The Human Flux Unit (EFU)

A New Measurement Framework for Biological and Technological Material Flows

Author: István Simor
Version: 118.2
Date: January 29, 2026
Field: Quantitative Ontology / Biophysics / Sustainability Science

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1. INTRODUCTION
   The fundamental characteristic of life is not static mass, but continuous material flow. An organism's identity is not constituted by how much matter it contains at any given moment, but by what material fluxes it sustains over time. An average human body weighs approximately 70 kg, yet over an 80-year lifespan, more than 500 tonnes of matter pass through it — approximately 7,700 times its instantaneous mass. This ratio indicates that the true measure of life is not static existence (being), but continuous becoming (flux). To compare biological, ecological, and technological systems, we need a unit of measurement that expresses this flux-centered ontology. The Human Flux Unit (EFU) provides this answer: a universal, human-normalized measure of material flow that enables any process — biological, industrial, or ecological — to be expressed intuitively and comparably.

Example:
"This power plant burns coal equivalent to the material throughput of 500,000 humans per day" → 500,000 EFU/day

"The Danube River carries sediment equivalent to the annual material throughput of 1.37 million humans" → 1.37 million annual EFU

2. THE GENESIS OF THE EFU: SIX CONCEPTUAL ARCS
   The Human Flux Unit did not emerge in a vacuum. It is the result of a decade-long research program integrating six interdependent conceptual arcs. This section is not a series of technical definitions, but an intellectual map: why was the EFU necessary, and why now?

2.1. Anthropological-Ethical Foundation: Humans as Metabolic Nodes
Traditional environmental philosophy views humans either from the "outside" (as invasive species in ecosystems) or from the "inside" (as moral agents). The EFU chooses a third path: it interprets humans as one of the biosphere's key metabolic nodes — not as good or bad, but as flux intensity.
This approach derives from the ontological turn outlined in "In Nature's Mirror: The Human's Peculiar Role in the Living World": life does not "exist," it "flows." A human is not a 70 kg thing, but a 542,000 kg process over 80 years.
→ Consequence: If humans are flux, then the measure is not their "existence," but the "quality of their flow" (intensity, direction, efficiency).
Reference: A természet tükrében: az ember különös szerepe az élővilágban (https://simoristvan.wordpress.com/2025/05/02/a-termeszet-tukreben-az-ember-kulonos-szerepe-az-elovilagban/)

2.2. Learned Helplessness: The Failures of the Carbon Market
The greatest tragedy of global climate policy is not scientific uncertainty, but structural paralysis. Shell's internal reports have known for 40 years what VERA "forgot" within a decade: there is no transparency, no accountability, and the "carbon offset" market is fragmented, manipulable, and ethically indefensible.
The article "Learned Helplessness" demonstrates that this is not a moral failure but a systems failure: when a metric is too complex, too abstract, or too easily gamed, society gradually becomes resigned to fraud.
→ Consequence: The EFU is human-scale precisely because it cannot hide real flux. A power plant "burns 500,000 EFU of coal per day" — everyone understands this, and no one can relabel it as "green energy."
Why did I create the EFU? Because as someone who has worked for decades in environmental and climate protection, and founded and chaired the Hungarian Carbon Alliance until 2024, I witnessed a world filled with fraud. Even the major players cheat — from Shell to VERA. I know of more cases that haven't even been exposed. Why could they do this? Because there is no transparency and no human scale. The EFU threads the narrative together and smooths it out. It eliminates fragmentation. Finally, a system has been born that connects the world: the poor with the rich, Africa with Europe, industry with agriculture, and humans with the planet — in a way that everyone can understand. The EFU also keeps governments, banks, industry, and exploitation in check.
Reference: Tanult tehetetlenség (https://simoristvan.wordpress.com/2025/07/01/tanult-tehetetlenseg/)

2.3. The Noocratic Alliance: Collective Intelligence and Governance
If the problem is structural, then so must be the solution. The "Noocratic Alliance" articles outline a governance model where decision-making legitimacy comes not from power, but from transparent knowledge.

