HUMAN NEEDS

I am sure you are reading this (or listening to it) because you are not afraid of a sudden lack of breathing air, and it is not long ago that you ate and drank something. Only people with their basic needs satisfied, bother to think about 'human needs' (desperate persons have to act without much thinking): *primum vivere, deinde philosophare*.

Once material needs satisfied, we may discover some intangible needs, like being valued by others, and self-esteem (Fig. 1), although it is sometimes difficult to discern the difference between needs and wishes (in traditional economics, needs are what clients demand). In some cases, even the differences between material and spiritual needs are not clear; e.g. people's migration towards large cities accounts for material or for spiritual development?

Human needs can be sorted from the most basic and immediate, to the most ambitious, according to the classical Maslow's pyramid (A. Maslow, 'A Theory of Human Motivation', 1943); in a simple classification:

1. Physiological needs, from breathing to reproduction.
2. Emotional (affective) needs, from simple achievements to loving and being loved.
3. Transcendental needs, from work (as personal achievement to posterity, not as a paid employment), to understanding the world around us (and our place in it).

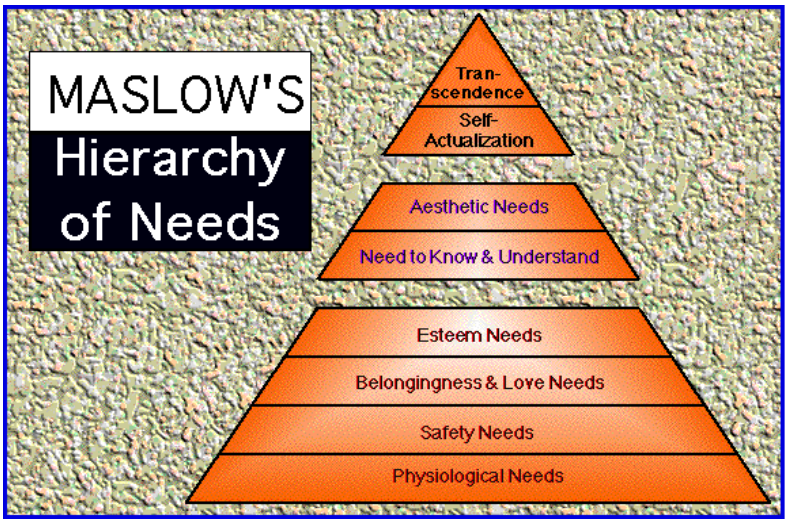

Fig. 1. Maslow's hierarchy of human needs.

There is a natural human tendency to struggle on for higher levels in this scale, once the lower levels have been satisfied (which is not always the case). Human Rights Declaration strives after setting universal rules allowing the realisation of all these stagess.

Concerning material human needs, which we must procure from our environment, some general requirements must be taken into account:

- Security of supply. Humans need some confidence on the availability of resources, e.g. on having some stock for the immediate future; people without future often become violent.
- Economy of supply. Humans which cannot afford basic goods and services tend to rebel and fight.
- Safety of supply. Humans do not expect to bear high risk by satisfying basic needs, not just personal physical damage, but neither a compromise on other basic needs; i.e. one expects clean

air, potable water, low voltage electricity, safe gas piping, etc. Although no so apparent, long term safety also means environmental sustainable supply.

Although we assume the natural environment on Earth by default, human needs become more apparent in closed artificial environments (from a submarine to an astronaut suit).

Basic physiologic human needs are food + oxygen + water as input, and CO_2 + water (in breath, urine, perspiration, and faeces) + solid waste + contaminants (chemical and microbial) + heat, as output, in addition to adequate environmental conditions (atmospheric pressure and temperature, protection against ionizing radiations, and so on). Basic material needs are:

