



THE INSTITUTE OF ADVANCED STUDIES ON SUSTAINABILITY
Institute of the European Academy of Sciences and Arts

Obligation of Environmental Science and Technology to Shape a Sustainable Future

Plea for an Ethically Sound Approach

Colloquium

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Motivation

The term “environment” commonly stands for the interaction of physical, chemical and biological factors affecting the organisms living in a distinct biotope. In this context, the term “environment” refers to the natural world.

But we also speak about economic and social environments. Economic environments encompass the economic impact of factors such as employment, income, productivity and wealth. The social environment refers to the immediate physical and social setting which people live in. This includes factors such as culture and traditions.

In a time overwhelmingly governed by humankind, often referred to as anthropocene, the ecological, economic, and societal environments are tightly interwoven. This means that ethics - traditionally applying for the right conduct of humans as actors in the framework of civilization - must expanded to the right conduct of humanity utilizing ecosystem services.

To be able to favor the functioning of natural and anthropogenic systems environmental sciences need to provide knowledge about the interaction between ecology, economy and society. Moreover, environmental science needs to provide guidelines for the ethically permissible extent of human impacts on natural and anthropogenic systems.

Which advice can science provide that leads to a process of ethical correctness in governing the interrelationship between society, economy and ecology? The authors of chapters in this brochure try to find answers to this question.

Peter Wilderer

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Environmental Ethics – General Thoughts

Martin Grambow

As an introduction in the topic of this Colloquium I will first give an overview of the issue of global ethics, and on environmental ethics in particular. Secondly, I want to present some ideas about what is important for the continuation of the discussions in IESP (International Expert Group on Earth System Preservation).

The very first question is: What duties does humankind has with respect to the environment, and why are we assigned to such duties. To be answered has first the “why”. That means questions like: are we responsible for the humans of today or also for future generations or even for all the other components of the environment? Different societies in the world have different answers to these basic questions. In any case ethics is about values. Obviously, humans living in different climatic and cultural regions of our planet have very different views about ethical obligations and the associated values. Vossenkühl (2005) and some other philosophers suggest to consider four different types of values: instrumental, intrinsic and inherent values and inherent worth.

Instrumental values are associated with physical and abstract objects as means to achieving particular targets. In this case not the object is important but its purpose. Intrinsic values refer to the value an object has in itself or for its own sake. Inherent value has lots to do with the appreciation of something for its appearance. A physical or abstract object gains an inherent worth when it is respected for itself. In all these categories the objects of concern could be humans of today and/or of tomorrow. Objects of concern could also be animals, plants, whole ecosystems or landscapes. It is an open question which objects is actually to be considered. The open questions is who and what is to be considered in our common code.

Some people considered only people belonging to “my” group or religion are of value. We call such an approach “Theo-centrism”. Anthropocentrism considers the natural environment or a certain landscape as a resource. Ratio-centrism recognize for moral reasons of intelligent creatures. Expansion of this view to sentient creatures leads to Patho-centrism. Biocentrism considers all creatures as worth. Eco-centrism includes all biotopes on Earth valuable, and Physio-centrism insists the entire nature to be recognized for moral reasons. Which of these approaches should we accept for our discussion on environmental ethics? Which of them provides the right basis for our ethical discourse?

In this context three ethical theories should be consulted. Utilitarianism suggest that provision of the greatest luck for everybody is the ultimate goal. This idea seems to be similar to what

Aristoteles once wrote: “The reason of life is having a good life” This is certainly a nice idea but it does not solve our problem, because the question remains who exactly is “everybody”. Is it the current or the next generation, all animals, all plants, all ecosystems or the whole nature?

The second idea comes from Emanuel Kant, and is kind of a religious idea. Kant proposes that there is as a categorical imperative that everybody has to find out what is good or what is bad. He talks about given ethics. The problem is that it remains unclear where this given ethics come from. There is no way to prove whether what is called good is fundamentally good. You just have to believe. Thus we might come to the conclusion that there are no given ethics. The dilemma is solved by the third ethical theory, the social contract theory which dates back to Epikur. It assumes that any group, any society and any nation is continuously discussing what values are to be taken in perspective. The “group” must decide what is important, what is right and what is wrong. Eventually a consensus is reached which is accepted at least by the majority of the group members. Moral becomes an implicit commitment of rationally acting persons – a contract and ethics are the result of a negotiation process. It appears that this theory is the state of the art of the understanding of global ethics.

According to Vossenkuhl in cases of competing values like sometimes an economic approach or an ecological one the process starts by looking for the rarest good. The problem is, however, who defines what the rarest good is and which value it has. Changes which are discovered as necessary should not violate other basic values. Some goods are not dividable, for instance, freeness, equity, life, health. Others are dividable like money, income, work and, cultural values. This process of balancing values will neither end nor has it a predefined end; we will never have a fixed ethic, humans typically create values and destroy them.

There is a significant problem involved in this theory, however. If we accept it we may end up in a market driven ethics. If we only follow the bargaining concept we won’t find a real solution. On the other side we should remember Kant’s categorical imperative. Modern philosophers such as Jonas and Sloterdijk who come up with the conclusion that there are some given limits to the Earth system and an absolute imperatives for our doings. This, in turn, brings us back to the question of stability. Sloterdijk as well as Jonas warn that the crisis of civilization might lead to humankind committing suicide. It seem to be that the idea of a negotiating ethic alone is wrong. We can proof this when accepting that our earth system has limits. This brings us back to Kant, but also to the field of anthropocentric ethics. As Mainzer tells, these three

approaches of Utilitarianism, Kantism and Commitments exist parallel, they do not exclude but complement each other.

I suspect that anthropocentric ethics have the best chance to receive broad acceptance. It is an important task of IESP to find out whether and to what extent we have limits not only to growth but also to the use of water and soil and to pollution of water, air and soil. Such findings would enable us to formulate a comprehensive concept of ethics.

Anyhow we have to accept that the environment and its ecosystems has more than an instrumental value. But how should we view ecosystems? Should we consider ecosystem services as means to maximize production and living standards? Alternatively, our aim could be to strengthen ecosystem's sustainability and resilience. If so, does it mean that we have to favor untouched ecosystems with no interference by humankind? Should we even favor an approach called "deep ecology" which is a new buzzword in eco-philosophy termed "ecosophy"?

Definitely, we could and we should limit the pollution of water, air and soil. This could be a very concrete contribution to environmental ethics. We should claim that drinking water quality according to worldwide standards are insufficient as they serve the basic requirements of the human population only. The quality requirements of most ecosystems are much higher meaning that the water used for human consumption (industry included) and thereafter emitted to aquatic or terrestrial environments should be purified to a level much higher than drinking water standards set by the World Health Organization (WHO) or by any national institutions including the EU.

The remaining question is who has to act. Here I refer again to Sloterdijk and his immunization concept. He suggests discrimination between physical, psychological and social immunization strategies. Physical strategies are aimed to avoid illnesses. Psychological strategies are focused on depression, injuries or fear of death. Social immunization strategies are addressed to State authorities and targeted against internal and external "enemies". It is basically an up-scaling of personal egoisms eventually leading to a consistent global group. In conclusion, it is the obligation of governments to install well knowledgeable institutions to act on the basis of a robust mandate.

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China's Development and Environmental Choices

MENG Wei

Introduction

Through three decades of rapid development, China's GDP is now listed as the second in the world, with the per-capita GDP reached 6,060 US dollars in 2012. At the end of 2013, the urbanization rate was 53%. It is anticipated that in 2018 the urbanization rate will be 60%. However, China's urbanization still has the problem that it only pays attention to the expansion of city scale, the regional development is not well coordinated, and the urban-rural dual structure is not rational.

Currently, China's economic zones are normally divided into east, middle, west and northeast areas. East China has developed economy. Its land area accounts for 9.5% of China's total land area and its GDP in 2008 accounts for 54% of China's total GDP. The environmental pollution in East China is comparatively more obvious. The middle part of China is the economic hinterland and important market. West China is a less developed area which needs further development. Its land area accounts for 71% of China's total land area, and its GDP in 2008 accounts for 17% of China's total GDP. The overall ecosystem in West China is safe. Northeast part is an old industrial base. Its land area, population and total GDP in 2008 accounts for around 8.0 % of that in China respectively.

