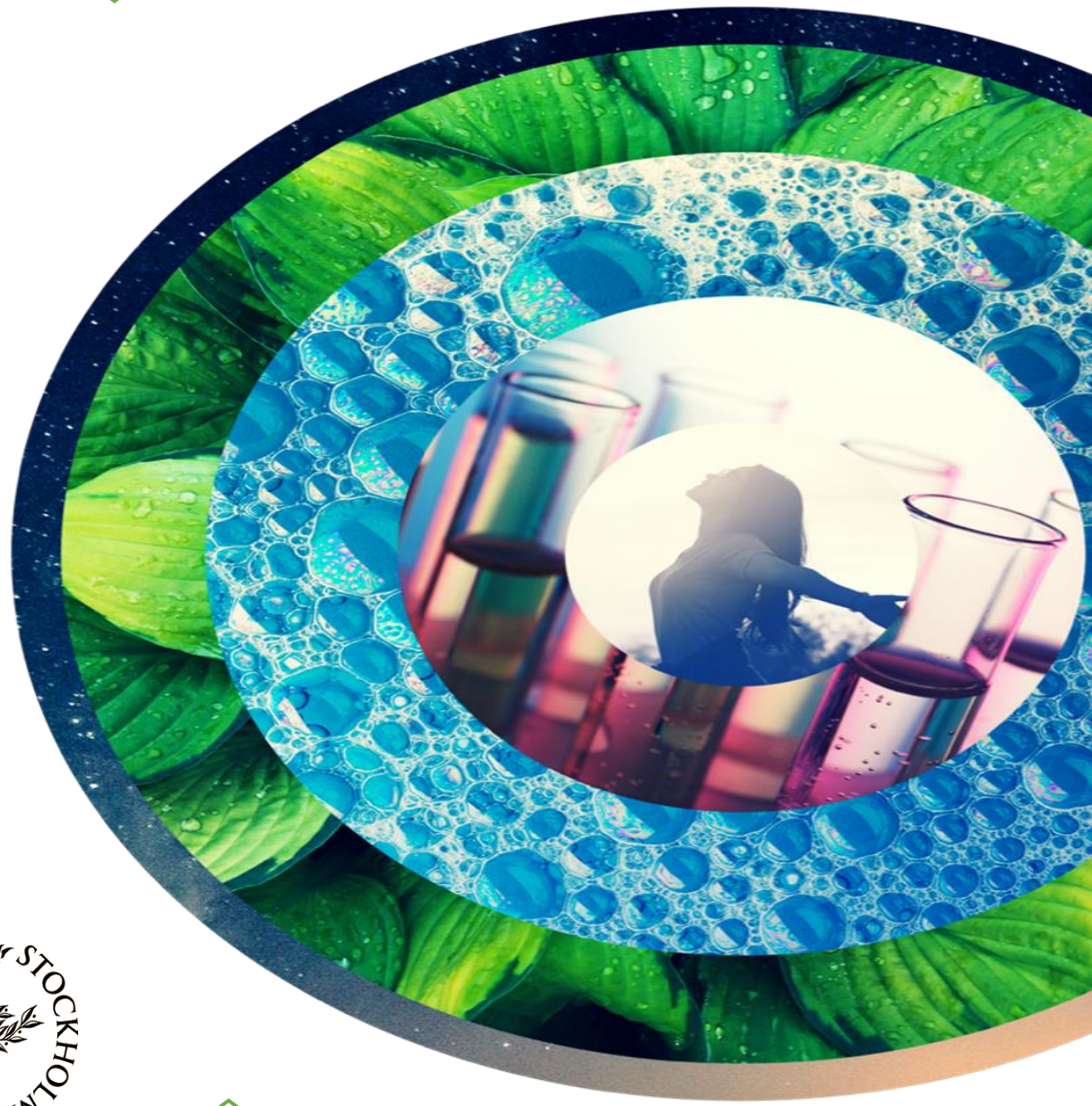
ECO56: UTOPIA

A multimedia unit world open-source model for microplastic

MARII WS Seattle

June 12 2023



Project Team

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UTOPIA -

A MULTIMEDIA UNIT WORLD OPEN-SOURCE MODEL FOR MICROPLASTIC

UTOPIA

The main objective of UTOPIA is to develop an open-source unit world multimedia modeling platform to synthesize knowledge and understanding about the fate of microplastic in the environment.

1. Describe all known relevant fate processes for microplastic with a reference set of equations
2. Provide a reference modeling platform for:
   - Screening level risk assessment
   - Calculation of exposure indicators
   - Identification of knowledge gaps and key drivers of uncertainty
   - Hypothesis generation
3. Provide a friendly user interface to run calculations and conduct sensitivity and uncertainty analysis
4. Include a generic database of microplastic properties for archetypical plastics
5. Be modular in design to allow further model development as the science evolves

