GLOBAL TRENDS AND DRIVERS AS CHALLENGES FOR LITHUANIAN RESEARCH AND INNOVATION POLICY

Background paper to support the development of a Smart Specialisation Strategy in Lithuania

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Introduction

This report is the result of a 'rapid' horizon scan of trends and challenges that may affect the Lithuanian economy and society in the coming decade. Horizon Scanning (HS) is a structured activity aimed at monitoring, analysing and positioning 'frontier issues' that are relevant for policy, research and strategic agendas. The types of issues mapped by a HS include current or new/emerging: trends, policies, products, services, stakeholders, technologies, practices, behaviours, attitudes, 'surprises' (wild cards) and 'seeds of change' (weak signals).

Trends, drivers of change, wild cards/shocks, discontinuities, and weak signals can be considered as the critical elements and essential outputs of a HS.

Figure 1 : Key definitions

Trends are those change factors that arise from broadly generalisable change and innovation. They are experienced by everyone and often in more or less the same contexts insofar as they create broad parameters for shifts in attitudes, policies and business focus over periods of several years that usually have global reach. What is interesting about trends is that normally most players, organisations or even nations cannot do much to change them – they are larger than the power of individual organizations and often nation states as well. We distinguish between two-types of trends:

- Mega-trends. A mega-trend extends over many generations, and in cases of climate, mega-trends can cover periods prior to human existence. They describe complex interactions between many factors. The increase in population from the Palaeolithic period to the present provides an example.
- Emerging trends: Possible new trends grow from innovations, projects, beliefs or actions that have the potential to grow and eventually go mainstream in the future.

Drivers concern those forces, factors and uncertainties that are accessible by stakeholders and create or drive change within one's business or institutional environment. These tend to be more immediate and relevant and distinct to different types of stakeholders – and also they can be both adapted by and/or strongly impact stakeholders, sometimes rapidly.

Discontinuities occur when over time and extending beyond single events, change is rapid and fundamentally alters the previous pathways or expected direction of policies, events and planning regimes. While this is normal in most market places where the processes of creative destruction and products and services innovation are familiar, when discontinuities occur in society and government, the changes tend to be more significant because they can alter so many other domains.

Wild cards (shocks) are those surprise events and situations which can happen but usually have a low probability of doing so – but if they do their impact is very high. These situations tend to alter the fundamentals, and create new trajectories which can then create a new basis for additional challenges and opportunities that most stakeholders may not have previously considered or prepared for.

Weak signals refer to the early signs of possible but not confirmed changes that may later become more significant indicators of critical forces for development, threats, business and technical innovation. They represent the first signs of paradigm shifts, or future trends, drivers or discontinuities

Source: Saritas & Smith (2011)

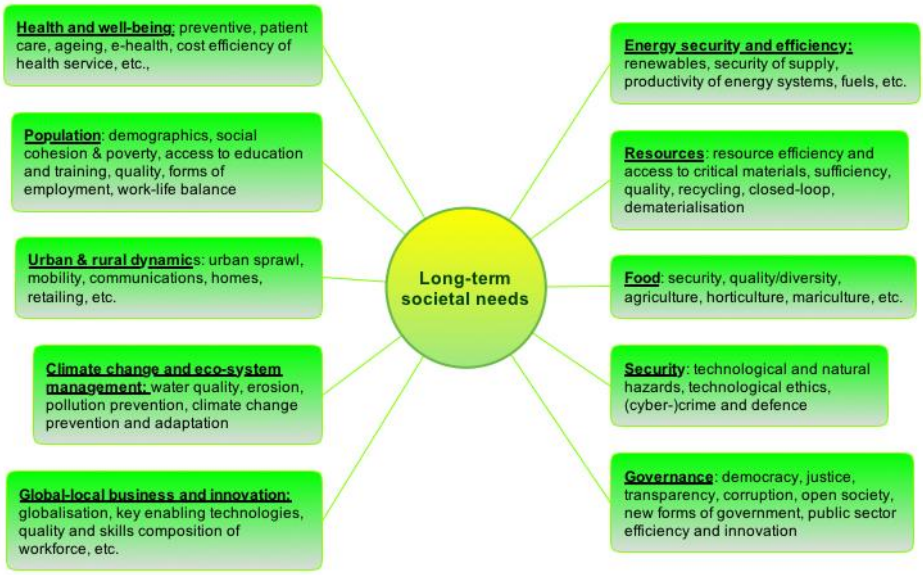
Drivers (as well as discontinuities and wild cards) occur in the near future (the coming 3-5 years); while trends may be visible already but their scale of their impact on Lithuania is hard to quantify (e.g. climate change). For the purpose of this report, the **time horizon is 2030**, however, early anticipation of longer-term trends may arise by identification of weak signals.

