U-turn or u die

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In their explorations, they encountered life in many forms and watched the workings of evolution on a thousand worlds. They saw how often the first faint sparks of intelligence flickered and died in the cosmic night.

And because, in all the Galaxy, they had found nothing more precious than Mind, they encouraged its dawning everywhere.

Arthur C. Clarke, 2010: Odissey Two.

1 Who's the stonehead now?

A lot has been written about the tragic story of *Rapa Nui* (Easter Island). A thriving culture, capable of building hundreds of *moai*, the emblematic giant stone statues, which obliterated itself due to unsustainable practices, mainly deforestation and overpopulation. The people who cut the last palm tree on the island are often mentioned. Did they understand they were committing suicide? Or were they just too concentrated on other things which they misjudged as more important than trees?

The giant stoneworks which haunt the island don't look promising in that respect. One feels a strong temptation to associate them with the ecological disaster that destroyed Rapa Nui's civilization. Were those people so obsessed with building titanic stone heads that they didn't hesitate to murder their environment – and their society with it – to build more?

Figure 1: A moai from Rapa Nui (source: Flickr user TravelingOtter).

Several pieces of evidence frighteningly point in that direction. Virtually all of the standing statues have been toppled. Moreover only a quarter of the statues were installed, nearly half of them remained in the quarry. It looks like there was a fierce civil war in which people unleashed their fury against the statues, as if they were rebelling against the gods or authorities who let them down. And it looks like this was a sudden disaster that struck an unaware population. The Rapanui were in the process of building *three times more* moai than there were in the whole island: the peak of an exponential growth. And there is strong evidence that this cataclysm happened just about when the last tree was cut. Rapa Nui's history has attracted much interest in the last decades. It became popular because it sounds like a warning to our current civilization. It is not my job to argue about the similarities between that insular society and the modern global one, as it has been done very effectively by more authoritative

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voices [1]. The metaphor is clear: The Rapanui are us. The palm trees are our environment. The island is planet Earth.

But are we as foolish as the Rapanui? My present impression is that yes, we are at least as foolish and as capable of harming our island-planet. In fact, we have our giant stone heads, which we stupidly value more than the environment. You name it: nuclear submarines, financial services industry, fighter aircrafts, show business, intercontinental ballistic missiles... the list could continue forever. These are things which we value immensely – one could argue, given their monetary values, that they are the things we value the most, as a society. And yet their value for our survival as a species varies from virtually useless to outright menace.

We are not doing this in a moment of abundance, with vast resources at our disposal. For the first time in its history Western Civilization is starting to see the toll that its development (and human activities in general) has been taking on the planet. And it might already be too late.

Jared Diamond [1] lists 12 environmental problems which, if not tackled, will become critical within 50 years. Each one of them, if not solved, has the power, alone, to destroy our civilization:

- Deforestation/habitat destruction
- Soil erosion, salinization, fertility loss
- Water management problems
- Overhunting
- Overfishing
- Effects of introduced species on native species
- Overpopulation
- Increased per-capita impact of people
- Anthropogenic climate change
- Buildup of toxins in the environment
- Energy shortages
- Full human use of the Earth's photosynthetic capacity

It really looks like we're cutting our last tree, while obsessed with making war on each other, idolizing celebrities and people with obscene concentrations of wealth. Some of our grandest projects, like Dubai's themed housing mega-projects, risk lying unfinished in the construction site, gloomy monuments to futility in a world in ruins, like Rapa Nui's largest Moai shown in Fig. 1. I think it is fair to say that, with all our knowledge and technology, we are more of a bunch of stoneheads than the Rapanui.

2 Give me a reason

I have no original solutions to humanity's problems to offer in this essay, no more than all the people who devoted their life to saving us from ourselves. As Diamond [1] puts it:

> *We don't need new technologies to solve our problems; while new technologies can make some contribution, for the most part we "just" need the political will to apply solutions already available.*

My main goal in this essay is to present a different perspective on the issue. In particular, I will offer yet another *reason*, which is seldom thought of, why we should solve our environmental problems.