UTOPIA – Project timeline

October 2021

September 2022

WP1 Model conceptualization and design of user interface

WP2 Model Coding, error checking and verification

WP3 ase study and odel evaluation

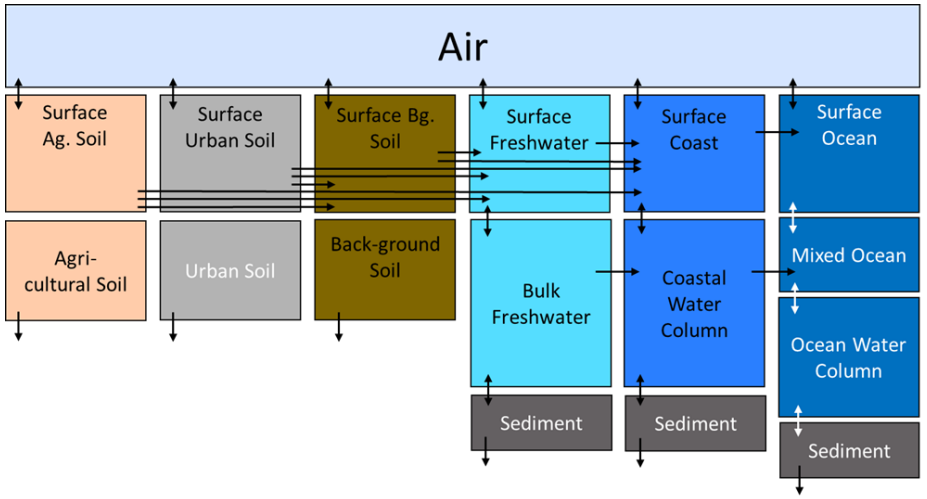
WP5 Stakeholder engagement and development of user base

WP4 Outreach and coordination with ECO57-59 researchers

Time (months)	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24
WP1 Model conceptualization and design of user interface	M1.1:Decide on compartments, processes and inputs M1.2Review on MPs hazard indicators	D1.1	D1.2					
WP2 Model coding, error checking and verification		Formulation of UTOPIA model Formulation of hazard risk calculations	D2.1	Sensitivity and Uncertainty analysis	D2.2	D2.3	D2.4	
WP3 Case study and model evaluation			Case Study Unit World				D3.1	
WP4 Outreach and coordination with researchers	M4.1 - 4.6: Contact with researchers leading ECO57-59 D4.1				D4.2			D4.3
WP5 Stakeholder engagement and development of user base							Model testing at UVA and SU Tutorial on use of UTOPIA SETAC short curse UTOPIA	D5.1, 2 & 3

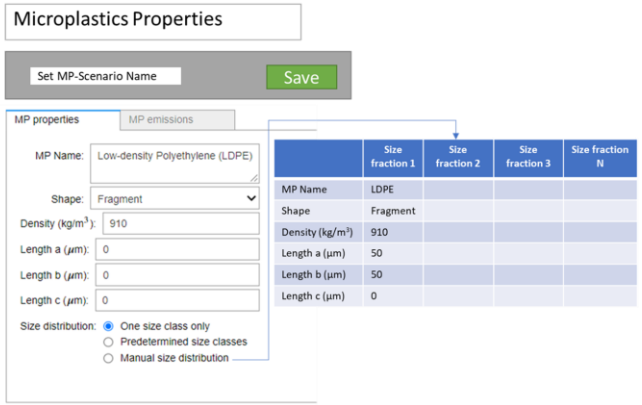
UTOPIA – WP1 – Model formulation and design of user interface

Compartmental model structure



Concept drawings of user interface

The MICROPLASTICS INPUT PARAMETERS MENU will provide the option to load a default scenario of micoplastic (MP) properties as well as the option to build your own scenario though the pictured MP properties menu.

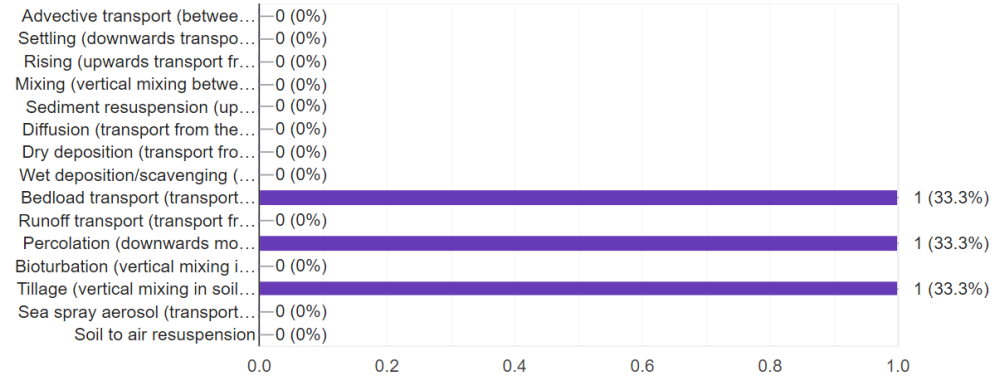


Model processes

A list of TRANSPORT PROCESSES for microplastics between the UTOPIA defined compartments is below. From this list, please select any that you consider to be NOT RELEVANT for inclusion in the UTOPIA model.

Copy

3 responses



Model outputs

UTOPIA will calculate the concentration of the different species and size fractions of MPs in the various environmental compartments as the steady-state solutions of the system of mass balance equations. Exposure indicators will also be calculated by the model.