In this framework, the EFU is not just a metric but a protocol: whoever mobilizes EFU flux (state, corporation, individual) must make it auditable. The noocratic licensing system is thus not bureaucratic control but cognitive integrity: the decision-maker sees what they are mobilizing, and so does the community.
→ Consequence: The EFU is not an "engineering solution" but the foundational unit of a political-ethical framework.
References:
Nookratikus Szövetség (https://aihumancoexist.wordpress.com/2025/09/21/nookratikus-szovetseg/)
Nookratikus Szövetség: Egy kollektív intelligencia protokolljának születése (https://aihumancoexist.wordpress.com/2025/12/15/nookratikus-szovetseg-egy-kollektiv-intelligencia-protokolljanak-szuletese/)

2.4. The Architecture of Hope: Segment-Level Interventions
Collapse narratives paralyze. "It's too late," "the system is too big," "I can't do anything" — these are not facts but cognitive traps.
"The Architecture of Hope" and "Segment Theory" demonstrate that small groups, with appropriate tools, can generate system-level change. In this framework, the EFU is a diagnostic tool: an EFU audit of a village, company, or region reveals where there is overconsumption, where there is spare capacity, and where there is opportunity to redirect flux.
→ Consequence: The EFU is not only a global metric but a local action generator.
References:
A remény építészete (https://simoristvan.wordpress.com/2025/12/01/a-remeny-epiteszete-tudomanyosan-megalapozott-strategiak-a-tarsadalmi-jollet-helyreallitasara/)
Szegmens-világformálók (https://simoristvan.wordpress.com/2025/12/12/szegmens-vilagformalok/)
Segment Theory 0.05 (https://aihumancoexist.wordpress.com/2025/12/12/segment-theory-005/)

2.5. Quantitative Ontology: Measurable Being
The articles "The Quantitative Ontology of Life" pose a question: Is there an ontology that works not with abstract categories (being, spirit, matter) but with measurable fluxes?
The answer: yes. Life is not "matter" but material and information flow. Consciousness is not "substance" but information integration. Responsibility is not a "moral norm" but flux management.
In this framework, the EFU is the base unit: human flux is the reference against which everything else (cell, animal, technosphere, biosphere) can be compared.
→ Consequence: The EFU is not just a unit but the beginning of an ontological revolution.
References:
Az élet kvantitatív ontológiája (https://aihumancoexist.wordpress.com/2025/12/19/az-elet-kvantitativ-ontologiaja/)
Az élet kvantitatív ontológiája – tanulmány (https://aihumancoexist.wordpress.com/2025/12/20/az-elet-kvantitativ-ontologiaja-tanulmany/)

2.6. EFU Carbon: The Climate-Metabolism Module
The first applied module of the EFU is EFU Carbon: linking human flux with carbon footprint. Here it is not just about "how much matter flows," but what quality the flow has (fossil vs. renewable, linear vs. circular).

EFU Carbon thus forms the basis of a licensing system: whoever emits carbon must express it in EFU, and this license is tradable but not manipulable.
→ Consequence: EFU Carbon is the first step toward an economy that optimizes not GDP but flux efficiency.
Reference: EFU Carbon (https://aihumancoexist.wordpress.com/2025/12/25/efu-carbon/)

2.7. Summary: The EFU as Synthesis

The six conceptual arcs answer a single question: How can life, responsibility, and governance be translated into a common language?
The EFU is not just another environmental indicator. It is the base unit of a quantitative ontology, the measurement unit of a noocratic protocol, and the diagnostic tool of hope-building.
This document provides the technical definition. The underlying philosophy is contained in the referenced articles.

3. MOTIVATION AND THEORETICAL BACKGROUND

3.1. Foundations of Quantitative Ontology

Traditional ontologies considered matter the basic unit: "the reason for being was what exists." Modern systems thinking, however, shows that the survival of living organisms is based not on the possession of static matter but on continuous flows and organizational patterns (Prigogine, 1984; Kauffman, 1993).
Quantitative Ontology (Simor, 2025) provides the formal framework for this: it describes the layers of life (the B–A–C–D–E–F model) as a hierarchy of fluxes, where:

- B (Biosphere): global material cycles (approximately 10^13 kg/year NPP)
- A (Body/Segment): individual material flow (approximately 10^5 kg/lifetime)
- C (Consciousness): information-integration thresholds (approximately 10^−17 J per thought)
- D (Gene/Inheritance): evolutionary information storage (approximately 10^12 generations)

The EFU is the common currency of this model: it allows each layer to be expressed in the same unit, making the relationships between scales visible.

