

The Human Flux Unit (EFU)

Szerző: Simor István 2025-12-23

The **Human Flux Unit (EFU)**

A human-scale unit for measuring material throughput in the Anthropocene[simoristvan.wordpress](https://simoristvan.wordpress.com)

Why EFU?

Life is not a static object; it is a continuous, high-turnover flow of matter and energy. Traditional sustainability metrics focus on **stocks** - biomass, carbon pools, ecological footprints - while largely ignoring the **throughput** that actually sustains living systems. The defining feature of the Anthropocene is not humanity's mass, but its unprecedented material flux, which now approaches the scale of planetary net primary production.pmc.ncbi.nlm.nih.gov⁺²

The **Human Flux Unit (EFU)** is introduced as a simple, human-scale reference that makes these invisible flows visible, comparable and communicable across disciplines and decision levels.[simoristvan.wordpress](https://simoristvan.wordpress.com)

Definition: 1 EFU

1 **EFU (Human Flux Unit)** is defined as the **total daily material throughput of an average adult human body**.[simoristvan.wordpress](https://simoristvan.wordpress.com)

- 1 EFU = **20 kg per day** of matter flowing through the body.[simoristvan.wordpress](https://simoristvan.wordpress.com)
- Composition (lifetime-averaged):
 - ≈15 kg/day of inhaled air
 - ≈3 kg/day of water intake
 - ≈0.5 kg/day of dry food
 - ≈1.5 kg/day of metabolic water and minor components[simoristvan.wordpress](https://simoristvan.wordpress.com)

Over an 80-year lifespan this daily flow accumulates to **≈542 tonnes** of material - about **29,200 EFU** - which is roughly **7,700 times** a 70 kg body's instantaneous mass. A human being is therefore not a 70 kg "thing", but a persistent pattern maintained by more than half a million tonnes of flowing matter.[simoristvan.wordpress](https://simoristvan.wordpress.com)

Any process with a known mass flow can be expressed in EFU by simple normalization:

- **Daily flux:** $\text{EFU}_{\text{day}} = \text{kg/day} \times 20 \text{ EFU}_{\text{day}} = 20 \text{ kg/day}$
 - **Annual flux:** $\text{EFU}_{\text{year}} = \text{kg/year} \times 7,300 \text{ EFU}_{\text{year}} = 7,300 \text{ kg/year}$ [simoristvan.wordpress](https://simoristvan.wordpress.com)
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Four key examples in EFU

Expressing familiar processes in EFU puts everyday and planetary phenomena on a single human-scale axis.[simoristvan.wordpress](https://simoristvan.wordpress.com)

- **Coal power plant**

A medium-sized coal-fired power plant burns coal at a rate of about **500,000 EFU per day**, i.e. the daily material throughput of half a million human bodies.[simoristvan.wordpress](https://simoristvan.wordpress.com)

- **Global plastics production**

Annual global plastics production of **≈400 Mt per year** corresponds to roughly **55 million EFU per year**, showing how deeply synthetic materials permeate the technosphere.[plasticseurope](https://plasticseurope.org)⁺¹

- **River sediment (Danube)**

The annual sediment load of the Danube, about **10 Mt per year**, equals approximately **1.4 million EFU per year**, comparable to the flux of entire industrial sectors or regions.[academia+1](#)

- **Humanity vs. the biosphere**

With **≈8.1 billion people**, humanity sustains **8.1 billion EFU** continuously, amounting to **≈60 Gt of material throughput per year** - of the same order as terrestrial net primary production ($\approx 50\text{--}65 \text{ Gt C per year}$, expressed as dry biomass). While humanity makes up only about **0.01%** of global biomass, its metabolic flux already rivals the photosynthetic engine of the land biosphere.[essd.copernicus+3](#)

Why EFU matters

The EFU provides a **common language** for quantitative sustainability science, corporate reporting, policy design and public communication.[oecd+1](#)

- It unifies fragmented indicators (CO₂-equivalent, water footprint, material footprint, nutrient loading) on a single, intuitive human-scale reference.[pmc.ncbi.nlm.nih+1](#)
 - It allows decision-makers to ask a simple but powerful question: **“How many human-equivalent fluxes are we mobilising with this choice?”**[simoristvan.wordpress](#)
 - It reframes the core challenge of the Anthropocene as learning to **steward flows rather than merely accumulate stocks** in a finite planetary system.[essd.copernicus+1](#)
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Learn more

- **Full EFU whitepaper (technical details, tables, calculations)**
Extended derivations, human input-output balances, mammal scaling and sectoral applications in EFU.[simoristvan.wordpress](#)

- **EFU Example Library**
Curated examples of humans, animals, infrastructures and global cycles expressed in EFU for education, research and policy.

