Summaries of the 1st KNAW/AcTI Mini-symposium

Leefbare toekomst vraagt inzet van wetenschap over de volle breedte

1 September 2014

Introduction

By Prof. Mick Eekhout, TU Delft, KNAW, AcTI

The world as we know it is a complex system of infinite movements in all kind of directions. Not in control by organisations, companies or governments. Each organisation has its own ambition and limited playing field. As a total there is not equilibrium. And besides the societal problems in the West, other regions in the world suffer from even the most basic ingredients that make a human living. These basic needs as Water, Nutrition, Clothing, Health, Housing, Energy, Materials and Mobility are recognized by world wide thinkers as the Grand Challenges of the world. Civilisation starts with water and sewage in order to prevent large scale diseases. As much as 3 billion people on this planet live under internationally agreed poverty level and this amount is yearly increased by wars and natural disasters.

Traditionally KNAW (Royal Netherlands Academy of Arts and Sciences) as the Academy of Science and AcTI (Academy for Technology and Innovation) as the Academy of Engineering occupy themselves with science, technology and innovation. These are usually quite specialised areas. In the light of the Grand Challenges these specialties of KNAW and AcTI are not combined to an impressive impulse or ambition. The potential holistic power of the two societies is not combined. In a time of generation renewal in both organisations surely some of the internal energy could be directed towards the Grand Challenges. Both organisations desire to show their combined views and knowledge for the good of the future of the world, expecting on the long run to address their particular efforts also in the same holistic direction.

For that reason the KNAW and AcTI have initiated a working group to scout the possibilities in the far future for societal problems of the world in order to give collaborative research and development towards that direction a boost. The result is a report which has been recognised by the board of both KNAW as well as AcTI. A part of the human efforts are to be spent in the Global Challenges, from a modest awareness and discussion topic up to the formation of a political instrument as a Platform with internal connections, knowing where and what is else happening.

This mini-symposium gives a modest overview over a number of the world's most challenging problems for the future: Water, Food, Energy, Materials, Housing, etc. The aim of the symposium is to familiarize participants from KNAW and AcTI with these Grand Challenges of the world, to invite them into a wider participation. Apart from the core of the beta scientists and technologists, also the alfa members are necessary for the social structuring and implementation and the gamma members are guiding it via politics and economics. For an important and effective movement both A,B and Y scientists and industrialists are needed.

The result could be a wider movement started inside KNAW and AcTI, but also grown outwards in The Netherlands and connected abroad to realise the contours of the Grand Challenges. The ambition is to propose an influential Platform grown from the origin of the two academies. Distinguished Academy member Guus Berkhout even aims at an Open Scientific Platform for Global Prosperity. The actually desired and possible boost the Dutch Science and Technology can bring in that field has of course an eye on its own development in the long run, but a touch of altruism is not strange.

Energy and sustainable development

By Prof. Margot Weijnen, TU Delft, WRR, AcTI

Energy is essential for social and economic development. Energy provides mobility, heat and light, and it fuels the machinery that drives the global economy. However, while some parts of the world have successfully exploited energy resources for the creation of advanced economies, 2.6 billion people in today's world still lack access to clean and affordable energy services for cooking, heating and productive uses. More than 1.3 billion people lack access to electricity, while another 1 billion depend on unreliable power grids. Smoke produced by inefficient cooking, lighting and heating devices kills almost 2 million people every year, mainly women and children. Besides worldwide climate change, energy related emissions create public health deteriorating conditions in many urban agglomerations around the world. Many historic and current practices of energy resource harvesting, including some of those advertised as sustainable, furthermore contribute(d) to habitat loss and therewith to diminishing biodiversity.

In modern economies, electricity infrastructure is no doubt more critical than any other infrastructure. The systems through which electricity is provided have evolved over more than a century. Starting at city (district) level, local networks have gradually been interconnected and expanded to create regional and national systems which, through cross-border interconnections, have become entwined in continental networks. To improve the quality and affordability of electricity services, the European power sector, previously in the hands of vertically integrated, state-run monopolies, has been reformed in the 1990's. The introduction of competitive markets for electricity production and energy service provision has added unprecedented multi-actor complexity to the complexity of the physical power system. While improving economic efficiency and accelerating technological innovation were the central objectives of European power sector reform, societal priorities in subsequent decades shifted towards stimulating clean and sustainable energy and combating climate change and, more recently, in view of mounting geopolitical tension, towards ensuring security-of-supply. However, in the institutionally fragmented state of today's European power system, it is increasingly clear that our policy interventions do not succeed in steering power system behaviour towards generating the outcomes that society wants. Unrelated events, such as the Fukushima disaster, the US shale gas boom, and the financial and economic crises have evoked unexpected and unwanted system behaviour that cannot be curbed with the institutions in place.