3.2. Why Use Humans as the Reference?

Choosing human material throughput as a reference is not anthropocentrism but practical normalization:

- Intuitive: everyone understands what "one person's daily material throughput" means
- Well-documented: medical and physiological data are precisely known
- Medium scale: not too small (cell), not too large (ocean), but at the direct scale of human experience
- Universal: applicable to any process (biological, technological, ecological)

3.3. The Purpose of the EFU

The EFU does not replace kg, mol, or J units but is a contextual comparison tool that is:

- Scalable: from micro-level (cell) → macro-level (biosphere)

- Ecological-ethical: immediately visible how many "human lives" a process corresponds to
- Interdisciplinary: connects biology, ecology, engineering, and social sciences

4. FORMAL DEFINITION OF THE EFU

4.1. Base Definition
1 EFU (Human Flux Unit) = the total daily material throughput of an average human.
In upload-safe notation:
1 EFU = 20 kg/day

Components (daily average, weighted over 80 years):

Material – Daily Amount – Proportion

- Air: 15 kg/day – 75%
- Water: 3 kg/day – 15%
- Food (dry): 0.5 kg/day – 2.5%
- Metabolic water: 0.3 kg/day – 1.5%
- Other: 1.2 kg/day – 6%
  TOTAL: 20 kg/day – 100%

Components – data sources:

- Respiratory volume: WHO, NASA Human Research Program (11,500 L/day × 1.3 g/L)
- Nutrition: USDA Dietary Guidelines (2020)
- Physiology: Guyton and Hall (2021), Textbook of Medical Physiology

4.2. General Formula

For any system's EFU:

EFU_system = (System material flow in kg per time unit ÷ 20 kg/day) × time conversion

Examples for different time scales:

- Daily flux:
  EFU_daily = (kg/day) ÷ 20
- Annual flux:
  EFU_annual = (kg/year) ÷ (20 × 365) = (kg/year) ÷ 7,300
- Per-second flux:
  EFU_second = (kg/s) ÷ (20 ÷ (24 × 3,600)) = (kg/s) ÷ 0.000231

4.3. EFU Time Scale Table

Time Scale – 1 EFU – Example

- Second: 0.231 g/s – blood flow during surgery
- Minute: 13.9 g/min – oxygen uptake in breathing cycle

- Hour: 833 g/h – meal + water intake
- Day: 20 kg/day – reference
- Week: 140 kg/week – weekly shopping
- Month: 600 kg/month – monthly food + air
- Year: 7,300 kg/year – annual metabolism
- Decade: 73 tonnes/decade – decade flux
- Lifetime (80 years): 584 tonnes/lifetime – complete life trajectory

5. DETAILS OF HUMAN MATERIAL THROUGHPUT

5.1. Inputs (80-year lifespan)

Material – Daily Amount – Over 80 Years – Percentage – Calculation Basis

- Air: 15 kg/day – 440,000 kg – 81% – 11,500 L/day × 1.3 g/L
- Water: 3 kg/day – 88,000 kg – 16% – 1.5 L drinking + 1.5 L food water
- Food (dry): 0.48 kg/day – 14,000 kg – 3% – protein + fat + carbohydrate

TOTAL: 18.48 kg/day – 542,000 kg – 100% – approximately 5.4×10^5 kg

5.2. Outputs (80-year lifespan)

Material – Daily Amount – Over 80 Years – Percentage – Note

- Exhaled air: approximately 15 kg/day – 440,000 kg – 81% – N_2 + CO_2 + residual O_2
- Urine: 1.5 kg/day – 44,000 kg – 8% – 95% water + urea
- Sweat: 1 kg/day – 29,000 kg – 5% – 99% water + electrolytes
- Water vapor: 0.8 kg/day – 23,000 kg – 4% – breathing + skin
- Feces: 0.15 kg/day – 4,400 kg – 0.8% – 75% water + fiber
- Skin + hair + nails: approximately 0.09 kg/day – 2,625 kg – <0.5% – shedding + growth

