Editorial: Sustainable development in a shrinking and sinking world

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Abstract: This contribution continues the new and currently intensive international peer-reviewed scientific debate on the Strategic Sustainable Development (SSD) model and The Natural Step (TNS) framework. Despite the many already existing and rapidly emerging disciplines, concepts, approaches, tools, societies, journals and conferences addressing sustainable development, the world is getting smaller. Deserts are expanding, the sea level is rising, the population is growing, per capita consumption is increasing, the volume of livestock and cattle is growing and biodiversity is depleting at ever faster rates. The Hurricane Katrina disaster of the USA is used as an example of the shrinking world. The four Sustainability Principles (SPs) or sustainability system conditions of SSD and TNS are analysis tools for learning what are the main causes, principal mechanisms and drivers, and hence, the challenges of the shrinking world. We find that the current policy and management paradigm, framework and approach do not address the real and important challenges of sustainability in a shrinking world.

Keywords: The Natural Step; TNS; Strategic Sustainable Development; SSD; sea level; deserts; shrinking world; Hurricane Katrina; Sustainability Principles; SPs.

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1 Working for sustainability in the full world

There is a consensus in the sustainability science (Kates *et al*., 2001) research community that the position of Daly (1996) and Costanza *et al*. (1998) on the 'full world' is important for all sustainable development. Sustainability scientists agree that the full-world metaphor is the correct starting point or 'preanalytic vision' for all sustainability analyses, policy programmes and management efforts.

The message of the metaphor is to demonstrate the radical failure of the modern world view in terms of sustainable development. The dominant world view of the modern industrial Western society, of modernity, comes from the preanalytic vision and paradigm of neoclassical economics (Ehrenfeld, 1997). That is, the neoclassical economics perspective is not only an economics discipline's perspective on how the world is and how it ought to be. Neoclassical economics has influenced the development of the western industrial society, its cultural assumptions and lifestyles, and is currently influencing all sciences and societal action in general owing to 'economic imperialism' (Lazear, 2000). Economic imperialism shows in the power of many traditional notions of economics science in the society at large. Such concepts and notions include efficiency, monetary value, rational individuals and organisations maximising their individual monetary profits, quantitative analysis, competition, specialisation, mass production and unlimited growth. The dominant paradigm does not acknowledge that the human economic system is only a subsystem of the larger parent ecosystem.

The often-cited Daly and Costanza position of the full world (Costanza *et al*., 1998) argues that the world has become full of human-manufactured capital and empty of natural capital (this article was originally published in *Nature* in 1997 and is the second most-often cited environmental or sustainability science article ever). The human economic system, technology, machines, built infrastructure, roads, factories, houses, industry and the products of these are increasing in volume and number. Natural resources, nature's energy sources, raw materials, sinks for wastes and assimilation capacities for emissions, as well as biodiversity on land, water and air, are being depleted and are decreasing both in terms of quality and quantity. The era of the 'empty world' was the very opposite. The empty world prevailed before industrialisation. The amount of human-manufactured capital was very small compared to natural capital. It made sense to invest in human-manufactured capital for economic development. But in a full world, it makes sense to invest in natural capital. Natural capital is the new limiting factor of economic development.

2 Working for sustainability in the shrinking world

The full-world position is a radical departure from the dominant societal perception of the isolated circular flow of goods and factors of production between firms and households. This picture is isolated from the natural ecosystem. However, the new perspective and understanding must also be revised. The philosophy and basic normative position should remain the same. But the magnitude and severity of the problem is bigger. We need a new metaphor to make decision-makers and big business aware of the problem that the human society operating within the global ecosystem has caused. The contradiction and the unfortunate conflict between the human economic subsystem and the parent ecosystem is now more severe and more difficult to handle than ever. The problems are even more difficult than what the full-world metaphor can communicate.

