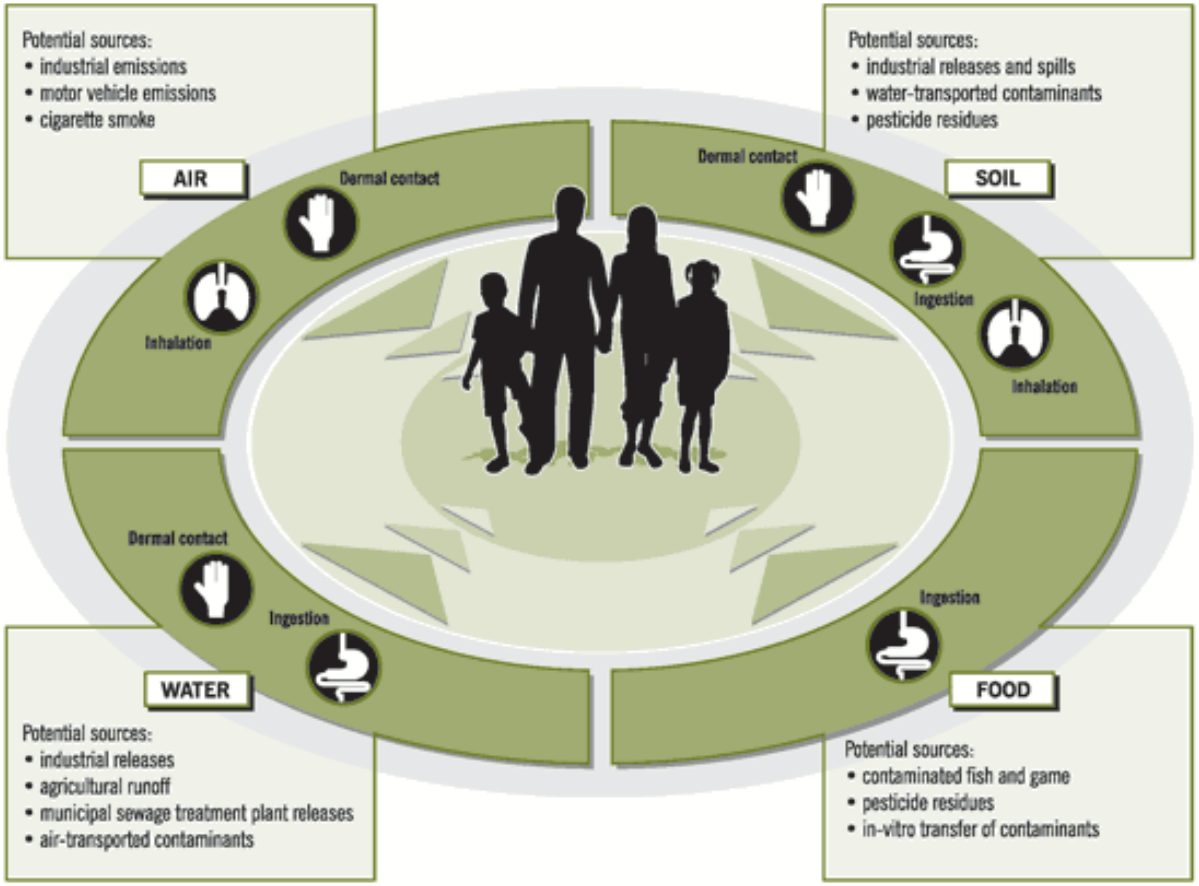
Molecular initiating events

Bioinformatics / systems biology

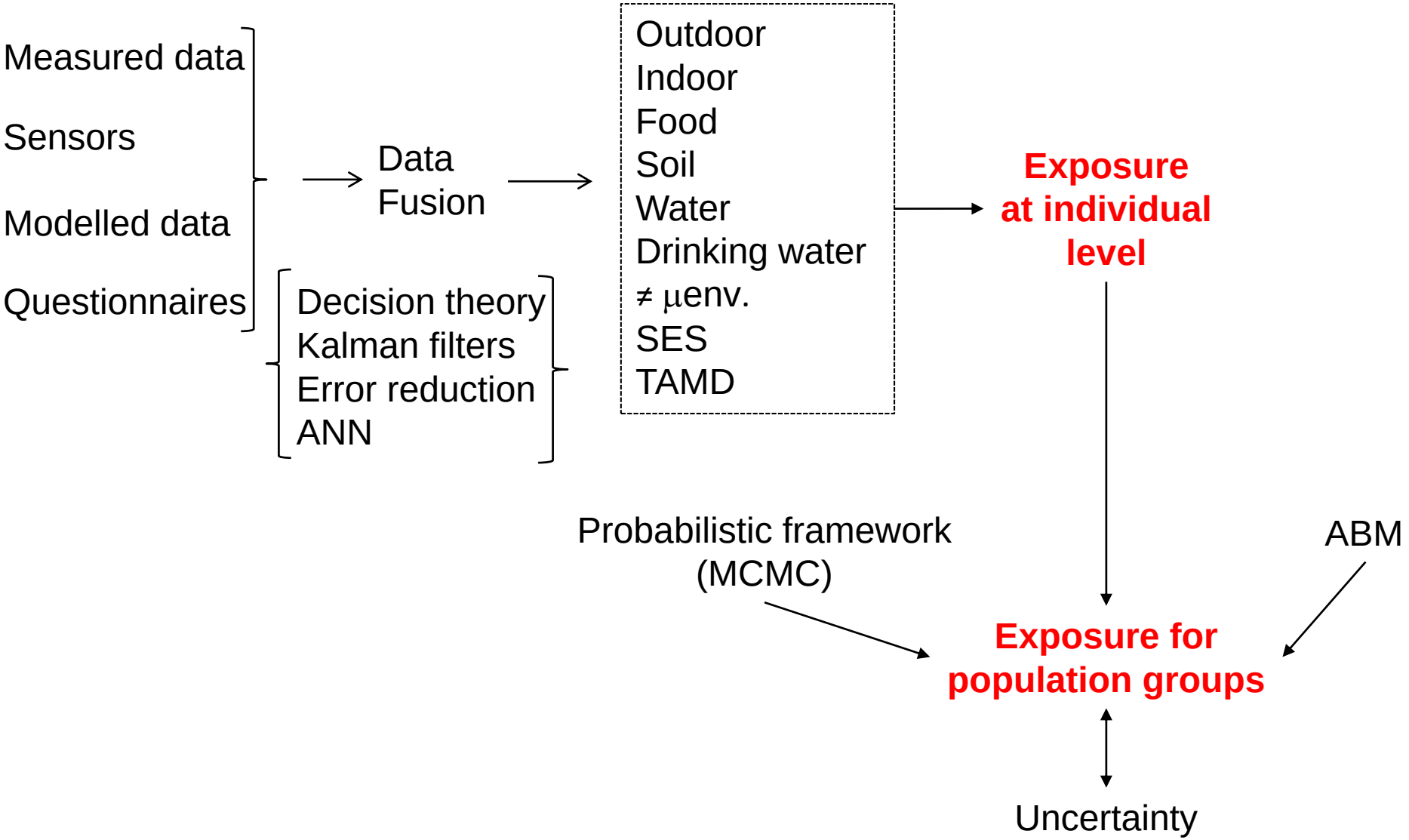


Pathway analysis

The external exposome



External Exposome workflow



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Pilot Campaign

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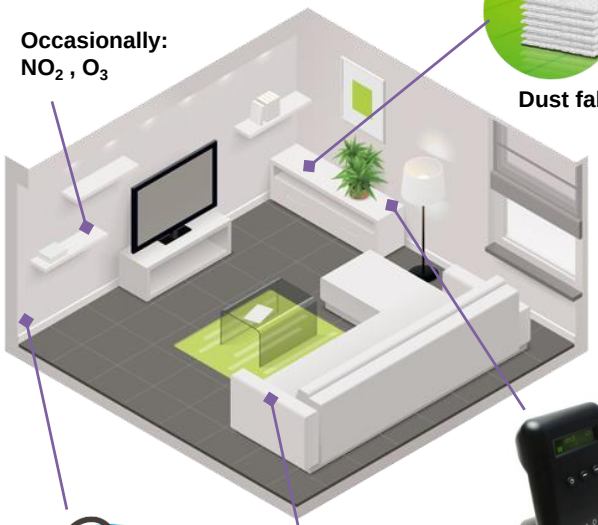
Occasionally:
NO_2 , O_3

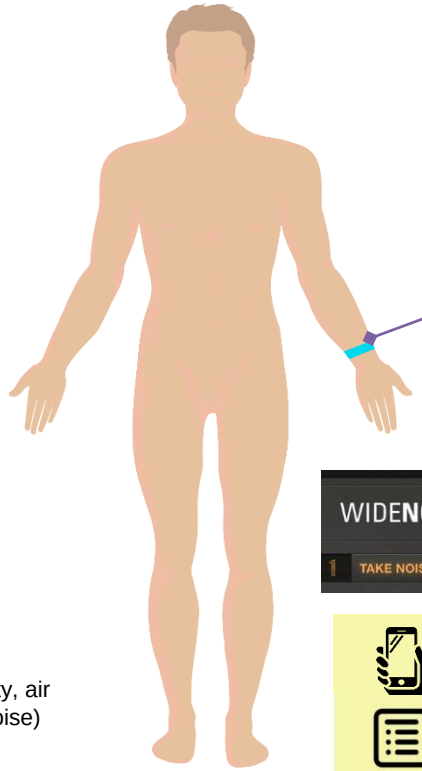


Dust fall