- **Quantitative Ontology of Life - main article**
The theoretical framework that embeds EFU within a broader ontology of life, consciousness and the technosphere as hierarchies of flux.[simoristvan.wordpress](#)

<https://simoristvan.wordpress.com/2025/12/23/quantitative-ontology-of-life/>

<https://simoristvan.wordpress.com/2025/12/23/the-human-flux-unit-efu/>

<https://pmc.ncbi.nlm.nih.gov/articles/PMC4375797/>

<https://essd.copernicus.org/articles/15/4829/2023/>

<https://plasticseurope.org/media/plastics-europe-launches-the-plastics-the-fast-facts-2023/>

https://www.academia.edu/2749875/Impact_of_humans_on_the_flux_of_terrrestrial_sediment_to_the_global_coastal_ocean

<https://essd.copernicus.org/preprints/essd-2023-244/essd-2023-244.pdf>

<https://pmc.ncbi.nlm.nih.gov/articles/PMC12405561/>

https://www.oecd.org/content/dam/oecd/en/publications/reports/2020/02/systemic-thinking-for-policy-making_a95b3226/879c4f7a-en.pdf

<https://essd.copernicus.org/articles/17/965/2025/>

THE HUMAN FLUX UNIT (EFU)

Reframing Life and the Anthropocene as Throughput
rather than Stock

Szerző: Istávn 2025.12.23

LIFE AS FLOW



Life is sustained,
high-turnover flow.
Not static stock.
Traditional
metrics ignore
that we throughput.

$$1 \text{ EFU} = 20 \text{ kg day}^{-1}$$

air + water = food passing
an adult human in 24 hours

THE EFU FRAMEWORK



APPLICATIONS & EXAMPLES

- * 🚎 Coal Power Plant
 $\approx 500,000 \text{ EFU day}^{-1}$
- * 🥤 Global Plastics (400 Mt y⁻¹)
 $\approx 55 \text{ million annual EFU}^1$
- * 🌎 $\approx 1.4 \text{ million annual EFU}^1$

SHIFTING FOCUS: From Stock to Flow.
Stewarding flows for a finite planet.

EFU: A common language for sustainability.

 Consciousness: minute modulation of a vast material stream.

History / Motivation

How and why the EFU emerged

The Human Flux Unit did not start as a metaphor, but as a technical necessity. In working on a quantitative ontology of life and on the biophysics of the Anthropocene, I needed a way to compare very different material flows on a single, human-intuitive scale: the lifetime flux of one person, the combined metabolism of humanity, the sediment load of rivers, the fuel consumption of power plants, and the net primary production of the biosphere. [simoristvan.wordpress+1](#)

Existing frameworks in material flow analysis and sustainability research provide rich datasets in kilograms, tonnes, and gigatonnes per year, but they do not offer a simple, shared unit that answers the question: *"How many human lives' worth of flux is this?"* The resulting expressions became too complex for communication and too fragmented for cross-scale reasoning. [onlinelibrary.wiley+1](#)

EFU emerged as a response to this gap. By defining **1 EFU as 20 kg per day**, the total daily material throughput of an average adult, it became possible to translate any mass flow—biological, technological, or geophysical—into an equivalent number of human daily fluxes. This preserves full physical rigor while drastically lowering the cognitive barrier: a decision-maker, a scientist and a layperson can all understand what “500,000 EFU of coal per day” or “55 million EFU of plastics per year” mean in human terms. [plasticseurope+2](#)