China's Water Environmental Problems and Characters

The water pollution in China is still serious with regional, composite and compact characters. First, the water quality is poor, with heavy load of pollution discharge which is far over the environmental capacity. About 30% of the key lakes and reservoirs are in the state of eutrophication. Second, there is little per capita water resources, unbalanced temporal and spatial distribution and low water efficiency. The ten thousand Yuan GDP water consumption is 2-3 times over the world's advanced level. Third, the water ecology is damaged. The natural ecological space such as wetlands, coastal zones, lakes and river shores has been decreasing continuously. Fourth, there are lots of hidden dangers in the water environment. Almost 80% of the chemical and petro-chemical industrial projects are located at sensitive zones along rivers or with dense population. Fifth, water environmental management is based on jurisdiction, which has fragmented the integrity of the hydrology and ecosystems of watersheds.

Case Study 1: Water Pollution and Water Ecology Health of Liaohe River

Liaohe River watershed (Figure 1, top level)) is located in northeast part of China. In 2011, the proportion of water sections, where water quality was worse than Grade IV (four), was nearly 60% in Liaohe River watershed, with serious pollution in urban river courses. There are 60 new types of detected toxic and hazard, refractory pollutants. The non-point source agriculture pollution accounts for a bigger and bigger portion of the pollutants in the entire watershed. The water environmental pollution has influenced the aquatic communities. The aquatic ecosystem in over 70% of River Reaches is in the state of sub-health.

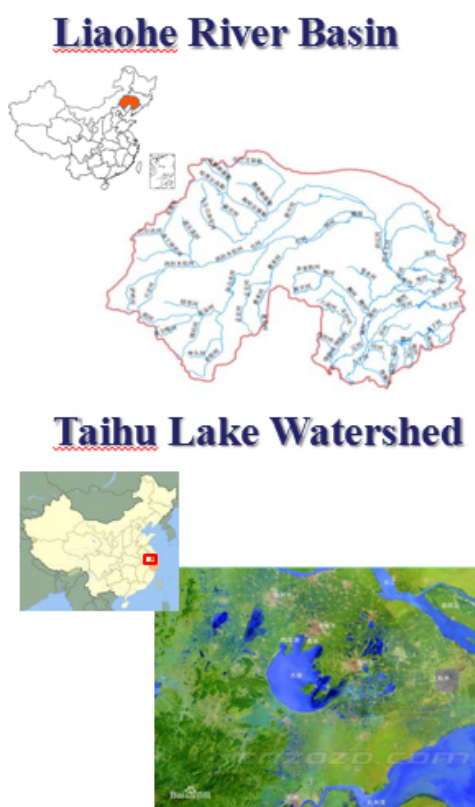


Figure 1 Liaohe and Lake Taihu watershed

Case Study 2: Water Pollution and Water Ecosystem Health of Taihu Lake

Taihu Lake watershed (Figure 1, tower level) is located in Jiangsu Province and Zhejiang Province of East China with the most developed economy in China. With the process of industrialization and urbanization, the non-point source agriculture pollution has been increasing. However, the construction of sewage treatment facilities is still behind the pace of urbanization, resulting in obvious impact on water quality in Taihu Lake. In the past, the water quality was mainly at Grade II (Two), while currently it is mainly Grade IV (Four), becoming eutrophicated lakes. The aquatic organisms of the entire lake are in the state of sub-health, with frequent “algae bloom” in summer.

Choices for Ecological Civilization and Environment.

Parable of the Fish in the Air.

“Mencius” is a famous Chinese thinker and politician who lived in 372 B.C. to 289B.C. who is the successor of “Confucius” thoughts. His proposition is harmony between nature and human, calling for harmonious development of both. In those years, the King of Qi State in Shandong planned to conquer the world by wars but Mencius told him that to conquer the entire country by wars was just like climbing up the trees to catch fish which could not achieve the aim but only with serious results. Such a way which cannot achieve the aim is summed by China’s idiom as “Fish in the Air”.



Figure 2 Cartoon of Mencius' parable

The current situation

The current environment problems in China have attracted attention from the whole society and the world. Mr. Zhou Shengxian, the formal Minister of Environmental Protection of China, analyzed the problems and believed that the fundamental causes for the environmental problems are the approaches of economic and social development, namely the selection of different development approaches will inevitably result in relevant environmental problems. In order to solve the environmental problems, it is necessary to find the correct ways in the economic development, including the entire process of production, circulation and consumption, as well as the production modes and consumption modes. Only this could solve the environmental problems. Otherwise, it is just like “Fish in the Air”.

Construction of Ecological Civilization and Environmental Protection in New Period.

Chinese government has put forth the concept of “New Normal” economic development, namely the economic and social development enters into the “New Normal state” that growth rate transits from high speed to medium-high speed, economic structure transits from medium-low end to medium-high end, development momentum transits from element driving, investment driving, overdrawing resources and environment to dependence on innovation driving.

Chinese government is promoting actively the construction of ecological civilization, requiring a scientific understanding on the mutual dependence relationship of human being and nature, to respect nature, conform to nature, protect environment, and integrate ecological civilization construction into all aspects and entire process of economic, political, cultural and social construction. China is now building a new mechanism “to protect eco-environment with institutions and systems”, to improve natural resource asset management, to identify red line for eco-conservation, and to establish eco-compensation system. The new Environmental Protection Law of the People’s Republic of China was put into implementation this January, which requires that “economic and social development should coordinate with environmental protection”. Concerning basic principles and concepts, protection should be the priority, prevention should be the first, and more attention should be paid to the integration of total pollution control and environmental quality improvement, so as to ensure that the environmental quality will not degrade, and eco-system service function will not be weakened. China has developed a series of important action plans on environmental protection such as *Action Plan on Water Pollution Prevention*. The National Science and Technology Program on Water Pollution Control and Governance is now entering into the third stage, in which water quality target management will be conducted in ten key watersheds focusing on Liaohe River and Taihu Lake, to secure the water ecological safety, improve the service function and to complete the water ecological function zoning. The environmental criteria of major pollutants is stretched out, with the discharge permit be demonstrated, the Best Available Technology (BAT) and Environmental Technology Verification (ETV) be established, the environmental risk be controlled and the international cooperation be developed.

Chinas's Environmental Choices

Since 2013, China has begun to review and develop new patterns of development, adjusting the unbalanced relationship between the economy and environment with the aim to rebalance environment and economy.

First, it was necessary to establish a comprehensive eco-civilization concept, readjust the long-term unbalanced state of environmental protection and economic development, in order to promote the balance between environment and economy.

Second, it was decided to adhere to a preferential protection principle and transform the traditional environmental management mode of “pollution, treatment, re-pollution and retreatment” to the new mode of “protection, restoration, re-protection and continuous improvement of gross good ecological assets”, in order to advance the balance between treatment and protection.

Third, an integrated eco-system management system for mountains, water, forest, fields and lakes, following the law of nature is currently being established, in order to boost the balance between element management and system management.