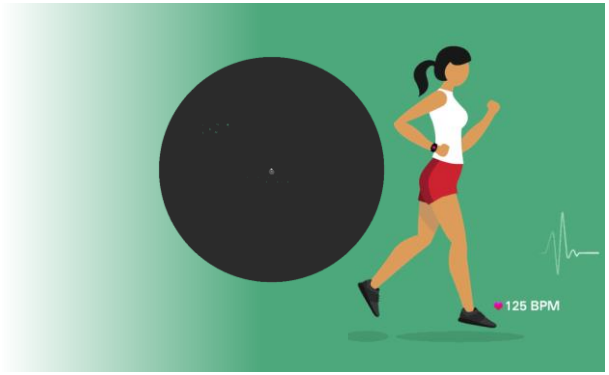
Dylos (PM)

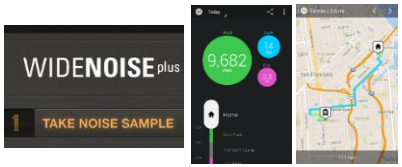
Vacuum Sample

Netatmo
(temperature, humidity, air pressure, CO_2 and noise)



Fitbit Flex



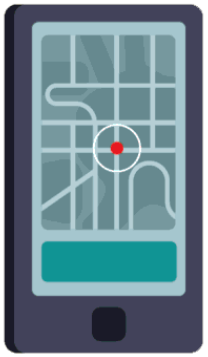


Smartphone apps

Paper Log & Questionnaires

ACTIVITIES

Sleep



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Personal Exposure Assessment

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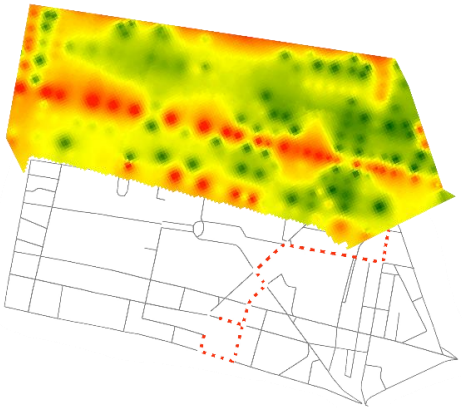
INPUT — SIMULATION — OUTPUT