The passage from Arthur C. Clarke's *2010* I quoted at the beginning depicts an ancient and wise spacefaring civilization which, having gained an almost total control over matter and energy, considers life and in particular intelligent life the most precious thing in the Universe.

I'm not as enlightened as Clarke's ancient civilization, so the – probably real – superior value of intelligent life for our species is still not clear to me.[2] But I do clearly see the inestimable importance

[2] Maybe one day we will reach that stage at which we will understand the importance of intelligent life as well, and we will cherish, say, dolphins much more than caterpillars, *and not because they're more cute* (A/N: any reference to D. Adam's *The Hitchhiker's Guide to the Galaxy* is purely coincidental).

of life for our very survival. And I'm not talking about *any* life. I'm exclusively talking about the only kind of life that, by all chances, is useful to us: Terrestrial Life, namely life on Planet Earth.[3]

The main point I want to make with my essay is:

WHAT WE CONSIDER VALUABLE NOW, WE WILL LAUGH AT IN THE FUTURE.

this, of course, provided we survive. And the main conclusion I want to draw is:

WE NEED A U-TURN IN OUR COURSE, AND TO INVERT OUR SCALE OF VALUES.

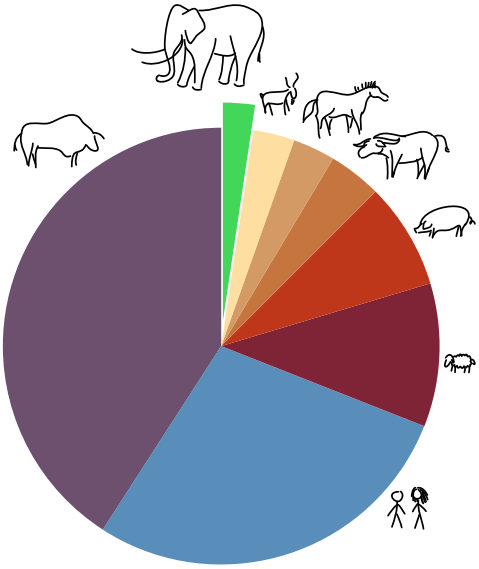

Figure 2: Pie graph showing the total mass of different land mammals. Wild mammals (represented by an elephant) represent only a tiny fraction of the overall mass, dominated by domestic animals and humans (source: explainxkcd and [2]). According to Smil [2] at the beginning of the 20th century the biomass of wild animals was equal to that of humans, while now it is less than one tenth.

The things we crave the most now are those things we believe bring us wealth. They are above all primary resources: oil and other fuels, radioactive elements, rare earths, ores, water. They are among the simplest compounds that matter can form. There is a precise reason for that: our backwardness. Our simple technology only allows us to extract energy or forge into building blocks very simple arrangements of matter. We've gotten progressively better at that, and we're still improving, but we're still hugely dependent on these simpler and more versatile states of matter. We have little use for more complicated naturally occurring compounds, like most rocks. And we have an almost complete disregard for the most complicated of all compounds: living matter. We have learned how to control a tiny fraction of it (domesticated plants and animals, and some bacteria and fungi, which represent a negligible portion of living species), but it appears we have little or no use for all the wild life. This is illustrated by the fact that we have replaced most of the biomass of land mammals on earth with domesticated ones (see Fig. 2).

Incidentally, these compounds we are obsessed with are extremely abundant in our Universe. Thanks to their simplicity, they are by far the most common things you can find in space: hydrocarbons are ubiquitous in the atmospheres of gas giants, rocky planets are teeming with heavy and radioactive elements.

