Using RI to investigate and document the impacts of the environment on human health

Session 15 | Great room 2 | 2.00-2.55PM

Dr Gary Miller

Vice Dean for Research Strategy and Innovation at the Mailman School of Public Health of Columbia University

Jana Klánová

Director of RECETOX, the European Centre of Excellence in Environmental Health Sciences

Jochen Mueller

Professor at University of Queensland

Carthage Smith

Head of the OECD Global Science Forum (GSF)

Charlotte Roehn

Acting Deputy Division Director for the Division of Biological Infrastructure at the US National Science Foundation (NSF)

Jan Hrušák

Senior Research Fellow at the J. Heyrovsky Institute of Physical Chemistry of the Czech Academy of Sciences

Using RI to investigate and document the impacts of the environment on human health

Moderator

Gary Miller

Vice Dean for Research Strategy and Innovation, Columbia University Mailman School of Public Health

Panelist

Carthage Smith

Policy Analyst, OECD

Panelist

Jana Klanova

Director of RECETOX, RECETOX MUNI, EIRENE

Panelist

Charlotte Roehm

Program Director, National Science Foundation (NSF) USA

Panelist

Jochen Mueller

Professor, University of Queensland

Panelist

Jan Hrušák

Executive Board Member, ESFRI

ICRI 2024

International Conference on Research Infrastructures

3-5 December 2024

Brisbane, Australia

icri2024.au

Exposome: the integrated compilation of the physical, chemical, biological, and psychosocial influences on biology and health*

The exposome is the environmental complement to the genome

genes x environment = phenotype

The **exposome** provides the platform to integrate the full spectrum of environmental exposures into health. This can provide actionable information to prevent and diagnose disease, develop therapeutic approaches, and drive policy. Its importance to human health demands infrastructure investment.

CSH Cold Spring Harbor Laboratory

THE BANBURY CENTER
Cold Spring Harbor Laboratory

The Banbury Center is pleased to confirm your invitation to participate in a meeting:

Integrating Exposomics into the Biomedical Enterprise

The exposome and health: Where chemistry meets biology

Roel Vermeulen[1,2]*, Emma L. Schymanski[3], Albert-László Barabási[4,5,6], Gary W. Miller[7]*

EXPOSOME

Neurotoxic mixture effects of chemicals extracted from blood of pregnant women

Georg Braun[1], Gunda Herberth[2], Martin Krauss[3], Maria König[1], Niklas Wojtysiak[1], Ana C. Zenclussen[2,4,5], Beate I. Escher[1,5,6]*

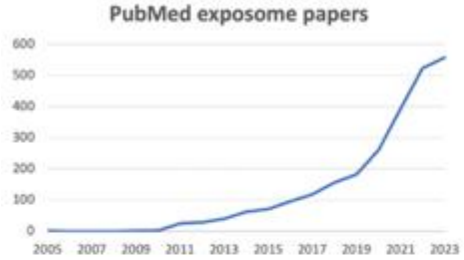
Exposome Moonshot Project at Johns Hopkins 2025

NEWS EVENTS

Will it take a moonshot to characterize and map the human exposome? Join the Exposome Moonshot Forum to have your say, May 12-15, 2025!

Exposomics Meets Genomics

A brief history of the exposome and exposomics



EU Exposome 3 projects

exposomics HEALS HELIX BUILDING THE EARLY-LIFE EXPOSOME JECS

Japan study

Human exposome Project website

HERCULES Exposome Research Center

1st NIH center

NATIONAL ACADEMY OF Sciences

Exposome Workshop

EU Human Exposome Network 9 projects

European Commission

NIH CHEAR HHEAR

NIH

NIEHS workshop exposome series

DECODING THE MOLECULAR UNIVERSE m/q INITIATIVE

NIH

MOHD

THE BANBURY CENTER Cold Spring Harbor Laboratory

Banbury-CSHL

EIRENE RI

IHEN

CANCER GRAND CHALLENGES

Vermeulen et al. Science

2005 2010 2015 2020 2024

The Exposome à la Chris Wild

Editorial

Complementing the Genome with an "Exposome": The Outstanding Challenge of Environmental Exposure Measurement in Molecular Epidemiology

Christopher Paul Wild

The Exposome Rappaport + Smith

Patel…Butte 1st EWAS

1st book

@exposome on social media

Institute and NYC symposium

Icahn School of Medicine at Mount Sinai

Miller 2nd Edition

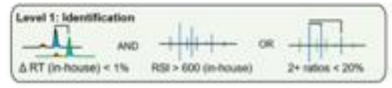
1st journal founded

Columbia Center for Innovative Exposomics

NEXUS Network for Exposomics in the U.S.

?

EXPOSOME THERAPEUTICS INC.



GC-orbitrap exposomics user group

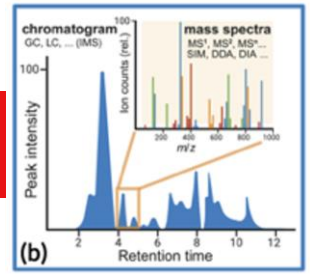
NEXUS Hubs

NEXUS
Network of Exposomics in the US

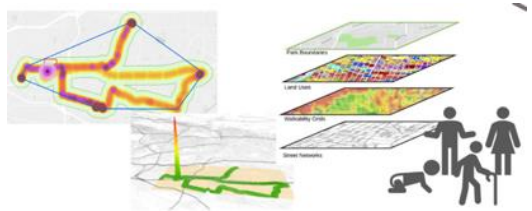
1. **Administrative/Stakeholder Engagement Hub** (Miller, Singh, Wu, Thualt-Restituito).

2. **Analytical Sciences Hub** (Metz, Pollitt). Yale, PNNL/DOE

ThermoFisher SCIENTIFIC



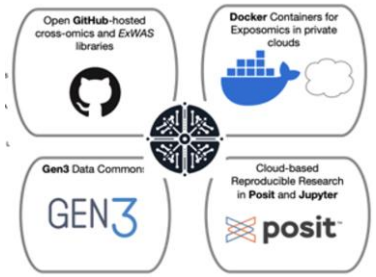
3. **Geospatial Sciences Hub** (Habre, Rajasekar). USC, UNC



esri

aws

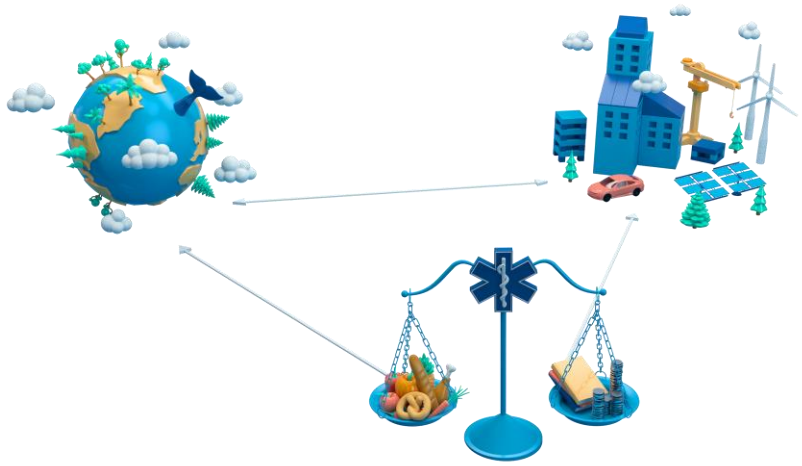
4. **Data Sciences Hub** (Patel, Sirota). Harvard, UCSF



