Theodore W. Hall

Theodore W. Hall was born in Michigan, USA. He earned B.S., M.Arch. and Arch.D. degrees in architecture at the University of Michigan. His professional career turned toward software development for computer-aided design, while he also maintains a long-term personal interest in space architecture, especially for artificial gravity for orbital habitats. In 1994, he accepted a post-doctoral fellowship at the Chinese University of Hong Kong (CUHK), developing software for scientific visualization and virtual reality in architecture. He has also had small teaching and research positions at the University of Hong Kong (HKU), Deakin University in Geelong, Australia and the New Jersey Institute of Technology in Newark, USA. He returned to the University of Michigan in 2009, where he is now a virtual-reality visualization specialist at the interdisciplinary Duderstadt Center.

He was a founding member of the Space Architecture Technical Committee (SATC) in the American Institute of Aeronautics and Astronautics (AIAA) and chaired the committee during 2010-2014. He also organized and chaired the space-architecture sessions at the annual International Conference on Environmental Systems, 2007-2010 and 2013-2014.

Let's try to put some numbers on this.

A) What is the mass of a human body?

I don't know if there are any data regarding an 'average' for all genders, races, ethnicities, ages (from infant to peak-fit young adulthood), across the Earth's entire population, so I will simply use my own mass: 82 kg

B) How many human bodies are currently living on Earth?

About 7,763,000,000 as of the moment I write this (2020-02-08).

https://www.worldometers.info/world-population/

C) Total mass of living human bodies:

82 × 7,763,000,000 = 636,600,000,000 kg

That's obviously an over-estimate since I'm a North American caucasian adult male.

D) Another estimate, from

https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-12-439

'In 2005, the total adult human biomass was approximately 287 million tonnes' = 287,000,000,000 kg

That's obviously an underestimate, since it's 15 years old and counts only 'adults'.

E) What is the mass of even a small ‘planet’?

The smallest known dwarf planet that meets all of the criteria for a planet (including ‘enough mass that its own gravity has pulled it into a spherical shape’) is Hygiea:

https://www.newscientist.com/article/2221288-surprisingly-round-asteroid-may-actually-be-the-smallest-dwarf-planet/

Properties of Hygiea, from Wikipedia:

https://en.wikipedia.org/wiki/10_Hygiea

m [mass] $= 8.32 \times 10^{19}$ kg
r [mean radius] $= (434 \text{ km})/2 = 217{,}000$ m
ρ [mean density] $= 1.94 \text{ g/cm}^3 = 1{,}940 \text{ kg/m}^3$
v [volume, sphere] $= \frac{4}{3}\pi r^3 = 4.28 \times 10^{16} \text{ m}^3$

F) How many times the entire current human mass is Hygiea?

Using the estimated human mass from (C):

$$\left(8.32 \times 10^{19} \text{ kg}\right) / \left(6.366 \times 10^{11} \text{ kg}\right) = 131{,}000{,}000$$

Using the estimated human mass from (D):

$$\left(8.32 \times 10^{19} \text{ kg}\right) / \left(2.87 \times 10^{11} \text{ kg}\right) = 290{,}000{,}000$$

So, even the smallest dwarf planet with enough self-gravity to form itself has between 131 million and 290 million times the mass of the entire current living human population.

G) How big would be a “planet” formed from all current living human bodies? First, let’s estimate the volume.

As a very rough estimate, let us assume the density of this ‘planet’ is the density of a human body, and about equal to the density of water: $1{,}000 \text{ kg/m}^3$

Using the estimated human mass from (C):

$$\left(6.366 \times 10^{11} \text{ kg}\right) / \left(1 \times 10^{3} \text{ kg/m}^3\right) = 6.366 \times 10^{8} \text{ m}^3$$

Using the estimated human mass from (D):

$$\left(2.87 \times 10^{11} \text{ kg}\right) / \left(1 \times 10^{3} \text{ kg/m}^3\right) = 2.87 \times 10^{8} \text{ m}^3$$

For a sphere:

$v = \frac{4}{3}\pi r^3$
$r = \sqrt[3]{(3v)/(4\pi)}$

Using (C): $r = 534$ m
Using (D): $r = 409$ m

So the diameter of a 'planet' containing the equivalent of all current living human bodies would be only about 1 km. Very tiny for a 'planet'.

H) How many times the entire current human volume is Hygiea?