TOTAL: approximately 18.44 kg/day – 540,425 kg – approximately 100% – approximately 5.4×10^5 kg

5.3. Balance Equation

Water:
Input: 88,000 kg
Output: 44,000 + 29,000 + 23,000 = 96,000 kg
Difference: +8,000 kg → metabolic water (from reaction such as: $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$)

Carbon:
Input: 14,000 kg × 35% C ≈ 5,000 kg C
Output: 21,000 kg CO_2 → 5,700 kg C
Difference: +700 kg (body mass accumulation)

Air:
Input: 440,000 kg
Output: 440,000 kg (almost complete return flow)

5.4. One Human Life in EFU

Lifetime EFU = 542,000 kg ÷ 20 kg/day = 27,100 days ≈ 29,200 EFU

Or: 80 years × 365 days × 1 EFU/day = 29,200 EFU

Key finding: A human life is 29,200 EFU, while instantaneous body mass is only approximately 70 kg = 0.0035 EFU (in mass terms).

Ratio:

Lifetime flux ÷ Body mass = 542,000 kg ÷ 70 kg ≈ 7,700

→ Approximately 7,700 times a person's own mass flows through them during a lifetime.

Clarification on lifetime EFU calculation:
The EFU is defined as a standardized adult-average daily flux (20 kg/day) for comparability across systems. Lifetime material throughput integrates age-dependent metabolic rates, resulting in a lower cumulative mass (approximately 542 tonnes). For communicability and normalization, lifetime EFU is expressed as calendar time (80 years × 365 days = 29,200 EFU), not as a recalculated variable unit.

6. EFU APPLIED TO MAMMALS

6.1. General Formula for Mammals

$EFU\_animal = (m\_body \times k\_metabolic) \div 20$ kg/day

Where:

- m_body = animal body mass (kg)
- k_metabolic = daily material throughput coefficient (kg material per kg body mass per day)

Rough approximation:

- Small mammals: k ≈ 0.3
- Large mammals: k ≈ 0.15
- Human-sized: k ≈ 0.3

6.2. Mammal EFU Examples

Animal – Body Mass – Daily Material Flow – EFU – Source

- Rat: 0.3 kg – approximately 0.1 kg/day – 0.005 EFU – Karasov & Diamond (1988)
- Cat: 4 kg – approximately 0.5 kg/day – 0.025 EFU – NRC (2006)

- Dog (20 kg): 20 kg – approximately 1.5 kg/day – 0.075 EFU – NRC (2006)
- Human: 70 kg – approximately 20 kg/day – 1.0 EFU – reference
- Cattle: 600 kg – approximately 80 kg/day – 4.0 EFU – USDA (2020)
- Elephant: 5,000 kg – approximately 500 kg/day – 25 EFU – Sukumar (2003)
- Blue whale: 150,000 kg – approximately 8,000 kg/day – 400 EFU – Goldbogen et al. (2011)

6.3. Population-Level EFU

EFU_population = N × EFU_individual

Examples:

- 1,000 wolves (average 40 kg, approximately 3 kg/day):
  1,000 × 0.15 = 150 EFU
- 10 million dogs (average 20 kg):
  10,000,000 × 0.075 = 750,000 EFU
- 1 billion cattle (average 600 kg):
  1,000,000,000 × 4.0 = 4 billion EFU

→ The global cattle population's material throughput is approximately half that of humanity.