Given the time and resources available, this report is limited to identifying key trends and drivers based on a literature review. The trends and challenges are grouped in 10 broad topic fields (see Figure 2).

The same 10 topics have been used in a parallel exercise aimed at reviewing Lithuanian evidence and views on future challenges.

The two exercises have been run in parallel so as to build up a basis for contrasting and discussing how the global trends and 'local' challenges.

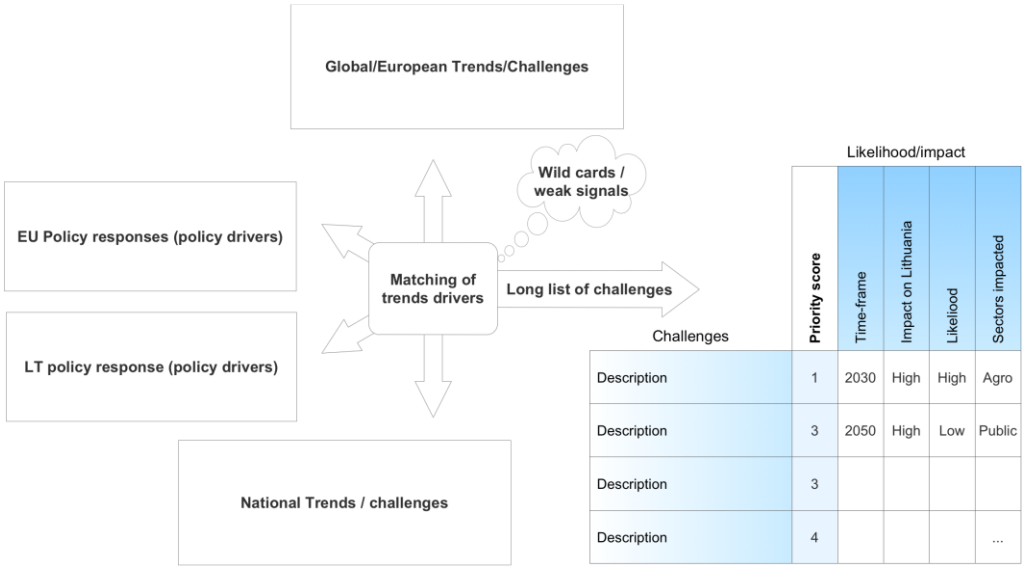
Figure 2 : 10 key topics for structuring the analysis of long-term societal needs



Source: Technopolis Group, adapted from Loveridge (2009) and http://iknowfutures.eu

The results of the two exercises will be the subject of a workshop held in Vilnius on 29 March 2012 with a view to agreeing on a long list of challenges. The overall process for the analysis is summarised in Figure 3.

Figure 3 : Process for the horizon scan analysis



Source: Technopolis Group

This report has been prepared by Pieter Tuytens under the supervision of Alasdair Reid and Michal Miedzinski, of Technopolis Group (Belgium).

SUMMARY OF IDENTIFIED TRENDS AND DRIVERS PER TOPIC

This section provides a set of tables summarising the identified main trends and drivers per topic.

Summary Health and Well-being	
Ageing population	Developing new therapeutic approaches and treatments
	Promoting self-care and patient empowerment
	Training health and social work professionals
(Non-) infectious diseases	Developing Detection, Identification and Monitoring systems
	Addressing life-style diseases through 'Preventive Medicine' and Do-It-Yourself medical monitoring and services
New medical technologies	Developing 'Personalised Medicine' markets
	Stimulating medical Key Enabling Technologies
	Employing ICT (e.g. telemedicine) and health informatics
Rising expectations and abilities	Developing a more efficient and equitable healthcare system

Summary Population	
Need for inclusive labour markets	Raising pension age
	Promoting willingness to employ elderly people
	Ensuring Life Long Learning
	Providing childcare and other support to women
	Exploring technologies to enable disabled people
	Expanding and using skills of immigrants
Flexible labour markets and atypical careers	Preventing labour market dualisation
	Addressing the New Social Risks
Balancing work and life	Accommodating workplace arrangements (e.g. telework)
	Adapting social regulation (parental leave, etc.)
	Changing social attitudes (gender and caring roles)
Preserving social cohesion and poverty	Addressing youth unemployment and poverty
	Addressing poverty among elderly and the Working Poor
	Addressing the gap between winners and losers of globalisation
	Improving social integration of immigrants

Summary Urban and Rural Dynamics	
Move towards Sustainability	Developing new ways to manage space and environmental capital
	Implementing concepts of Eco-neighbourhoods and Eco-cities
	Ensuring business and citizens participation
Migration flows	Providing cohesion solutions with limited budgets
	Rethinking the concept of 'cities' (flows instead of territory)
	Adjusting concepts of government and citizenship
Urban Infrastructure	Countering urban infrastructure degradation
	Developing and experimenting with new forms of public transport
	Developing Intelligent Infrastructure Systems (IIS)
Urban-Rural Dynamic	Developing new strategies to deal with urban-rural relationship

