CONTRIBUTIONS to SCIENCE, **7** (1): 51–55 (2011)
Institut d'Estudis Catalans, Barcelona
DOI: 10.2436/20.7010.01.108 ISSN: 1575-6343
www.cat-science.cat

Celebration of Earth Day at the Institute for Catalan Studies, 2010

The immediate future: Challenges and scales*

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Resum. Les noticies emmascaren la informació i l'excés d'informació sense jerarquitzar dificulta el coneixement. La societat de la informació no ens porta a la societat del coneixement; i sense coneixement no hi pot haver projecte. Això és inquietant en moments de crisi de model, i d'aquí ve la necessitat de destriar els reptes categòrics de les alarmes anecdòtiques i d'ubicar-ho tot plegat en una matriu topològicament i escalarment adequada. Que és i que no és un repte, segons el bon criteri sostenibilista? Alguns dels reptes més destacats, i als quals caldria prestar realment atenció, son: el canvi climàtic, l'esgotament energètic, l'erosió genètica, les consecucions de la bioenginyeria, l'explosió demogràfica i les migracions, la globalització econòmica, les deslocalitzacions o migracions industrials, la configuració de la societat del coneixement, la creixent banalització de la cultura o l'auge dels fonamentalismes; en definitiva, l'esgotament del model industrial que ha presidit el pensament —l'occidental, si mes no— en els darrers dos segles. La dimensió escalar, en l'espai o en el temps, es diferent per a cada una d'aquestes qüestions. A la dificultat d'identificar-les i jerarquitzar-les, s'hi afegeix la d'escalar-les convenientment: quina dimensió i transcendència espacials tenen i en quin moment temporal s'expressen. La bona gestió de les diferents escales dels diferents reptes es un repte en ella mateixa, potser el mes gran de tots.

Paraules clau: dimensions escalars · reptes categòrics · societat del coneixement · relació cost-eficàcia · eficiència · valor dels serveis socio-ambientals · sostenibilitat global

Abstract. The media obscures information, and a surplus of information with no hierarchy hinders knowledge. The Information Society is not leading us to the Knowledge Society, and without knowledge there can be no future planning. This is disturbing at a time of crisis; hence the need to distinguish categorical challenges from anecdotal alarms and to place all information within a matrix with the appropriate topology and scale. What is and is not a challenge, using a sound sustainability criterion? Some of the most important challenges, and the ones which truly deserve our attention, are climate change, energy depletion, genetic erosion, the consequences of bioengineering, the demographic explosion and migrations, economic globalization, outsourcing or industrial migration, the shaping of the Knowledge Society, the rising banalization of culture, and the rise in fundamentalisms; in short, the exhaustion of the industrial model that has prevailed in thinking—at least Western thinking—over the 19th and 20th centuries. The scalar dimension, in space or in time, is different for each of these matters. The difficulty of identifying either one and of placing both within a hierarchy is accentuated by the challenge of scaling them properly: Which dimension and spatial transcendence do the challenges have? And at what moment in time are they expressed? Sound management of the different scales of the different challenges is a challenge in itself, perhaps the greatest of all.

Keywords: scalar levels · categorical challenges · knowledge society · cost-efficacy ratio · efficiency · value of socio-environmental services · global sustainability

The media obscures information, and a surplus of information with no hierarchy hinders knowledge. The Information Society is not leading us to the Knowledge Society, and without knowledge there can be no future planning. This is disturbing at a time of crisis; hence the need to distinguish categorical challenges from anecdotal alarms and to place all information within a matrix with the appropriate topology and scale, if we truly want to make headway towards technologically and scientifically solid, and socially desirable, sustainability.

Scalar levels

The scale of a phenomenon reveals not its size but its character. An expanded map is not a floor plan; it is only a large map. Floor plans include details, while maps do not. Driving on the motorway with the floor plan of a flat is futile. This is why we must be aware of the large scale of a map when talking about the territory, and of the small scale of a floor plan when talking

* Based on the lecture given by the author at the Institute for Catalan Studies, Barcelona, on 28 April 2010 for the celebration of Earth Day at the IEC (*2a Jornada de Sostenibilitat i Canvi Climàtic*).