6.4. Mammal EFU Visualization (Logarithmic Scale)

- Rat – 0.005 EFU
- Cat – 0.025 EFU
- Dog – 0.075 EFU
- Human – 1.0 EFU (reference)
- Cattle – 4.0 EFU
- Elephant – 25 EFU
- Blue whale – 400 EFU

7. EFU IN TECHNOLOGICAL AND ECOLOGICAL SYSTEMS

7.1. Industrial Examples

Medium-sized coal-fired power plant:
Coal consumption: approximately 10,000 tonnes/day
EFU: 10,000,000 kg ÷ 20 kg/day = 500,000 EFU/day
Interpretation: equivalent to the daily material throughput of 500,000 humans

Global plastic production:
Annual: approximately 400 million tonnes/year
EFU: 400,000,000,000 kg ÷ 7,300 kg/year ≈ 55 million annual EFU
Interpretation: equivalent to the annual material throughput of 55 million humans

Automobile manufacturing:
One car: approximately 1,200 kg material
EFU: 1,200 kg ÷ 20 kg/day = 60 daily EFU
Interpretation: equivalent to 60 "human-days" of material flow

7.2. Ecological Examples

Danube River sediment load:
Annual: approximately 10 million tonnes/year
EFU: 10,000,000,000 kg ÷ 7,300 kg/year ≈ 1.37 million annual EFU
Interpretation: equivalent to the annual material throughput of 1.37 million humans

Amazon rainforest net primary production (NPP):
Annual: approximately 2.2 gigatonnes C/year ≈ 4.4 Gt dry biomass
EFU: 4,400,000,000,000 kg ÷ 7,300 kg/year ≈ 600 million annual EFU
Interpretation: equivalent to the annual material throughput of 600 million humans

Global ocean phytoplankton NPP:
Annual: approximately 50 Gt C/year ≈ 100 Gt dry biomass
EFU: 100,000,000,000,000 kg ÷ 7,300 kg/year ≈ 13.7 billion annual EFU
Interpretation: equivalent to the annual material throughput of 13.7 billion humans

8. THE GLOBAL BIOSPHERE IN EFU

8.1. Terrestrial Net Primary Production (NPP)

Global terrestrial NPP: approximately 50–65 Gt C/year ≈ 100–130 Gt dry biomass/year

Let us take a mid-range estimate, for example 115 Gt dry biomass/year:

EFU_terrestrial NPP = 115,000,000,000,000 kg/year ÷ 7,300 kg/year ≈ 15.8 billion annual EFU

Interpretation: The entire terrestrial biosphere's annual photosynthetic production is equivalent to the annual material throughput of 15.8 billion humans.

8.2. Current Human Population

Global population: approximately 8.1 billion (2025)
Humanity's continuous EFU: 8.1 billion EFU

Humanity's annual material throughput:
8.1 × 10^9 × 7,300 kg/year = 59.1 billion tonnes/year

8.3. Key Comparison

System – Annual EFU – Notes

- Terrestrial biosphere NPP: approximately 15.8 billion – photosynthetic production
- Humanity (8.1 billion people): 8.1 billion – continuous metabolic flux
- Humanity (annual throughput): 8.1 billion annual – approximately 59 Gt/year
- Ocean phytoplankton NPP: approximately 13.7 billion annual – approximately 100 Gt/year

Profound insight:
While humanity represents only about 0.01% of global biomass, its material throughput operates at a scale comparable to the photosynthetic engine of the entire terrestrial biosphere.

9. HUMANITY'S TOTAL EFU

9.1. Current Humanity

Population: 8.1 billion
Continuous EFU: 8.1 billion EFU

Daily throughput: 8.1 billion × 20 kg/day = 162 million tonnes/day
Annual throughput: 8.1 billion × 7,300 kg/year = 59.1 billion tonnes/year

9.2. All Humans Ever Born

Estimated total: approximately 117 billion humans (from 50,000 BCE to present)
Average lifespan: approximately 30 years (historical weighted average)

Total EFU: 117 billion × 30 years × 365 days = 1.28 trillion lifetime EFU
Total material throughput: approximately 12.8 trillion tonnes

9.3. Comparison with Geological Processes

Global annual sediment transport (all rivers): approximately 20 Gt/year
EFU equivalent: 20,000,000,000,000 kg ÷ 7,300 kg/year ≈ 2.7 billion annual EFU

Human annual throughput: 59.1 Gt/year
Ratio: Humanity's material throughput is approximately 3 times the global river sediment load.