Air Quality Data



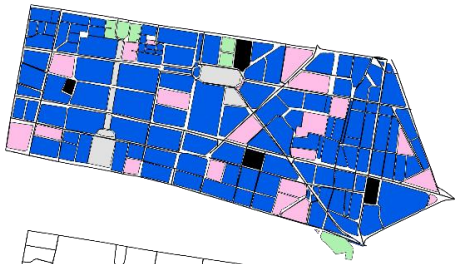
Personal Exposure

Human Agent Trajectories

Population Data

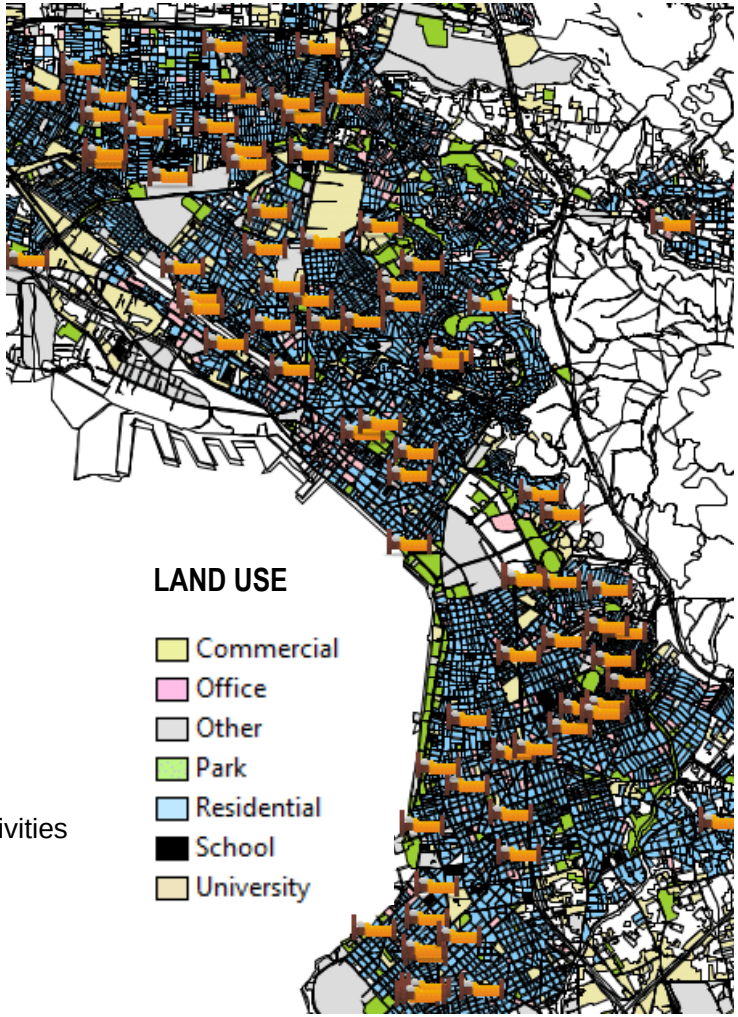
Agent Based Modelling

Buildings, Land Use



Road Network

ABM simulation preview



Thessaloniki, Greece

Waste types and pollutants

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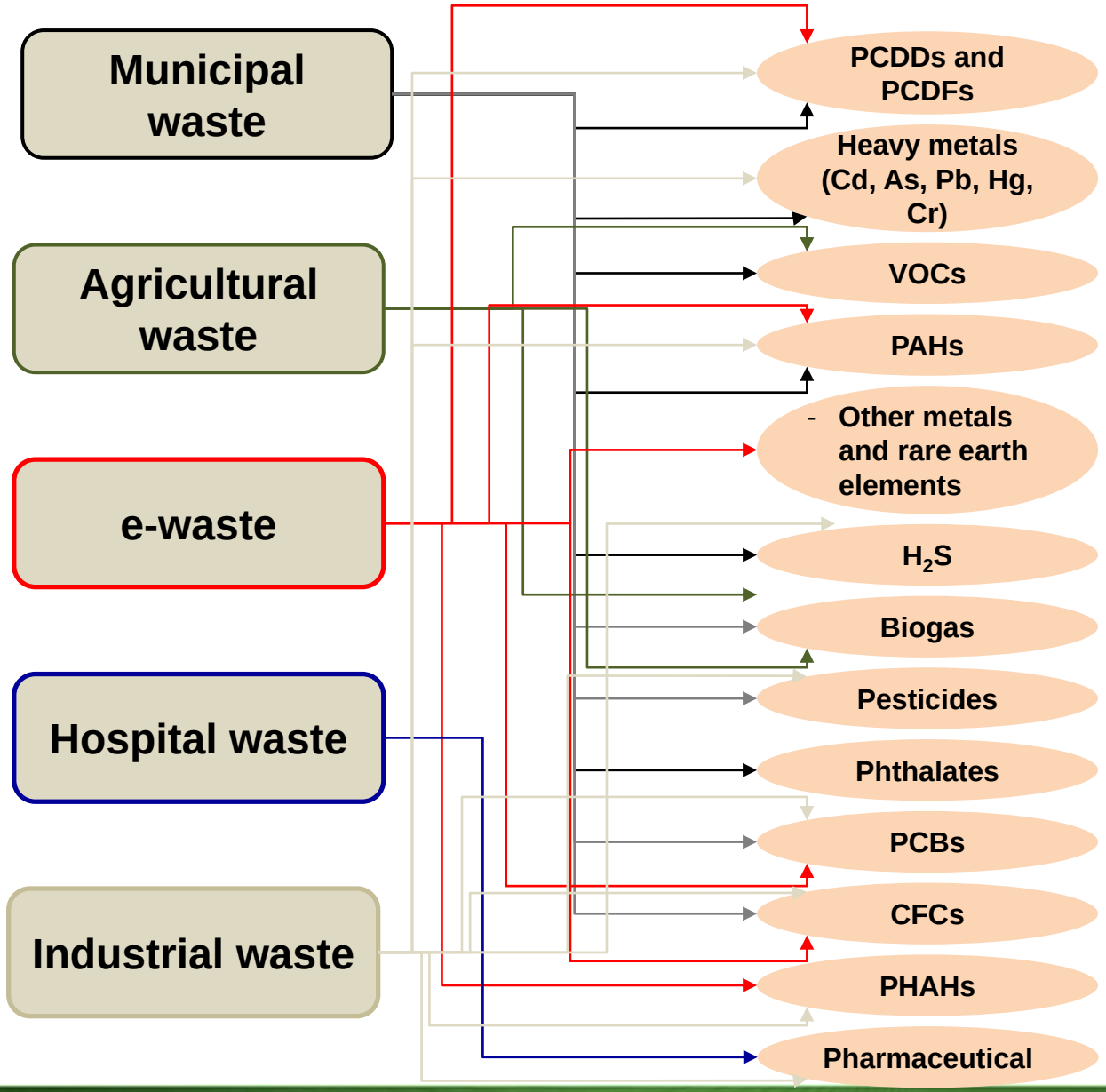

Environmental mobility and exposure pathways

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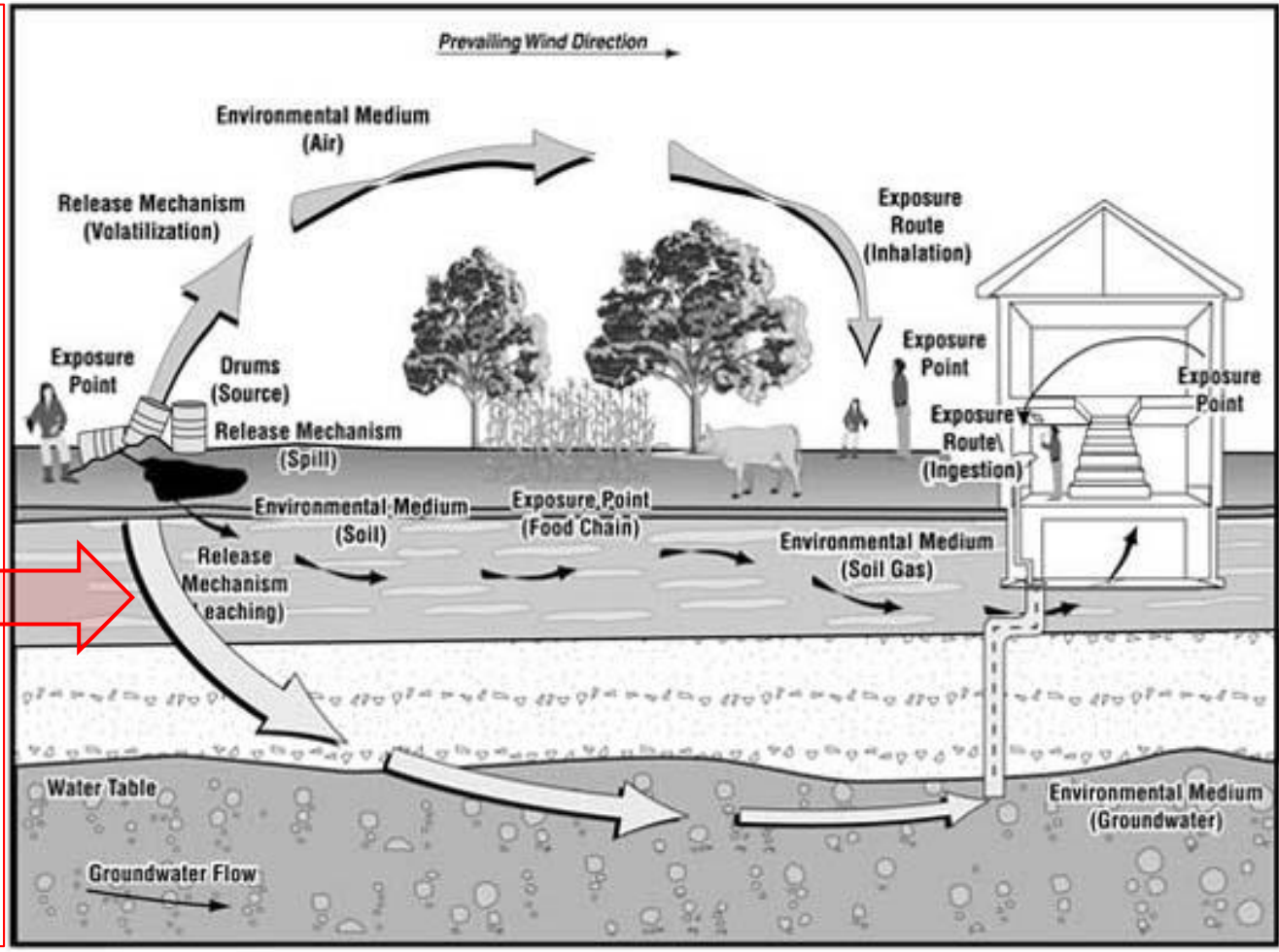
Leachate substances associated with health risks