A list of the envisioned model outputs is provided below.

The following outputs are envisioned for the UTOPIA model. Please click on those options that you consider NOT relevant.

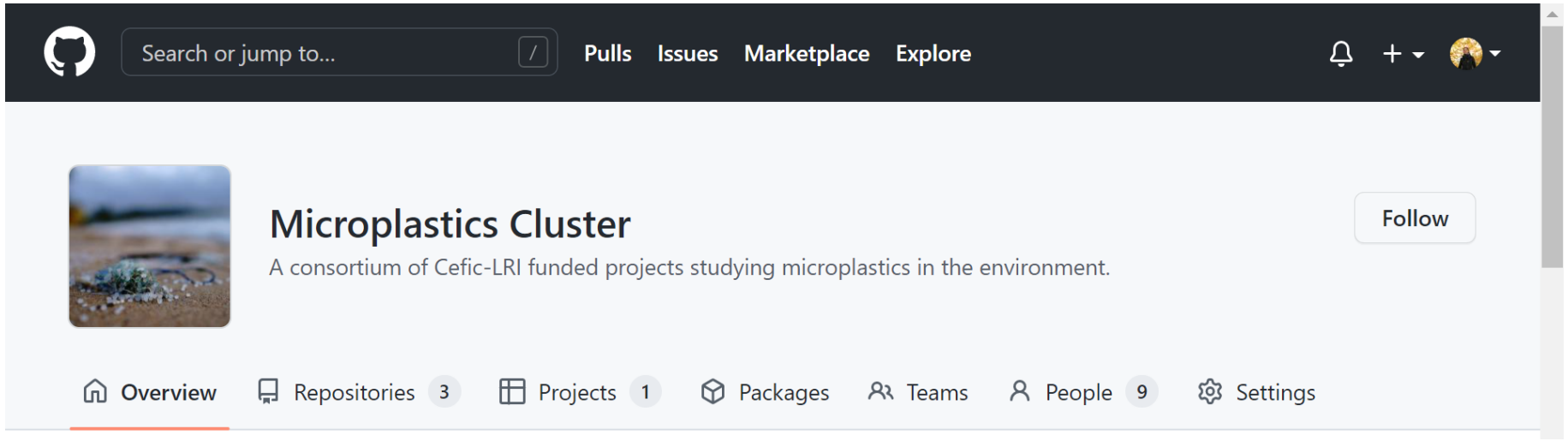
- [ ] Multi-panel mass balance diagrams to show different size and speciation classes of plastic.
- [ ] Exposure indicator: Overall persistence (Pov) and persistence per size fraction (Pn)
- [ ] Exposure indicator: Characteristic travel distance (CTD) in air, freshwater and ocean water
- [ ] Exposure indicator: Transfer efficiency (TE), as the fraction of plastic emitted that reaches a certain part of the environment. For example, transfer efficiency from coastal water to remote beaches.

UTOPIA – WP2 – Coding and error checking

UTOPIA model coding workflow:

1. **Select input parameters** through interactive voila dashboards to generate input csv files **Pending user friendly interactive version**
2. ✓ **Generate model objects** by reading on input files:
   - **Model box** (UTOPIA)
   - **Model compartments** (15 compartments for UTOPIA)
   - **Particles** (20 particles: one object per MPform (e.g. freeMP, heteroaggregated, biofouled and heteroaggregted and biofouled) and per size fraction (defined 5 size fractions in the range of 0.5 um to 0.5 mm separated by a factor of 10))
3. ✓ **Connect objects** to define the modeled system:
   - Assign compartments to the unit world
   - Add particles to compartments
   - Associate particles to the compartments
4. ✓ **Parameterise boundary condition concentrations/emissions**
5. ✓ **Generate model processes input parameters table** based on the established model structure (key parameters such as attachment efficiency, degradation times, fragmentation times, etc.)
6. ✓ **Calculate process rate constants** (per particle in each compartment and model box)
7. ✓ **Generate the system of mass balance equations**
8. ✓ **Solve mass balance (in steady state for UTOPIA)** **Error checking and verification in progress**
9. **Present results** **Pending user friendly interactive version**

UTOPIA – WP2 – Coding and error checking



https://github.com/microplastics-cluster/FullMulti_OOP

(Private repository, contact Matthew or Prado to get access)

- Next step: Coding of (provisional placeholders for) exposure indicators
- Implementation of sensitivity and uncertainty analysis
- Case study development

UTOPIA – Other outputs

nature computational science

Perspective

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Computational models to confront the complex pollution footprint of plastic in the environment

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Check for updates

Matthew MacLeod [1], Prado Domercq [1], Sam Harrison [2] & Antonia Praetorius [3]

The threat posed by plastic in the environment is poorly characterized due to uncertainties and unknowns about sources, transport, transformation and removal processes, and the properties of the plastic pollution itself. Plastic creates a footprint of particulate pollution with a diversity of composition, size and shape, and a halo of chemicals. In this Perspective, we argue that process-based mass-balance models could provide a platform to synthesize knowledge about plastic pollution as a function of its measurable intrinsic properties.