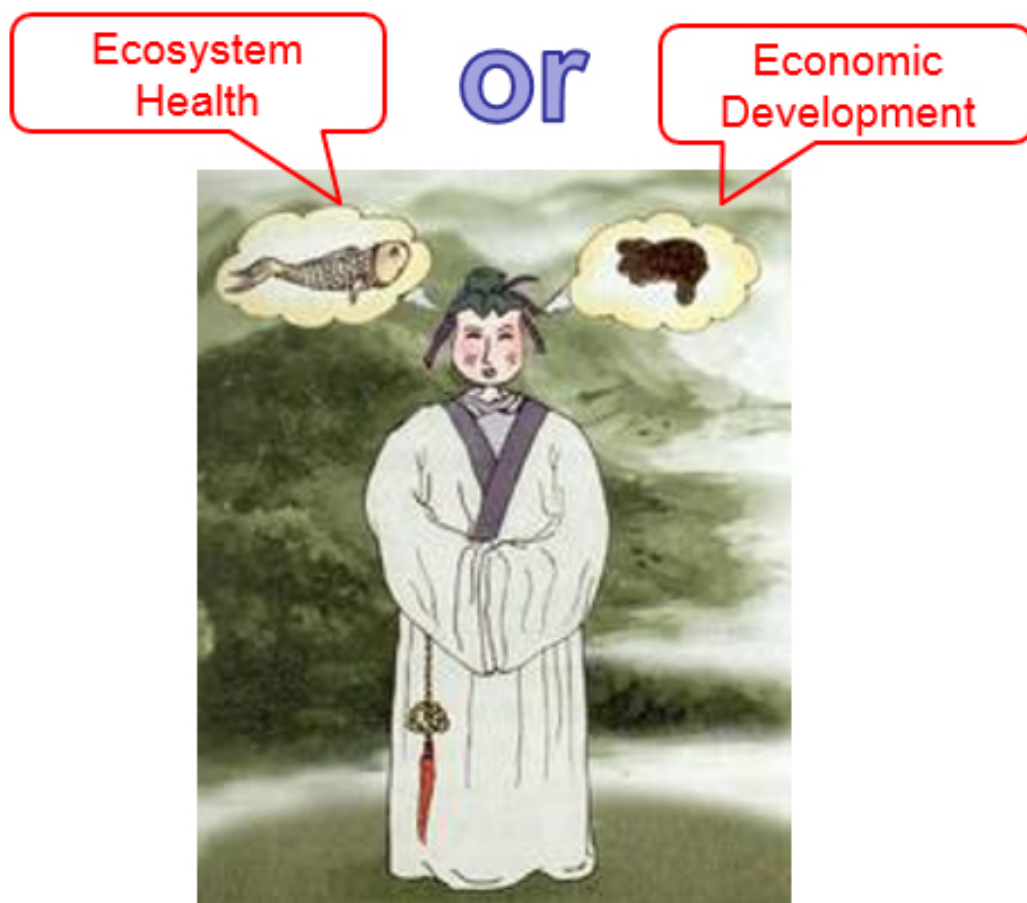


Figure 3 Mencius's other important proposition: *Fish is what I desire*

Closing Remarks

- The natural property of water environment needs to be respected.
- The prerequisite for the utilization of the water environment is that the natural property of the watersheds is kept from being damaged.
- The socio-economic development shouldn't be obtained at the costs of environmental quality degradation, watershed natural integrity loss and ecosystem health deterioration.
- The harmony between humans, nature and the water environment needs to be secured.

Annex 1

Mencius' another important proposition is that "Fish is what I desire". Mencius believed that human being shall not do things which are against the etiquette or rules. In the context that we are not able to obtain both the economic development and natural environmental health, we would rather give up the achievements of economic development and choose sustainable natural environmental health, which reflects the mutual dependence, interactive and coexistence relationships between human being and environment, and conforms to the law of nature.

Annex 2

President Xi Jinping of China points out that: mountains, water, forest, fields and lakes are a life community. Taking the ecosystem of watersheds as an example, watersheds are compound systems consist of natural elements such as mountains, water, forest, fields and lakes (sea) as well as humanity elements such as society and economy which take the water as the link. It is not only the basic unit for ecosystem to circulate substances and energy, and maintain system balance, but also the spatial carrier for human activities and social and economic development. Based on the concept of "integrating mountains, water, forest, fields and lakes (sea)", China has assessed the water ecology health of watersheds in Liaohe River Basin, and conducted zoning of Grade I (One), II (Two), III (Three) and IV (Four) of water ecology in watersheds, identified the protection scope of the main stream of Liaohe River Basin based on the study outcomes of the water ecology function zoning of watersheds, and developed catalogue of protected fish species in main stream of Liaohe River so as to provide technical support to the "integrated management of mountain, water, forest, fields and lakes (sea)". The implementation of watersheds ecosystem management has enabled rapid economic growth of Liaohe River Basin while improving the water quality significantly. From 2008 to 2011, Liaohe River Basin achieved rapid GDP growth, and the water quality in the watersheds was improved continuously, recovering from worse than Grade V (Five) to Grade IV (Four).

Do we need economic growth?

Michael von Hauff

Four trends in economy

When asking the question “Do we need economic growth” the typical answer is “of course we need growth”. But what kind of growth do we really need? To answer this question we are typically confronted with extremely different position. To be mentioned are four approaches:

1 Neoclassical economics (mainstream economics).

Many economist assume that we need economic growth mainly to stimulate the labor market, to strengthen the systems of social security, to increase the budget of the government, to increase the income level of the society, but also to protect the environment through new environmentally technologies.

2 Ecological Economics.

In the middle of the 80th a new paradigm was presented and discussed in response to the environmental damage caused by unlimited economic growth. Hermann Daly (2008) hypothesized that we – at least the industrialized countries – should not have and do not need economic growth. Instead, we should focus on a “steady state economy”. However, there are some representatives of ecological economics differentiating between growth which has a negative impact on the environment and growth which has no or low impact on the environment. This discussion led to the concept of

3 Post-growth economy or post-growth society.

There is a difference between post-growth economy and post-growth society. The latter refers to negative impacts to the society. Concerning post-growth economy Tim Jackson (20011) argues in his book “Prosperity without growth” that we don’t need growth because we can reduce our consumption without becoming less happy. We would become happier with less consumption and we would reduce damages of the environment. The representatives of a post-growth-society like Angelika Zahrnt (Seidl and Zahmt, 2011)also reject economic growth for two reasons: Growth madness and negative impacts of growth on the environment.

4 De-growth.

Nowadays, we have a fourth approach, a growing movement which started in France and also in some Asian countries, the de-growth movement. It calls for no growth. In general, the process of “de-growth” is characterized by

- an emphasis on quality of life rather than quantity of consumption;
- the fulfilment of basic human needs for all;
- societal change based on a range of diverse individual and collective actions and
- policies;
- substantially reduced dependence on economic activity, and an increase in free time,
- unremunerated activity, conviviality, sense of community, and individual and
- collective health;
- encouragement of self-reflection, balance, creativity, flexibility, diversity, good
- citizenship, generosity, and non-materialism;
- observation of the principles of equity, participatory democracy;
- respect for human rights, and respect for cultural differences.

All these positions are based on the same indicator, the gross domestic product (GDP). Our own analysis of various sectors of the German economy revealed that we have sectors with a growing GDP. In parallel we found sectors with zero growth. With respect to CO₂ emission we found sectors which are growing while others do not. There is one example which puzzled us. In Germany we have a well-developed railroad system known for its relative low CO₂ emission. But recently our government decided to allow private companies to compete with far distance bus traffic. Buses are known to emit by far more CO₂ compared to railroad trains. Despite of the political “Energiewende” policy the German government obviously considers competition between companies worth more than reduction of CO₂ emission.

Comparing other sectors polluting the atmosphere with CO₂ with respect to growth or de-growth, respectively, Figure 1 and 2 present similar surprises.

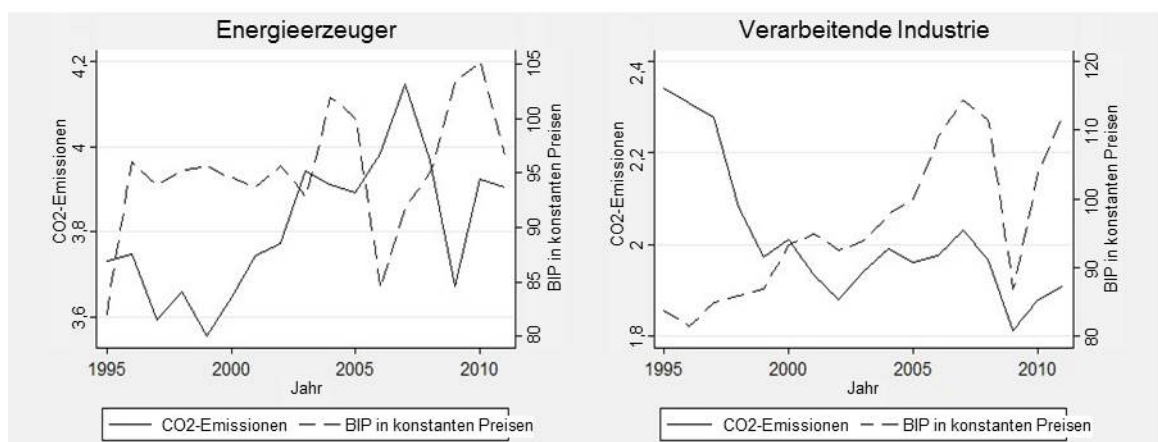


Figure 1 Trends of CO₂-Emissionen und GDP (germ. BIP) – Power generating industry (germ-
Energieerzeuger) and manufacturing industry (germ. verarbeitende Industrie); Source:
Umweltbundesamt (2014)