Summary Climate Change and Eco-System Management	
Mitigating Global Warming	Shifting towards a zero-emission energy system (energy efficiency, decarbonisation, etc.)
	Meeting the EU 20-20-20 requirements
Adapting to Climate Change	Adapting to higher temperature
	Adapting to changing rainfall patterns
	Adapting to changing ground conditions
	Adapting to impact on materials
Managing Eco-systems	Integrating biodiversity in the environmental agenda (e.g. integrated management of land, water, forest and environmental resources)
	Integrating biodiversity in the economic agenda (e.g. environmental accounting, phasing out of 'perverse subsidies' to agriculture etc.)

Summary Global-Local Business and Innovation	
Rapid integration, fragmented economic governance	Dealing with declining share of global GDP by developed countries
	Focusing on countries with growing middle-class, as well as bottom of income-pyramid
	Developing a balanced and integrated system for economic governance
Future Innovation Skills Needs	Training high and middle-high (occupational) skilled labour with better cognitive and interpersonal capacities
	Dealing with decline of demand for low-skilled workers
	Ensuring responsiveness of educational systems to new professional demands
	Providing students with skills that allow for life-long learning
Technologies to compete in a globalised world	Ensuring resource productivity to deal with price and supply shortage increases of energy and some critical materials

Summary Global-Local Business and Innovation	
	Promoting an increasing and more efficient transfer and co-operation of universities, applied research organisations and industry
	Using industrial and social needs as market drivers to exploit commercialisation
	Integrating users in the innovation process to promote the acceptance and success of future NMP applications and products
	Developing the regulatory setting and investing in risk research to address the environmental, health and safety concerns

Summary Energy Security and Efficiency	
Increasing energy demand and shifts in power generation	Dealing with price rises from increasing global energy demand
	Anticipating long-term shifts in power generation
	Acknowledging that unexpected events (e.g. nuclear plant disaster) can have huge impact on public opinion
Moving towards sustainable energy provision	Developing clean energy technologies that are cost-effective and available to all income groups
	Upgrading energy infrastructures such as grid infrastructure
	Developing ICT solutions to support decentralisation (e.g. smart metering)
	Improving the design of incentives to change personal/public choice behaviour
Dealing with emerging issues	Hybrid nuclear energy
	Renewable energy from the desert
	Biofuels, biomass and biomimicry
	Unknown risks of the hydrogen economy
	Deeper and farther digging for resources

Summary Resources	
Increasing consumption of Raw and Critical Materials	Reducing material extraction and consumption
	Dealing with price and supply uncertainty of critical materials for key technologies
	Increasing efficiency of material use
Depletion of water resources	Dealing with water-related conflicts
	Developing new technologies for freshwater production (e.g. desalination plants)
	Increasing efficiency of freshwater use (eco-innovation)
Increasing conflicts over land use	Developing coherent and consistent approach to land use management

Summary Resources	
Paradigm shift to eco-innovation	Increasing efficiency gains and ensuring that the benefits of new solutions are widely disseminated
	Going from relative decoupling to absolute decoupling

Summary Food	
Rising food demand and nutritional transition	Assuring food security (e.g. price volatility) and preventing malnutrition
	Addressing health consequences of nutritional transition
	Addressing ecological consequences of nutritional transition
Conflicts between food demand and other objectives	Increasing water-efficiency in agriculture (efficient irrigation, using waste-water)
	Optimising land-use (e.g. limiting land conversion, agro-forestry schemes, increasing crop yields)
	Increasing energy efficiency in agriculture (e.g. on-farm biomass production, fertiliser efficiency)
Agri-innovation and the 'competing risks'	Introducing new technologies to increase crop yields
	Integrating emerging food processing technologies in value chain (e.g. high hydrostatic pressure, smart packaging).
	Performing 'Competing Risks' exercise
	Dealing with Food security and GMO

Summary Security	
Occupational health and safety challenges resulting from new technologies	Reaching, monitoring and enforcing health and safety conditions in decentralised work processes
	Transforming business processes and skill sets to match new necessities
	Anticipating and monitoring consequences of conflicts between green objectives and occupational health
	Developing an occupational health and safety assessment of any new technology at the development stage of the process
Security challenges resulting from new technologies and ICT	Dealing with non-military adverse effects of new technologies (nanotech, biotech, etc.)
	Dealing with "dual use" of new technologies
	Anticipating cyber-security challenges resulting from increased dependence on ICT and internet technologies
	Dealing with privacy and reliability issues resulting from dependence on cloud-computing
Security challenges resulting from natural hazards and disasters	Bridging knowledge gap between early warning and early response systems
	Anticipating and managing the risk of consequences of natural climatic events