Funded by NIH (NIEHS, NIA, NCI, NIAMS, NINDS, ORWH; funding started Sept, 2024)

https://www.nexus-exposomics.org/

EIRENE RI



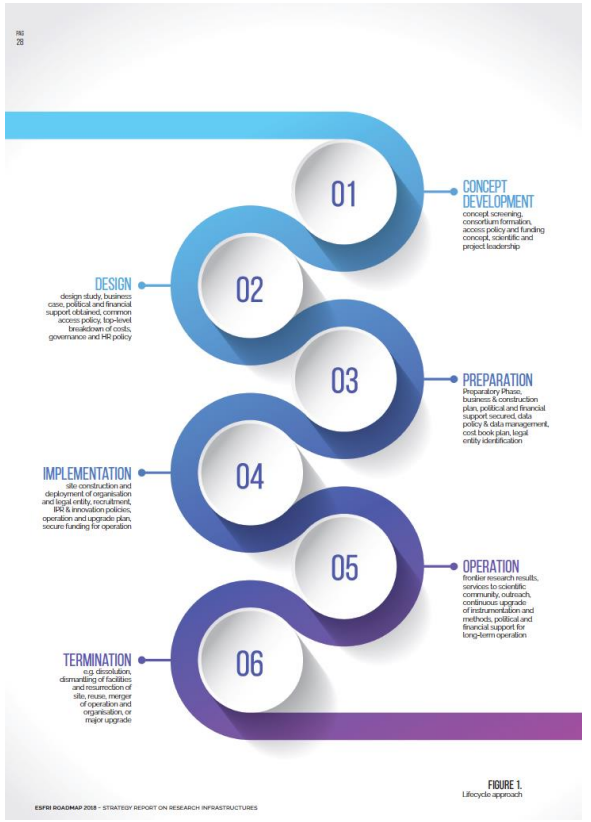
SETTING UP AN INFRASTRUCTURAL LANDSCAPE FOR HUMAN EXPOSOME RESEARCH

Jana Klánová on behalf of the EIRENE Consortium

Gap in the 2018 ESFRI Roadmap

„There is a need to enable a research infrastructure that will facilitate research on the human health and wellbeing at all stages in development, including ageing, nutrition and behavioural studies, and their connections to the social sciences and humanities. There are ***geographic, economic and environmental drivers affecting human health and wellbeing. Climate change, extreme weather, dramatic changes in ecosystem services, environmental pollution and exposure to harmful chemicals*** *represent a new combination of issues that* ***require an integrated approach at pan-European level.***

At the heart of this approach is the ***EXPOSOME****, taking* ***a holistic view throughout the human lifetime on the effect of exposures to diet, lifestyle, and the environment on human health and disease****. The EXPOSOME coupled with advanced genetic and medical approaches represents an opportunity to tackle this complex issue by connecting to the landscape of Health & Food RIs and other domains. Ongoing EU projects and networks on human biomonitoring (HBM4EU and EMEP) are important steps to bring together relevant parties."*



EIRENE RI

EIRENE RI: Prioritised in the 2021 ESFRI Roadmap

EIRENE RI

Research Infrastructure for EnvIRonmental Exposure assessmeNt in Europe

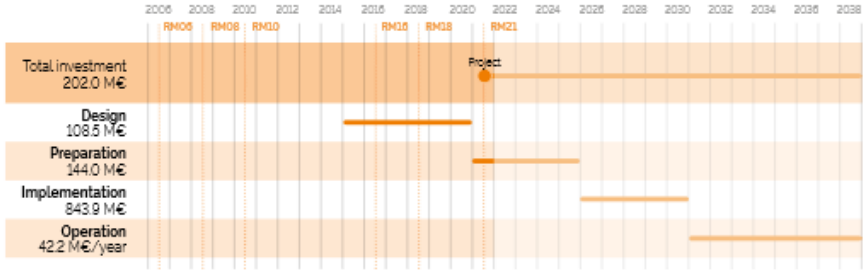
Website	Headquarters	Legal status	Type
pending	Masaryk University Brno, Czech Republic	pending	distributed

DESCRIPTION

The Research Infrastructure for EnvIRonmental Exposure assessmeNt in Europe (EIRENE RI) pioneers the first European Research Infrastructure on environmental determinants of human health, the Human Exposome. EIRENE RI intends to support large-scale research for the interdisciplinary assessment of environmental determinants of health, including indoor and outdoor environment factors, lifestyle, socioeconomics, and the individual's ability to cope with various stressors such as infection or disease. EIRENE RI will provide harmonised workflows and integrated services for data and sample collection, as well as knowledge and tools that will be made accessible to academic researchers, private companies, public authorities and citizens through the EIRENE open-access system and the EIRENE knowledge hub.

The concept of a pan-European Infrastructure supporting research on the effects of long-term exposures to various types of stressors on population health and the roles these exposures play in the development of chronic diseases is based on ten-year experience of Czech national RECETOX RI. Entered in the ESFRI Roadmap 2021, EIRENE RI already connects 50 research institutions from 17 countries. It builds on the legacy of the European environmental monitoring networks and their databases (EMEP, GMP, GMOS), GEO Initiatives (GOS4POP and GOS4M) and related H2020 projects (ERA PLANET, e-SHAPE), EU biomonitoring initiatives (DEMOCOPHES, HBM4EU), UNEP/WHO global biomonitoring efforts, EU exposome (HELIX, EXPOSOMICS, HEALS and EHEN cluster) and other related projects (HERA, EURION cluster).