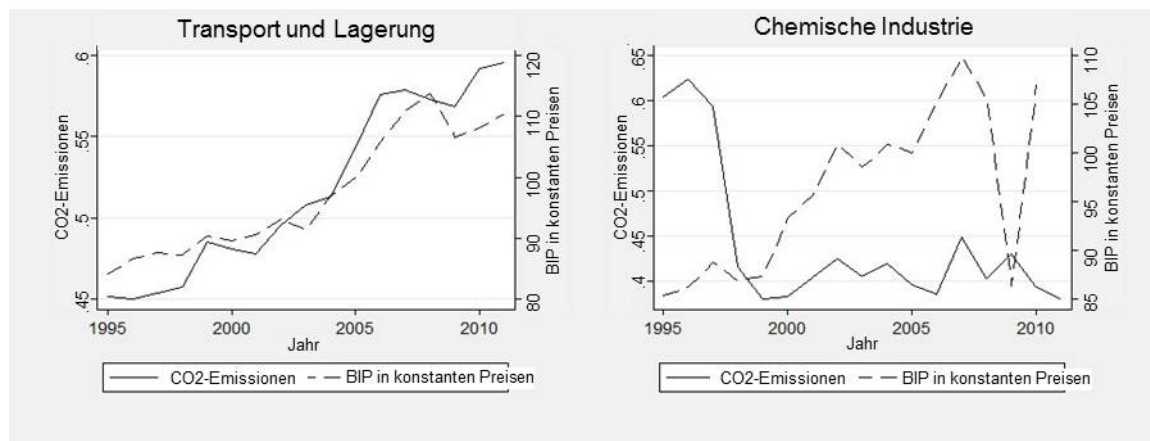


Figure 2 Trends of CO₂-emission und des GDP (germ. BIP) – transportation & storage(germ Transport und Lagerung) vs. chemical industry (germ. Chemische Industrie); Source:Umweltbundesamt (2014)

The manufacturing and the transportation sectors are growing fast but are huge emitters of CO₂. On the other hand, manufacturers and chemistry and emit much less CO₂ but grow fast as well. Obviously, GDP is not a proper indicator with respect to the nexus between economic growth and pollution.

Overcoming the controversy between the proponents and the opponents of economic growth

The four approaches still stand in opposition to each other. Efforts were made relatively early to bridge the differences in the contrary positions. This effort also includes the concept of the “sustainable economics”. It advocates of a balanced sustainability and promotes an economic and ecological optimization.

Balanced sustainability envisions a slowing of growth or a stop to growth solely as a potential result of the ecological restructuring of the society. In effect, the aim is for the harmonization of growth and environmental quality. In this respect, it is appropriate to return to the category of vital natural capital. The problem, as has already been mentioned, is in defining acceptable limits on the use of the essentials of the natural capital. The issue involves accounting for the unpredictability and risk which is not always clear or easy to define. As a minimum, an intact ecosystem multiplies the prosperity of humans and is therefore indispensable. Sometimes real and natural capital are substitutable and, in other cases, complementary.

If this insight is applied to the central point of the controversy between neoclassical economics and ecological economics, the following becomes evident: Neither a general halt to growth (ecological economy) nor infinite quantitative growth (neoclassical economy) seems to be warranted. Pearce claims that growth, in addition to the many positive effects like the strengthening of the social security systems, stabilization of the labor markets, and the increase

in government revenues with the associated greater scope for government expenditures on things like education and research, also facilitates efforts to preserve the environment for motivational, structural, and financial reasons.

Take home message

As explained in the contribution of Martin Grambow ethics are associated with values. Economic growth has definitely an instrumental value which does not qualify *per se* for ethical correctness, however. As we have seen economic growth exposes positive effects but also negative impacts, particularly on the natural environment. Only when the positive effects are brought in harmony with avoidance of negative impacts growth gains a sound value of ethical correctness. Finding the proper balance between economic growth and preservation of ecosystem function is a responsibility of economic sciences in partnership with ecological sciences.

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Transformation into a Cyber-World

Klaus Mainzer

This contribution is to be understood as a speech for using the tools of the cyber-world for proactively handling the increasing complexity of our civilization. We should realize that the cyber-world is not something artificial. Rather it is an expression of a consequent continuation of evolution when taking in account that for billions of years trillions of organic sensors and “algorithms” have been involved in the evolution of life.

Nowadays, mankind is able to construct new forms of life by means of metabolic engineering aiming to the design of metabolic networks. Sensor and software simulates the controlling and regulating tasks of molecular and cellular sensors and genetic algorithms in organisms. The message is: Sensors and algorithms are already an integral part of natural evolution. The hierarchy from molecular to cellular and organic algorithms and sensors made life as self-organizing complex systems possible.

Another important aspect of the cyber-world is the emergence of the global information and communication networks. What we observe nowadays is that the classical internet is no longer isolated but integrated in physical infrastructures. This is called the “Internet of Things”. This term sounds a bit as metaphysically which is misleading a notion, however. The parts of complex technical infrastructures are equipped with and interacted with their environment by means of sensors and communicating interfaces. This integration of the information technology (IT) in infrastructure design and operation is the essence of “Cyber-Physical Systems” (CPS). In the course of technical evolution a global communication network is emerging with surprising similarity to self-organizing neural networks of the human brain. Its increasing complexity needs intelligent strategies of fast data mining (“Big Data”) and learning algorithms, according to the synaptic plasticity of a brain.

In fact, CPS are composed of a large number of self-organizing net components which permit a significant increase of adaptability, autonomy and reliability. They are already applied in technical sectors such as automotive, aerospace, energy, healthcare, manufacturing and transportation. For instance, the transformation of energy generation and distribution systems from the classical linear model to a network of decentralized prosumers (small and large facilities producing electrical energy) and consumers can only be successful when designed and operated as a mostly self-organized system, called “Smart Grid”. Smart grids mean the integration of the power delivery infrastructure with a unified communication and control network, in order to provide the right information to the right entity at the right time to take the

right action. It is a complex information, supply and delivery system, minimizing losses, and providing self-healing and self-organizing components. Local, personalized and decentralized solutions are made possible. This example clearly shows that CPS are not an illusion but very practical tools facilitating the well-functioning of our modern civilization.

Another example is the integration of industry in the IT-world, called “Industry 4.0” meaning the forth step of the industrial development (Figure 1). The first industrial revolution began with the introduction of steam engines. The second was characterized by mass production, division of labor, and working on assembly lines. During the third industrial revolution robots were introduced for further automation of production. In the fourth industrial revolution the production gets changed on the basis of Cyber-Physical Systems and Internet of Things. Production, marketing, and trade are transformed into a more or less self-organizing complex system of sensors, actuators, circuits, and electrical control units. On demand and tailored productions with respect to preferences of consumers is made possible instead of mass standard in the tradition of Henry Ford.

In the background of all these development there is as a driving factor, the so called Moore’s Law. It suggests that in a period of 18 months the computational capacity gets doubled, with a simultaneous decrease of costs and the miniaturization of the computational instruments. Moore’s law runs into limitations of miniaturization with nano and atomic scaling. Behind the nano and atomic scaling the quantum world begins. Traditional semiconductor technology must be improved and overcome the limitations by integration of „More-than-Moore technologies” with analog/mixed signals, biochips, and interactions with the environment by sensors and actuators.

This is the technical background of exciting changes in our economies. Here also the organizational structure must cope with the speed of technical developments. Google and Amazon are already in this process of transformation and acceleration. In this context the effects of “Additive Manufacturing”, better known as “3-D-Printing”, needs to be taken into account in relation to industrial development. Very likely, in the near future parts of machines including cars will be produced by relatively cheap 3-D printers. Subsequently, car production will mainly depend on the data fed into the 3D-printers. The owners of the required, mostly very voluminous and sensitive data (Big Data) will gain a significant power in the entire business of the production and application.

Concerning Big Data (Mainzer, 2014) we should realize that in the classical internet we use only structuralized data. Now, the information technology must handle not only such kind of data but even more an amorphous mass of signals and tendencies (Mainzer and Chua, 2013) . To

process such data requires a new set of algorithms which are able to seek in a parallel way data correlation, data patterns to detect tendencies and profiles of causes and effects. Big data technology opens up new avenues of fast data mining and profiling in various fields, for instance in medicine, in ecology (e.g., early warning), in economy (e.g., on demand & tailored production), and in society (e.g., pre-criming).