We consider them precious because we're stuck on Earth, and we only have extremely primitive means of extracting them.[4] If we were smarter, we would have access to the cornucopia that is waiting up in the sky, and we would never think about poisoning our own land to extract any of that stuff. On the other hand, the living creatures we treat with such contempt here on Earth are very rare in the Universe. We have still no evidence of extraterrestrial Life, and even if most scientists would bet that it abounds in our Galaxy, we can be sure of one thing: it's by no means as abundant as the simpler inanimate compounds we're so addicted to. And the situation is, in my opinion, much more severe than that: if we restrict to *Terrestrial Life* (life as we know it on Earth), all the chances are that it's basically unique. You can forget about the little green men because, if life evolved truly independently on each planet,

[3] Extraterrestrial life, or life that evolved *independently* on other planets, won't share our basic biochemistry and will almost surely be either completely inert or utterly poisonous to us: imagine lifeforms which are based on arsenic, or the lifeforms that evolved on the surface of a neutron star described by R. L. Forward in *Dragon's Egg*. We won't be able to integrate with an extraterrestrial living environment, and we better stay away from it.

[4] In most cases we just dig giant holes in the ground, grind the rocks we find, and filter the desired material away, devastating the environment in the process and leaving an incurable wasteland behind.

there won't be anything like that out there in the Universe. Extraterrestrial life will be wildly different from what we're used to. I'm sure that, in its beauty and strangeness, it will beat by a long shot our craziest imaginations. This is what Nature always does when she lets us peek through her mysteries. And with all that strangeness, incompatibility will come. I'm convinced that extraterrestrial life will be so radically different from what we're used to that, for the purposes I'm considering her it will also be utterly useless to us. So here comes the consideration that motivated this essay:

Terrestrial life is effectively UNIQUE in the Universe.

So here's my thought: aren't we squandering, simply through ignorance of its objective value, a very precious resource in which we were initially immensely rich?

3 The objective value of Terrestrial Life

Of course there is no surprise in this 'inversion of values' that holds sway in our current society: as Adam Smith put it [3]: *The real price of every thing, what every thing really costs to the man who wants to acquire it, is the toil and trouble of acquiring it.* In the last century, the primary resources we depend on have been very hard to get hold of, while wild animals and plants were abundant and pervasive, and nobody saw much use in them. Should we grow out of our infancy and reach for the stars (or at least the Solar System), the immense disparity in abundance of those resources compared to Terrestrial Life is bound to shift the balance of value in favour of the latter. This just out of sheer scarcity, even if we remain blind to the "use value" (to keep using the economic language) of life.

But the situation is actually different, as I will argue now:

If we survive the ensuing threats to civilization and we become a spacefaring species, the utility of Terrestrial Life for us will become immense.

To conquer space, we will need habitable planets to spread to. Potentially-habitable planets won't look at all like immense prairies teeming with native populations to mass-murder and bisons to kill and replace with cattle. They will look more like this:

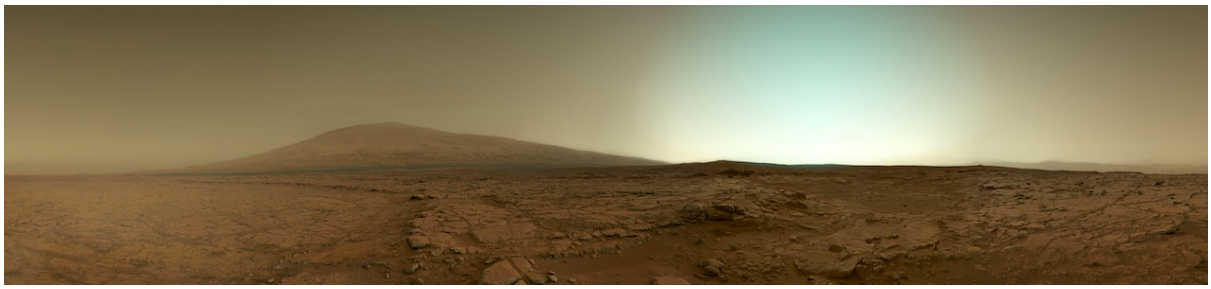

Figure 3: *Curiosity*'s picture of twilight on Mars (Image courtesy: NASA).