TIMELINE & ESTIMATED COSTS



INTERCONNECTIONS

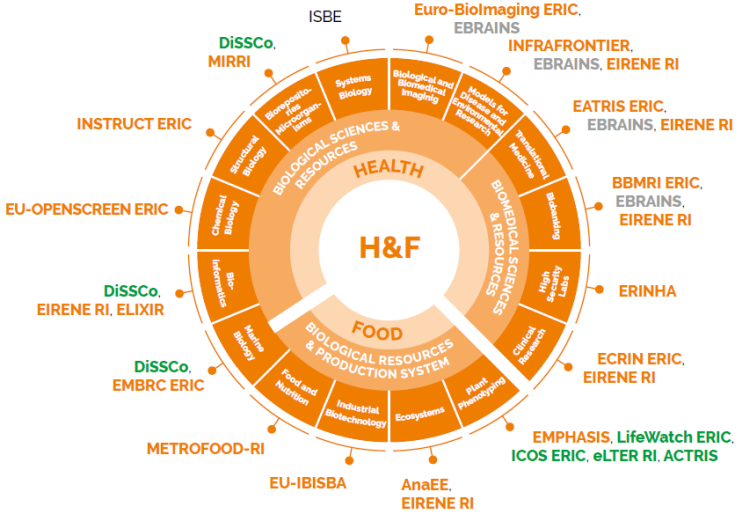
POLITICAL SUPPORT

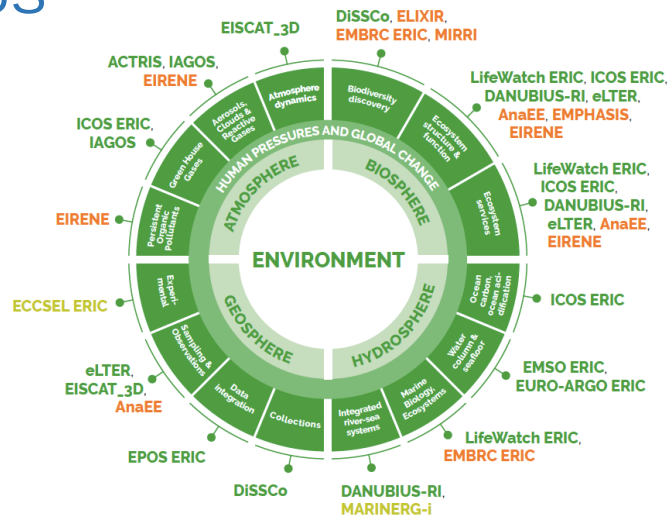
Lead
CZ

Prospective member
AT, BE, DE, EL, ES, IS, IT, NL, SK

Member states

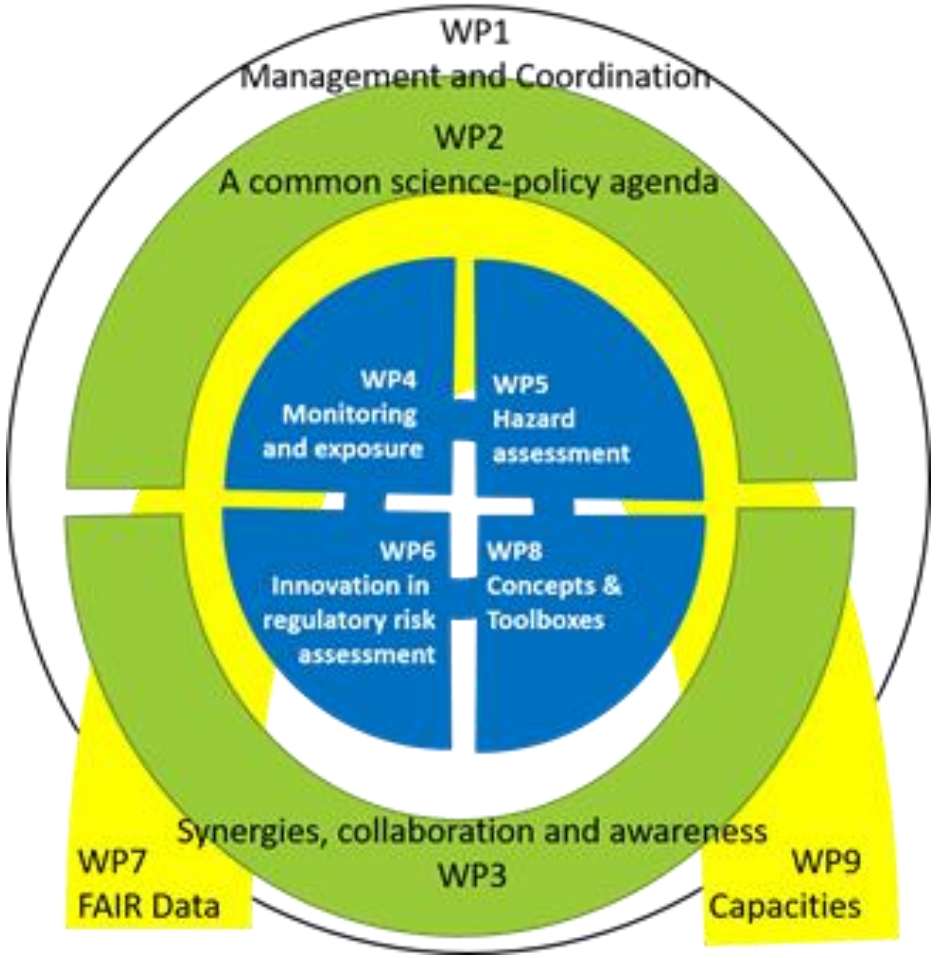
- Austria, Belgium, Czechia, France, Italy, Netherlands
- Germany, Greece, Island, Slovakia
- Norway, Sweden
- Finland, Slovenia, Spain, UK, US
- Cyprus, Denmark, LX, Portugal