Summary Governance	
ICT as a driver of governmental transformation	Increasing transparency and responding to the increased accountability expectations
	Dealing with new forms of policing and law enforcement and privacy consequences
	Empowering of and dealing with new countervailing powers
	Dealing with increasingly networked, decentralised and multi-stakeholder models of government
	Creating intelligent and responsive government
Dealing with changing expectations by citizens	Dealing with increasing demands by citizens for high level of service and participation
	Countering the decline in trust and citizen participation
	Adapting to "non-territorial citizenship"
	Promoting an open and inclusive society
Public Sector Innovation	Educating and training public officials, providing incentive schemes, etc.
	Need for leadership, good management and 'inspiring' public managers
	Stimulating collaboration between public and private sector; involving service user in process of designing services
	Using national awards, international rankings etc. to drive innovation
	Using budget restrictions and financial shortages as a driver for public innovation
	Providing political support and using laws and regulations to support public innovation

HEALTH AND WELLBEING

A first scan reveals four closely interlinked trends that influence the future developments concerning health and wellbeing. Both ageing populations and new or re-emerging diseases entail several challenges for public health. Access to new technologies allows for developing solutions for these challenges. However, increased abilities, together with rising expectations, create new challenges regarding the cost and equity of public health systems.

Demographic and societal change: 'Triple Ageing'

Demographic and societal change in industrialised countries is often characterised as "triple ageing": not only the population, but also the workforce and the group of elders (people aged 80 or over) are ageing (SESTI, 2010, p.5).

This change results in complex disease patterns (e.g. multi-morbidity), requiring new therapeutic approaches that are comprehensive and holistic rather than based on isolated specialities (CRF, 2012, p.22). Also growth in incidence of physical disability, cardiovascular and neurological diseases (e.g. dementia) require new treatments (CRF, 2012, p.22; p.24-25).

Healthcare costs for 65-75 year olds are 2.5 times greater than for people under 65, for those over 75 years this increases to 4.5 times (SESTI, 2010, p.5). With fewer people in the workforce, it will be increasingly difficult to cover old-age related costs (healthcare, long term care and pensions). Opportunities are situated in technological advances that promote independence and continued interaction of individuals with society. Examples are solutions for sensory impairment or wireless healthcare solutions that allow health monitoring at a distance (CRF, 2012, p.22-24).

Another challenge is the recruitment of health and social service jobs. Many European countries are already experiencing acute shortage of doctors, nurses and social workers (SESTI, 2010, p.5). Accordingly, intensified recruitment of cross-border recruits within the healthcare sector in Europe creates both opportunities and threats.

Lifestyle diseases, (re-)emerging infectious diseases and antimicrobial resistance

Over the past 40 years, 39 new infectious diseases have been discovered and 20 of them are now drug resistant (Millennium Project, 2009). Several diseases have direct impact on rich countries (BSE, foot-and-mouth disease) and increased travel, trade and migration make new exotic diseases and pandemics more likely (Foresight, 2006, p.6; ICSU, 2011, p.11; Millennium Project, 2009).

In order to meet the challenge of stop infectious diseases from spreading at an early stage 'Detection, Identification and Monitoring' (DIM) systems need to be developed (Foresight, 2006). Future uses of genetic data, software, and nanotechnology will help detect and treat disease at the genetic or molecular level (Millennium Project, 2009).

Also non-communicable diseases create a major challenge for public health, both those related to population ageing (ICSU, 2011, p.11) and lifestyle problems such as poor

dietary habits and a lack of physical activity (CRF, 2012, p.22). Half of the European population is estimated to be overweight or obese, causing rising occurrence of diabetes and metabolic syndromes (CRF, 2012, p.22). The Joint Research Centre is currently undertaking a foresight study on research priorities for foods and diets.[1] Preventive medicine plays an important role, entailing putting greater emphasis on applying Do-It-Yourself (DIY) medical monitoring and systems (CRF, 2012, p.24).

Access to new medical technologies

Advancement in genomics is expected to open markets for diagnostic testing, preventive medicines, follow-up treatments and even support services such as lifestyle counselling (SESTI, 2010, p.6). This enables a paradigm shift towards 'personalised medicine': the convergence of diagnosis and therapy into novel diagnostic tests and less toxic therapies on an individual basis (Sigma Scan[2], 2012a; CFR, 2012, p.20).

Nano-medicine and synthetic biology are quickly establishing themselves as key enabling technologies (CRF, 2012, p.24). Developments in nano-medicine could allow for revolutionary improved manners to deliver drugs in the human body (Sigma Scan[3], 2012b). Some of the biotechnologies being developed include biomaterials and tissue generation, biosensors and bioinformatics (CRF, 2012, p.24; SESTI, 2010, p.6).