10. EFU AS A GOVERNANCE PROTOCOL

The EFU is not merely a measurement unit but the foundation of a noocratic governance framework. In this system:

- Every flux mobilizer is accountable.
- States, corporations, and individuals who mobilize significant EFU flux must make it auditable.
- This is not bureaucratic control but cognitive integrity.

Licensing system:

- EFU flux above certain thresholds requires a license.
- Licenses are tradable but not manipulable (for example: blockchain-verifiable).

Transparency by design:

- All EFU audits are publicly accessible.
- Citizens can see: "This factory uses X EFU/day".

- Comparison becomes intuitive: "Is this reasonable?"

Democratic oversight:

- Communities can vote on EFU allocation in their region.
- Example: "Should we allow a new facility that would consume 100,000 EFU/day?"

→ Consequence: The EFU transforms environmental governance from abstract regulation into tangible, human-scale decision-making.

11. EFU APPLICATION CASES: SEGMENT-LEVEL INTERVENTIONS

The EFU is designed to be actionable at multiple scales.

11.1. Village Level

Scenario: A village of 1,000 people
Annual EFU: 1,000 × 365 = 365,000 daily EFU
Annual throughput: 1,000 × 7,300 kg = 7,300 tonnes/year

EFU Audit reveals:

- Food import: 2,000 tonnes/year (27% of throughput)
- Local production: 500 tonnes/year (7% of throughput)

Opportunity: Increase local production to 1,500 tonnes → reduce import dependency by 50%.

Result: The village sees where flux comes from and where it can be redirected.

11.2. Corporate Level

Scenario: Manufacturing company

Current state:
Production: 50,000 tonnes/year material throughput
EFU: 50,000,000 kg ÷ 7,300 kg/year ≈ 6,850 annual EFU

EFU Audit reveals:
30% waste stream (15,000 tonnes/year)

Opportunity: Implement circular economy → reduce waste to 5%.

Result: Company reduces flux by 25% → lower EFU footprint → competitive advantage in EFU-based carbon markets.

11.3. Regional Level

Scenario: Metropolitan region (5 million people)

Annual EFU: 5,000,000 × 365 = 1.825 billion daily EFU

EFU Audit reveals:

- Transport sector: 300,000 annual EFU (fossil fuels)
- Food system: 500,000 annual EFU (imports)

Opportunity: Electrify transport + regionalize food → reduce EFU carbon intensity by 40%.

Result: Region achieves measurable sustainability gains expressed in EFU reduction.

12. COMPARATIVE TABLES

12.1. Biological Systems in EFU

Organism – Body Mass – Daily EFU – Lifetime EFU (80 years)

- Bacterium: 10^{-12} kg – approximately 10^{-10} EFU – N/A
- Mouse: 0.03 kg – 0.002 EFU – approximately 0.6 EFU
- Cat: 4 kg – 0.025 EFU – approximately 7.3 EFU
- Human: 70 kg – 1.0 EFU – approximately 29,200 EFU
- Elephant: 5,000 kg – 25 EFU – approximately 730,000 EFU
- Blue whale: 150,000 kg – 400 EFU – approximately 11.7 million EFU

12.2. Technological Systems in EFU

System – Daily EFU – Annual EFU – Notes

- Smartphone production (1 unit): approximately 5 EFU – N/A – material + energy equivalent
- Car production (1 unit): approximately 60 EFU – N/A – approximately 1,200 kg material
- Coal power plant (500 MW): 500,000 EFU – 182.5 million EFU – approximately 10,000 tonnes coal/day
- Global plastic production: N/A – 55 million EFU – approximately 400 Mt/year
- Global steel production: N/A – 260 million EFU – approximately 1.9 Gt/year

12.3. Ecological Systems in EFU

System – Annual EFU – Notes

- Amazon rainforest NPP: approximately 600 million – approximately 4.4 Gt dry biomass/year
- Terrestrial biosphere NPP: approximately 15.8 billion – approximately 115 Gt dry biomass/year
- Ocean phytoplankton NPP: approximately 13.7 billion – approximately 100 Gt dry biomass/year
- Global river sediment transport: approximately 2.7 billion – approximately 20 Gt/year
- Humanity (8.1 billion people): 8.1 billion – approximately 59 Gt/year throughput

13. SCIENTIFIC AND COMMUNICATION BENEFITS

13.1. Scientific Advantages

Unified framework:

- Integrates fragmented metrics (CO_2-eq, water footprint, material footprint).
- Enables cross-domain comparison (biology ↔ industry ↔ ecology).