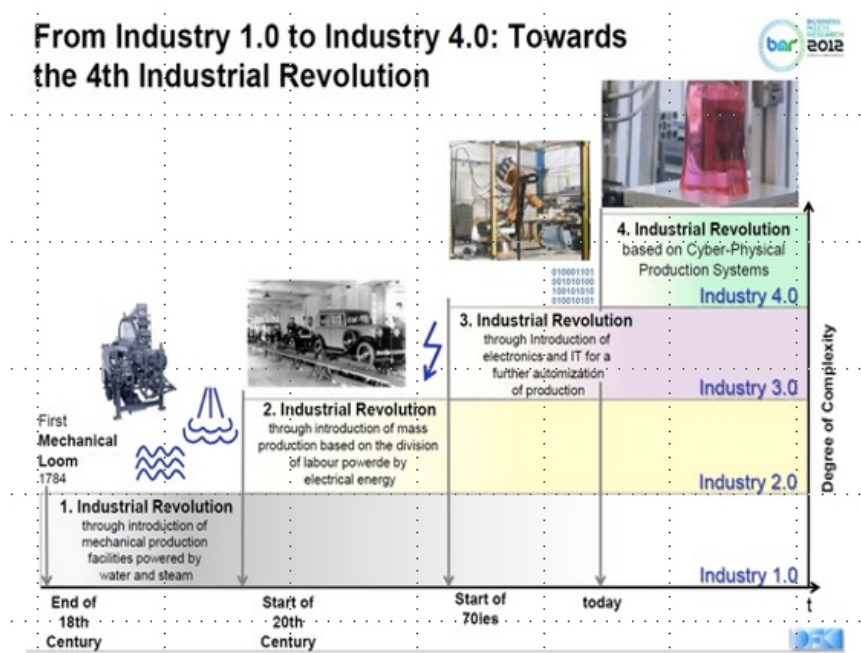


Figure 1 The history of industrial evolution

All these innovations (Internet of Things, Industry 4.0, Big Data) provoke worries about privacy, data security, safety and espionage. The tendency in the direction to a totalitarian state is obvious. Avoidance of such a development is a challenge calling for strengthening legal democratic power. Digital dignity is the primary ethical goal in a complex world with increasing automation.

In the age of globalization, mankind is in an unstable transformation of high complexity, depending on innovations of science and technology and risk taking in ecological, economic and financial issues. Cyber-Physical Systems should help handling the complexity of the modern civilization by self-organizing service systems. The task of Cyber-Physical System is to provide service to the society – no more and no less.

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Ecosystems and Landscapes

Wolfram Mauser

Central Thesis.

Agriculture is the dominant transformer of ecosystems and landscapes and is at the core of human-environment interaction.

Here, we are not talking about undisturbed ecosystems and landscapes but about those which are transformed by human interaction. In future humankind has to interact even more than in the past because our world will likely become more populated, wealthier and more urbanized. The peak population will be reached at approximately 9.5 billion around 2050. The demand for food will double until then and may still increase afterwards. To be able to handle such significant changes and by coming back to the aspects Klaus Mainzer brought up in his contribution to this brochure we have to assume the following:

- All things will follow us on our way into the internet, they (and we) will co-exist in two forms: real and virtual.
- The fate of ecosystems and landscapes will be determined by the interaction of the real with the virtual environment.
- Agriculture has become an information business, so will preserving ecosystems and landscapes.
- Environmentalism will all be about information sovereignty.

Thus, we have to gain a sound understanding of what happens when the real and virtual environments interact.

The complex world of food generation, food technology, trade and consumption

Figure 1 presents an overview of the complex interaction between farming, geography, politics and governance and social- cultural issues. Food, water, energy and finance build the link between farmers (primary producer) and the consumers. Science and advanced technology is required to facilitate the maximum yield achievable at the respective site.

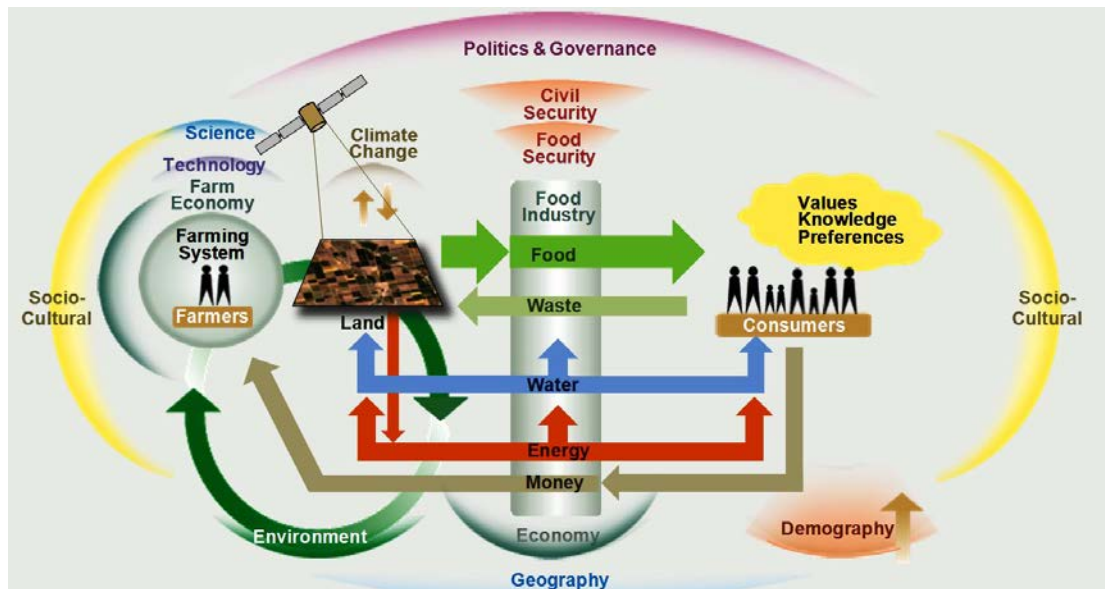


Figure 1 Graphical representation of the global food system

A political and governance framework is required to ensure civil security which food security depends on. There are external pressures to be considered such as the marketing of the agricultural products, and climate change which causes changes of the whole system. The entire system is managed with the aim to balance supply and demand.

Today, almost all commercial farmers are connected to the global food supply system, farmers in developing countries are well as farmers in developed countries. However, the impact of farming is quite different. In any case modern farms are so far

- not sustainable through soil degradation.
- not efficient through waste of water, energy, labor and food
- expanding and destroying natural ecosystems at large.

How is the global food supply system expanding? The trend points to a further increase of efficiency gains.

GDP governs transformation

Studies on the relationship between and the percentage of people working in agriculture reveal that in countries with low GDP a large fraction of the population works in agriculture whereas the opposite is true for countries with a high GDP (Figure 2). In low income countries about 1 t of agricultural products is produced by one worker per year on 1 ha of land (left hand side of the graph). In contrast, in high income countries the yield per worker is about 2.000 t per year, and only one person is required for working on 150 ha (right hand side of the graph).

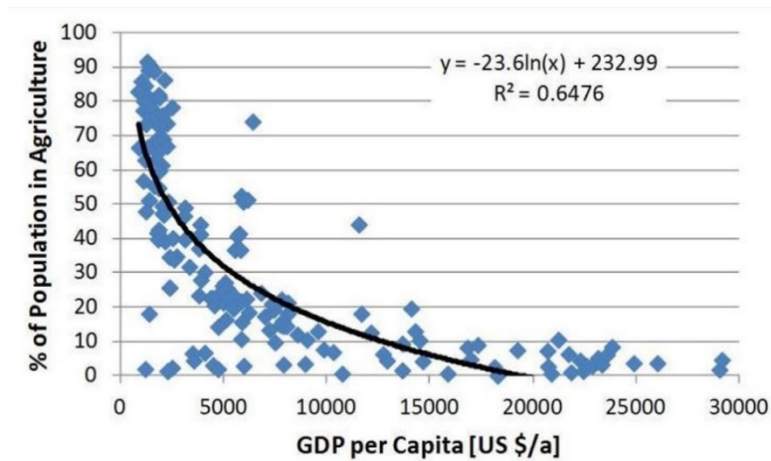


Figure 2 Correlation between labor force in agriculture and GDP

If GDP increases globally - what we have to expect - the fraction of workers on farms will likely decrease respectively and the area per farm increase. How can this work out? The answer is clear. Advanced technology has to be introduced in so far low income countries. It is not only a transformation toward mechanized farming what we will see over the next years but also a transformation towards environmental information and mathematical modelling – in short: transformation into a cyber-environmental type of agriculture.

Future of smart farms – The cyber-environmental approach

We already have satellites available which can be used for environmental modelling with the aim to detect how biomass is growing at a distinct field. In addition it can be simulated how much fertilizers has to be added at which moment in time in order to raise the yield of crops and at the same time save fertilizer. These data can now be transmitted to the tractors, which allow to support the types of plants seeded at each point in the field with an optimal amount nutrients such as nitrogen or phosphorus. By adding information about the soil and the weather conditions the dosage can be modified in order to minimize nitrogen leaching causing groundwater pollution, for instance, or the salt accumulation in the soil.

This provides the possibility of a new world of high yield and at the same time sustainable farming as depicted in Figure 3.