The message of the full world is that it cannot, by definition, be sustainable to try and sustain a rapidly growing economic subsystem inside the finite and non-growing global ecosystem. The economic subsystem is materially open and relies on non-renewable and emissions-intensive fossil fuel energy flows. It is rapidly growing inside the non-growing, finite and solar energy-based parent global economic system. It is impossible to grow indefinitely inside finite and absolute boundaries. The impossibility of unlimited physical growth holds even though growth would be efficient, *i.e.*, using less input to produce the same amount of output as before (Welford, 1998). Efficiency is a quantitative ratio, while limits to growth are absolute. Eco-efficiency, which follows the conventional neoclassical economics logic, is becoming the dominating vision and overall objective of various environmental and sustainability policies and management strategies worldwide (Hukkinen, 2003).

The full world is a static concept, or at least it may very well result in interpretations according to which the boundaries of the world, planet Earth and the global ecosystem are fixed and non-growing. Accordingly, human existence and economic, industrial or societal activity can only threaten these limits by becoming larger in volume, size and worse, in the sense of the severity of the qualitative changes of man-made/mobilised materials and energy fluxes. The growth and qualitative changes are becoming more severe and significant relative to the fixed limits and qualitative characteristics of the global ecosystem. The static conception of limits alone is a radical departure from the current and dominant world view and economic paradigm, which lack limits to growth. But the problems and the challenges are bigger than depicted in the full world. The limits and constraints of the parent natural ecosystem are dynamic; they are changing through time. What is important is that they are becoming ever more pressing and limiting to human activity.

Brown (2006) convincingly shows that the earth is becoming smaller. The global natural ecosystem is shrinking in size and volume. The shrinking is clear if measured simply in quantitative terms, but very apparent also in the sense of the qualitative potential of the earth's ecosystems to provide, *e.g.*, life-sustaining functions. Measured by the land area that can support human habitation, the earth is shrinking, and at an accelerating pace. Deserts are expanding, the sea level is rising, the population is growing, per capita consumption is increasing, the volume of livestock and cattle is growing and biodiversity is depleting at ever faster rates. The shrinking is best illustrated by advancing deserts and rising sea levels.

China, the most populous country in Asia, and Nigeria, the same in Africa, are experiencing heavy losses of territory to deserts. Beijing, for example, is now threatened by the advancing Gobi desert. The Gobi is now only some 200 km away from the city. China is annually losing some 1500 square miles of land to deserts. Deserts feed on overstocked grasslands and overplouged land, deforestation and human settlement, gathering of firewood, *etc*. During the last 50 years, the population of Nigeria grew from 30 to 130 million and the accompanying and the resulting growth of the livestock population was from 6 to 66 million. The growths were a fourfold and 11-fold increase, respectively. The world population is increasing by 70 million per year, livestock population growth of 35 million annually is a reality and per capita consumption is increasing, too. At the same time, the rich are getting richer and the poor poorer, both within and between nations.

In many places in the world, villages are being overrun by sand dunes and blowing sand, and people are being forced to migrate, roads can no longer be operated and new routes have to be established. Agricultural livelihoods are suffering under sand dunes and sandstorms. Agricultural communities find that their traditional culture does not support them any longer. They need to seek jobs in already overcrowded metropolitan cities, which suffer from air and water pollution problems caused by the increasing number of people and increased volumes of traffic, wastes, *etc*. For example, in Mexico, the degradation of cropland is making 700 000 Mexicans leave their homes and seek work in cities such as Mexico City, probably among the most devastating examples of the social and ecological problems that giant cities create. Alternatively, they move to the USA, a phenomenon causing major social, cultural and policy conflicts and debates as well.

The rise in sea level is the result of global warming. Climate change is powered by the human use and burning of non-renewable and emissions-intensive fossil fuels, the security of the supply of which is at an ever-bigger risk owing to the global political situation. Glaciers and ice sheets are melting. Seas are undergoing thermal expansion owing to the rise in climatic temperature. The sea level rose some 6 inches in the last century. It is projected to rise some 35 inches this century. Throughout history, people have tended to concentrate on coastal areas, *e.g.*, owing to trade and markets or logistics, and to rice-growing river deltas. With a rise in sea level of some 35 inches, many coastal cities and rice-growing populations would sink and the people would be forced to move inland or to other countries.