- Aniline
- Fluoride
- organotin compounds
- Arsenic
- Mecoprop
- Pentachlorophenol
- Biphenyl
- methyl chlorophenoxy acetic acid
- Phenols
- Cyanide
- methyl tertiary butyl ether
- Phosphorus
- di(2-ethyl hexyl)phthalate
- Naphthalene
- Polycyclic aromatic hydrocarbons
- Dichloromethane
- Nitrogen
- Toluene
- Ethylbenzene
- Nonylphenol
- xylenes



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Multiple scale interactions of environmental modelling

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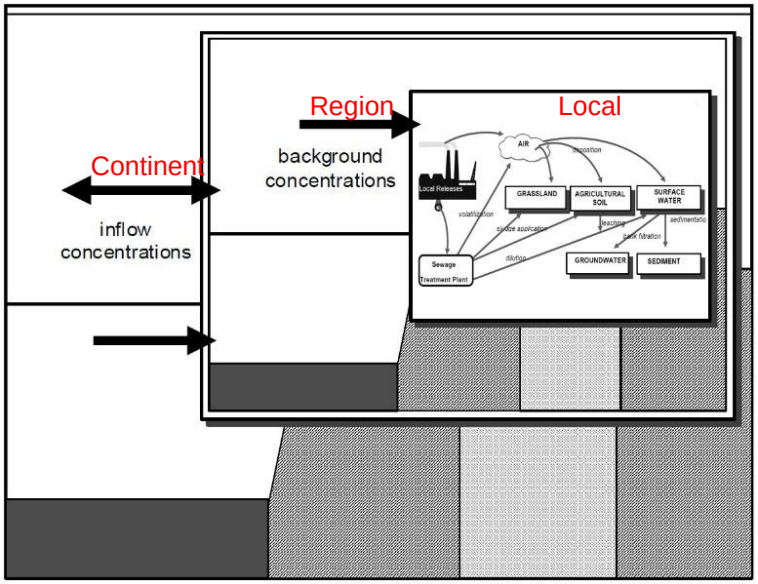
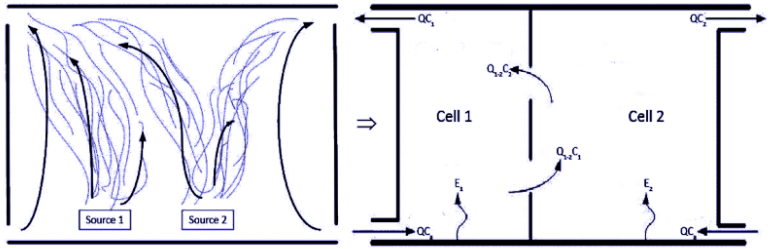
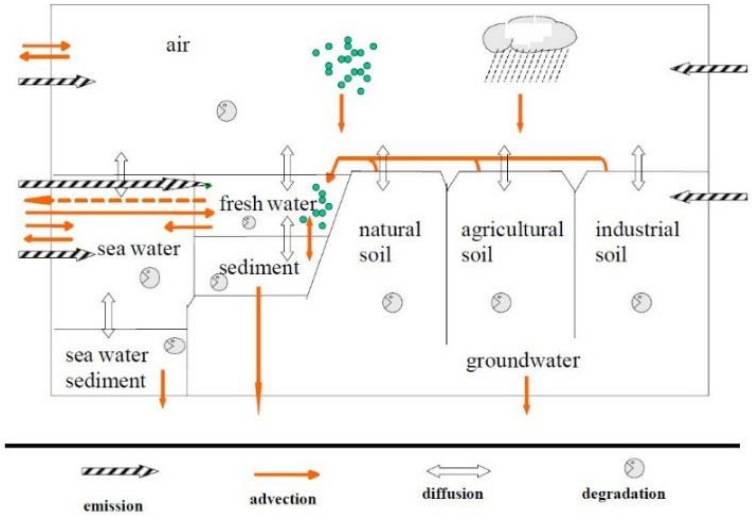


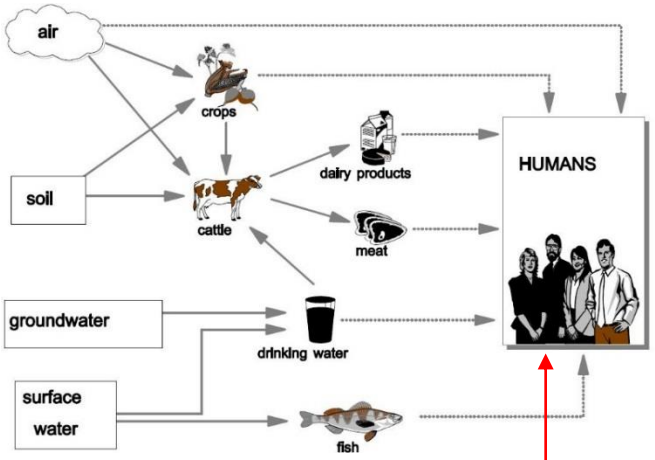
Microenvironment



Detailed micro-environmental concentrations taking into account interactions among different media (gas, particles and dust)