ICT offers the society the opportunity to become better informed on health issues and health professionals to revolutionise information sharing (e.g. through seamless electronic patient records). As this entails various security challenges related to health information, security solutions are likely to be provided by a range of procedures and technologies, such as smart cards and biological identifiers (SESTI, 2010, p.6).

Another area where ICT is anticipated to have a major impact is in the remote delivery of health and social care services, i.e. telemedicine. Related applications of ICT include 'telesurgery', defined as remote surgery via telepresence and haptic (touch) feedback (SESTI, 2010, p.6).

Rising expectations and increasing abilities

The trend towards "consumer patients" implies that people are increasingly expecting to receive high quality health services at an affordable price (SESTI, 2010, p.5). As ICT enables patients to be better informed about healthcare services (see higher), dependence on professional 'gatekeepers' for diagnosis is reduced (SESTI, 2010, p.5). Together with increasing technological ability to treat more conditions, this puts serious pressure on public expenditures on healthcare (CRF, 2012, p.22).

The challenge is to find ways to limit expenditure without reducing the quality of services or their accessibility. Emerging government initiatives in trying to define the core elements to be covered by tax or social insurance funding could threaten the universal availability of a high level of health and social welfare. Socio-economic

[1] http://www.b2match.eu/next2012/system/files/Challenges_in_Food_and_Nutrition-The_role_of_the_JRC-Petros_Maragkoudakis__Phd.pdf; http://ec.europa.eu/health/nutrition_physical_activity/docs/ev20120614_co04_en.pdf

[2] http://www.sigmascan.org/Live/Issue/ViewIssue/468/1/advances-in-dna-microarray-technology/

[3] http://www.sigmascan.org/Live/Issue/ViewIssue/528/1/targeted-delivery-for-drugs/

inequalities could hence translate into health divides between the haves and have-nots.

POPULATION

The focus of this topic is on aspects of demographic change and globalisation that affect the population with respect to work, family life and social integration. This implies that not all dimensions of demographic change and globalisation will be discussed under this heading: consequences of population growth will mainly be discussed under 'Resources' and 'Climate Change', urbanisation will be discussed under 'Urban and Rural Dynamics' and several aspects of demographic transition have already been discussed under 'Health and Wellbeing'. The specific challenges of globalisation for businesses are discussed in "Global-Local Businesses and Innovation".

More inclusive labour markets for elderly, women, people with disabilities and immigrants

Demographic transition (i.e. falling fertility and mortality rates) implies that fewer workers have to provide output for more people (as more people exit than enter the labour market (see Barr, 2006)). While productivity increases can provide higher output to a certain extent, this is not sufficient and itself related to demographic change. Hence a major challenge will be to integrate more people into the labour markets (See UN, 2007)[4].

Employing more elderly people has the double advantage of increasing the supporting workforce while limiting social expenditure. However, there are several challenges that need to be overcome: retirement age needs to be raised which proves politically difficult, many older workers need to be retrained to integrate in the knowledge economy while Life Long Learning is required for everyone, firms need to be encouraged to employ elderly people.

Other ways to integrate more people is to provide childcare (women), explore the possibilities of new technologies (disabled people) and raising the skill level or using the skills available with migrants (see Rand, 2004)[5].

Increasingly flexible labour market and atypical careers

Firms are moving from vertically integrated organisations to more specialised ones that outsource noncore functions and to more decentralised forms of internal organisation. This includes a shift away from more permanent, lifetime jobs toward less permanent, even nonstandard employment relationships (e.g., self-employment) and work arrangements (e.g., distance work) (Rand, 2004). In order to adapt business strategies to globalised markets, there is a growing tendency for flexible employment arrangements and atypical forms of work (e.g. part-type work, temporary agency work, very short fixed contracts, etc.) (Eurofound, 2010)[6].

These trends have created several challenges. Dualisation of labour markets when a gap emerges between protected fixed employment and flexible employment with less

[4] World Economic and Social Survey: http://www.un.org/esa/policy/wess/wess2007files/chap4.pdf

[5] http://www.rand.org/pubs/research_briefs/RB5070/index1.html

[6] http://www.eurofound.europa.eu/pubdocs/2010/091/en/1/EF10091EN.pdf

social protection and benefits. A second challenge is addressing the so-called 'New social risks' that emerge when new and atypical forms of employment are not covered by the existing social security system.

Adapting to new family structures and balancing work and family life

The balance between work and family life is changing due to a series of trends (see OECD, 2012). Women's labour force attachment continues to grow and this trend seems irreversible (women are increasingly well educated, wage gaps are diminishing, etc.). This changes family structures as two-earners replace the male breadwinner and decisions to have children are postponed.