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about the personal sphere. Shifting from one dimension to the other easily and proportionally is crucial for moving consciously. The time scale matters, too. Not everything happens at the same time. We laugh quickly but grow slowly. Laughter comes after tears, without the child having grown. Each phenomenon has its *tempo*. The vast quantity and diversity of challenges that humanity is facing today necessitate the capacity to identify the proper scale for each situation.

There is no need to falsely re-scale a given phenomenon so that it does not exceed the dimensions of the territory in question; rather the way to address it should be determined at the supra-territorial scale if this is its real scale. A comprehensive presentation of the different phenomena characterizing a territory requires the simultaneous use of different scales, meaning that a given space is fully represented not by a single map or floor plan but by a coherent series. Phenomena on the correct territorial scale should induce equally appropriate sub-phenomena on the local scale. Environmental variables often need to be evaluated at different scales before a decision is made. In any event, the problem is not improper representation, but a misunderstanding of the phenomena that are improperly represented. This distinction is particularly important in the case of human communities with a small qualitative dimension, such as Catalans. Indeed, the modest dimension of Catalonia's territory as a whole, not to mention its small regions or counties, leads us to consider far-ranging questions as if they were phenomena understandable at much smaller scales. This has highly negative consequences when making planning or management decisions.

The increasing intersection of different analyses and projections often entails working simultaneously with phenomenogically different categories, which poses a problem of scale compatibility. As one of many examples, we could cite the case of biological corridors or connectors, which make no sense without their proper large macro-territorial scale, but which cannot be properly planned unless planning takes place on the medium or small micro-territorial or even biological scale. Space, therefore, presents a scalar sub-dimension, which means that time, space, and scale must all be taken into account in territorial planning.

Biological corridors, which are perceived as extremely important by land planners, are considered irrelevant in the eyes of energy strategists. This is understandable: they operate at different scales. This means that there is also a perceptive scale, regardless of the nature, dimension, or transcendence of a given phenomenon. This is not a minor issue, because perceptions condition decisions. Here, the media play a crucial role because it triggers perceptions and modifies the perceptive scales of public opinion. In short, regarding the issue of scale, we must consider not only space (dimension) and time but also the societal perception of the phenomena being considered. In a world with globalized news reporting, this has become extremely important. To accomplish this, we must be capable of distinguishing the categorical challenges and their real scalar importance from the anecdotal alarms triggered by an erroneous understanding of the scale, or by distorted perception. The difficulty of identifying either one and of placing both within a hierarchy is accentuated by the challenge of scaling them properly: Which dimension and spatial transcendence do the challenges have? And at what moment in time are they expressed? Sound management of the different scales of the different challenges is a challenge in itself, perhaps the greatest of all.

Categorical challenges

What is and is not a challenge, using a sound sustainability criterion? Some of the most important ones, and the ones which truly deserve our attention, are climate change, energy depletion, genetic erosion, the consequences of bioengineering, the demographic explosion and migrations, economic globalization, outsourcing or industrial migration, the shaping of the Knowledge Society, the rising banalization of culture, and the rise in fundamentalisms; in short, the exhaustion of the industrial model that has prevailed in thinking—at least Western thinking—over the 19th and 20th centuries.

Redundancy is not wealth. A language with many synonyms yet without terms for certain phenomena or with deficient syntax is not a solid language. What fixes the functioning of the biosphere is not the fact that there are so many species but that it has all those that it needs. Inventories that compile specific diversity are not indicative of functional efficiency. However, the naturalistic tradition, which is more concerned with describing diversity than interpreting its meaning, often becomes stuck on this point. Surely there have been more species that are extinct today than species that are currently alive.

When faced with the undeniable wave of extinction for anthropic reasons, our concern should be to improve our functional knowledge of everything. If wheat runs the risk of extinction, it is not the same as an endemic orchid on a Polynesian island running the same risk. Knowledge of biodiversity should run parallel to knowledge of species' interactions with each other and with their environment and to improvements in our bioengineering skills. Handling genetically modified organisms properly in order to avoid biological conflicts and, equally or even more importantly, socioeconomic conflicts, is also a major challenge.