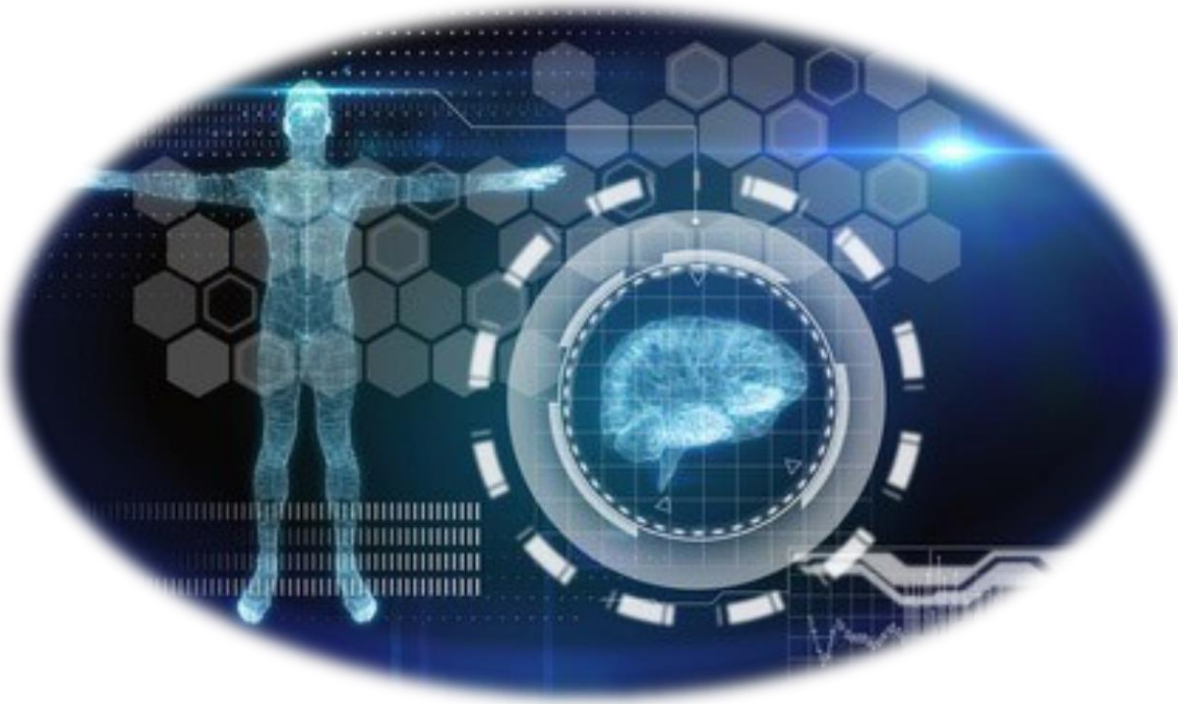


Detailed exposure modelling taking into account multiple pathways and routes of exposure



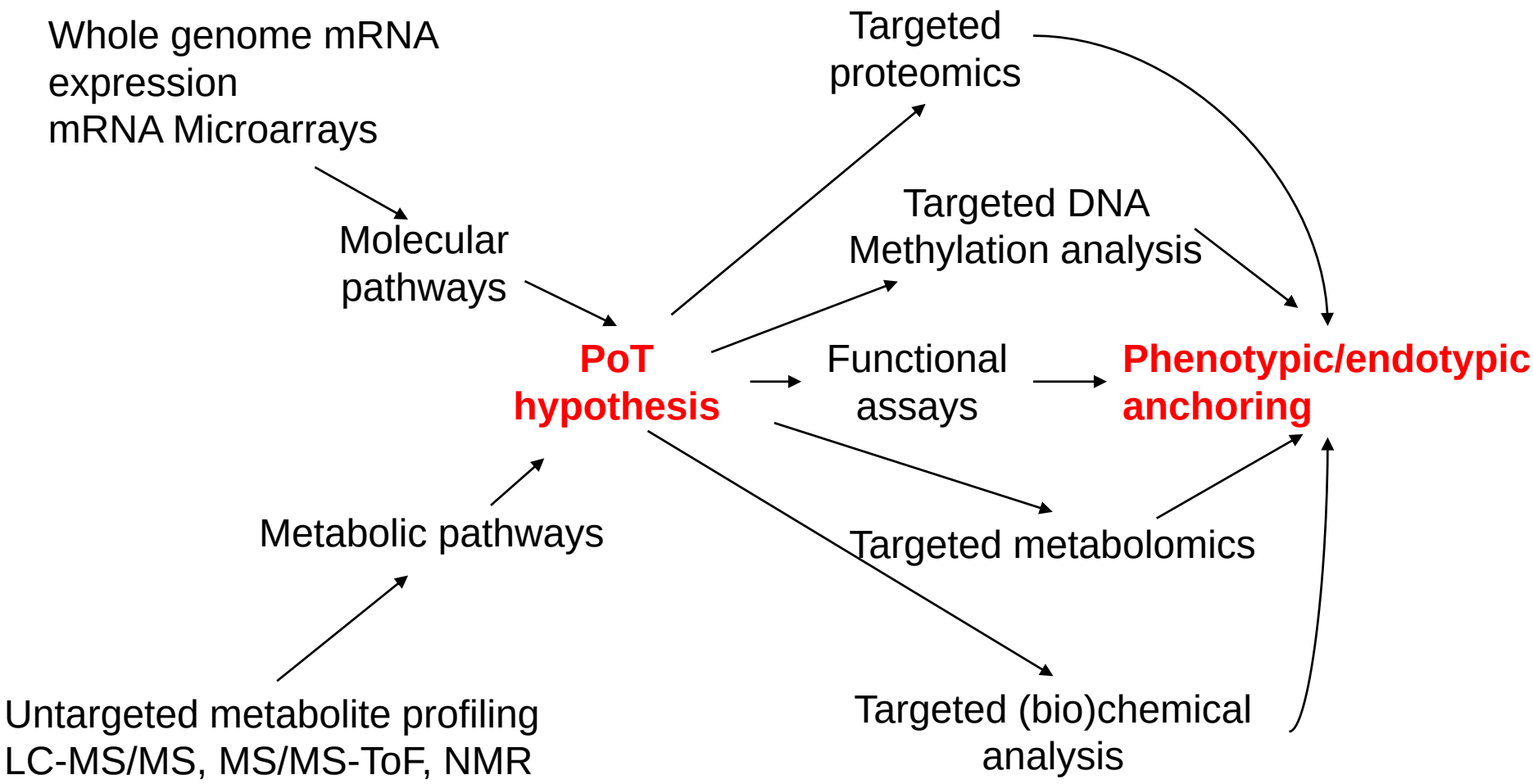
Consumer products

The internal exposome



Exposure biology workflow

Rendering high dimension biology operational



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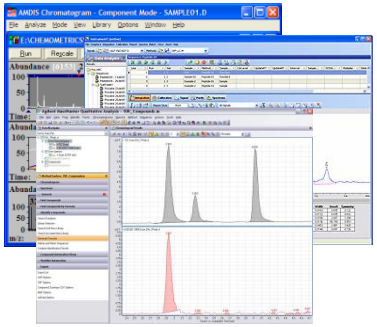
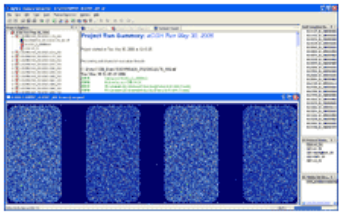
Exposure biology workflow