Using the estimated human volume from (G) and (C):

$$\left(4.28\times10^{16}\ \text{m}^3\right)/\left(6.366\times10^{8}\ \text{m}^3\right) = 67{,}200{,}000$$

Using the estimated human volume from (G) and (D):

$$\left(4.28\times10^{16}\ \text{m}^3\right)/\left(2.87\times10^{8}\ \text{m}^3\right) = 149{,}000{,}000$$

I) Our mass ratio estimates in (F) above are between 131,000,000 and 290,000,000 Our volume ratio estimates in (H) are between 67,200,000 and 149,000,000 These are consistent with Hygiea having a density of 1.95 times the density of the body planet (which we initially estimated to be the density of water).

J) What would be the surface gravity on a planet 534 m in radius with a mass of 6.366×10^{11} kg (our biggest estimate for the body planet)?

Combining Newton's Laws of motion and gravitation, the acceleration due to gravity on the surface of this planet would be:

$a = \text{G}m/r^2$ [where G is Newton's universal gravitational constant]
$= 6.674\times10^{-11}\ \text{m}^3/\left(\text{kg}\cdot\text{s}^2\right)$ [= G]
$\times 6.366\times10^{11}$ kg [= m]
$/\left(534\ \text{m}\right)^2$ [= r^2]
$= 1.49\times10^{-4}\ \text{m}/\text{s}^2$

On Earth, the corresponding value – defined as 1 g – is $9.80665\ \text{m}/\text{s}^2$.

So, a human body based planet's surface gravity, even after accumulating all currently living human bodies, is only about
$1.49\times10^{-4}/9.80665 = 0.0000152$ g

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In conclusion, there aren't nearly enough human bodies to form a planet that will coalesce under its own gravity. We don't know that Hygiea is the smallest possible, but it's the smallest we've found, and it's several hundred million times as massive as the entire current supply of human bodies.

It would take some wild assumptions regarding human generations, human longevity and population growth to come up with any kind of estimate of how long it will take to produce 100,000,000 times the current number of bodies, but I think it will be a very long time.

I don't know everything that happens to an unprotected human body in the space environment, considering it would have to deal with vacuum, radiation, extreme temperature swings, micro-meteoroid bombardment.

I suppose that one of the first things to occur will be the vaporization of all of the body's water, due to the hard vacuum.

'Up to 60% of the human adult body is water.'

https://www.usgs.gov/special-topic/water-science-school/science/water-you-water-and-human-body

That mass will jet out of any available orifice or pore. The body's self-gravity will not be sufficient to restrain it. It will be lost to space, especially in the presence of the solar wind, which is known to strip the atmosphere from much larger 'planets'. The remainder of the body will be a desiccated husk, smaller and much less massive, but perhaps denser, comprising the dry mineral contents of the body. Over time I suppose this will be reduced to dust by the other space environmental factors mentioned above: radiation, bombardment by micro-meteoroids, temperature extremes between sunlit and shaded ares, and so on.

Over eons of time (the time it will take to replicate the human population 100,000,000 times), this dust might be attracted to other celestial bodies with a bigger head-start on planetary accretion.

Alternatively, the bodies might be cryogenically frozen and sent in protective insulated caskets to deep space beyond the asteroid belt where icy bodies can endure the Sun's distant glow. The bodies might retain their mass of water ice. The question then would be: how to separate the caskets from the bodies so as not to contaminate the purity of the body planet. The mass of caskets would exceed the mass of bodies and would be relatively more likely to coalesce into a casket planet (but still unlikely to do so anytime soon).

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I have not even begun to consider the mass of launch vehicles and propellant required to deliver that many human bodies (and caskets) to deep space – Jupiter, Saturn, and beyond. Launch vehicles are not huge just because rocket scientists love huge rockets. In fact, they are the smallest, least massive vehicles that engineers can devise to accomplish the delivery.

The cost – including vehicle and propellant manufacturing as well as mission control – would be enormous. Even the USA manages to launch only about one payload to deep space in a decade (e.g.: Galileo, Jupiter, 1989; Cassini, Saturn, 1997; New Horizons, Pluto, 2006; Juno, Jupiter, 2011). The vast majority of rocket launches are incapable of escaping Earth's orbit. Even lunar distance is rarely achieved.

The damage to Earth's environment as well as the human economy from dedicating the necessary resources to this endeavor would be untenable.

Judging from the population statistics at

https://www.worldometers.info/world-population/

about 135,000 people around the world will die today, comprising on the order of 10,000,000 kg of bodies to be delivered to deep space each and every day.

By comparison, the payload mass of the Juno probe now orbiting Jupiter was only 3,625 kg, whereas just the propellant for the first stage of the Atlas V launch vehicle to deliver Juno was over 284,000 kg.

https://en.wikipedia.org/wiki/Juno_(spacecraft)
https://en.wikipedia.org/wiki/Atlas_V

What would happen to the living people on Earth if 800,000,000 kg of rocket propellant were combusted in its atmosphere each and every day?