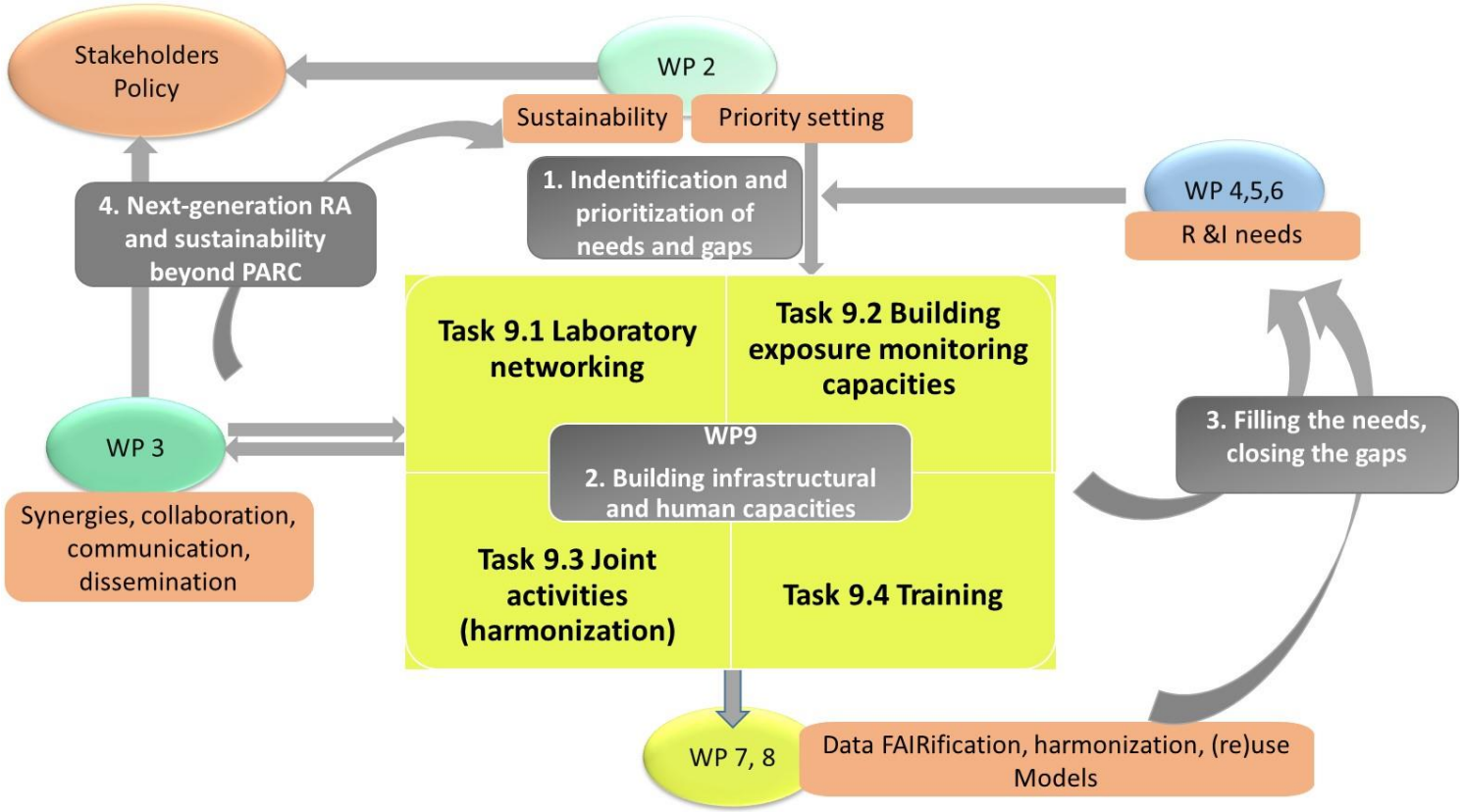




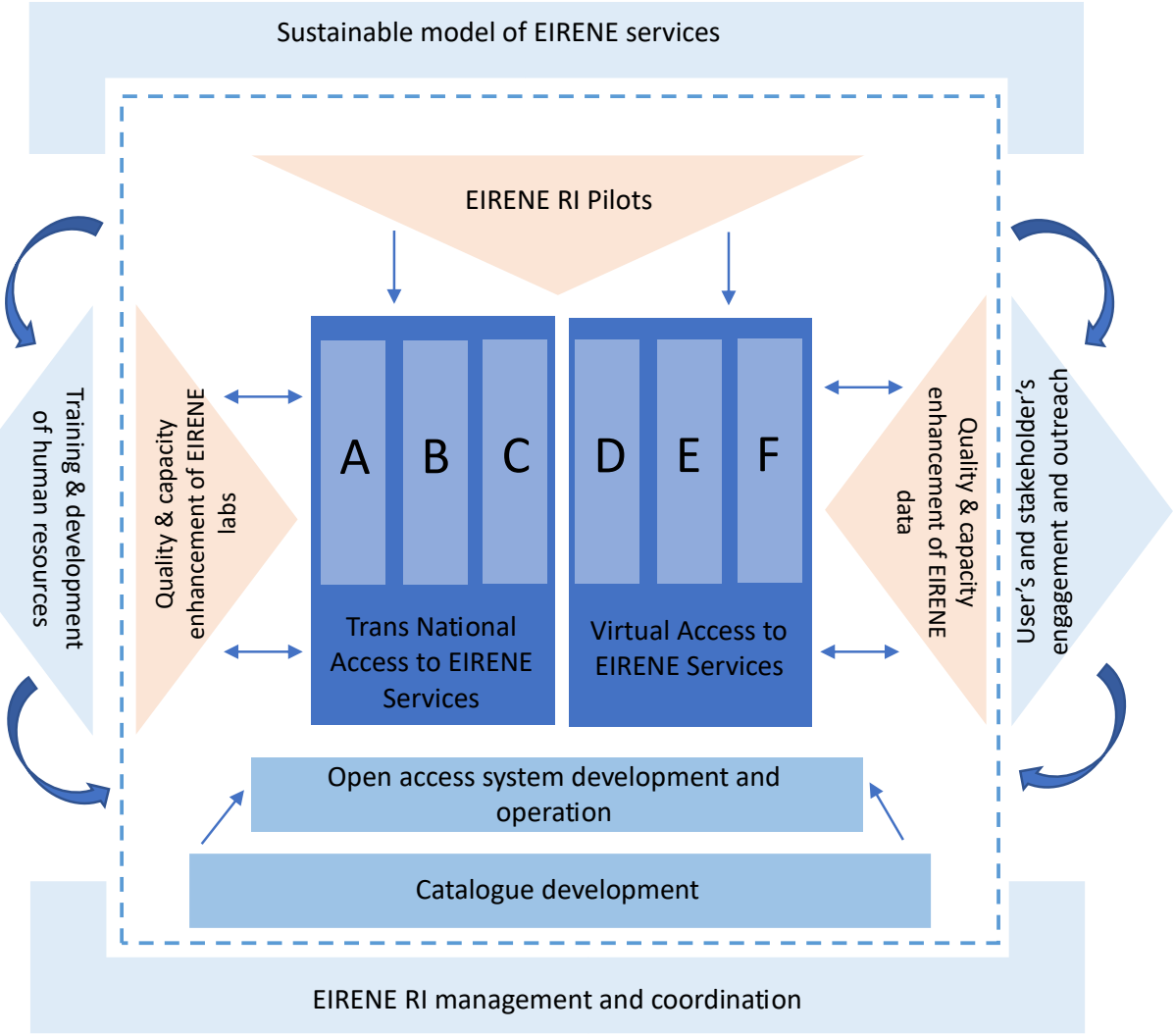
EIRENE RI

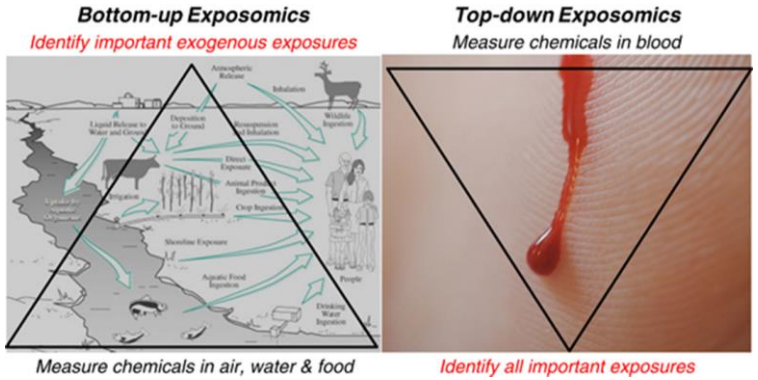
Building infrastructural and human capacities in PARC





EIRENE services



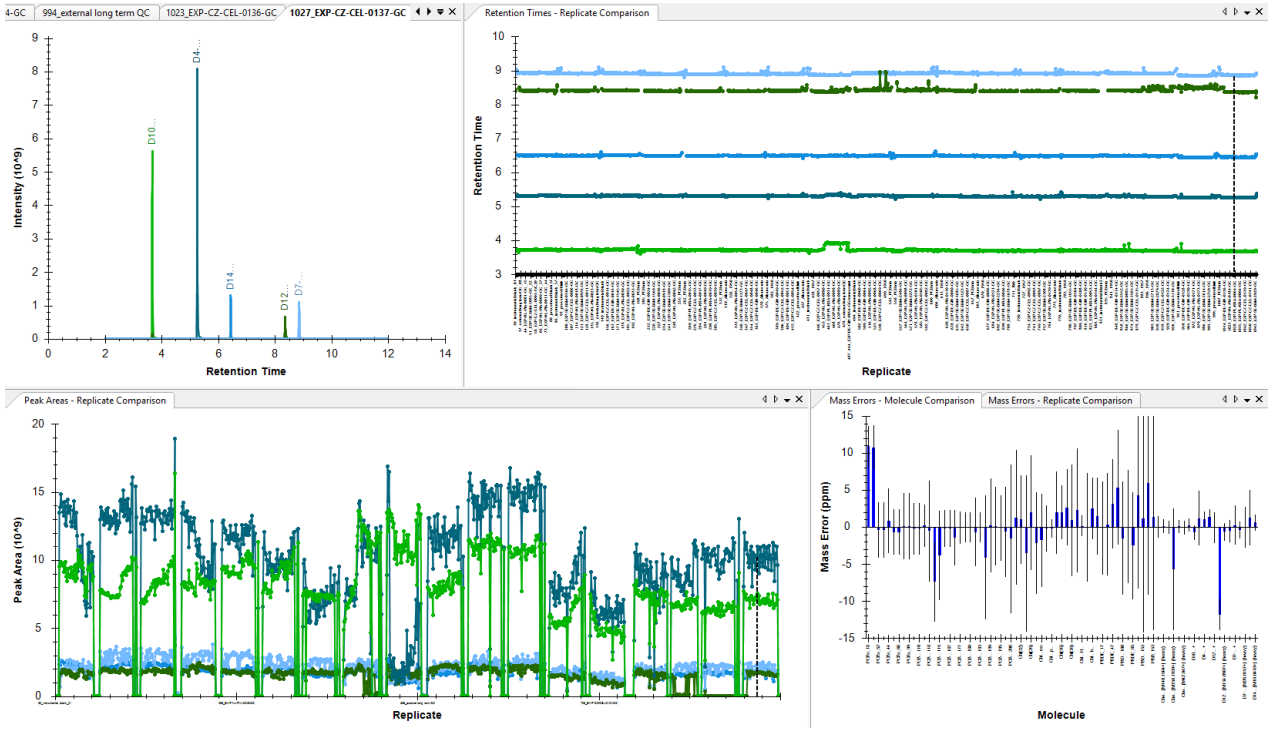


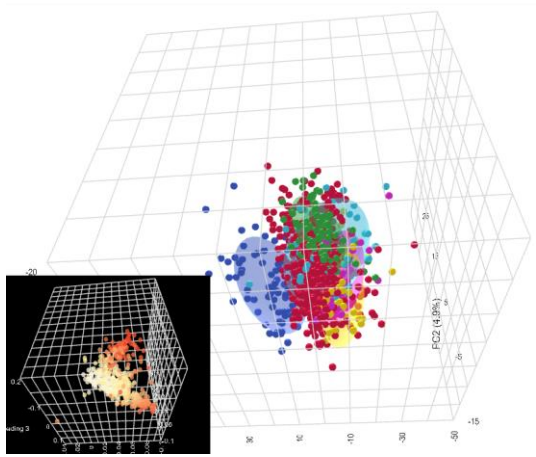
- six pillars providing an access to experimental capacities, samples, data and tools
- experimental/data/metadata standards, harmonization and QA/QC procedures established centrally
- promoting open science

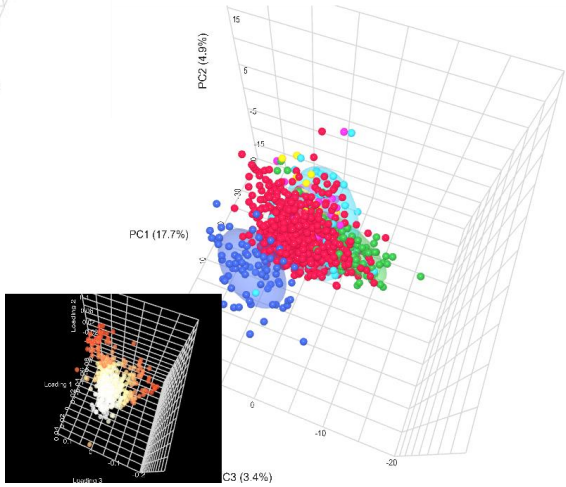
https://www.eirene-ri.eu

EIRENE RI

Method standardization, multi-site (EU-US) replication, application in the EU cohorts/ EHEN projects