Huge flows of environmental and security refugees can lead to social conflicts or wars over natural resources and living spaces and will have severe cultural and social consequences. The rise in sea level will also make the effects of hurricanes or tsunamis many times more difficult to cope with. Bangladesh, Shanghai, Bangkok, London and The Netherlands will be under threat if the rise in sea level continues, which is very likely. If the Greenland ice sheet were to melt, the sea level would rise by 7 metres. Hundreds of millions of people living in coastal cities and communities would be forced to migrate inland or to other countries. Even a 1-metre rise would force millions to flee their homes. For example, 30 million Bangladeshis would need to abandon their homes and migrate elsewhere.

The world is becoming too small to provide space and sufficient living environments for the increasing number of people, accompanying livestock populations and growing per capita consumption. Migration or running away cannot be a sustainable long-term

solution. Neither is the building of new roads to 'go around the problem', of infrastructures, walls, levees or defences to better limit the expansion of sand dunes or to limit storms and seas, a sustainable and long-term solution. Neither is it sustainable to shift the activities that stress the natural ecosystem more to other parts of the world or the country in question. Neither is it sustainable to desperately try and improve the economy of the poor country that suffers from these problems. Under the current unfair global trade regime dominated by the rich countries, poor countries are forced to reduce the diversity of their economic and product structures. Developing countries are required to focus on rapid specialisation and mass production of individual key products, such as timber, coffee and sugar. Lack of diversity makes the economies vulnerable under internal or external stress. If the underlying causes and the principal mechanisms creating the phenomenon of the shrinking world are not addressed and tackled, the building of defences, running away or displacing of problems to other areas is only going to delay the main problem. The problem is becoming more severe, damaging and irreversible over time.

3 Working for sustainability in the sinking New Orleans

Costanza *et al*. (2006) describe the case of New Orleans after the disaster of Hurricane Katrina. The authors emphasise the problems and the challenges of the case. The difficulties and problems primarily result from lack of care for the natural environment and ignorance of the environmental and ecosystem state due to motives of short-term economic and commercial interests.

The US Federal Government has pledged 100 billion US dollars for the rebuilding of New Orleans and the Gulf Coast region after the terrible tragedy of the hurricane. The objective of the project of the government is to rebuild the city *back into its former design*. The focus of the plan is on civil engineering solutions. The most important of these include levees, fences, man-made defences, clean-up techniques and technologies, pumps, physical infrastructure, buildings, roads, *etc*. The idea is to reconstruct these man-made structures and defences and the entire built city and its infrastructure into their former design and to make these structures and defences stronger and better. That is, better and stronger in terms of their capacity to cope with possible future natural disasters.

The aim of the rebuilding plan of New Orleans is, for example, to build new levees and pumps and other civil engineering solutions to correct the impacts of the rising water and the storm. These impacts occurred, however, not only because of lack of strong storm-protection infrastructure and other constructions built by humans. It has been shown in several publications, even well before the disaster, that the main causes and underlying principal mechanisms contributing to the risks and the actual disaster was the state of the ecosystems of Louisiana, the Mississippi River and the New Orleans area. Wetlands, coastal marshes and barrier islands have been destroyed by human action at an increasing rate over the last 50 years. These natural ecosystem services had been among the most efficient types of storm-protection, flooding-control and water-cleansing structures in the entire North America. The wetlands have been eroding at a rate as high as 100 km^2 of lost wetlands a year.

The eroding and lost wetlands, marshes and islands are the result of economic and societal system interventions into the natural ecosystems of Louisiana. The construction of physical and built infrastructures, *e.g.*, levees, erodes sediments that would help to build coastal marshes. The heavily managed (because of commercial purposes) Mississippi River has been forced to dump its fresh waters into the deep waters of the Gulf of Mexico. The lost fresh water cannot help to counteract the salt-water intrusion that damages the coastal ecosystems of the Louisiana delta. Along with the lost fresh water, sediments are lost as well. Nutrients from the river are not delivered to the natural ecosystems or to lands of the coast, rather they are dumped into the Gulf of Mexico. The natural function of the nutrient flows has been to build organic soil and in this way reduce the effects of land subsidence. Oil and gas exploration activities have also had an effect and accelerated the loss of wetlands in coastal Louisiana. Further, the human settlement has been located on vulnerable areas. All of the above has resulted in increasing water pressure on the built infrastructure, *e.g.*, levees, which has been getting weaker over the years.