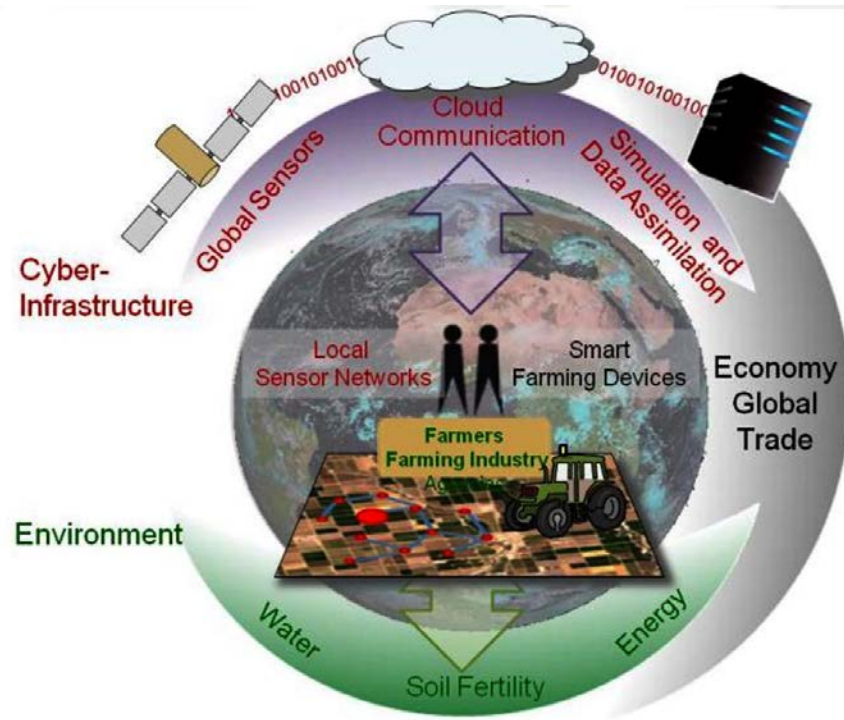


Figure 3 Schematic of cyber-environmental agricultural system

Cyber-environmental systems consist of the environment, water, soil-fertility and energy, but also of farmers and farming industry. It consists on a cyber-environment that produces the information the farmers need: sensors, cloud-communication and computers for simulation/data assimilation. It also relies on smart farming devices. All this is connected to a global economy and trade.

The global perspective

The question needs to be answered how to deal in a transforming world with agriculture and environment. Our simulations show that at least twice as much food as today could be produced sustainably on the cropland currently used and with current water resources.

From this we conclude:

- sustainable intensification on today's cropland seems to be the best option to feed 9 billion people,
- intensification or extensification of agriculture determined locally by its sustainability,
- further destruction of natural landscapes not justifiable by demand for biomass,
- genetic modification of crops not justifiable by demand for biomass,
- can only be achieved by transforming agriculture into an information business.

What is the prize to be paid? Obviously we have to admit transformation into the anthropocene (Galaz, 2014) is unavoidable. This means in particular:

- human domination of the planet through knowledge and information,
- each farmer, each tree, each lake, etc. on the globe will be integrated into the cyber-environmental system of the anthropocene,
- all farmers become information workers and use natural and industrial resources most efficiently and sustainably,
- at least 4 billion people are resettled from rural areas to megacities. Presumably, in future 8.5 of the 9.5 billion people will live in (mega-)cities,
- rural cultures are largely transformed, homogenized and connected to the global food market and the social networks.

But there are still many question which need to be answered:

- Will the algorithms take over decision making at some point on the way of this transformation?
- Who will own algorithms and information?
- How will delocalized, virtual farming (satellite information, models, autonomous tractors) change rural societies and environments?
- How will 8.5 billion (mega-)city people perceive and treat natural environments, water resources, wildlife, biodiversity, etc. (if they only source of nature is the internet)?
- Who will be responsible for this process?

Epilog

To consider all these trends and open questions it seems reasonable to start writing a book on the **history of the future of agriculture** in which we try to explain:

- how the cyber-environmental system managed to completely ingest nature into human societies (each plant, field, drop of water, animal, farmer, ecosystem, landscape),
- how models created a virtual world which made visible the state of the Earth system and the living conditions, identities and potentials of all living beings (human, animal, plant),
- how this saved millions of km² of natural land from being transformed into “cultural landscapes” and still feeds 9 billion in a sustainable way,
- how and why we failed to share this virtual world equitably among all societies of the planet and convert information from a commodity into a public good,
- how this enabled globally-operating private entities to monopolize knowledge and information, appropriate nature, lever out nation states and use the virtual world to

redefine both natural species and the identities, shopping desires and life scripts of all human inhabitants on the Globe.

The purpose of this history of the future of agriculture is to explore how not to fail at the start of the anthropocene!

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Humanity facing Pollution

René Moletta

The role of science in the battle against pollution

From the beginning on humanity used its capacity to accumulate knowledge and use it for improving the way of life. Humans cultivated land and created the basis of agriculture, food supply and welfare. Wolfram Mauser describes in his contribution how scientific advances and their technical applications help increasing agricultural production to feed an ever growing human population on Earth. The steam engine was invented which permitted industrial production. The progress of knowledge and technology is continuing at a fast pace. As Klaus Mainzer mentions in his chapter this leads to the modern time concept of “Industry 4.0”. Less and less people are required for agricultural and industrial production. Thus, people move into cities to find alternative jobs and an improved lifestyle.

As a result of the development of civilization, natural resources are exploited at an unprecedented extent, and an increasing amount of solid, liquid and gaseous wastes are generated, particularly in urban areas. The wastes accumulate in the biosphere and changes the parameters responsible for the planet’s balance. Wastes including noxious substances accumulate in soil, water and in the atmosphere. The latter causes global warming. Toxic substances kill bacteria, plant organisms, animals and sometimes even human beings. The accidents at Chernobyl and Fukushima are examples for the latter.

Humanity has begun to realize such disastrous effects. Science is called upon providing knowledge and concepts capable of correcting such negative developments. The concept of sustainable development is considered the correct answer to solving the pollution problem and its consequences.

- Solving pollution problems involve a large number of scientists in order to develop processes which avoid and even correct environmental damages. The scientific approach is based on research, experimental trials and sharing knowledge. In the scientific and technological development process it is a must to continuously scrutinize the mainstream knowledge and find sound answers to the question how far humankind is permitted to go. Moreover, scientists have the obligation to respond to the desires, concerns and fears of the society. Based on the scientifically verified results the legislation has to set up rules which must be in accordance with the actual knowledge base and with the economic feasibility of the country or the region under consideration. In the following, engineers in cooperation

with economists and sociologists are responsible of providing the tools required to meet the scientifically proven and economically confirmed goals of remediation and reorientation towards sustainable development.

- The principle of the decontamination processes applied are often derived from the observation of the nature.
- Regarding low income countries, the level of technologies must be adapted and integrated to the prevailing economic and social realities, including skills, local traditions and religious belief.
- In the following two example will be presented showing how science and engineering has improved our approach to social and environmental problems and created valuable resources from wastes.

Anaerobic processes and technologies as an example

The first example uses anaerobic processes to reduce environmental pollution and at the same time provides “renewable” energy.

Alessandro Volta in 1776 looking at the gases escaping from bubbling pools discovered the relationship between the amount of decaying matter and the amount of flammable gas produced (Figure 1)



Matériel de collecte et d'analyse des gaz des marais utilisés par Volta² en 1778

Figure 1 A sketch showing Alessandro Volta in front of a bubbling lake

Facing the problem of pollution and the lack of energy scientists and engineers studied the phenomenon any further and developed the technology of anaerobic fermentation. In this process organic substance contained in wastewater, organic sludges, animal manure of agricultural residuals are biologically converted into methane gas. Therefore, the process is also called methanization or biogas production (Figure 2).

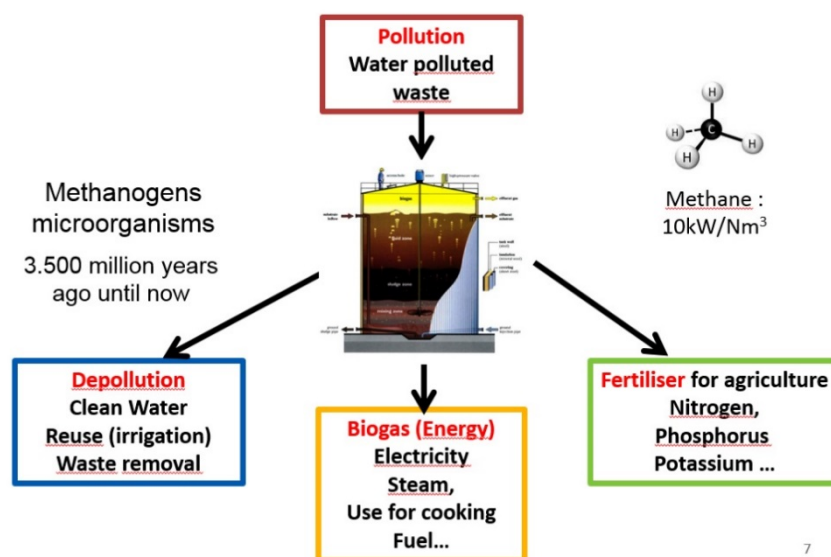


Figure 2 Graphical representation of anaerobic treatment processes

By the way, anaerobic processes and methanization are very common in the intestinal tract of animals and human beings. With respect to technical application biogas can be transformed into electricity or heat, replacing fossil fuels. The remaining digested material contains plant nutrient and can be used as fertilizers and soil conditioners, provided contaminants such as heavy metals are not present in significant concentrations.