In many developing parts of the world, IMF and World Bank have brought governments to liberalize their power sector in order to accelerate electricity infrastructure development with private capital injection. While the residents of urban regions in these countries enjoy the blessings of this policy, those in rural areas are too often left behind, as power grid extension into rural areas will not be accomplished without substantial public funding. In some areas, decentralized off-grid power supply schemes have been successful, as in Bangladesh, where many rural households benefit from solar panels. However, the downside of this success is soil and groundwater pollution, caused by the lack of a collection and recycling scheme for the lead acid batteries that solar powered households use to store energy for sunless hours.

The interlinkages between energy and waste are manifold and extend far beyond the power sector. To the negative example of Bangladesh, many positive examples of waste-to-energy can be added. The interactions between energy and waste will pose an array of new challenges for the future, especially as the use of critical materials in sustainable energy supply, energy conversion and storage technologies is increasing. This year, at the occasion of World Water Day, the UN highlighted the energy-water nexus. The provision of drinking and irrigation water, sanitation and energy are intimately linked. From the energy-water nexus it is only a small step towards recognizing the energy-water-food nexus in its overwhelming complexity.

The world today is far from providing access to affordable, safe, sustainable and secure energy (bound) services to all its citizens. The interlinkages of energy with water, food, land use, mobility and waste must be recognized in solving this complex socio-technical systems puzzle, which will require science and engineering experts to join forces with experts in the social sciences and the humanities in a concerted research effort that will be crucial to achieve sustainable development conditions for all.

Water

By Prof. Jaap Kwadijk, Deltares, University of Twente

The global water resource system, essential for life on Earth, provides already centuries services for the livelihood and creation of welfare for human kind. The occurrence of water has always attracted people providing drinking water, enabling crop growing for food production and allowing easy transport of goods and people over long distances. The flip side is the flood hazard that threatens the population living close to the water bodies.

The Global Water Partnership adopted the concept of water security to describe the global water challenge. Its goal is to improve the life for everyone and is a starting point for negotiating the allocation of the limited resources among many competing demands. Water security has the dimensions: (a) household water security which is the access to clean water and sanitation, (b) Economic water security to sustain economic growth, (c) Urban water security to develop livable cities, (d) environmental security to sustain ecosystem services and (e) resilience to water related disasters, i.e. the capacity to recover from water related-disasters (ADWO 2013).

Unsafe water and inadequate sanitation are two of the great drivers of world poverty and inequality. Although access to safe water and sanitation are recognized as a human right, today's estimate is that 768 Million people of the global population do not have access to improved water while 2.5 Billion are still lacking access to improved sanitation (HDR 2014). This is a crisis of the poor, almost two in three people lacking access to clean water survive on less than $2 a day, with one in three living on less than $1day.

With respect to the economic security, food production accounts for roughly 70% of total freshwater withdrawals globally, with the industrial and domestic sectors accounting for the remaining 20% and 10%. Energy production and water is, and will be, much more interlinked than was thought before. Energy accounted for 75% of all industrial water. Due to increasing energy demand accompanied by a shift to more water intensive energy production the pressure on the water stocks will strongly increase. Global water demand (in terms of water withdrawals) is projected to increase by some 55% by 2050. Much of this water is extracted from ground water resources, where the withdrawals exceed by far the recharge leading to a depletion of the available stocks.

Environmental water security is at stake. For example 80% of Asia's rivers are poor in health and 50% of the irrigated area in Asia is salt effected, water logged or both.

Rapid urbanisation is raising the desire for improvement of flood protection in delta's. In future ongoing adaptation of the flood protection will be needed, since these trends are expected to continue in the coming decades. Sea level rise and subsidence further requires strategies of continuous adaptation. The current conception is that hard infrastructural measures are the safest solution for protection. Given the size of the regions that need to be protected in the coming decades and the high rates of change, hard flood defenses may be reaching their limit in applicability.

What is mostly needed to reach water security differs between the different dimensions. Household water security will need strong political leadership, where technology is available; economical security can benefit a lot from the development of more salt tolerant crops and managing groundwater as a limited resource; urban security requires well established forecasting systems. However, first of all reaching water security needs approaches that take into account all stakeholder needs and water supplies. An example of Jakarta illustrates that lacking access to improved water in the end leads to an incredible risk of flooding.

Food and Nutrition

By Prof. Rudy Rabbinge, Wageningen University & Research centre, KNAW

Food and nutrition security are the backbone of sustainable development. When food availability, access to good food and food utilization are not guaranteed, there is no sustainable future.

During the last century and more specifically the last decades food production has increased considerably and although the number of people at the globe increased six-fold, the food production was even higher. Food availability per capita has increased in nearly all regions with the exception of Sub Saharan Africa. Availability increased but accessibility and utilization increased less.

Therefore chronic hunger is still a major problem and more than 800 million world citizens especially in SS Africa and South Asia are suffering.

Regional food and nutrition productivity should be increased substantially to overcome that problem and in the same time globally food production has to increase at least with 70% in the coming three decades as demand increases partly due to population growth up to 9.5 billion people, but merely as a result of diet changes (more animal proteins at higher income levels). The enormous increase in food production was for 80% a result of productivity increase per ha and for 20% a result of the expansion of agricultural area.