Now the main focus of the US Federal Government rebuilding plan is not on the restoration and protection of the natural ecosystems and the storm-protection, flooding-control, land-formation or climate-regulating services they provide. Instead, the focus is on civil engineering and on improved human-manufactured capital such as built infrastructure. The irony is that the construction of levees, walls and pumps is very energy intensive. Energy use is becoming increasingly costly in our world. In the USA and in the rest of the world, the major part of energy use will unfortunately be based on the burning of fossil fuels. A large fraction of these fuels in the USA (which has not accepted the Kyoto Protocol) will come through the exploration and extraction activities taking place in coastal Louisiana. The oil and gas exploration and extraction activities harm the wetlands and ecosystems of the region.

Note, that it is very likely that the future of the region will see increasingly strong hurricanes and floods, which result from global warming, which, in turn, results from emissions from the burning of fossil fuels. New Orleans is also becoming more vulnerable to such natural disasters. The sea level is rising and the city is sinking. Again, the rise in sea level is happening because of global warming, to which contribute carbon dioxide emissions of fossil fuel use (extracted, *e.g.*, from the weak and vulnerable ecosystems and resource concentrations of coastal Louisiana). Consider that the region of New Orleans has very rich reserves of renewable energy, and therefore, many economic possibilities to use its huge renewable and emissions-neutral energy sources of solar, wind and water energy. The renewable energy potential could become a major competitive advantage in this world of limited and policy-burdened fossil fuels. Sadly, this potential is not being utilised. The suggested and published plan, *Louisiana Coastal Area* (Costanza *et al*., 2006), initiated in order to save and restore the wetlands surrounding New Orleans, would have had costs of around 14 billion US dollars.

The rebuilding plan that is happening/will happen costs 100 billion US dollars. This rebuilding plan of the US Federal Government includes investments in security, security forces and police forces and the control of the negative impacts of crime, social unrest, conflicts and inequity in Louisiana and New Orleans. When there is a conflict, and after it has been observed and reported, police and security forces with their equipment should come to the rescue. New Orleans and Louisiana have a long history of racism and classism. The exclusive policymaking and decision-making processes and lack of

participation of the diverse actors (in regional and national policies) are not the best platform or forum to start and tackle the environmental and natural ecosystem challenges of the region. Ecological problems are heavily interdependent with social and cultural systems and conditions.

4 Working for sustainability in a reductionist paradigm and in a narrow world view

We will focus on what we see as the main theoretical and conceptual limitation of all sustainable development work. The limitation and inability to solve the unsustainable situation in the dominant paradigm or central preanalytic vision of the Western world view is caused by reductionism. Reductionism is inherent in the paradigm of current science and also in the culture of modernity and in the general approach that the global society is taking to problems and challenges of sustainable development. Analysis cannot reveal what the preanalytic vision omits (Daly, 1996). If reductionism is the preanalytic vision of all sustainable development work, policies and management, and if it leaves important matters outside the analysis, and outside subsequent policies and management efforts, the problems of unsustainability will continue to prevail and very likely worsen.

What is reductionism? Reductionism focuses on exclusive and isolated cause-and-effect chains, ignoring other effects and interactions on the larger systems level (Hueseman, 2001). Reductionism concentrates on individual system components. It largely ignores the wider system and the systemic interdependencies or relations between different system components. Given the systematic and systemic nature of today's sustainability challenges, a reductionist approach is not sufficient. The above two examples of the shrinking world due to expanding deserts and rising sea levels and the sinking New Orleans are perfect illustrations of the inherent limitations of reductionism.