- Air. Adults breathe some 0.5 L of air (up to 2 L in deep gasps), and the rate varies from 12 breath/min at rest to 120 breath/min on panting. Notice that this 0.5×(12/60)=0.1 L/s per person is just breathing air; but we need some 50 times more (5 L/s per person) for ventilation indoors. Notice that we can store nutrients (fuel) but not oxidants (oxygen), so that we can pass days without eating, but we die in a few minutes without air.
    - Intake composition (fresh air) is 77% N_2 + 21% O_2 + 1% H_2O + 1% Ar + 0.04% CO_2. Pressure and oxygen fraction are important because what matters for species flow is chemical potential, depending on their product, known as partial pressure: $p_{O2} \equiv x_{O2} p$. Safe range for oxygen is p_{O2}=18..40 kPa. Hyperoxia at p_{O2}=100 kPa causes chest pain in half the population after few hours, and develop pulmonary oedema after one day. Hypoxia provokes muscle fatigue if p_{O2}<18 kPa, dizziness and faint (loss of consciousness) after 5 minutes if p_{O2}<10 kPa, and quick death in 5 minutes if p_{O2}<5 kPa. For carbon dioxide (with x_{CO2}=390 ppm in the open air and 0.1% in typical ventilated rooms), safe range is p_{CO2}<1 kPa, or 1% at standard pressure, with p_{CO2}=3 kPa producing headache, and p_{CO2}>10 kPa being deadly in minutes by blocking blood decarboxylation). In a purely nitrogen atmosphere, oxygen flow is reversed in the lungs and loss of consciousness follows within seconds.
    - Exhalation is 74% N_2 +17% O_2 +4% H_2O +1% Ar +4% CO_2, corresponding to 1 kg/day of CO_2 + 0.5 kg/day of H_2O (net oxygen consumption is 0.8 kg/day). Basic metabolism is glucose reaction with 400% excess air: $C_6H_{12}O_6+5\times(6O_2+3.76N_2)=6CO_2+6H_2O+24O_2+112.8N_2$. Expired air can be assumed saturated at the exit temperature, which can be approximated as 37 ºC minus 0.2 ºC per ºC of ambient-air coldness relative to 37 ºC (e.g. for ambient air at 10 ºC, exhalation is at $37-0.2\cdot(37-10)=31.6$ ºC).
- Water. Adults need some 3 L of potable water per day (less than 1 g/L TDS). Intake is 2 L with drinks, and 1 L with food. Outflow is 1.5 L with urine, 0.7 L with transpiration, 0.5 L with respiration, and 0.2 with faeces (there is some 0.2 L of net water outflow by metabolic production). In very hot and dry situations, adults may drink up to 15 L of water. Additionally, water is the best cleaning agent for hygiene, but the needs in this case are dependent on habits, from <1 L/day to >100 L/day. There is a 30 L/day allowance per person on the ISS. (We spend 150 L/day per person in Madrid.)
- Food. Adults need some 0.6 kg of dry food per day (some 2 kg/day including water content). In the context of environmental science, it is worth recalling that humans, as animals we are, feed from other living matter.
- Heat release. Adults basal metabolic rate is around 1 W/kg (some 70 W for a 70 kg person), being nearly double for children and nearly half for elders. See Human thermal comfort, aside.

Natural human needs are changing with human progress, from survival tasks to intellectual activities. Needs are no longer limited to water and food availability (procurement and storage), and shelter against bad weather and enemies; it is nowadays harsh to renounce to sanitation systems, health care, education, electricity, individual mobility (private car), air conditioning, global instantaneous communications (TV,

cell-phone), etc. Astronaut allowance at steady-state is 30 kg/day of input, including basic ingesta (5 kg/day for oxygen, water, and food) plus ancillary conveniences (washing water, cleaning paper, containers...); of course, long journeys require reprocessing (we master gas recycling, and are approaching good liquid recycling, but lack solid recycling knowledge), or finding new sources.

In the beginning, individual and family needs for resource access and waste disposal were solved by roaming (nomadism). When sedentariness began with the Neolithic Revolution around 8000 BC, civil engineering had to be developed to procure water supply, sewage, and landfill management. War sieges and shipping forced the development of water purification processes. Another major change took place around 1800 (just two centuries ago!), when the steam engine liberated men from the hardest physical efforts, and substituted animal power and the small water and wind mills by the high power of fire (Industrial Revolution). Electricity, this convenient energy carrier, has become an imperative need in developed societies (elevators, computers, air conditioning...), in spite of the fact that we lived without just two centuries ago (and there is still a fifth of the world population without electricity as for 2015). Human energy needs are presented aside. An adequate supply of energy, water, and food, is a major challenge. At present, a small fraction of the world population (7000 million in 2011) is consuming a large share of world resources, but this is an untenable situation: people wellbeing is a necessity for peace and development (the most in a global society).

Mining, subaquatic activities (submarines, diving), and aeronautics have developed air revitalization systems, and space travel has already added water revitalization, and is pursuing a full close life system. It is important, however, that all this artificial-environment developments are costly in economic terms, and dangerous in terms of dependence and accidents.