In the coming decades that process has to be continued and accelerated. For economic reasons (more productivity is more effective and efficient in terms of use of inputs), for environmental reasons (less negative side effects when high productivity at well endowed soils is attained), and for safeguarding has for nature conservation and biodiversity aims, increases per ha are the most important strategy.

That is certainly possible as theoretical production ecological insights show that far out the majority of agriculture systems attain actual yields which are far below what is at present attainable and again much lower than the potential yield.

Insight in the basic physical, chemical, ecological and physiological processes help to define what is possible and which factors are most limiting. That requires biophysical insights and knowledge of the technical possibilities.

Producing more food is a technical exercise that requires such insight and practical experience and knowledge. The tremendous increase in land, labour and animal productivity is a result of that knowledge and the appropriate innovations in genetics, breeding, crop protection, water management, soil fertility and plant nutrition. The need to increase potential yields by genetic engineering may become acute in the next decades in systems where the potentials are approached. Especially in protected cultivation and in systems where LED lamps replace sunlight that may be profitable and necessary. The perspectives for such developments are bright.

Here the technical sciences offer opportunities, make utopia a reality and contribute to the most important need for global and regional societies, sufficient food of good quality tuned to the needs of individuals especially in ageing populations.

From Big Idea to Open Platform to Global Center

Prof. A.J. (Guus) Berkhout, KNAW, AcTI, TU Delft

Due to the immense complexity of today's socio-economic systems, our current scientific models are unable to address the mega issues we are facing today. We are beginning to realize that more system research on a component level does not guarantee a better understanding of the system as a whole. On the contrary, we increasingly observe that the behaviour of complex systems cannot be extrapolated from the individual parts (think of the human brains, the energy market or the earth's climate). In other words, the model of a complex system is much more than the collection of its disciplinary constituents. We urgently need a different emphasis that gives much more focus on systems *as a whole*. For this effort we require large volumes of multidisciplinary data ('big data') that can reveal the total system behaviour and that will provide information on the essential interactions ('big data analytics'). If we connect knowledge of the components with knowledge of the total we will better understand the behaviour of complex systems, with the ultimate ambition to simulate their *future* behaviour with less uncertainty (think of 'Health Map').

The big data approach requires the use of massive multifaceted sensor networks, which are more and more fed by the 'Internet of people and things'. These networks generate a wealth of information that will fuel the processes in the innovation circle. Looking at one of today's biggest issues, *global inequality*, innovations will be vital to raise the standard of living of more than three billion people that refuse to continue their life under the current poor conditions. Social unrest confirms that they are firmly determined to obtain a larger share of the total global wealth.

An Open Scientific Platform is proposed with the ambition to make a significant contribution to a sustainable increase in the quality of life on a global scale ('beyond Piketty'). The Platform will use a new scientific framework that makes a connection between the two different worlds of social development and economic growth. It leads to a global *socio-economic landscape* that is based on empirical data from the World Bank and the UN. The landscape clearly shows the immense differences in the quality of life on our planet and reveals the remarkable property that growth follows an autonomous socio-economic transition path.

This new knowledge has led to an alternative way of observing our complex world, as well as a better understanding how to balance economic growth and poverty reduction. It also has led to a new way of predicting fundamental changes in human behaviour such as global consumption. Use of the socio-economic framework has already produced pioneering *forecasts*, showing that a large reduction of global poverty will dramatically increase the demand for energy, food and water: "It is not the ever-quoted influence of population growth, but it is the effect of poverty reduction that determines the real global sustainability challenge". The consequences of these forecasts will be used by the Platform to challenge universities to show more leadership.

In the proposed Open Platform large volumes of socio-technical data will be connected with large volumes of socio-economic data to make images of today's global changes. These images confirm the fundamental incapacity of current silos to create sustainable solutions. Our first experience indicates that the total system approach acts as a catalyst in the process of inspiring and organizing a new start in the *collaboration between α,* β *and* γ *scientists* ('connected science'). Such a border-crossing collaboration is an absolute necessity for the development of combined socio-technical and socio-economic solutions that are directed to the vast problems our planet is facing. For these new solutions close integration between social and technological innovation is a must. This holistic approach to innovation is described by the model of circular innovation (CIM).

The Open Scientific Platform should support the Delphi 'Center for Global Socio-Economic Change'. Deliverables of this Center include new insight into the relationship between social inclusion and economic growth, as well as new insight into the relationship between poverty reduction and shifts in consumption patterns. This again will provide new insight into the influence of these shifted patterns on future big markets and, above all, on the sustainability performance of these markets. These integrated socio-economic foresights will be connected with foresights on breakthrough technologies. Last but not least, the new Center will develop an intelligent dashboard that assists organizations in better decision making, with an emphasis on those decisions that have a large impact on the future. By showing early signals of change, the Center's dashboard will assist a new generation of leaders who navigate into the future with an anticipating mindset.