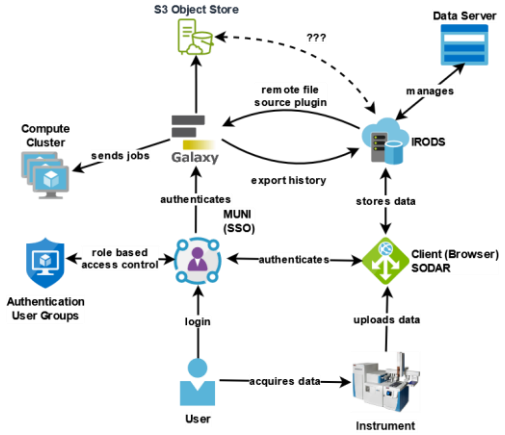
https://www.eirene-ri.eu

European Human Exposome NETWORK

EIRENE RI

Computational resources and data infrastructure

- Global network for mass spectrometry data processing with Galaxy
- Coordinating shared re-sources (software, data, tutorials)
- Coordinating shared projects and collaborations across Galaxies
- Promoting collaboration and engagement with community stakeholders

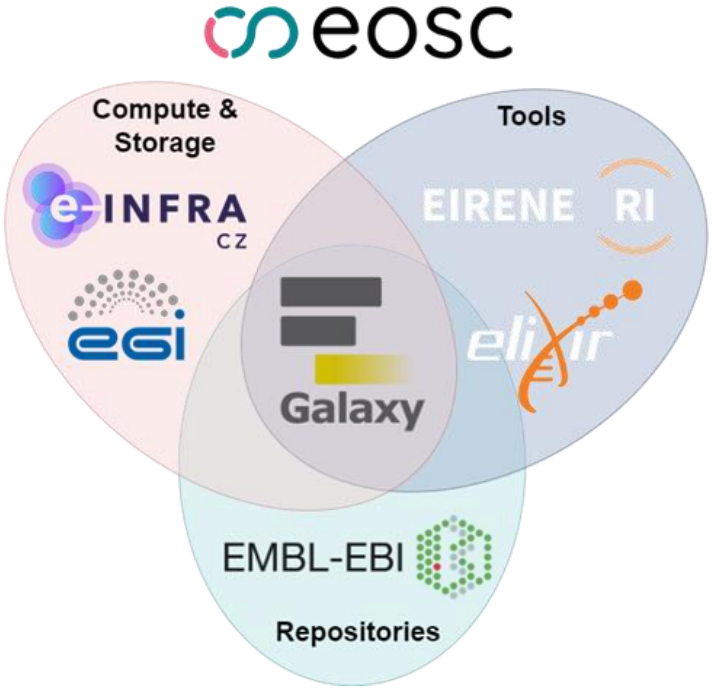


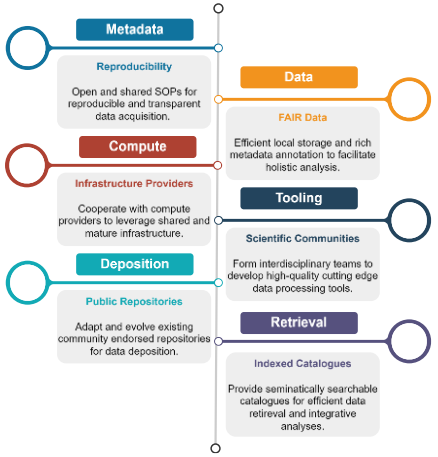
- Robust open-source research data management software (i.e. iRODS)
- Integrating ELIXIR authentication mechanisms (LifeScienceRI)
- Interoperable framework of distributed data storage and processing solutions (Galaxy)
- Ontology based metadata annotations, standardized data formats and procedures

- 20 open-code repositories released
- 67 tools
- 24 SW packages maintained
- 2 workflows published via WorkflowHub
- 2 trainings provided via the Galaxy Training Network

https://www.eirene-ri.eu

Package	Downloads
matchms	73433
r-ramclustr	9808
r-recetox-aplcms	11926
r-recetox-xmsannotator	2503
riassigner	8028
r-recetox-waveica	3428
msmetaenhancer	15479
gc-meox-tms	1830
spec2vec	5626
ms2deepscore	8677