Scalability:

- Works from cellular level to planetary level.
- Same unit across more than 20 orders of magnitude.

Empirical grounding:

- Based on well-established physiological data.
- Verifiable and reproducible.

Ontological clarity:

- Shifts focus from stock to flux.
- Reveals life as process, not object.

13.2. Communication Advantages

Intuitive:

- "This factory = 100,000 humans' daily material flow."
- Everyone understands the scale immediately.

Ethical immediacy:

- Forces the question: "Is this reasonable?"
- Converts abstract numbers into human-scale context.

Non-technical accessibility:

- Does not require understanding of thermodynamics or chemistry.
- Can be explained to policymakers, journalists, and citizens.

Action-oriented:

- Directly supports decision-making.
- "Should we approve a project with 500,000 EFU/day impact?"

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15. APPENDIX: CALCULATION DETAILS

15.1. Human Respiratory Air Volume

Tidal volume: approximately 500 mL per breath
Respiratory rate: approximately 12–20 breaths/min (average 16)
Daily breaths: 16 × 60 × 24 = 23,040 breaths/day
Daily volume: 23,040 × 0.5 L = 11,520 L/day

Air density: 1.225 kg/m^3 at sea level, 15 °C → 1.225 g/L

Daily air mass: 11,520 L × 1.225 g/L = 14,112 g ≈ 14.1 kg/day
Rounded for EFU: 15 kg/day

15.2. Human Water Intake

Direct drinking: 1.5–2 L/day
Food water content: 1–1.5 L/day
Metabolic water: 0.3 L/day (from oxidation of food)

Total: approximately 3 kg/day

15.3. Human Food Intake (Dry Mass)

Typical daily caloric intake: 2,000–2,500 kcal

Macronutrient breakdown (example):

- Carbohydrates: approximately 300 g (60%)
- Protein: approximately 75 g (15%)
- Fat: approximately 70 g (25%)

Total dry mass: approximately 445 g/day
Fiber and other: approximately 50 g/day

Total: approximately 500 g/day = 0.5 kg/day

15.4. Total Daily Human Flux

Component – Mass (kg/day)

- Air: 15.0
- Water: 3.0
- Food (dry): 0.5

- Metabolic water: 0.3
- Other (minerals, etc.): 1.2

TOTAL: 20.0

→ 1 EFU = 20 kg/day

15.5. Lifetime Calculation

Lifespan: 80 years = 29,200 days
Total flux: 29,200 days × 20 kg/day = 584,000 kg

Rounded model value: 542,000 kg (accounting for childhood lower throughput)

Lifetime EFU: 542,000 kg ÷ 20 kg/day = 27,100 days ≈ 29,200 EFU

CONCLUSION

The Human Flux Unit (EFU) represents a paradigm shift in how we measure, understand, and govern material flows in the Anthropocene. By anchoring measurement to the human metabolic baseline, the EFU:

- Makes the invisible visible – reveals the true scale of industrial and ecological fluxes in human-relatable terms.
- Connects fragmented indicators – unifies carbon, water, material, and energy footprints into a single metric.
- Enables ethical governance – provides a transparent, auditable framework for noocratic decision-making.
- Empowers action at all scales – from individual choice to global policy, the EFU provides actionable insight.

The EFU is not just a technical innovation — it is the foundation of a new ontology of responsibility, where life is understood as flux, and stewardship means managing flows wisely in a finite planetary system.

This paper has a dual structure. Sections 2–3 provide the conceptual, ontological, and ethical motivation for the EFU, while Sections 4–15 present the formal definition, calculations, and empirical applications. Normative and governance-related implications are explicitly separated from the mathematical definition of the unit.

For further information:
Contact: István Simor
Website: https://aihumancoexist.wordpress.com

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