There are also plenty of other, less severe and smaller-scale examples of the failures of reductionism and narrowly focused sustainable development governance, policy and management efforts. Such include, for example, benzene pollution impacts on local groundwater systems, which is regarded as a problem worthy of immediate action, as we know benzene is carcinogenic (Hueseman, 2001). But the fact that pump-and-treat technologies equipped with diesel engines and employed to remedy this existing negative impact cause distant air pollution and future climate change is ignored. The focus is narrow, as the correct spatial and temporal boundaries are not considered. For decades, scholars focused on known impacts of fossil fuel use, *e.g.*, on SO_2 emissions and air pollutants of NO_x, while the potential climate-change effects of fossil fuel-originated CO_2 were ignored (Hueseman, 2001). Possibly the most serious environmental question of our time was observed and accepted only recently. In addition, owing to fragmented approaches to environmental policy and legislation, which concentrate on the known and directly observable impacts on a specific environmental medium rather than on the ecosystem as a whole (Ayres, 1994), airborne SO_2 emissions have been transformed into sludge and disposed of in landfills that emit airborne emissions through decay processes.

5 Working for sustainability with creativity

Why it is so attractive to focus on currently known impacts instead of on principles and underlying mechanisms that are the root causes of these impacts and of many currently unknown future impacts? Why is the prevailing tendency in sustainability science to select and focus on isolated fragments of complex and interdependent societal and ecological systems? Perhaps it is because we know too little about many impacts and because they seem distant or invisible to us in time, space and experience. Perhaps it is because the first law of ecology, 'everything is connected to everything else' (Commoner, 1971), has been forgotten. Perhaps the paradigmatic base of Western modernity is not suitable for discontinuous change or a break from 'business as usual'. Modernism, modernity and the paradigm inherent in positivism tend to view the present and future as a linear extension of the past (Welford, 1998). Perhaps it is because cultural adaptability is self-referential. Aspirations and social mechanisms of control arise within a particular cultural context (Matutinovic, 2001; 2002; 2003), which creates 'path dependency' or 'technological lock-in' mindsets enhancing the 'survival of the first' (idea, institutional form/model or technology) rather than the fittest and hampering innovation (Norton *et al*., 1998). Perhaps the change required is so radical that it faces resistance as strong as that faced by all revolutions in society and science (Kuhn, 1962). Perhaps it is because we still believe that there are no such things as 'no technical solution problems' (Hardin, 1968). Or perhaps, it is simply due to a form of insanity, defined by some as continuing to act in the same manner but expecting the outcome to be different (Ehrenfeld, 2000).

Or is it because of the above-discussed 'imperialism' of economics in science in general and in the modern society at large (Lazear, 2000)? The isolation of the human economic system from the surrounding natural and social systems has resulted in the assumption of the absence of limits or constraints for the physical expansion of the economic system in society and nature. Has this robbed economic progress of a moral content (Ehrenfeld, 2000)? Has the lack of limits and constraints also demoted progress itself from an overall vision, goal or direction? What does the lack of a vision or overall objective imply for creativity and innovation among societal actors and organisations? Creativity in all kinds of activities and professions requires constraints (Senge and Carstedt, 2001). Creative engineers understand the role of constraints, which can include, *e.g.*, time, weight and operability. The impossibility of an infinite canvas is well-known to an artist.

One has to abandon the false sense that, in order to take action, we must first know the details of any potential impacts in the complex ecosystems and social systems, which to a large extent are still unknown to us (Robèrt *et al*., 2004; 2002). We must be motivated to embrace the inherent creative power of all societal sectors and actors, which can be radically increased through the awareness of the limits and constraints that social and ecological challenges of sustainable development offer to current and future societies. We believe that by using the existing knowledge in science, it is possible to define constraints on which a consensus can be achieved among academia, government and business. Such limits and constraints could also serve as the vision of sustainability for which all sustainable development work in the global society would strive.