Mars is a terrible place to live, at the moment. But if you exclude the Earth, it's probably among the best places for us in the Universe. It is this sort of planets we will be looking for when we'll be searching for new homes. We won't go after the planets with life: as I said, they will be full of life-forms with a totally incompatible biochemistry, likely poisonous to us. You don't want to eat a silicon-based fruit, or breathe sulphur dioxide. If we were to turn an already-inhabited planet into an inhabitable place for us, we would be forced to completely sterilize it, killing every living thing in the process, and bring it back to a state similar to that of present-day Mars. Our best choice, instead, is to go for planets in

the 'Goldilocks zone'[5] with sufficient mass to retain a long-lived atmosphere, with little or no native atmosphere and with a readily-accessible source of water in great amounts.

On this sort of *tabula rasa*, the humans of the future will first have to install an atmosphere and oceans, and then build an ecosystem from scratch. If the first task looks titanic to the contemporary eye, the second one is gargantuan. The challenges posed by a fundamentally alien environment to Earthly organisms are such, and the variables involved are so many, that this endeavour requires a much more mature science than ours. For such a feat, a vast choice of tools is absolutely necessary.

Fortunately, we have at our disposal in this very moment on Earth the most amazing collection of such tools, featuring more than 5-10 million (some say 100 [4]) different instruments. This super Swiss army knife is our ecosystem, and the tools are the species of living organisms that compose it. Given a virgin planet, we could play endlessly putting together all sorts of Terrestrial species to try and form a functioning ecosystem that adapts well to the conditions on that planet. If, in a far future, we manage to master this complex art, no one can predict now what sorts of organisms living today will turn out to be useful – or even essential – for the survival of those engineered worlds. Earth will be an invaluable repository of genetic diversity, and virtually all the species presently living here are sure to find an application, sooner or later, somewhere in the Galaxy.

So we need to save the biodiversity of Earth. But, tragically, we've been doing exactly the opposite for a long time. We've been blindly wiping out our ecosystem since the recent advances in our hunting techniques, which took place 50,000 years ago. And we've been doing it at an ever-accelerated pace: We've already extinguished virtually all of the megafauna in 4 continents out of 5, and one half of Earth's higher forms are expected to get extinct within 100 years [5]. According to May [4]:

> *recent extinction rates in well-documented groups have run 100-1000 times faster than the average background rates. This is the same acceleration in extinction rates as characterizes the Big Five episodes of mass extinction in the fossil record. And four different approaches to estimating impending rates of extinction suggest further acceleration by a factor 10 or more.*

Maintaining the biodiversity of planet Earth is one of the necessary conditions for our success in the colonization of space. We've been wasting this biodiversity to such an extent that we are at risk of losing it completely in a few decades. All evidence at this stage suggests that we've already triggered the Sixth Mass Extinction in the history of Planet Earth.

4 Что делать? (What is to be done?)

After such a pessimistic note, I want to conclude this essay with a bit of hope. If I were convinced that everything is lost, there would be no point in writing this essay.

I explained in the last two Sections why we should preserve biodiversity, as it will be our most precious legacy to future generations trying to colonize other planets. I will now stress some things we should do, in my modest opinion, to avoid the ecological disaster we are facing. I will conclude with a picture of the kind of society we should be working to create, one in which biodiversity is kept as the most cherished treasure for the use of future generations.

So I think there is still hope, but, as my title suggests, we need a sudden and dramatic change of course. It's absolutely not enough to gently adjust our trajectory, as most lawmakers seem to believe. It's not even enough to hit the brake: even if our development came to a full stop now, that would probably not arrest the ongoing ecological collapse. We need to make a U-turn, and start operating actively to heal our environment.

[5] The region around a star within which planets with sufficient atmospheric pressure can support liquid water at their surfaces.