LC-MS/MS
GC-MS/MS



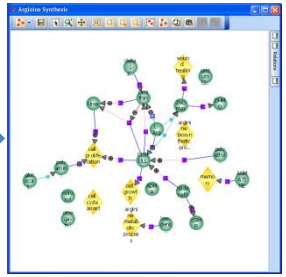
MassHunter Qual/Quant
ChemStation AMDIS

Microarrays



Feature Extraction

GeneSpring Platform



Biological Pathways

NGS

Alignment to Reference Genome

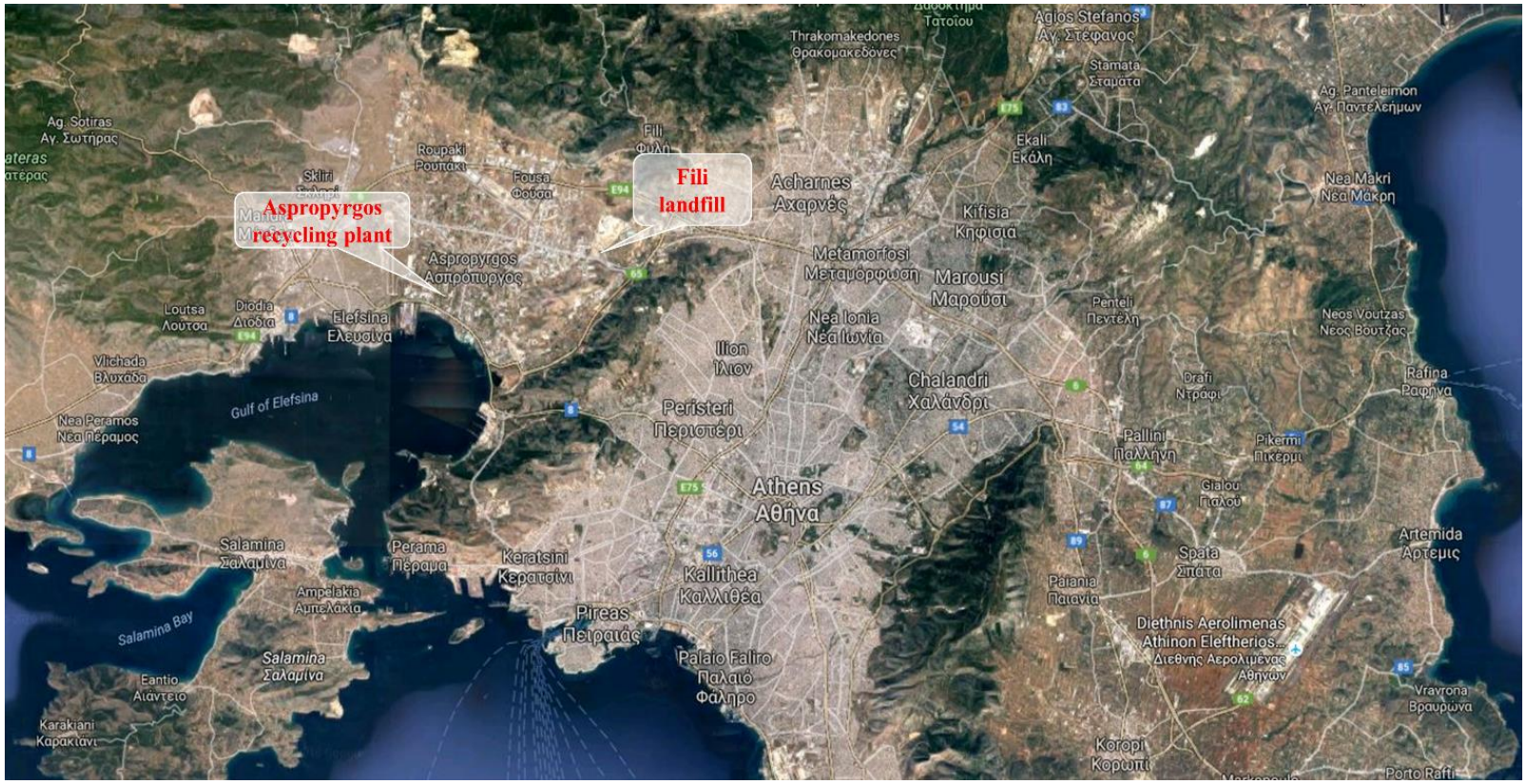
Methodological transition facilitated by exposome

Congenital anomalies → RR 1.01 - 1.08 for various defects (2 km from landfills)

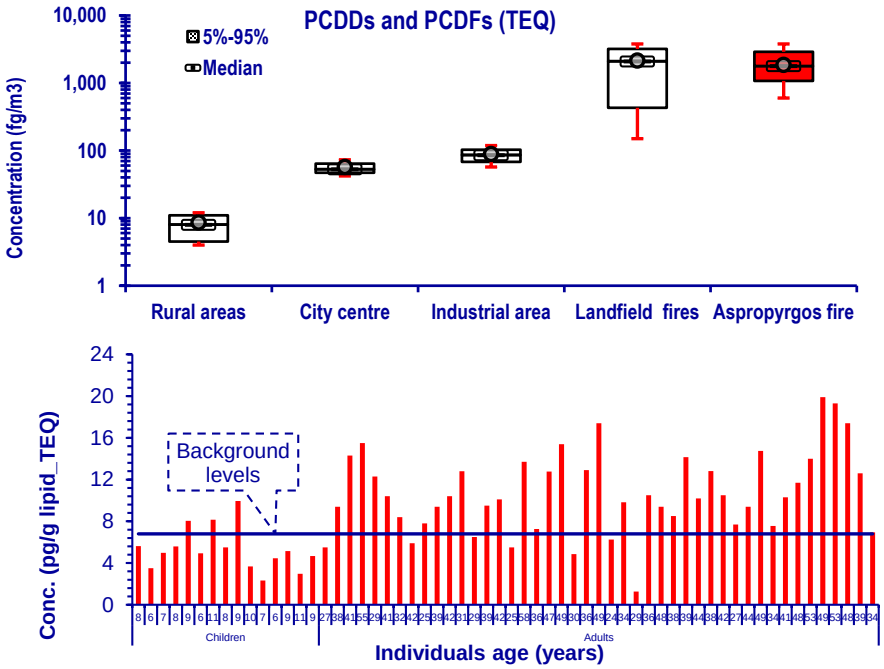
Cancer risk → RR 1.035 for all cancer types (3 km from incinerators)