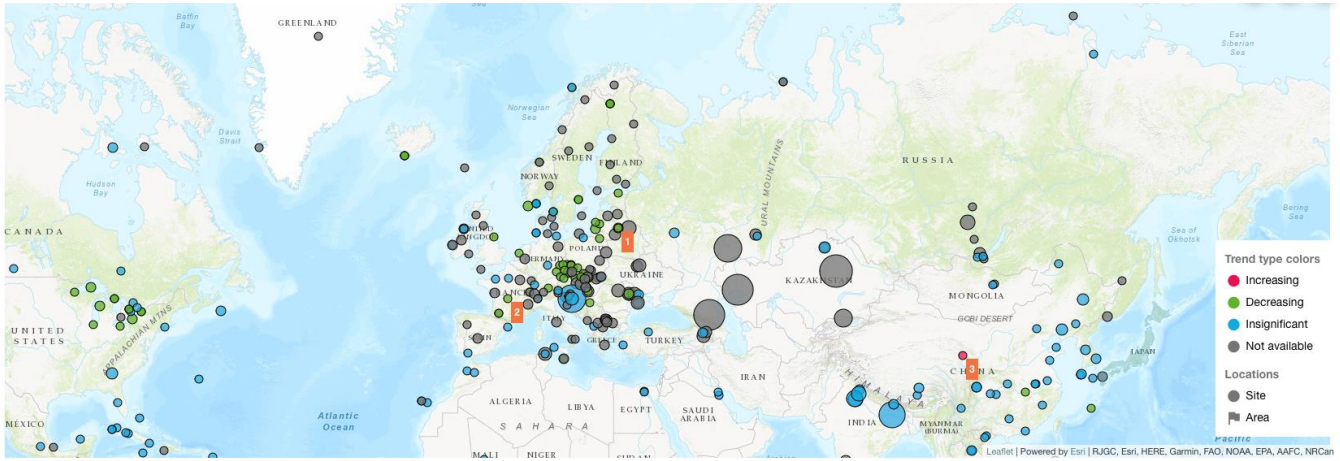


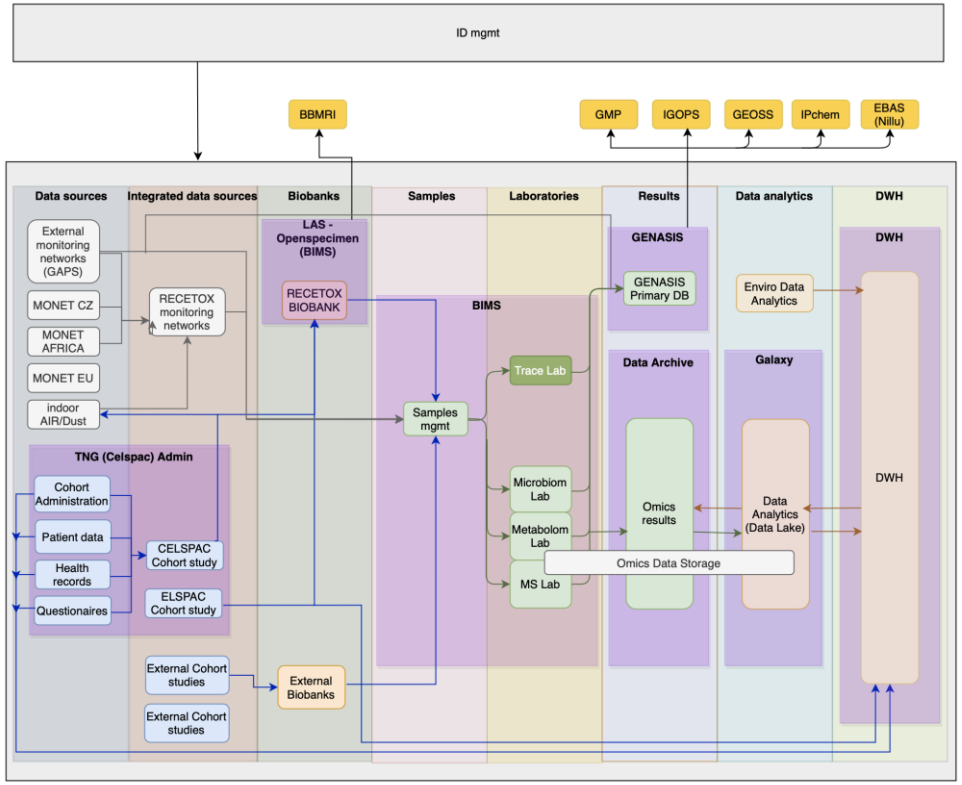
EIRENE RI

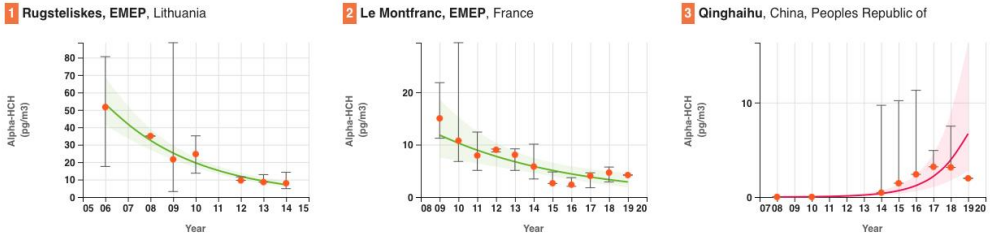
Data integration and visualization

Development, customization and operation of information and database systems

To support: Data integrations across systems and scientific domains







EIRENE RI

history

culture

architecture

science

BRNO
city for life

MUNI | RECETOX

Using RIs to investigate and document the impacts of the environment on human health.

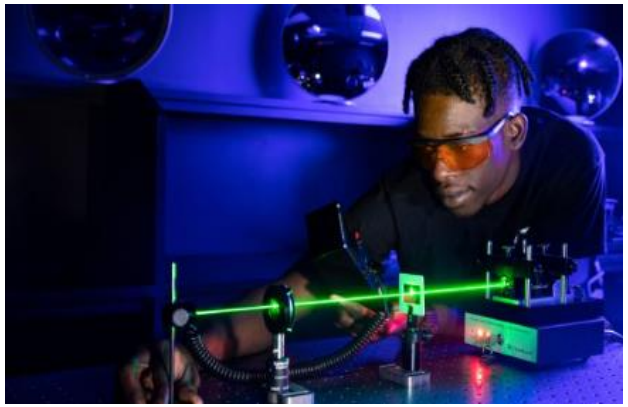
Charlotte Roehm, PhD, PMP
Division of Biological Infrastructure
Directorate of Biological Sciences
National Science Foundation

- Strategic Planning
- Sharing RDI strategies
- Identification of Gaps
- Benchmarking International RDI

NSF Research Facilities and Infrastructure

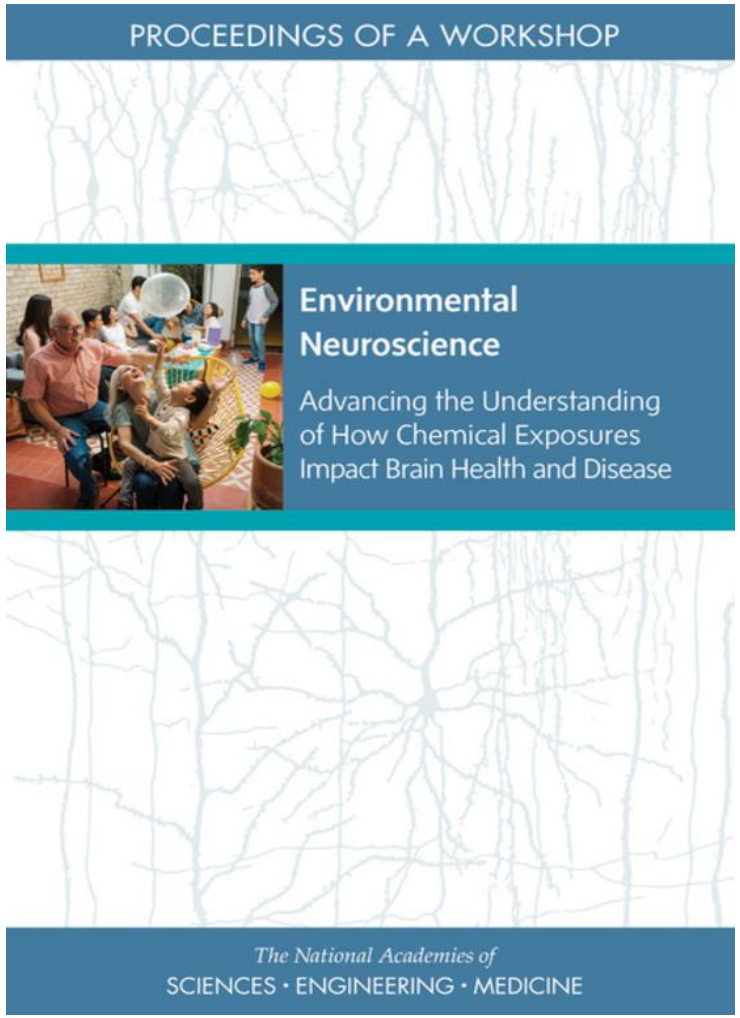
Enabling
Discovery and Innovation

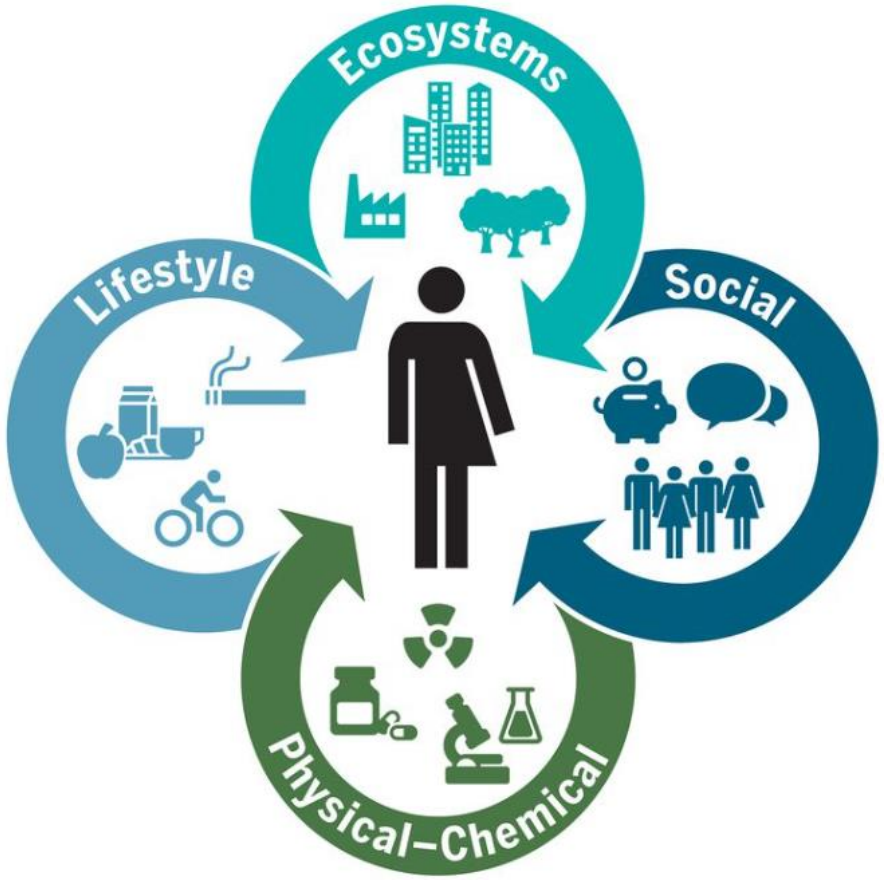
Addressing
Societal Challenges



Enhancing Training &
Workforce Development

The Exposome





[Source: Vermuelen et al., 2020: *Neurotoxicology* 29(5)]