Most ecosystems are already compromised, some of them irreversibly. On most of them (think about the oceans) we have little or no data. They are collapsing, and in most cases removing the original causes of their deterioration won't prevent, at this point, their demise. We need to learn how to *rebuild* them, understand their workings and fix the weak links of their ecological networks. This task requires an immense amount of work, both theoretical and applied. Considering what is at stake, it is just staggering that we are not already investing most of our resources on this. By contrast, the vast majority of our resources are devoted to building our modern versions of moais. Our task is not only difficult: it's also dangerous, because we need to make a U-turn at full speed, and there is a serious risk of losing control of the vehicle. Tampering with the ecosystem without the right knowledge might do more damage than good. But we have no other choice: we have one chance, and we better get it right.

Reduce our impact

Population growth is often cited among our worst problems. While it is certainly true that we're still growing and this is a factor in the increase in our impact on the planet, at this point it is not the most important factor anymore. In fact the last decade saw *"a 'tipping point' in our demographic history: the planet's average woman is having almost exactly one female child [...] if indeed fertility rates continue at replacement levels the population will continue to grow, to some nine billion or so, before possibly coming to equilibrium around 2050"* (from [4]).

The population growth problem is being tackled, and that's good news. But the burden we are putting on the planet's ecological resources is still growing at an alarming rate. In Fig. 4 (left) I show an estimate of WWF's indicator called 'Ecological Footprint' of humanity, expressed in terms of the number of Planet Earths that would be needed to stably sustain human consumptions. It was already well above 1 Planet Earth in 2002.

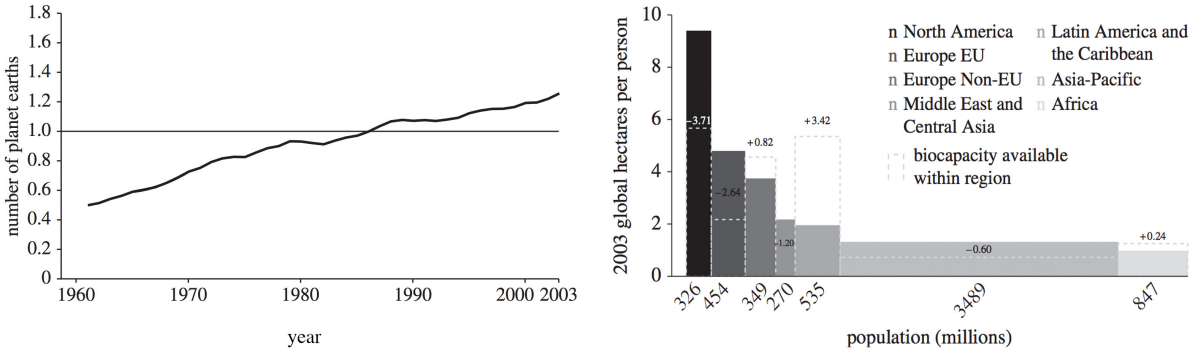

Figure 4: (left) Estimated "Ecological Footprint" of the human population between 1960 and 2003. This indicator measures the global hectares of land that are needed to sustain the human population at its actual consumption levels. This graph is expressed in units of the total capacity of planet Earth [6]. (right) Ecological Footprint in 2003 of each of the planet's major geographical regions, expressed in global hectares per person. The horizontal axis represents the populations of those regions, and the rectangular areas gives the total Ecological Footprint per person. The dashed rectangles represent the maximum capacity of each region [6].

What we really need to do is to reduce the *per-capita* burden on the environment, starting with already-developed countries. In Fig. 4 (right), again from WWF, I show the Ecological Footprint of different macroregions, compared with their capacity. It is clear who is living above their possibilities. The main emergency, at the moment, is the increase in consumption of developing economies. These people aspire to reach the living standards of the European Union or North America, with corresponding levels of consumption and waste. They are getting there at an alarming speed. As Diamond [1] wrote in 2005: *"Even if the people of China alone achieved a First World living standard while everyone else's living standard remained constant, that would double our human impact on the world"*, and that figure

goes up to *12 Earths* if all of the population of what used to be called "The Third World" adopted "First World" living standards.