At the same time there are dramatic organisational changes in the workplace that have strong implications on work-family life balances (OECD, 2012, p.139). Less regular and predictable working hours, together with work intensification, are aggravating factors for the work-family life balance. Relationships may suffer as a result of poor work-life balance or being overworked. Overworked parents may be unable to provide their children with sufficient attention, leading to greater likelihood of anti-social behaviour (See Sigma Scan, 2010).

This poses challenges for accommodating changes in workplace organisation (e.g. tele-work), policy measures (free child care, regulations concerning parental leave and in-work benefits[7]) and broader societal attitudes (social norms and values concerning caring responsibilities and gender) (See OECD, 2012). New working time patterns offer the possibility for new combinations of work, education and training, social responsibility and leisure in a more integrated life cycle, with associated measures going beyond traditional labour law rights to equal treatment in employment and social security (See Eurofound, 2009). Such measures include rights and entitlements to training, caring responsibilities and community service, and the provision of incentives for workers to undertake these activities.

New challenges concerning social cohesion and poverty

Future trends in technology, globalisation, and demographics will support higher wages and are likely to affect the distribution of wages, just as they have in the past several decades (Rand, 2004). In the absence of a strong increase in the supply of skilled workers in response to the higher returns to education, wage dispersion — particularly as measured by the gap between more- and less-educated workers — will likely remain at current levels or even continue to widen.

High unemployment among (often educated) youth and immigrants creates problems concerning social cohesion (IMF/ILO, 2010[8]). Given the effects of past recessions, the cost to those who become unemployed could be a persistent loss in earnings, reduced life expectancy, and lower academic achievement and earnings for their children. And unemployment is likely to affect attitudes in a manner that reduces social cohesion.

[7] http://www.cef-see.org/pension_reform/Bovenberg%20_New%20social%20risks.pdf

[8] http://www.osloconference2010.org/discussionpaper.pdf

According to iKnow, examples such as the 2011 riots in UK cities exposed new questions about the effects of global consumption culture on those without the means to buy into it (iKnow, 2011, p.50). Given the limitations of fiscal redistribution and the relative poverty driven by consumption desire, iKnow presents other responses such as third sector social enterprises as possible ways out.

URBAN AND RURAL DYNAMICS

Driven by natural population growth, rural-urban and intercity migration, urbanisation growth will accelerate over the next 20 years (HCSS, 2010). By 2030, 59% of the world population will live in cities – 81% in developed countries and 55% in developing countries (Roland Berger, 2011). Continued urbanisation amplifies existing risks and creates new risks. This topic focuses on four emerging issues that are foreseen to be crucial for (European) cities.[9]

The move towards sustainability

A first trend in Europe and beyond is the effort to make territorial development models more sustainable (CoT, 2010, p.11). Cities consume significant resources and urbanisation growth creates important challenges regarding air and groundwater pollution, resource and energy use, waste processing etc. (PwC, 2005). This causes health problems (such as asthma and allergies) and decreases the quality of life in cities, which makes it more difficult to attract human capital (PwC, 2005, p.58). This calls for sustainable ways to manage space and environmental capital in cities (ranging from using roofs as gardens to subsurface parking, underground transport of hazardous substances and fiscal measures such as the Congestion Charge in London) (PwC, p.59). In particular, the concept of eco-neighbourhoods and eco-cities is increasingly implemented both in Europe (see CoT, 2010 for an overview) and beyond (the world's biggest eco-city in development will be in China and around half the size of Manhattan)[10].

The movement towards sustainability all show that a large degree of cooperation is needed between citizens, local and national authorities and businesses (CoT, 2011). Coordination within the city government is necessary to integrate sustainability in all planning phases (e.g. Stockholm requires services such as procurement to promote environmentally responsible products and solutions) (PwC, 2005, p.60). Also Public Private Partnerships (such as the PPP for waste processing in Amsterdam) and new ways to engage citizens' participation in decision-making and environmental commitments (see for example Agenda 21 in Barcelona) are increasingly used to achieve sustainability objectives (PwC, 2005).

Cities in developing countries face even more stringent challenges, often because more people are exposed to consequences of climate change and environmental degradation. Particularly extreme weather, vulnerability of coastal zones, urban food and water scarcity and epidemics and zoonoses create threats (HCSS, 2009).

Migration flows and demographic challenge

Cities remain highly attractive for international migrants, but also for students, some elderly groups and for low- to middle income families. As a consequence, population

[9] Even though growing cities in developing countries are expected to experience the greatest challenges as a result of urbanisation, these aspects are only treated on the margin.

[10] http://www.bbc.com/future/story/20120503-sustainable-cities-on-the-rise

increases whereas net revenues of cities decrease (CoT, p.12). The challenge is to find social responses as well as the means to finance them.