National Ecological Observatory Network

neon Operated by Battelle

About Us | Data & Samples | Field Sites | Impact | Resources | Get Involved

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Get access to over 500,000 samples and specimens

BIOREPOSITORY SAMPLE PORTAL >

Learn how data and samples are collected

DATA COLLECTION METHODS >

Start your journey with data and resources

GET STARTED >

Global Ecosystem Research Infrastructure

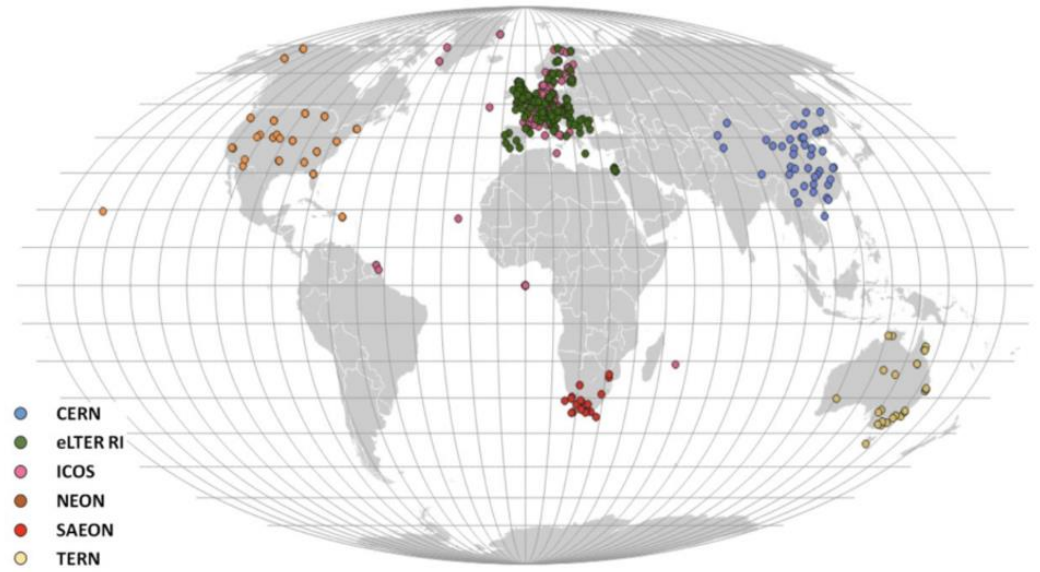
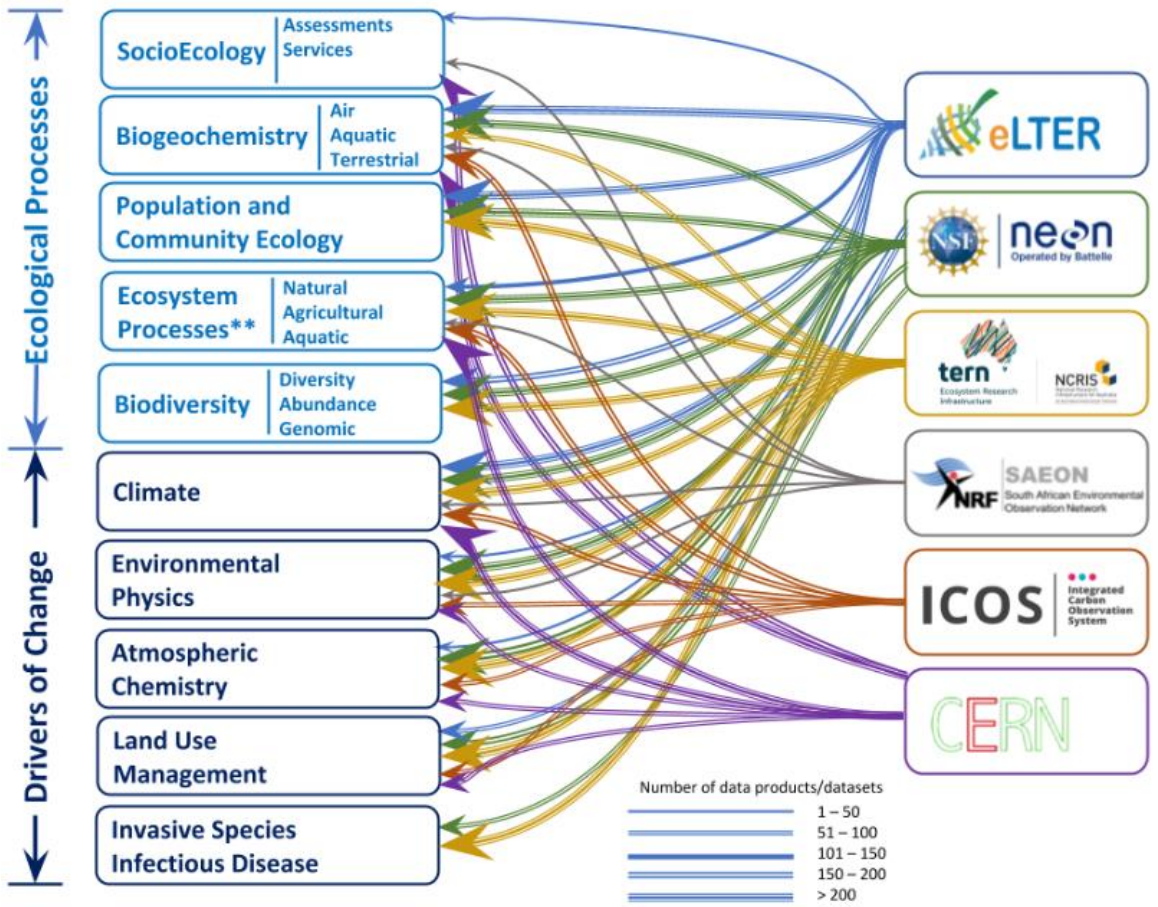