Nobody in the west is entitled to blame China or Brazil for aspiring to an unsustainable lifestyle, as long as North America and the EU keep exploiting, respectively, 3.7 and 2.6 hectares per person more than the maximum they would be entitled by their land (cfr. Fig. 4). It is therefore in the western world we need to intervene more urgently, starting with North America, by far the biggest waster. If we find a viable compromise between wealth and sustainability in this region, this would set forth an example for the kind of development that other regions ought to pursue. Again, it is not my job here to offer a solution, other people have done a much better job over many years than I could possibly do here.[6] Moreover, there is no one-stroke solution: the problems are complex, and the number of different interventions needed is large.

It is true that a lot has been done, in western countries, since the 70's: for example the emissions of internal combustion vehicles have been hugely cut, the oil industry has reduced its impact,[7] the management of waste and garbage has improved a lot, and the overall ecological awareness of people has increased from zero to something. However, people are still not properly informed about what needs to be done, there is only a generalized awareness of impending disaster. The U-turn I'm advocating must be first of all in mentality. For example, North America is still a huge consumer of meat, which is an extremely inefficient source of sustainment because all the land we use to raise cows and other livestock could be used to support much more people if devoted to purely arable farming (without mentioning all the damages that grazing livestock imparts to the soil and wildlife). Meat is extremely cheap in this historical period because it is being mass-produced with industrial methods.[8] But this underpricing is an artifact of the temporary 'inversion of values' we're living with. If we attributed a more reasonable value to land, ecosystems and resources, meat would be a luxury good. And that would actually be a good thing: the meat-based diet of Northern Americans is very unhealthy, supporting the largest concentration of obese people in the world.

Here's a radical proposal, which might turn out impossible to realize, on how to reduce our Ecological Footprint, improve our health and quality of life, and the beauty of our lands: let's give up animal husbandry altogether. I'm not advocating an impossible mass-conversion to vegetarianism: we would still be consuming meat, but only game meat. It seems very unlikely that people would accept this. And yet our ability to adapt to radical changes will determine our chances to survive the incoming crisis.

Let's all become Tikopians

In his book *Collapse*, Jared Diamond mentions some pre-industrial societies which, out of trial-and-error and a good deal of luck, managed to solve their ecological problems. One of the most striking examples is a tiny Pacific island called Tikopia, isolated by hundreds of miles of ocean from the nearest land. With less than 5 square kilometers of surface, Tikopia supported a population of 1,200 people (very dense for a pre-industrial society) continuously for almost 3,000 years. Here is Diamond's description of the island:

> *As you approach Tikopia from the sea, the island appears to be covered with tall, multi-storied, original rainforest, like that mantling uninhabited Pacific islands. Only when you land and go among the trees do you realize that true rainforest is confined to a few patches on the steepest cliffs, and that the rest of the island is devoted to food production. [...] This whole multi-story orchard is unique in the Pacific in its structural mimicry of a rainforest, except*

[6] Just take a look at WWF's website, John Baez's Azimuth Project, or the Worldwatch Institute to mention some.

[7] Unfortunately we cannot say the same about all kinds of extraction industries.

[8] Many people are distressed by the industrial methods of producing meat: meat factories and industrial butcheries look a lot like the animal version of Nazi extermination camps. I might be sympathetic with these feelings, but I think we have a much better basis than the moral one to argue against these practices.

that its plants are all edible whereas most rainforest trees are inedible. [...] Sustainable exploitation of seafood resulted from taboos administered by chiefs, [...] (which) had the effect of preventing overfishing.

Tikopians traditionally maintained their population stable by means of contraception, abortion, infanticide and ritual suicide (or emigration by sea, which was virtually equivalent to suicide). The arrival of Europeans introduced religious or cultural taboos against most of those practices and triggered an overpopulation crisis and consequent famine in the 1950s. After that,

...Tikopia's chiefs limit the number of Tikopians who are permitted to reside on their island to 1,115 people, close to the population size that was traditionally maintained by infanticide, suicide, and other now-unacceptable means.