Ecologically speaking, we humans are a pest, an opportunistic species resistant to the defence mechanisms of others, at whose expense we grow quickly and uncontrollably. The problem of pests is that they dig their own grave. By expanding at the expense of everything around them, they are eventually decimated and reduced to tiny residual stocks, eager, of course, to begin again. If we humans think intelligently as a species, we would not bow so readily to the general principles of ecology; instead, we would adopt sensible strategies for our interests. Yet we do not. Poised to reach the peak of our epidemic expansion, we are aware of nothing; we think that we govern the system that actually governs us, and we act on instinct, like any random African locust. For millennia, we have been a marginal species, secondary consumers who barely figured in the global balances, just like the other primates. However, the capacities associated with knowledge have boosted this situation as logarithmically as our accumulation of skills has risen logarithmically. Now there are humans stretching from the poles to the Equator, exploiting the planet's entire arc of ecosystems. Our global biomass is modest, equivalent to that of ants, around 300 million tonnes, but there are fewer of us: almost seven billion humans (7×10^9) while the estimated ant population is 10 trillion (10^{16}). That means that there are more than one million ants for every human. Even though there are many more of us than was the case centuries ago (2 billion at the beginning of the 20th century; 1 billion at the start of the 19th century; only an estimated 200 million at the start of the Christian era...), there are really not that many of us: 6.9 billion in 149 million km^2 of dry land (46 people per km^2).

The problem is not so much the number of humans but the rising demands of each human, demands for raw materials, energy, and personal attention (education, healthcare, etc.). A human from a modern industrial society demands up to 20 times more energy than a primitive farmer. This means that, today, the human population, made up of people with many different levels of development and living together, is equivalent to 70 billion zoological humans, perhaps even more. Here the scale is shifting. If all of humanity were at the level of Western development, this figure would double and reveal the true magnitude of the problem we are facing, not to mention the cultural conflict generated by migrations towards the developed side, of course.

Yet these migrations cannot be objectionable in a world where human rights are recognized. If goods move freely, why shouldn't people be able to? Nor should it come as a surprise that migrations move towards industry and enterprise. The biosphere is a globalized system. All the basic codes of living matter respond to the same standards, which is why it is possible, for better or for worse, to practice genetic engineering: a bacterial gene can be added to a plant cell that is digestible by an animal, for example. The same carbon, oxygen, hydrogen, nitrogen, phosphorous, potassium, and a handful of other atoms are used to build animals, plants, fungi, bacteria and viruses, and they constantly circulate through the vast carousel of the universal biosphere. There is only one atmosphere, where all emissions languish without knowing who issued them. We humans are governed by the same rules.

The problem is that instead of a globalization of the economy, for the time being all we have is a globalization of markets. The market is global, but some of us have Euros while others have currencies that cannot be converted. The benchmark value of money is nullified, and the supposedly regulatory markets are captive to practice. All seven billion human beings are not operating under equal conditions. What is even worse, if they did the system could not withstand it, because apart from issues of equity, it fails to consider many physical factors that have become particularly prominent in recent decades for reasons of scale.

In effect, the economic ideas of the 19th and 20th centuries posited that the biophysical matrix was alien to economic processes, to the extent that some of its essential components for production (water, soil, the climate, etc.) were free, irrelevant assets. This biased way of seeing reality has supposedly placed the economic system on the sidelines of the biophysical environment. However, today more than any time before, these purportedly secondary factors have a vast socio-economic value (climate change, oil and other energy resources, water, forest fires, floods, volcanic eruptions and earthquakes, etc.). They are part of the economic reality, and someone is in charge of them, either the public administration (reforestation, supplies, decontamination, sanitation, etc.) or the private sector (rising cost of manufacturing processes or transport, for example), and this does not even take into account natural and social decapitalization (pollution, illnesses, risks, loss of biodiversity, congestion, etc.). These are all economically relevant factors, yet they do not figure in the balance sheets.