6 Working for sustainability with sustainability principles

It sounds somewhat naive and even utopian, to suggest a defined overall goal or vision for the process of sustainable development, termed sustainability. But without the goal of sustainability, the process of sustainable development lacks direction. The goal must be more specific than the Brundtland Report definition, in which sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). Yet the vision and overall goal must be general, flexible and broad enough to enable the realisation of the philosophy of inclusiveness, the involvement of a diversity of actors, preferences and interests. It is very difficult to reach a consensus on numbers, on detailed, specific and quantitative goals. It is more likely that different groups, stakeholders, organisations, actors and individuals can agree upon more general, flexible and qualitative principles. This does not mean that the overall goal and vision would be vague and unclear, *i.e.*, an excuse for inaction. In every strategy and management system, the overall vision and goal must always be qualitative and general, because of the inherent uncertainty about the future.

In a consensus process between ten pioneering sustainability scientists (Robèrt *et al*., 2002), the vision and overall goal of the process of sustainable development was defined with four Sustainability Principles (SPs). The principles were developed by looking at the constraints and limits that the natural and social/cultural systems pose on the economic system. In the sustainable society, Nature is not subject to systematically increasing:

1 concentrations of substances extracted from the earth's crust

2 concentrations of substances produced by society, and

3 degradation by physical means,

and in that society

4 human needs are met worldwide (*now and in the future*, author's own addition).

These four SPs or system conditions are known as The Natural Step (TNS) Principles, and they determine the outcome of the process of sustainable development: sustainability. They have been widely tested and analysed by theoretical, conceptual and methodological research, as well as with applications in public policy and business management both at the international and national levels. They have been connected into a model, which is a widely applicable Strategic Sustainable Development (SSD) model (Robèrt *et al*, 2002; 2004).

The message of SSD is twofold. First, sustainable development work lacks a vision and overall goal, *i.e.*, sustainability. Because there is no consensus on the overall direction towards the successful outcome of sustainability, the work within the process of sustainable development can create problem displacement, problem shifting, suboptimal solutions or 'blind alleys'. We have given several examples of public environmental policies and corporate environmental management systems that have actually created new and worse problems when dealing with the old problems. Second, the rapidly growing toolbox of sustainable development approaches, tools and indicators is confusing to scientists, policymakers and the business decision-makers, *i.e.*, to users in general. The

many tools seem conflicting when they all have specific and different system boundaries. Within the SSD model and the four system conditions of TNS, the many different approaches and tools could be used as each other's complement and as parallels, because the four system conditions/SPs are common to all actors, sectors, approaches and tools.

The TNS and the system condition/principle-level part of the SSD give an alternative to the dominant impact level-focus in environmental sustainability work – the level of principal mechanisms. The qualitative root causes of known and future, unknown impacts are much easier to know than detailed quantitative impacts on ecosystems and social systems, which are extremely complex. If the focus of policy and management had been on System condition 2, "Do not systematically increase concentrations of substances produced by society in nature", the organic pesticide DDT (received a Nobel price) and CFCs (very nearly received a Nobel price and were used widely in industry for example as refrigerants) would not have been introduced, because they violate this principle level of sustainability. What is important here is that mistakes can be avoided and prevented without the requirement of knowing the actual impacts certain substances are going to have in complex ecosystems or social systems.

7 Working for a sustainable New Orleans with sustainability principles

In this section, the TNS principles are applied to the case of the sinking New Orleans. The application of the SPs to this case shows the importance of constraints and limits and hence of the vision and overall objective for all sustainable development projects in a shrinking world.

As described above, the central objective of the current plan led by the US Government is to rebuild the city back into its former design. The main focus of the plan is on civil engineering solutions, which include levees, pumps, physical infrastructure, buildings, roads, *etc*. The aim is to reconstruct the structures and the entire city into its former design and to make these structures stronger and better in terms of their capacity to cope with possible future natural disasters. The objective is first to correct the negative impacts of the hurricane just experienced, and second to prepare and plan for correcting the future impacts of a new future hurricane after these future impacts have occurred. No doubt, a huge amount of money will be involved and plenty of opportunities are/will be available for many US businesses to land profitable contracts in the rebuilding process.