The Tikopians successfully went through the U-turn and inversion of values I'm advocating. They started practicing slash-and-burn agriculture, overexploitation of bird and marine life and damaging pig farming. Gradually, over thousands of years, they learnt to carefully safeguard wildlife, they decided to slaughter all pigs and they stopped destroying the forest, make it instead into their primary resource. We need to find a way to do the same on a much larger scale: our values need to be aligned with the factual importance that the different resources have for our survival. Fostering the regrowth of our biosphere must become economically advantageous, the wealth of the people must turn into a synonym of the health of their environment. To do so, we don't have millennia like the Tikopians. We need to be swift. You decide. You turn, or you die.

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Technical endnotes

On the feasibility of surviving without Nature

Reading my Section 3, one could be tempted to object: a future version of humanity so advanced that it moulds entire planets according to its needs surely won't depend on animals and plants for its sustenance! This, I think, is a misconception, fueled by decades of science-fiction which has accustomed us to expect marvels like synthetic food, self-aware robots, living creatures created genetically from scratch. These things are not impossible, but at the moment they definitely belong to the realm of the imagination. For example, in 70 years of research on Artificial Intelligence, we have made little progress since Turing's groundbreaking work. Similarly, our understanding of the workings of life is extremely rudimentary: even the simplest cells are an absolute conundrum, and we are just starting to make the first timid steps towards engineering a cellular membrane. It can probably be done, it will just take a very long time to understand how. Terraforming a planet, in contrast, requires less of a conceptual breakthrough, and could well be within the possibilities of the humans of tomorrow. Creating a biosphere will then be the next step. Every species, including ours, is defined by the complex and fragile interrelations that it maintains with its environment: from the viruses, bacteria and protozoa to the flora and fauna that surround it. Its survival depends on its equilibrium with this environment. It's not only the chemicals that are provided by exchanges with the environment: think about the fact that bacteria in our bodies outnumber human cells 10 to 1, and we depend on them in ways that we haven't completely understood yet. Our success in colonizing most regions of the Earth has given us a false sense of omnipotence, as if we could free ourselves from the bonds that tie us to our Terrestrial environment and reach for the stars, providing for all our needs on our own. This is plain wrong: our diffusion over the five continents proves nothing about our ability to adapt to them. We colonized most of these lands without finding sustainable practices to provide for our needs, and if we keep our present course we will rapidly get extinct in most of these regions, which cannot really support us. We're like bacteria in a petri dish that experience an exponential growth and assume they will do so forever. We badly need to learn how to survive – stably – on Earth, and only then we might look up towards our natural destiny: the stars.

On abandoning animal farming

We could forbid the breeding of domestic livestock (or impose exorbitant taxes on it) and get all the meat from hunting wild animals in the forests. If we do a good job in recovering wild ecosystems, the forests will be able to sustain a reasonable, although greatly reduced, production of meat. Hunting will be necessary in any case to correct the unbalances and keep the ecosystems stable. The meat produced in this way would be way less, and consequently way more expensive. But hey, it's a luxury you have to pay for, and it's even bad for you. We consider acceptable to impose crazy taxes on cigarettes. I don't see the difference with heart-disease-causing meat. The current average per capita meat consumption in the US is a disturbing 377 grams/day of beef, pork and poultry (2009 data), of which 191 g come from beef and pork alone [7]. I must remark that there is a lot of pressure, nowadays, on nutritionists trying to curb the consumption of red meat in the west. To me there is absolutely no controversy about the superiority of a low-meat diet, as is proven by the better health performance of countries that rely mainly on fish proteins like Japan, or champions of the Mediterranean diet like Italy.

Of course hunting should be strictly regulated (as it already is to a large extent, in western countries); we cannot allow our forests to be subject to the same ruthless overexploitation that is devastating the oceans. Actually we should apply worldwide severe regulations on fishing as well. The European Union is moving in the right direction by imposing fishing quotas, but these measures remain insufficient, with quotas set well above the levels recommended by scientists (source: The Guardian).