We do not have complete, realistic ecological balance sheets that include these items, as they are usually ignored or at best downplayed. The goal should be to include them into our economic accounts, whenever possible through objectifiable quantifications (tons of CO_2 emitted, liters of water consumed, square meters of land occupied, etc.). Still, we should avoid confusing the economic value of the socio-environmental externalities with a mere monetization of the values. An overall balance sheet should aim not to put a price on things that cannot possibly have a price (beauty, happiness, dignity) but to duly appraise those that should have one. The inclusion of the more neglected items, and thus a vision of the economic system from the sustainability vantage point, requires three essential factors to be taken into account: the *cost-efficacy ratio* in monetary, social or socio-environmental terms in the short, mid, and long term; *efficiency*, or the relationship between the expenditure of resources and the service yielded; and the *value of the socio-environmental services*, because many services are fundamental for human development and for the functioning of the economic system, though they may be furnished passively as a complement to the productive uses linked to the biophysical systems.

This latter consideration is particularly important. Surpassing the thresholds in the use or depletion of resources, as well as the loss in competitiveness of certain productive activities—such as agriculture or forestry—has led to the abolition of the natural capacity of the past, or at least a decline in its efficacy. For this reason, we should 'artificially' assess and, if necessary, put a price on the maintenance and management needed to ensure feasibility (planning, restoration, decontamination, etc.). Including all these factors in our economic accounts is essential for taking government decisions that truly aim to guide any economy towards sustainable options.

The socio-environmental parameters could be considered according to their *use value*, which stems directly from the current and future enjoyment of an environmental asset; the *stock value*, which derives from the fact that an asset exists and will continue to exist regardless of how it is used; the *option value*, which refers to the willingness to pay to ensure that an environmental asset remains available for future use; and the *quasi-option value*, which refers to the willingness to pay to ensure that an environmental asset remains available for potential future use. These values should be monetized. There are precedents (such as the price per ton of CO_2 according to the value granted to the emissions market created by the Kyoto Protocol), but the majority of times a reference value will have to be based on the costs of reversion (replacement, decontamination, sanitation costs, etc.).

The externalities that have not been included in the balance sheets until now may be direct or indirect, and generated across the planet. Therefore, we must prioritize the direct externalities generated and borne in every specific place. Likewise, each economic sector generates environmentally harmful externalities, yet also receives them. For example, farming usually pollutes the water and soil with nitrates and pesticides, but it also suffers from a decline in the quality and quantity of water or the loss in arable soil. Therefore, the balance sheet must be determined for each sector in order to avoid double entries.

All of this requires an exercise in economic imagination. We need it to combat the current excess of fantasy accounting. Today's balance sheets are not serious enough. Sustainability tends to internalize the social and economic costs of economic processes and prioritize the added value of work and resources over financial sleight-of-hand. To accomplish this requires accurate balance sheets and accounts. In the end, ecology is the economy of ecosystems and economics is the ecology of the productive system.

It would seem that the Knowledge Society should facilitate these paradigm transitions. However, this is not so. Mental inertia and the interests of the powerful minorities weigh more heavily. Knowledge is, in fact, rising, but culture is becoming banalized. Fewer and fewer people know more things, and more people are unaware of the majority of what is known. Perhaps for this reason, too, there is an upsurge in fundamentalism: in view of such a lack of equality and such incomprehensible knowledge, the truths that can and have been revealed—scant and weak, yet clear—gain followers. Science has more work than ever.

The case of energy and climate change

At the latest climate change summit, held in Copenhagen (December 2009), the participants barely talked about climate. By now there is clear evidence of the alterations in the atmosphere triggered by the massive dumping of carbon dioxide, methane, and other greenhouse gasses. They deserve discussion, clarification, and reasonable scientific doubt, as always, but on the socio-environmental scale they are already an established fact. This is why they were barely discussed in Copenhagen. Instead, the meeting's participants discussed energy, and more precisely the degree of dependence on fossil fuels with which industrialized countries and those on the pathway to industrialization are willing to live. No agreement was reached because the emerging countries want the same opportunities that the emerged countries did back in their day, or at least to be fairly compensated if this is not to be the case.