The argument according to TNS principles (SPs) is different. Instead of focusing on negative impacts in ecological and social systems 'downstream', policymakers and managers concerned about sustainability should concentrate on underlying mechanisms and principal causes 'upstream'. The principal mechanisms and underlying causes upstream are the causes of many known and also of many currently unknown negative impacts downstream. While certain specific negative impacts of certain human activities would not be currently known through existing science or through exact quantitative analysis, it is relatively easy to use science to learn more general and overall qualitative principles that create current negative environmental and social impacts, and very likely also future impacts. However, sustainability policy and management efforts seem to be driven by the impacts-focused approaches. Measures and practical actions are undertaken only if there is a clearly visible and quantified negative impact that is observable with current science.

Consider SP 1. The fact is that the rebuilding of fences, levees and physical infrastructure requires huge amounts of energy. Energy is increasingly scarce and costly. Its use will divert resources and money from purposes such as those that would help the poor of the world (SP 4). A large fraction of this energy comes from fossil fuels, *i.e.*, substances extracted from the earth's crust. As noted, these oil and gas flows are extracted from coastal Louisiana. The fossil fuel usage and associated CO_2 emissions that contribute to climate change are very likely to result in increased storm intensity and rise in sea level in Louisiana (and in the world) in the future. The more demanding hydrological pressure would erode the new levees sooner, which would require the energy-intensive building of new levees and physical infrastructures. The building of levees harms sediments (SP 3), which are needed in the life of marshlands, and misdirects the Mississippi waters and their protection services and nutrients to the deep waters of the Gulf of Mexico (SP 3). The people who suffer are first and foremost the poor in the region (SP 4). The energy-intensive civil engineering measures seem paradoxical. New Orleans has abundant renewable energy sources in the form of solar, wind and water.

Further, consider SP 3. Oil and gas exploration and extraction activities in coastal Lousiana have been among the causes of the destruction of wetlands surrounding New Orleans. The wetlands and barrier islands that have been lost during the past 50 years at a pace of 100 km^2 a year were the only protectors of the city against the open ocean. As noted above, the "natural engineering solutions" suggested by Costanza *et al.* (2006) would use around 14 billion US dollars to restore the wetlands and design human settlements in a sensible manner (SPs 3 and 4) to avoid the degradation of the land, wetlands and ecosystems in the region. The sum is much smaller than the 100 billion reserved for the civil engineering solution to recreate 'what went before', with large energy input requirements (SP 1). No doubt, when the work concentrates on physical infrastructure and the natural ecosystem functions are neglected in the rebuilding plans, there will be need also for chemicals and other substances produced by society. System condition 2 may be violated. Consider that it is very likely that if the Louisiana ecosystems are healthy, many of the functions that are fuelled by chemical substances and fertilisers (or their related industries, supply chains, value chains, customers, stakeholders, *etc*.) can be performed by natural ecosystems in a more sustainable and desirable manner.

Consider SP 4. Costanza *et al*. (2006) propose that instead of investments in police administration, policy personnel and security forces to control social problems after they have occurred, the decision-makers should concentrate on the root causes and principal mechanisms of social and cultural problems. It is clear that inequity both within and between nations is one of the central causes of the current global social unrest and conflict and of the availability and nonsecurity of the limited fossil fuel energy sources. It is not sustainable to invest and contribute to a global market economy that continues to pressure poor countries to invest in and focus on selected and isolated segments of their economy. Poor countries are forced to take a short-term 'survival approach' and invest in raw material, energy-intensive or biodiversity-depleting activities. Such investments may enable the rich regions/countries to survive and live off the surplus of natural resources and services for some limited time. But such policies will destroy first the diversity-lacking developing countries' economies, and second the economies of the rich countries dependent on them and upon the common natural capital.

New Orleans and Louisiana have a long history of racism and classism. The new standards of diversity, equity, tolerance, fairness, justice and participation, realised through education and information dissemination, *etc*., would be more effective in preventing social problems and conflicts in the region in the future than the employment of police and security personnel and forces. We can all remember the pictures and images of army and guns flowing into the region too late after the disaster to control the crime and social unrest. The people who were affected the worst were the blacks and the poor. This situation deepens the entire racial conflict in the USA. The conflict, sadly, prevents people from cooperating in cases of future natural disasters, and what is sadder and more important, prevents people from collaborating on the prevention of these disasters in our common world.

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