Anaerobic digesters are nowadays intensively used to treat highly concentrated wastewaters from industry, sludges from wastewater treatment plants and manure from livestock breeding farms. In Germany, about 8000 digesters are currently in operation in farms producing approximately 4.000 megawatt of “renewable” energy.

In many countries the process was in use even before knowing how it works, and it was applied it for the treatment of wastes and for gaining fuel for cooking. Figure 3 depicts some rather primitive versions of the technology used particularly in low income rural areas. In rural China, there are 41 million digesters in operation.

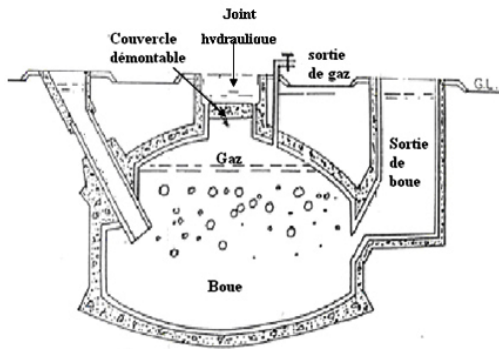


Figure 3 Examples for low tech-traditional digesters

Another low-tech but nevertheless simple application of methanization is shown in Figure 4. At a coffee plantation in the southern part of India biogas technology was applied not only to recover methane from waste but moreover to introduce the concept of circular economy into coffee processing. Electricity generated from methanization of the pulp of coffee beans is used to run the pulping equipment. The water released from the digester is cleaner as the raw water used for irrigation of the coffee plants.

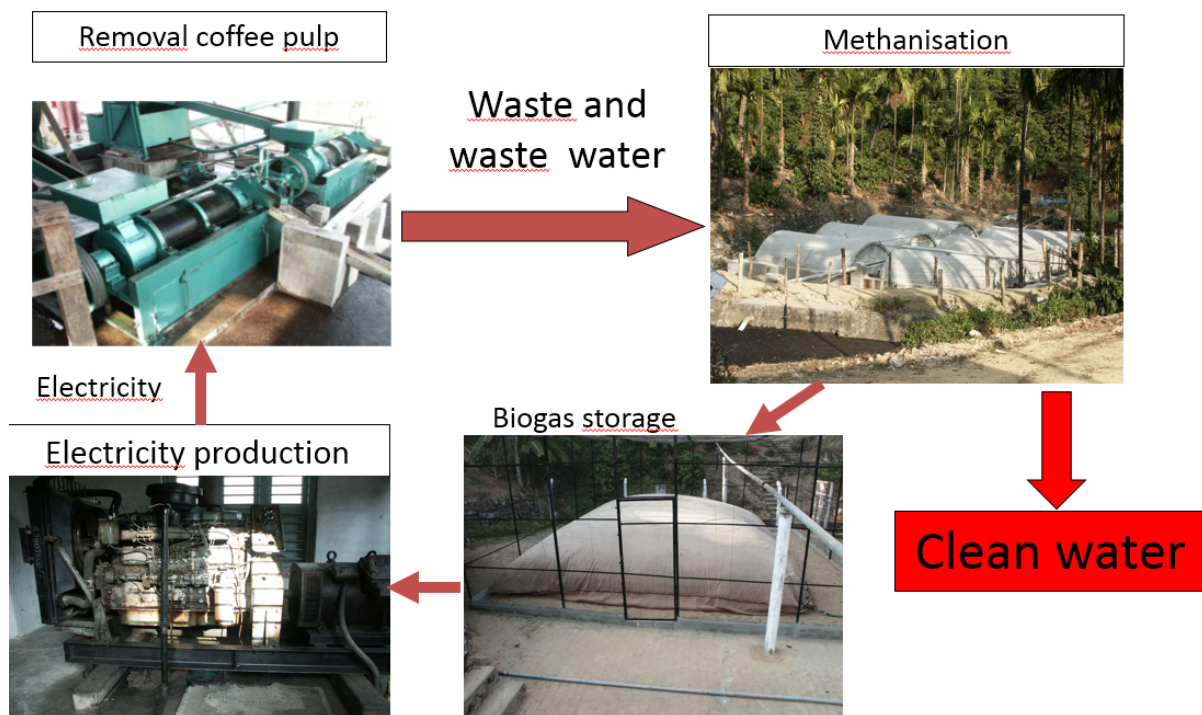


Figure 4 Implementation of anaerobic treatment in a coffee bean processing plant in South India.

Science engineering contributes to solving a CO₂ degasing phenomenon in Cameroun

As a second example of a successful cooperation of scientists and engineers for solving an environmental problem I want to bring forward the Nyos case.

Nyos is a deep lake located the north-western part of Cameroun high on the flank of an inactive volcano in the Oku volcanic plain along the Cameroon line of volcanic activity. A pocket of magma lies beneath the lake and leaks carbon dioxide (CO₂) into the water. In the night of August 21, 1986, possibly as the result of a landslide, a large bubble of CO₂ gas accumulated at the bottom of the lake which suddenly raised to the water surface spilling about one cubic meter of gas over shoulder of the lake (Figure 5, left side). 1.700 people living in nearby towns and villages and 3.500 livestock died. This was the first known large-scale asphyxiation caused by a natural event.

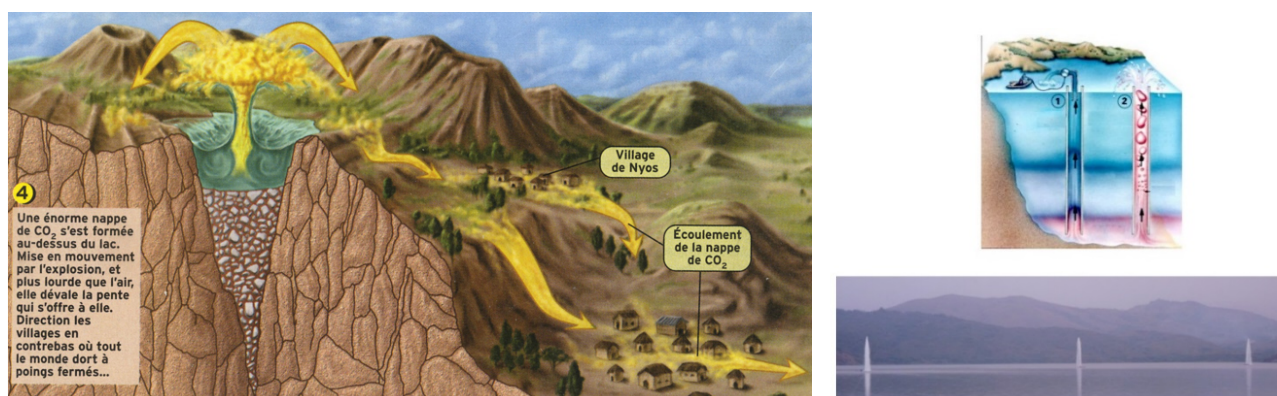


Figure 5 Artist view of Lake Nyos and the solution for continuously degassing the lake

To prevent recurrence of such a disaster in-depth studies were conducted by a team of scientists and engineers. It was discovered that Lake Nyos is thermally stratified, with layers of warm, less dense water near the surface floating on the colder, denser water layers near the bottom of the lake. Over long periods, carbon dioxide gas seeping into the cold water at the lake's bottom is dissolved in great amounts. Most of the time, the lake is stable and the CO₂ remains in solution in the lower layers. However, over time the water becomes supersaturated, and if an event such as an earthquake or landslide occurs, large amounts of CO₂ may suddenly convert in its gaseous form (http://en.wikipedia.org/wiki/Lake_Nyos).

It was concluded that installation of vertical pipes reaching to the bottom of the lake would avoid super-saturation of the water. By using a manual pump the water column in the lumen of the pipe is forced to move upwards causing an auto siphon getting started. As a result the pump is no longer needed. Three of such pipes were installed. Now, the gas is continuously removed from the lake without any input of energy.