This is understandable: trying to get the Chinese or Indians to stop dumping carbon dioxide into the atmosphere after we Westerners have filled it with this gas (in terms of the greenhouse effect) is not only unreasonable but also cynical. Yet dumping more CO_2 into the air would be harmful for everyone. In order to resolve this conflict, we need to think as a species. This would lead us to halt the demographic boom, to contain the demand for fossil fuel, and to redistribute the economic resources captured during the process of accumulation experienced in the West during the first phase of industrial civilization. However, it is doubtful whether we will actually do this because we think as individuals, and we have therefore failed to develop and embrace the cultural values that would induce us to adopt this sociologically fraught decision.

Forests are not CO_2 sinks, as is often claimed, but temporary storage places (one exception might be the case of the carbon retained in humic acids). The true carbon sinks are the seams of coal, oil, and natural gas, where millions of tons of them have been stored for millions of years. Hence the problem of burning them now, all of a sudden: the atmosphere becomes the new sink, the climatic consequences of which we are so keenly aware. In only two centuries, we have returned to the atmosphere the carbon set in the fossil fuel seams over the course of 100 million years. In the forthcoming decades, we will dump as much again.

We have to lower emissions, but we also have to find less pedestrian ways to be rid of all this CO_2 than dumping it directly into the atmosphere. We extract coal and hydrocarbons (reduced carbon) from the subsoil, we use combustion to release the energy retained in its chemical bonds, and we dump the residual gases into the atmosphere (oxidized carbon). It would be sensible to return this waste to the place from which it came. Carbon dioxide, or carbon without associated energy, would then harm no one. A logical solution would be to bury the depleted carbon that we unearthed back when it carried energy in the depleted former oil seams or in deep salty aquifers. There is no practical way to do this when emissions are diffuse, which is the case of cars, for example. However, we can attempt it when emissions are concentrated, such as at power plants or large industrial facilities. Every kWh generated with natural gas entails the emission of 400 grams of CO_2, which is plenty; when generated by coal, it entails 900 grams, which is a lot. However, because of its relative abundance, coal is the fuel used the most often at power plants in China, India, and the rest of the world. Its use is inexorably on the rise. If the CO_2 is not confined, the struggle against climate change is lost.

In the meantime, beyond the disturbing issue of the climate, the expected availability of fossil fuels is constantly waning. It is difficult to accurately determine the size of the reserves, but it is clear that at least for oil, it can be counted by decades (there is much more natural gas and coal). Deciding what is and is not a real reserve is also difficult. We do not know whether gas hydrates, bituminous schist, and deep underwater deposits are true reserves or not. Nor do we know whether we will truly master nuclear fusion or whether it will remain a chimera. It is best not to talk about hydrogen because it is an energy vector, like electricity, not a primary source of energy (there are no hydrogen seams; it has to be generated by expending energy). Furthermore, how long would we need to make these resources exploitable? In any event, peak oil and the inability to meet the momentary demand seem to be looming much closer than does harvesting the remaining seams. The immediate challenge is how we slow down the demand for fossil fuels, even if it is only to hold out until new seams or new resources are available.

That is why there is no future without renewable energies. We have to accept this fact. Renewable energies are not a choice; they are a factual need. Humanity has always operated with renewable energy—just like the entire biosphere, it is its way of doing things—and it can operate with it once again in the future. In the meantime, there will have been this wonderful parenthesis of fossil fuels, the shining exception that facilitated the onset of industrial civilization yet also, unfortunately, the first human-induced climate disorder. Nuclear energy, the familiar nuclear fission and the hypothetical nuclear fusion, may alter this wholesale return to renewable energies. If they do not, the 22nd century, or at least the 23rd, will be 100% renewable. But we still have to get there. It is just as blind to deny it as it is to believe that we are already there. We will not live to see it. First, there is still large amounts of fossil energy left (more gas and coal than oil, as mentioned above). Secondly, neither the technology nor the productive processes, nor the social skills to totally and suddenly do away with fossil fuels, is ready; it is a question of time scale. Finally, we have not yet developed all the facilities needed to capture and transport free energies.