In this sense, EFU is not a new physical quantity, but a **deliberately designed unit** that grew out of the need to make complex, multi-scale material flows computable, comparable and ethically interpretable within one coherent framework. [semantic-web-journal+1](#)

<https://www.nature.com/articles/s41597-025-04587-8>
<https://simoristvan.wordpress.com/2025/12/23/quantitative-ontology-of-life/>
<https://simoristvan.wordpress.com/2025/12/23/the-human-flux-unit-efu/>
<https://pmc.ncbi.nlm.nih.gov/articles/PMC4375797/>
<https://onlinelibrary.wiley.com/doi/full/10.1111/jec.13593>
<https://plasticseurope.org/media/plastics-europe-launches-the-plastics-the-fast-facts-2023/>
<https://www.semantic-web-journal.net/content/ontology-units-measure-and-related-concepts>
https://www.semantic-web-journal.net/sites/default/files/swj177_7.pdf
<https://dialnet.unirioja.es/descarga/articulo/10262965.pdf>
<https://svn.aksw.org/papers/2021/energy-ai-introducing-oeo/public.pdf>
<https://pmc.ncbi.nlm.nih.gov/articles/PMC11842773/>
<https://arxiv.org/html/2401.10751v1>

Human module - a single life in EFU

- **Definition anchor**
 - 1 EFU = 20 kg/day total human material throughput (\approx 15 kg air, 3 kg water, 0.5 kg dry food, + minor components).[simoristvan.wordpress](#)
- **Lifetime flux**
 - Total input over 80 years: \approx 542,000 kg \approx 29,200 EFU.[simoristvan.wordpress](#)
 - Lifetime flux / body mass \approx 7,700: the body is a pattern sustained by flows, not a static 70 kg object.[simoristvan.wordpress](#)
- **Detailed balance (examples)**
 - Air: 440,000 kg in and out over 80 years (~81%).
 - Water: 88,000 kg in; \approx 96,000 kg out (extra from metabolic water).[simoristvan.wordpress](#)

Mammal module – from rat to blue whale

- **Scaling rule**
 - $EFU_{animal} = m_{body} \cdot k_{metabolic} \cdot 20 \text{ kg/day}$ $EFU_{animal} = 20 \text{ kg/day} \cdot m_{body} \cdot k_{metabolic}$, with $k_k \approx 0.3$ for small/medium mammals, ≈ 0.15 for large ones.[simoristvan.wordpress](#)
- **Representative species**
 - Rat (0.3 kg): \approx 0.1 kg/day \rightarrow 0.005 EFU.
 - Cat (4 kg): \approx 0.5 kg/day \rightarrow 0.025 EFU.
 - Dog (20 kg): \approx 1.5 kg/day \rightarrow 0.075 EFU.
 - Human (70 kg): \approx 20 kg/day \rightarrow 1.0 EFU (reference).
 - Cattle (600 kg): \approx 80 kg/day \rightarrow 4 EFU.
 - Elephant (5,000 kg): \approx 500 kg/day \rightarrow 25 EFU.
 - Blue whale (150,000 kg): \approx 8,000 kg/day \rightarrow 400 EFU.[simoristvan.wordpress](#)
- **Population examples**
 - 10 million dogs \rightarrow 750,000 EFU.
 - 1 billion cattle \rightarrow 4 billion EFU (~half of the human EFU flux).[simoristvan.wordpress](#)

Technosphere module – infrastructure in EFU

- **Power plant**
 - Medium coal-fired plant: coal consumption \approx 500,000 EFU/day.[simoristvan.wordpress](#)
- **Plastics**
 - Global plastics production \approx 400 Mt/year \rightarrow \approx 55 million annual EFU.[academia+1](#)
- **Rivers and sediments**
 - Danube sediment load \approx 10 Mt/year \rightarrow \approx 1.4 million annual EFU.[pmc.ncbi.nlm.nih+1](#)

Planetary module – EFU and the biosphere

- **Global human flux**
 - \approx 8.1 billion people \rightarrow 8.1 billion EFU continuously sustained.
 - Annual human material throughput \approx 60 Gt/year.[essd.copernicus+1](#)