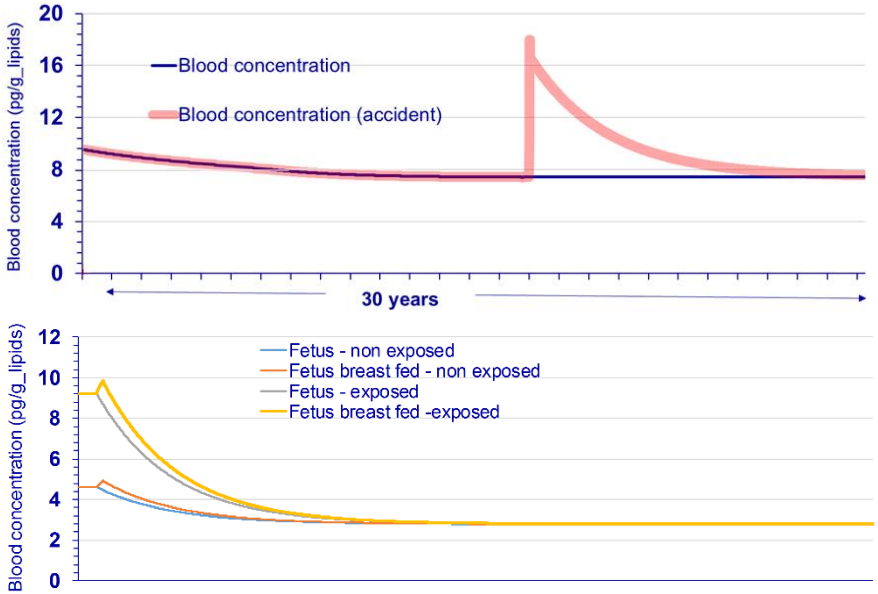
- Which compounds are associated to each endpoint?
- How we can refine exposure to these compounds related to waste disposition?
  - *Improved exposure modelling*
  - *Assimilation of biomonitoring data*
- How to improve health associations and identify causalities
  - *Identification of molecular markers of exposure and effect*

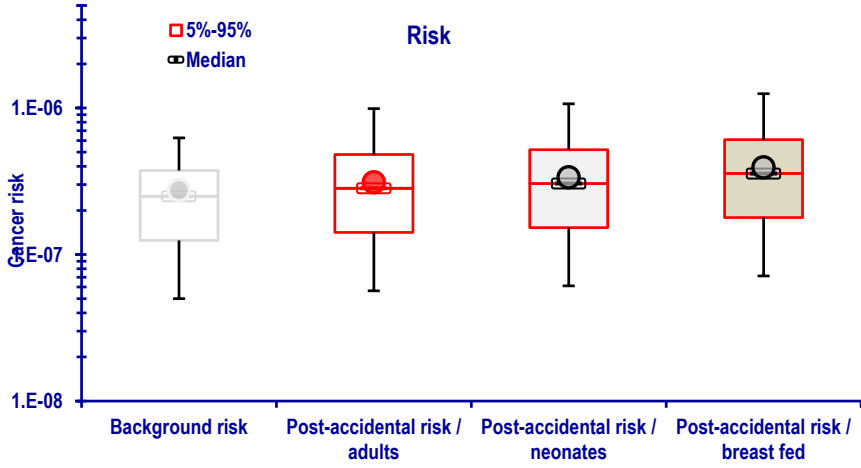
Waste management in Athens



Acute exposure to waste hazards
Cancerogenicity







Metabolomics and pathway analysis

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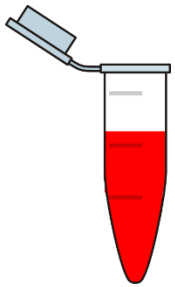
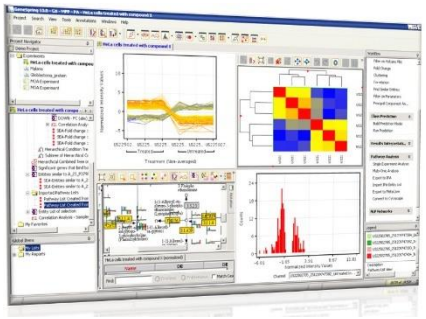
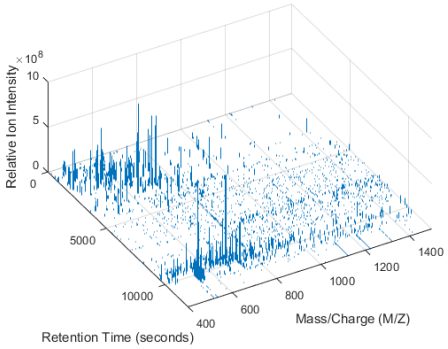
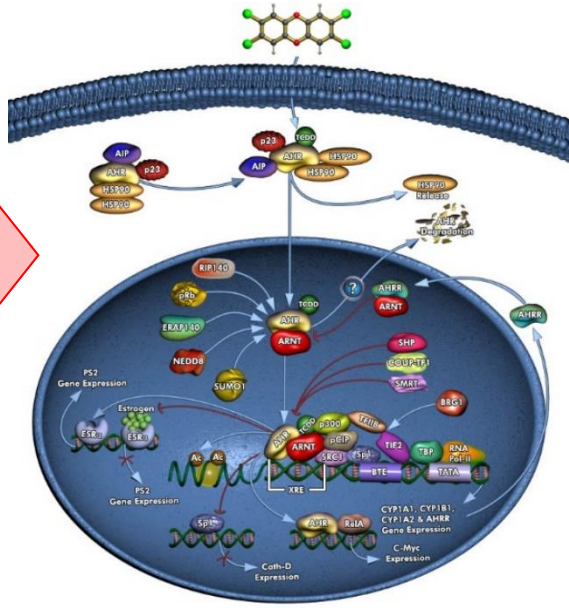