Beyond the existing problems of social segregation and cohesion in cities (see the European Agenda for Research on Cities and Social Cohesion)[11], new concepts and definitions of 'cities' are being developed to capture the developments concerning 'territorial cohesion' (iKnow, p.54).[12] Cities are increasingly understood not just as territories, but as flows or relationships (iKnow, p.54). One important consequence of unprecedented global mobility is that new forms of flexible governance and citizenship will increasingly be required. The project "Global Migration and the Right to the Cities of the Future" (Oxford, COMPAS) addresses these challenges of integrating migrants into local communities, improving cohesion and facing the ethical and practical tensions of allocating limited resources, such as housing and healthcare services.[13] Especially in developing countries governance structures often cannot manage the high levels of migration, creating the risk of "fragile cities" when political control and public security cannot be offered (HCSS, 2009, p.9).

Increasing pressure on urban infrastructure

Urban areas create a reliance on centralised infrastructure for the supply of energy, water, waste management and mass transportation (this because limited availability of land prevents individual provision) (HCSS, 2009, p.4). However, existing infrastructural networks have reached their limits, while the rate of infrastructure degradation increases when more people in cities. Accordingly heavy investments are needed to modernise and expand urban infrastructure (see HCSS, 2009, p.4-6). This challenge opens opportunities to use large-scale investments to use new technologies to offset the detrimental effects of increased urbanisation (HCSS, 2009, p.4).

Especially urban mobility emerges as a clear challenge for the future. Traffic congestion poses a major risk and the challenge will be to change towards more collective, more sustainable and efficient means of transport (CoT, 2011, p.13). A revival of public transport can already be witnessed in different shapes and speeds (tram, train-tram, light train) and in different cities (see CoT, 2011, p.13). German experiments of combining heavy rail and street running fixed link systems have been creating an upsurge in interest elsewhere (for example France and the UK). Efforts have been made to examine Intelligent Infrastructure Systems (IIS).[14] Also cycling infrastructure and public bicycle rental programmes are increasingly widespread (CoT, 2011, p.13). Cities offer a lot of opportunities for such social or technological experiments.

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[11] http://www.geo.fu-berlin.de/geog/fachrichtungen/anthrogeog/zelf/Medien/download/Hillmann/SocialPolisdocument.pdf

[12] Examples are: counter-urbanised 'edge cities', peri-urban hinterlands, networked communities and virtual cities, and new forms of sun-belt tourism or campus parkway type cities. (iKnow, p.54).

[13] http://www.futureofcities.ox.ac.uk/research/migration

[14] See UK Foresight Study on IIS in 2055: http://www.bis.gov.uk/assets/foresight/docs/intelligent-infrastructure-systems/the-scenarios-2055.pdf

Sustainable Urban-Rural Futures

Urban sprawl creates pressure on rural and peri-urban areas when different ways to use land (agriculture, residential, ecological, etc.) are in conflict (Plurel, 2011). Several regional strategies have been identified as steps towards more sustainable urban-rural futures. These include urban containment by conservation and densification, development of a Green Compact City with attractive inner-city areas[15], preservation of green infrastructure for biodiversity and healthy transport and promotion of local production and short circuits (Plurel, 2011).

[15] See also OECD report on Compact City Policies (2012)
http://www.oecd-ilibrary.org/urban-rural-and-regional-development/compact-city-policies_9789264167865-en

CLIMATE CHANGE AND ECO-SYSTEM MANAGEMENT

Climate change and global warming is a megatrend with clear impact on several other topics under discussion (urban dynamics, food, energy, etc.). This topic will focus on trends and challenges directly related to both prevention of global warming and adaptation to the consequences that result from it. Furthermore, one section discusses how sustainability depends equally on effective management of eco-systems and biodiversity.

Global warming and mitigation efforts

The IPCC Fourth Assessment Report is unequivocal about the warming of the climate system (IPCC, 2007, p.30), the role of human activities (CO2 due to fossil fuel use and land-use change, CH4 due to agriculture and fossil fuel use, N2O due to agriculture) (p.37), and the expected impact of climate change (p.44-54). According to the OECD (2012[16]), without new policies global greenhouse gas emissions are projected to increase by 50% by 2050 (primarily due to a 70% growth in energy-related CO2 emissions). As a result, global average temperature is projected to be 3 to 6 degrees Celsius above pre-industrial levels by the end of the century, exceeding the internationally agreed goal of limiting it to 2º C (OECD, 2012).

A key action to mitigate climate change is to reduce greenhouse gas emissions. In 2009, the European Council set the objective to reduce emissions by at least 80% below 1990 levels by 2050 (see Roadmap 2050[17]). This requires a fundamental shift to a new, nearly zero-emission energy system both in the way energy is used and the way it is produced. Emission abatement measures that need to be implemented include energy efficiency improvements up to 2% per year, nearly full decarbonisation of the power sector, replacing fossil fuels in building and transport sector by decarbonised electricity and low CO2 fuels, as well as all other measures such as Carbon Capture and Storage in industry and afforestation (Roadmap 2050, 2010, p.10).