Yes, free, because renewable energies actually do not exist. Energy is neither created nor destroyed; it is simply transformed. This is a classic principle of physics. It is neither created, nor destroyed, nor renewed (although it does entropically degrade). What is renewed is the onslaught of solar energy that the Earth intercepts every day. This, too, will come to an end, but not for another several million years. Solar energy, then, is the energy that is constantly replaced; it is not renewable energy but energy that is renewed on a daily basis, the energy that moves the seas, stirs up the air, and generates the meteorological phenomena that end up being the climate. What is renewed is our ability to capture solar energy, not solar energy itself; solar energy comes once and nevermore. We must also learn to accept this fact.

The proportion of free energies captured in our energy mix is already beginning to be considerable. It is quite noteworthy that one-third of the electricity consumed in Spain (at given times, not all day long) comes from wind farms or photovoltaic plants, not to mention classic hydraulic energy. Those who laughed at this possibility ten or fifteen years ago may have acknowledged their error. At the same time, those who cannot explain why we still burn gas or oil should be more cautious. Between skeptical reactionaries and impatient visionaries there has to be a balanced view, no matter how urgent climate change may be. Confusing desire with instantaneous feasibility is not an advanced attitude, although it is more likeable and useful than just trusting in the past.

The issue of energy security also favours capturing free energies. It is worth mentioning that the rise in the proportion of renewable energies in the energy mix is in the interest of countries with few or no fossil energies. It saves them from onerous imports and improves the security of their energy supply by lowering their dependence on third parties. In unstable international contexts, this extreme is in no way irrelevant. Just think about the incident that occurred a little over a year ago, in which the Russian gas supply to Central and Eastern Europe was interrupted in the middle of winter. When we talk about the wisdom of interconnecting energy distribution networks (electrical networks, gas pipelines), we are thinking about the ability to re-route it in the event of breakdowns but also about interstate conflicts. With free energies captured in situ, this problem is avoided.

Cyclical or speculative fluctuations aside, experts agree that the price of fossil fuels will only continue to rise in the forthcoming decades. In contrast, the capture of free energies will become increasingly cheap. I am not talking about today's debatable premiums, which are more financial stimuli than aids for production, but about the spread and cheapening of capture systems, which also tend to converge towards electrical generation, the major energy vector of the future. The gradual migration from internal combustion engines to electrical propulsion is extremely positive in this sense because it enables us to make better use of the high wind production during night-time hours, when electricity demand is lower. Moreover, the real electric vehicles of the future (not hybrids or conventional vehicles with their engines switched) will be much lighter and more energy efficient. They will be much lighter because with an engine at every wheel, as some modern trains have, no transmission, gear box, differential or heavy chassis will be needed to hold them. They will be more efficient because an electric engine performs better than an internal combustion engine. With a considerably lower vehicle weight and greater engine efficiency, the energy demand per unit of weight transported will drop considerably.

But not all renewable energies behave the same. An improper proportion at any specific time in the transition towards a production system low in carbon could lead to serious mismatches between the capacity to generate energy and the momentary demand. What is more, almost all renewable energies end up producing electricity. This is positive as long as the transport system and the lamination of the demand are poised to make the most of the energy generated. That is not yet the case. And we should also add that distributed generation (very small units of self-production or self-capture capable of sending surpluses to the grid) will enrich the energy model but also make it more complex and different to manage. We are not yet ready for that. This systemic transformation requires gradual preparation, without sudden moves or excess haste, but without stopping, either. True progress always works that way.

In any event, regardless of the nature of the primary source, ultimately the largest users of the energy produced are urban systems, the industry associated with them, and the transport that carries citizens and moves their goods. The decisive energy battle will therefore be waged in the cities. When thinking about urban planning and the construction of cities, about transport and industrial and urban or peri-urban activity, we have to move towards the birth of a socioeconomic model that is productively satisfactory, socially equitable, and biospherically supportable—beyond simple local environmentalism, it is precisely this ambition for global sustainability. It is not a religion to be preached; it is pro-active, to be built by merging technical and scientific skills and jointly making socioeconomic decisions.