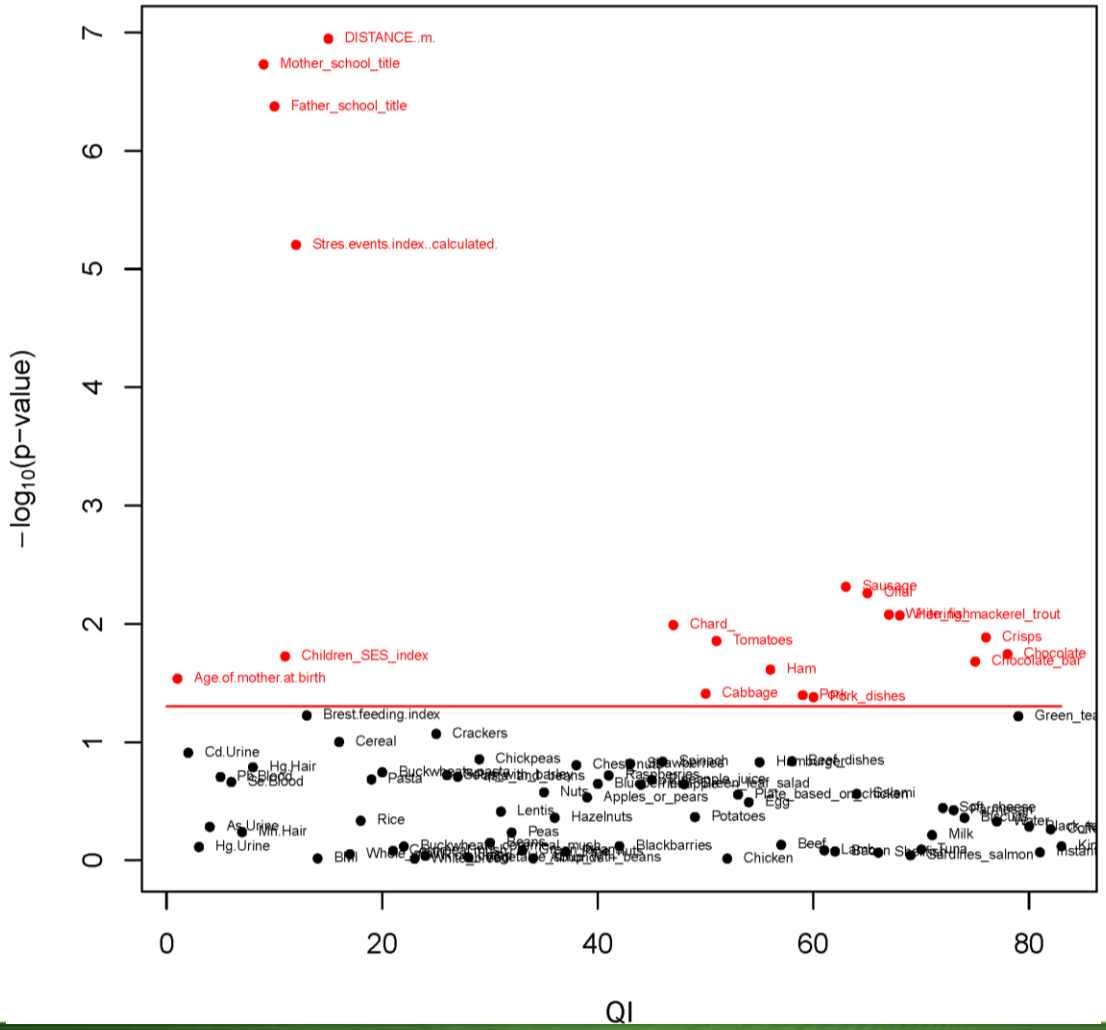




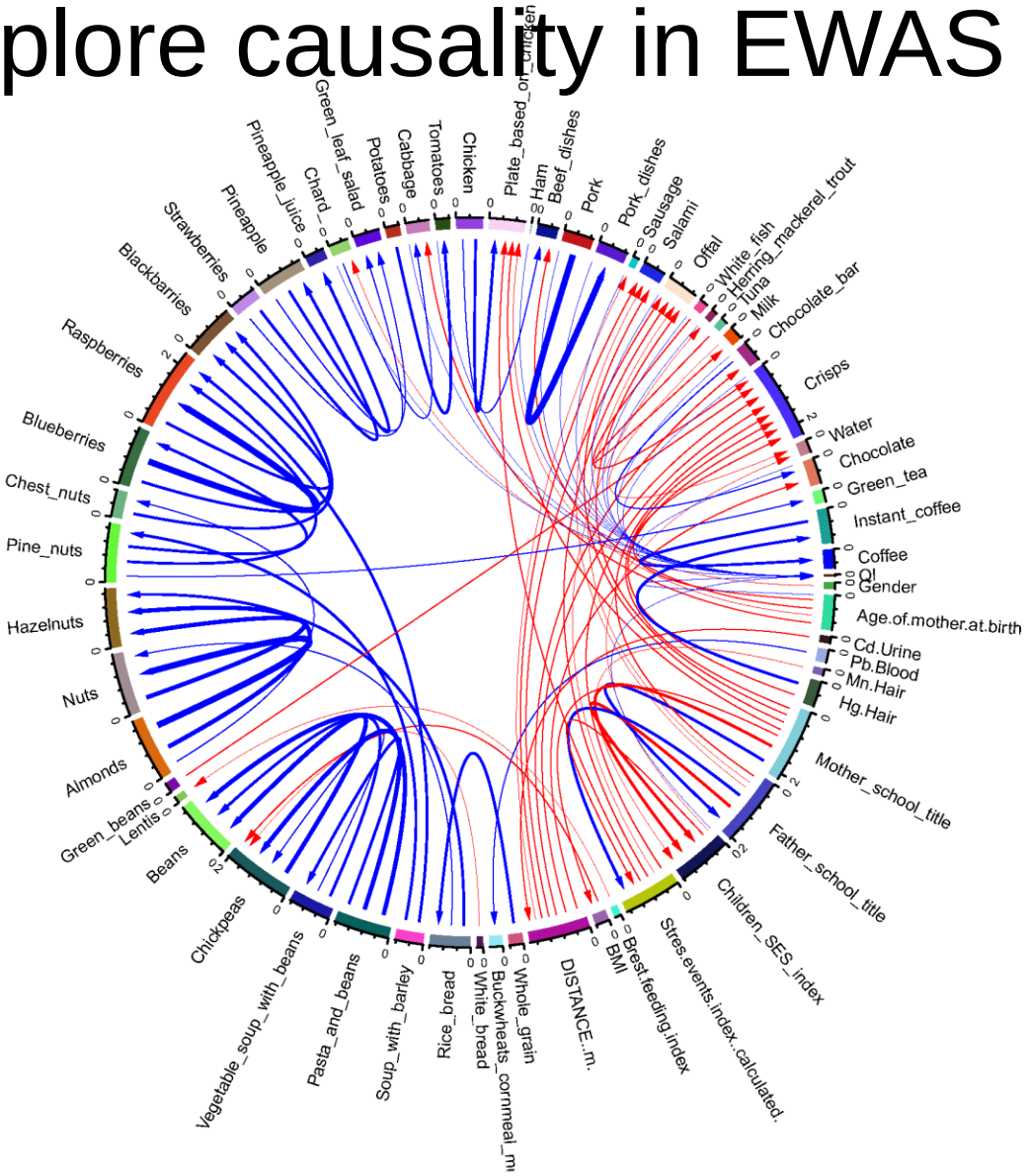


Increased levels of unsaturated vs saturated fatty acids, compared to controls → cholesterol homeostasis perturbation → **AhR deregulation**

Chronic exposure to waste hazards
Neurodevelopmental toxicity



Explore causality in EWAS



Conclusions

- Exposome science can overhaul the current environmental health risk assessment paradigm. This requires combination of high dimensional biology and system science aiming at integration using big data analytics and bioinformatics
- The connectivity approach to the exposome elucidates toxicity pathways and assigns causal associations between environmental stressors and health
- Precise prevention towards environmental risks by identifying the susceptible or vulnerable individuals or age-groups

Bertold Brecht's *Life of Galileo*:
"*The main objective of science is not to open the door to infinite wisdom but to roll back the boundaries of infinite error*"

www.enve-lab.eu

A connectivity perspective to environmental health