Final remarks

Scientists and engineers are obliged to answer ethical issues in favor of humanity and nature.

In their search for new knowledge and new technology they must take the notion of environmental issues facing the development of humankind and translate them into concrete technological responses.

It is their duty to explain to the society what it is in the long term technically possible and appropriate and what is not.

The concept of sustainable development must be every time in their mind when designing processes.

Facing the pollution and its impact on the balance of life on Earth, sustainable development is a *conditio sine qua non* with respect to the future of humanity.

It is important to develop technologies that allow sorting and recycling, and avoid release of matter which will pollute the environment.

Low income countries have the right to increase their way of life, and high income countries have the obligation to help their development using the concept of sustainable development.

In summary, science and technology contribute significantly to the proper evolution of humanity.

We need security, transparency and leadership

Werner Weidenfeld

Concerning the currently ongoing changes the political and economic life the keyword is complexity. During the past decades the complexity of our social, economic and political life increased significantly. The reason or that include processes such as globalization, growing speed of transfer of information, and digitalization. To be able to master complexity it is important to develop filters and orientation. Otherwise complexity leads to confusion. People as well as actors in political and economic institutions fall into the trap of insufficient understanding of what is going on. Losing power is the inevitable consequence. Joseph Nye, former Assistant Secretary of Defense under the Clinton Administration, was one of the first to discuss the importance of applying the proper type of power in the process of fostering political stability. Nye distinguishes between hard power, soft power and smart power – a new icon coined by Suzanne Nossel. It is assumed that an effective smart power strategy will effectively address threats to peace and security, climate change, global health, and humanitarian operations (Investing in new multilateralism, 2012). Some comments are to be made to put such thoughts in perspective:

Over centuries security was guaranteed by military forces, and by deterrence. During the cold war period on both sides, the East and the West Block, huge military forces were installed. Deterrence avoided a war to break out. In the time of terrorism type of deterrence does no longer work causing a dramatic decrease of security.

Secondly we have to notice that we have no international political architecture in place, organized by a few world powers. We certainly have a multi-collaborative world but no world protecting architecture. Terrorists act in a completely different, hardly predictable manner compared to state armies. They are driven by very different interests, for instance by religion, nationalism, poorness, lack of water, food, raw materials or electrical energy.

Finally we are confronted with cyber-attacks and cyber wars. Mostly it is unknown who is attacking and who the attacker is. This produces a wide spread insecurity feeling changing the public atmosphere. Since deterrence does no longer work it is replaced by protection schemes, worldwide.

A further aspect to be mentioned is trust. In a highly complex society trust plays a major role in keeping political, societal, economic and technical systems stable. To put it in simple words: If a person starts distrust the security of everything, the building the live in, the car they are

driving, the airplane they are using for flying from one to the other place, it becomes impossible to live a decent life. Actually however, in our world trust is progressively replaced by distrust adding to the confusion which undermines the stability of our civilizations at large.

To counteract such devastating developments an advanced crisis management is needed including a transformation strategy which has to be closely and continuously monitored. Some criteria of such a strategy include the capacity to act, participation, rule of law, political societal integration, and international cooperation. To be successful a legitimized leadership is required executed by an educated strategically competent elite. Moreover, we need transparency in decision making, participation and international cooperation. No one can handle the complex situation outlined above while doing things alone. Cooperation, and strategic partnerships must be established. This is certainly a very complicated task. It needs a properly organized cultural approach.

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Incentives for further Considerations

Advanced philosophical discourses are necessary to identify an ethically sound approach to sustainable preservation of life enabling conditions on Earth.

James Lovelock taught us that the self-regulative capacity of life made it possible that life could persist over the past 2.4 billion years despite of severe disturbances caused by hits of asteroids, volcanism and changes of solar radiation. With the appearance of *homo sapiens* life received another, cognition based aptitude of regulation and control. It appears that under the contemporary advances of science and technology expressed, for instance, by digitalization, cyberization and machine-to-machine communication the philosophical understanding of environmental ethics needs to be revisited.

Anthropogenic interventions in natural processes may not exceed ethical limits.

The term “environment” applies not exclusively to aquatic and terrestrial ecosystems. It includes social, economic and technical environments as well. It is important that the function of natural systems and the economic and societal interests of the human civilization are closely intertwined. A normatively correct and morally justifiable dealing with any of those subsystems requires a critical survey of the interests and limits of any other related subsystems. Ethically permissible interventions are to be derived from the result of such surveys.

Action is to be taken to lower the pressure on natural and man-made environments.

In the era of the anthropocene the functioning of the planetary environment is challenged by a wide variety of factors. The pollution of air, water and soil, environmental degradation and the growing demand of humankind for land are among those factors. Simultaneously, individual values and peculiarities may not be replaced by uniformity (e.g., fashion, language, structure of economy and governance). Humankind is well advised to counteract not only pollution. As important is counteraction against the loss of diversity of species and human cultures. Resilience of natural and man-made systems thrives and prospers from diversity and redundancy rather than from the model of monocultures.

The stability of ecosystems and civilizations needs to be strengthened.

Factors affecting ecosystems and civilizations cause feedbacks which impact the stability of natural and anthropogenic systems alike. Negative impacts occur, for instance by accumulation of pollutants in soil (e.g., heavy metals, pesticides, salts). Loss of soil fertility aggravates agricultural production. In turn, this hampers food supply and chances to escape the poverty trap. It is important to understand that control pollution of air, water and soil contributes to the enhancement of ecological, economic and societal stability. Costs for pollution control and remediation of polluted areas is to be understood as an investment in the future of societies, not as a burden.

Solving the pressing challenges currently piling up we need a well-educated and legitimated elite taking leadership providing transparency and fostering trust.

To overcome political, societal and economic instabilities it is crucial to build up domestic and transnational trust. In order to proceed it is necessary to invest time and intellectual energy in all aspects of social, political and economic affairs. Transparency and participation needs to be executed to strengthen trust among people and among the actors on the political arena, especially in explanation and interpretation of problem solving attempts.

An advanced form of education is required to prepare our societies of the rapidly proceeding global changes.

It seems important to spend more time to teach children the essence of life and its evolution. Moreover, the interest of children in scientific thinking needs to get promoted. Such efforts will allow the young generation to better understand the importance of keeping the fragile ecosystem's function intact, and thus pay more attention to sustainable development

Build-up of trust and internationally binding safety measures are required to support wide-spread acceptance of Cyber-Physical Systems including Internet of Things and the concept of Industry 4.0.

The current discussion of the pro and cons of Cyber-Physical Systems is dominated by proponents who embrace the advantages provided by Cyber-Physical Systems (CPS) to master complex systems to the benefit of civilization at large, and by opponents who expect a dramatic loss of people's self-determination and to the lack of safety measures. Personalized and decentralized solutions are made possible by self-organizing systems. In reality, CPS are to be

understood as nothing more than a highly elaborated tool for handling the complexity of our modern world. It is certainly not a “Silicon Valley” ideology. As any other early-stage innovation CPS currently exposes some incompleteness, however, which needs to be liquidated. Improvement of transparency and data security are two of the tasks the developers of CPS have to come up with. Only then trust can be build-up and broad-range acceptance by the society, the industry and by political institutions. Moreover, the cross-relationships between the fourth industrial revolution, environmental services, availability of resources and the evolution of civilization needs to be taken into consideration.

Economic and ecological sciences have to work closely together with the aim to serve both, the society and the natural environment.

As long as the four most discussed approaches to the issue of growth (neo-classical-, ecological-, post-growth- and de-growth economy) are based only on GDP as indicator a solution for the stabilization of both, civilization and natural environment can hardly be found. We need an indicator which covers the interest of the economy as well as of the ecology. A sustainable development of civilization can only proceed when long-term positive effects of economic growth correlate with long-term positive effects on stabilization of ecological functioning.

Technologies to overcome pollution of air, water and soil are to be valued as the precondition of the preservation of ecological stability and economic development.

Integration of new technologies in sustainable development policies should receive priority. Financial support of demonstration projects to show the practical applicability positive contributions of innovation is an urgent necessity.

We need innovation in governance to be able to effectively respond to global and local changes.

Governance of the rapid changes of climatic, economic and societal conditions require not only participative discussion but even more concrete action. Which kind of power do we need to make the various civilization on Earth ready and fit for the foreseeable changes of living conditions? The options to choose from include Wittvogel’s total power concept, the hard power exerted during the Cold War, soft or even smart power. The complexity of our world requires a reasonable answer to such questions.

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