Figure 1. Global distribution of GERI sites



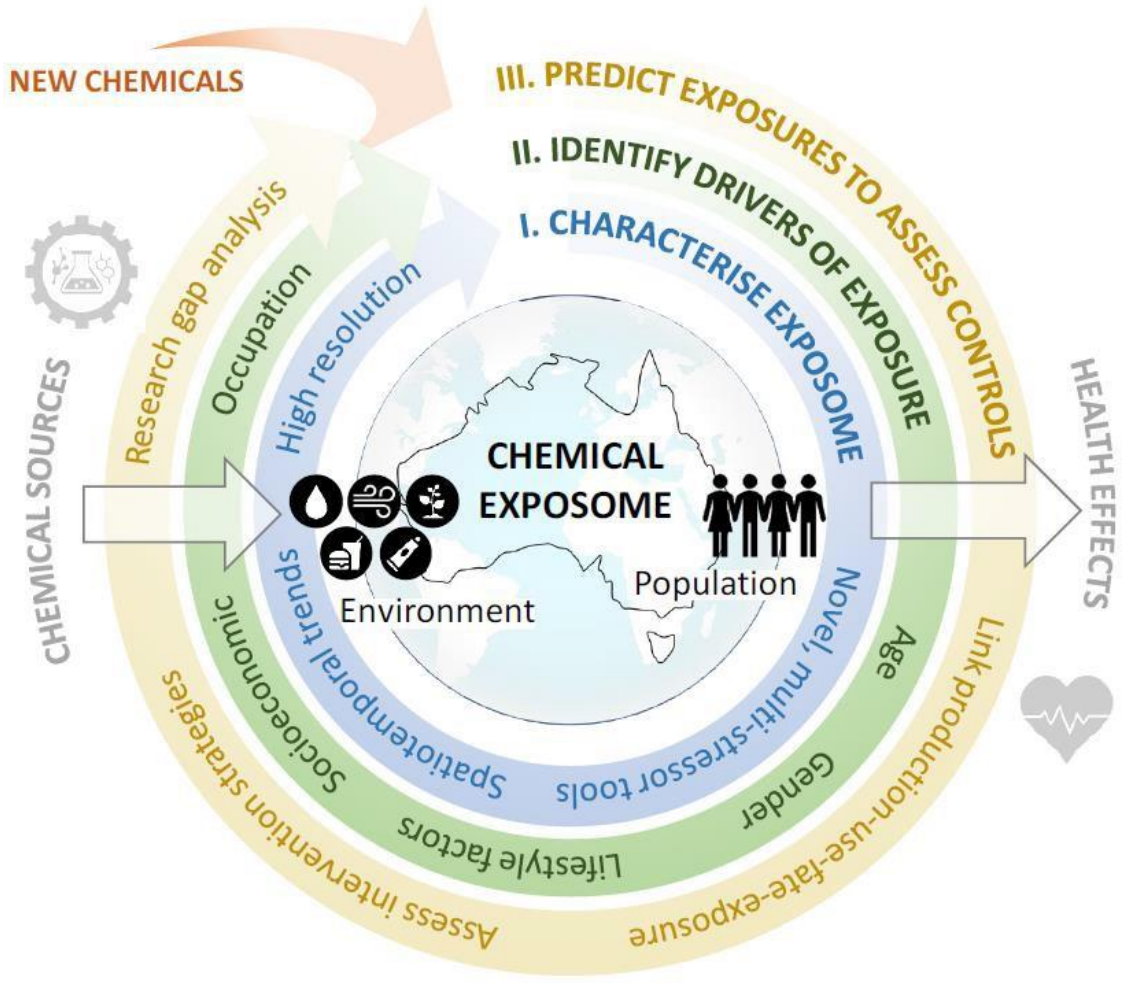
[Source: GERI 2022]

Human biomonitoring and human exposome research infrastructure in Australia

Jochen Mueller,

Kevin Thomas and QAEHS

University of Queensland



‘Australia’ has not had much interest in ‘human biomonitoring (HBM)’

Lots of reason for that (incl)

‘We think’ chemical exposure is less than in other industrialised countries

Studies very expensive

Exposure forgotten in the National Health Measure Study?

This ‘void’ formed my career in Human Biomonitoring @ UQ

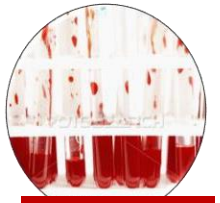
-the development of long-term sampling…

-and archiving programs…

Timeline

1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019 2023

Breast milk



Pooled Serum

Waste water

Pooled Urine

Firefighter Cohort

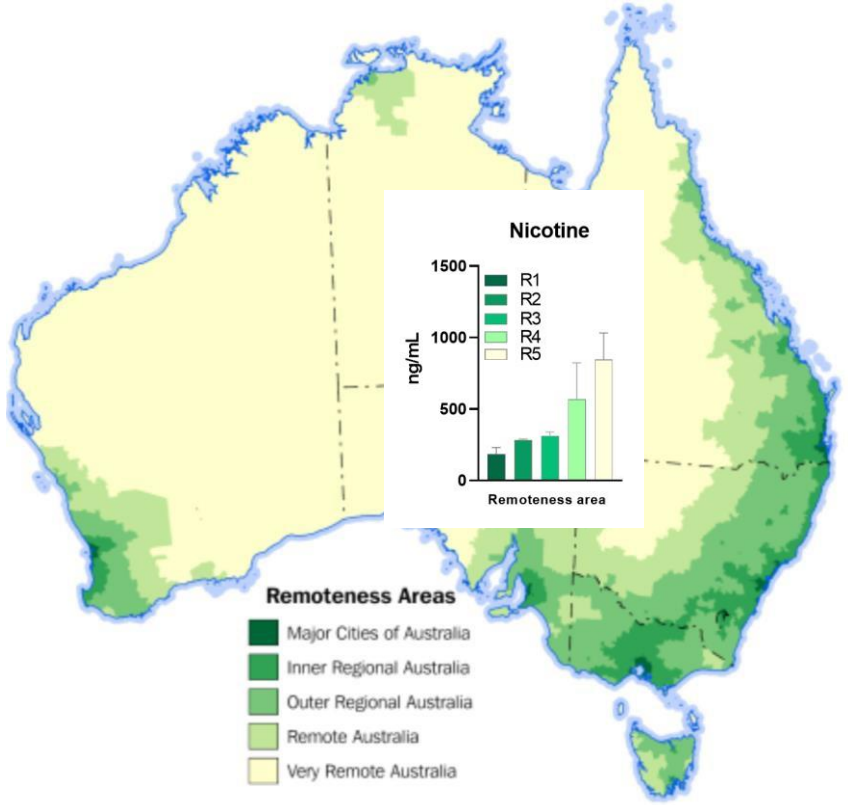
‘Australia’ covers amazing diversity that affect our exposome

- remoteness (see example)
- climatic including extremes/changes

etc.

And we have an amazing Census/ABS

Pooling urine by ‘remoteness’
Nicotine (in urine / adults)

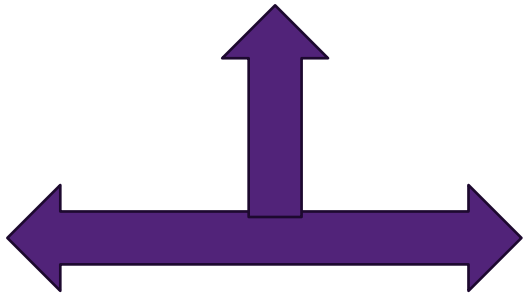


Australian CDC and EPA

➔ Basis for Exposome in Aus.

(ExpOZome)

EIRENE RI



NEXUS
Network of Exposomics in the US

MAKING SCIENCE HAPPEN

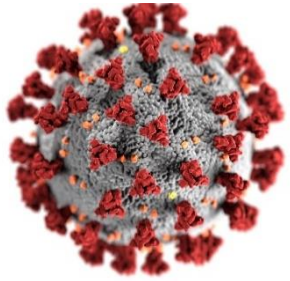
A new ambition for Research Infrastructures in the European Research Area

ESFRI WHITE PAPER
2020

RIs as strategic investments in competitiveness & societal well being

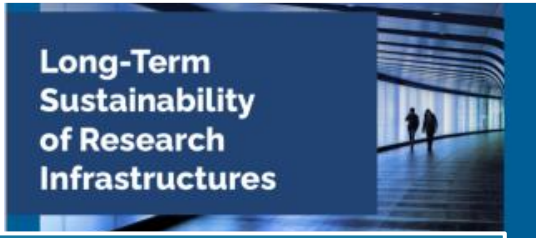
RIs regional impact and global outreach

Integrated and globally interconnected ecosystem of RIs – effective resources



World class RIs ecosystem is capable to deliver science based solutions to all important Societal challenges

Robust, long-term, emergency response across borders, sectors and domains, economic and social recovery



RI ecosystem backbone Readinness & Resilience

ESFRI SCRIPTA Vol. 2

Data & digitalization integrating environmental & medical research with social sciences

Added value of global interdisciplinary research - RIs building on that and use what have been already created
Interoperability across domains = **more effective science** (speed up sharing knowledge, transparency and reproducibility, harmonizing community standards, comparable and reusable data, **science quality and relevance)**
Multidisciplinarity as a driver of excellence and an opportunity for **broadening the service base and maximizing impact.**
Contribution to **economies of scale & sustainable resources use (**finances + people + RIs + data management)

Maintain **scientific excellence & societal relevance**
Ensure **right people are at the right place at the right time**
Harmonize and integrate **operation of RIs and e-INFRA**
Fully exploit the potential of **RIs as innovation hubs**
Demonstrate **the economic and wider benefit** to society
Effective **RI governance, long-term funding and effective management**
Coordination at national, European levels **and globally**

Global challenges require global solutions