- Net primary production (NPP)
 - Terrestrial NPP ≈50–65 Gt C/year (dry biomass), of the same order as global human flux in EFU terms.[pmc.ncbi.nlm.nih+1](https://pmc.ncbi.nlm.nih.gov/article/PMC4375797)
 - Key contrast
 - Humanity ≈0.01% of global biomass, yet with a material flux comparable to the land biosphere's photosynthetic engine.
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1. <https://simoristvan.wordpress.com/2025/12/23/the-human-flux-unit-efu/>
2. <https://plasticseurope.org/media/plastics-europe-launches-the-plastics-the-fast-facts-2023/>
3. https://www.academia.edu/2749375/Impact_of_humans_on_the_flux_of_terrestrial_sediment_to_the_global_coastal_ocean
4. [https://pmc.ncbi.nlm.nih.gov/article/PMC4375797/](https://pmc.ncbi.nlm.nih.gov/article/PMC4375797)
5. <https://essd.copernicus.org/articles/15/4829/2023/>
6. <https://pmc.ncbi.nlm.nih.gov/article/PMC12405561/>

Az EFU születése

Az Emberi Fluxus-egység nem metaforaként, hanem **technikai kényszerként** született meg. A Kvantitatív Ontológia és az Anthropocén biológiai-fizikai vizsgálata során egyre gyakrabban merült fel az igény, hogy nagyon különböző anyagáramlásokat lehessen **azonos, emberléptékű skálán** összehasonlítani: egy ember teljes életút-fluxusát, az emberiség együttes anyagszeréjét, folyók hordalékát, erőművek tüzelőanyag-fogyasztását és a bioszféra nettó elsődleges produkcióját.[simoristvan.wordpress+2](https://simoristvan.wordpress.com/2025/12/23/the-human-flux-unit-efu/)

A meglévő keretek – anyagáram-elenzés, fenntarthatósági mutatók – rengeteg adatot nyújtanak kilogrammban, tonnában, gigatonnában, de nem adnak egyetlen, egyszerű mértékegységet arra a kérdésre, hogy „**Ez hány emberéletnyi fluxusnak felel meg?**” A kifejezések enniatt túl bonyolulttá váltak a kommunikációhoz, és túl széttörédezzettek a skálák közötti gondolkodáshoz.[pmc.ncbi.nlm.nih+2](https://pmc.ncbi.nlm.nih.gov/article/PMC4375797)

Az EFU erre a résre adott választ. Amikor a **1 EFU = 20 kg/nap** – egy átlagos felnőtt teljes napi anyagsforgalma – definíció megszületett, lehetővé vált, hogy bármilyen anyagáramot (biológiai, technológiai, geofizikai) „**ember-napnyi fluxusra**” fordítsunk le. Így a fizikai szigor megmarad, miközben a kognitív teher drasztikusan csökken: egy döntéshozó, egy kutató és egy laikus egyaránt érzi, mit jelent az, hogy „500 000 EFU szenet égettünk el naponta” vagy „évi 55 millió EFU műanyagot mozgatunk át a rendszerben”.[plasticseurope+2](https://plasticseurope.org/media/plastics-europe-launches-the-plastics-the-fast-facts-2023/)

Ebben az értelemben az EFU nem új fizikai mennyiség, hanem egy **tudatosan megtervezett mértékegység**, amely a komplex, többszintű anyagáramlásokat teszi számíthatóvá, összehasonlíthatóvá és etikai szempontból is értelmezhetővé egyetlen koherens keretben.

1. <https://simoristvan.wordpress.com/2025/12/23/the-human-flux-unit-efu/>
2. <https://simoristvan.wordpress.com/2025/12/23/quantitative-ontology-of-life/>
3. [https://pmc.ncbi.nlm.nih.gov/article/PMC4375797/](https://pmc.ncbi.nlm.nih.gov/article/PMC4375797)
4. <https://onlinelibrary.wiley.com/doi/full/10.1111/jec.13593>
5. <https://plasticseurope.org/media/plastics-europe-launches-the-plastics-the-fast-facts-2023/>
6. <https://www.semantic-web-journal.net/content/ontology-units-measure-and-related-concepts>