Notice how societies with different levels of development have different perspectives on how to raise their quality of life:

- In developed-societies, major problems are health (heart stroke, hypertension, obesity...), security (terrorism, arms control, strikes...), environment (global warming, urban pollution...), infrastructure damage (electricity blackout, bad weather...).
- In developing-societies, major problems are health (AIDS, malaria, hunger, unsafe water...), security (wars), environment (lack of water, sanitation, and infrastructures, floods and draughts).

Natural resources may be scarce at the origin or because of depletion. But, what is actually depleted or consumed? Oers et al. (2002) defined consumption as "the decrease of availability of the total reserve of potential functions of resources". Air has been traditionally taken as free-available; water has always had a cost (although low in most cases); other natural resources have always demanded considerable human effort: food and clothing procurement, shelter building...

All environmental problems may be interpreted in economic terms. Economics is the social science of how people get a living, i.e. how people make choices for the allocation of scarce resources (production and consumption of goods and services) to satisfy their (unlimited) needs (desires), and the analysis of the commercial activities of a society to that end (only the most primitive tribal groups lack commercial activity).

- Economic activities (economic sectors):
    - Primary sector or extractive industries: fishing, hunting, recollection, quarrying, agriculture, cattle, mining. The major human development in this respect took place at the Neolithic Revolution in the 8th millennium B.C., with the change from nomadism to sedentarism.
    - Secondary sector or industrial manufacturing and construction. The major development in this respect took place at the Industrial Revolution in the 19th c., when subsistence farming

and handicrafts gave way to large scale manufacturing. However, the continuous decrease in price of manufactured goods, and the increase in labour cost, has yield consumerism and quick obsolescence (e.g. it may cost less to buy a new washing machine than to make it repaired), with major impact on the environment.
    - Tertiary sector or services: commerce, education, health, communications, and entertainment. The major development in this respect took place at the Information Revolution at the end of the 20th c.
- Economic factors (factors of production):
    - Natural resources (water, air, soil, fuels, minerals, flora and fauna...).
    - Human resources (labour and know-how).
    - Capital (human-made inventory stock: tools, machinery, buildings...).
    - Credit (finance and confidence).
- Economic markets (a market is the location or virtual place where the competition for maximum benefit at minimum cost takes place, i.e. where demand and offer meets; price is the value that equilibrates offer and demand):
    - Goods market (goods and services). Price of goods and services is the worth (in monetary units) at which a good or service can be bought or sold in a market.
    - Monetary market (or financial, or money market). Price of money is the worth of credit (the interest rate on lending).
    - Labour market (or sectors market). The price in this market is the salary paid by employers to employees.

Traditionally, consumer-economics has relied on price as the natural stabiliser between demand and offer: the more scarce a product is, the more expensive it becomes. The extension of this market-approach to environmental economics is the "the more you pollute, the more you have to pay", but problems arise when defining rights (e.g. smoking, mobility), responsibilities (e.g. who is responsible of urban congestion, of the loss of biodiversity), and damages (e.g. the cost of an oil spill remediation). As individuals, people tend to keep up a false appearance (politeness) to feel better, and to give better impression to the others: sharing resources, keeping cleanliness, renouncing to violence…, all are subscribed phrases, but we get mad when resources are scarce, and individuals have different acceptance levels for damage to oneself and damage to others: we all accept that rubbish is inevitable, but 'nimby' (not in my back yard).

And there are some human needs so broad or transcendental that they are most difficult to quantify in economic terms. For instance, biodiversity: Why it is so important?

- Biodiversity has been globally beneficial in the past. It is true that we had to fight for survival against wild beats, but we were able to select the best vegetal crops and animal breeds and go through the Neolithic Revolution to a more relaxed sedentary living standard in cities. And we will always need guinea pigs to try risky medication and surgery, before tests on human subjects.
- Biodiversity has always provided most of our medicines (analgesics like quinine, antiseptics, antibiotics...), and a lot of valuable materials (e.g. rubber and natural fibres).
- Biodiversity has shown to be the key to nature's resilience, i.e. the capacity of ecosystems to absorb large disturbances without breaking down.
- Biodiversity is the repository of life's knowledge (which we still ignore); it is for our own sake that we should preserve this living encyclopaedia to our descendants (furthermore, ethics prevent us from causing undue damage).

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