More directly, member states will have to ensure that the European commitments within the climate and energy package are met. These targets, known as the "20-20-20" targets, set three objectives for 2020: 20% reduction in greenhouse gas emissions from 1990 levels; raising the share of EU energy consumption produced from renewable resources to 20%; and a 20% improvement in the EU's energy efficiency (See EU, 2012)[18].

Trends related to the challenge of adapting to climate change.

Even if countries are able to mitigate emissions and climate change remains limited to 2º C, the world will experience more intense rainfall and more frequent and more intense droughts, floods, heat waves and other extreme weather events. Accordingly,

[16] http://www.oecd.org/environment/indicators-modelling-outlooks/49910023.pdf
[17] http://www.roadmap2050.eu/attachments/files/Volume1_ExecutiveSummary.pdf
[18] http://ec.europa.eu/clima/policies/package/index_en.htm

governments will need to adopt measures to adapt to climate change (see World Bank, 2010)[19].

More particularly, the World Bank (2010) foresees adaptation in the following areas: infrastructure (especially urban infrastructure such as drainage), coastal zones (sea-level rise and storm surges, increased intensity of tropical storms and cyclones), water supply (declining availability, flood management), agriculture (altered crop yields and areas where crops can be grown), human health (increased incidence of vector-born and water-born diseases, heat-and cold-related deaths, injuries and deaths following from flooding, malnutrition) and extreme weather events. The following paragraphs will address four (relevant) areas of adaptation on a more practical level.[20]

First, there is a need to adapt to higher temperatures (implications for human comfort, demand for cooling in buildings, demand for urban green space, open space and shading, falling cloud cover increases UV ray and sunlight exposure). Adaptation techniques include Green cooling, new insulation materials, innovations through water cooling, thermal storage, cool surfaces can increase surface reflectivity or increase rainfall permeability to encourage the cooling effect of evaporation.

Second, there is the need to adapt to changing rainfall patterns (both flood management and water conservation during droughts). Adaptation techniques to manage flooding include Sustainable Urban Drainage systems and the use of green open spaces and green roofs. Adaptation techniques to water conservation include xeriscaping or recycling rain and grey water recycling.

Third, ground conditions and land stability are affected by temperature and precipitation. This requires efforts to ensure that developments are designed to cope with changing ground conditions (including vegetation management, surface erosion control structures, Sustainable Urban Drainage systems and foundation design).

Fourth, also materials are affected by climate change (e.g. plastics are affected by increased UV, the strength of concrete decreases at higher temperatures, bricks are affected by moister content, etc.). This needs to be taken into account in construction design and offers possibility for innovation in materials.

Degradation of ecosystems and related environmental and economic costs

Biodiversity will be reduced in both developed and developing countries from 69% of its potential currently to 65% in 2030 and less than 60% by 2050 (Roland Berger, 2012, p.78; OECD, 2012[21]). The UN Foresight Report argues that the challenge of reduced biodiversity should be integrated in both the environmental and economic agenda (UNEP, 2012).

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[19] http://climatechange.worldbank.org/sites/default/files/documents/EACCSynthesisReport.pdf

[20] This summary is based on a best practice guide by the Islington government in London: http://www.ukcip.org.uk/wordpress/wp-content/PDFs/LA_pdfs/CC_adaptation_gd_prac.pdf
(See also: "Development of a National Adaptation Strategy in Lithuania: http://www.bef-de.org/Members/befadmin/projektdateien/baltclim_bgp_final.pdf).

[21] http://www.oecd.org/environment/indicators-modelling-outlooks/49910023.pdf

First, there are strong linkages between biodiversity and the environmental agenda. Biodiversity and ecosystem functioning play an important role in the of global biogeochemical cycles that are vital for sustaining life (e.g. carbon is sequestered and stored by natural ecosystems, which regulates climate). Furthermore, biodiversity plays an important role for other eco-system services (food production, disease control, flood regulation, coastal protection, etc.). Hence the challenge is to integrate nature conservation and preservation into the rest of the environmental agenda – for example by pursuing integrated management of land, water, marine, forest and environmental resources; or promoting sustainable agriculture (see below).

Secondly, there are strong linkages between biodiversity and economic activity and value. The 2010 TEEB study on the economics of ecosystems and biodiversity has conservatively estimated the global economic impact of biodiversity loss at between 2 to 4.5 trillion dollar. Accordingly, the challenge is to value eco-system services (for example by introducing 'environmental accounting', letting the public gradually pay for undervalued ecosystem services or phasing out 'perverse subsidies' such as agricultural price support that leads to deforestation).

GLOBAL-LOCAL BUSINESS AND INNOVATION

As Europe faces new global leaders in the globalised economy, it needs to rethink its innovation and growth agenda. Europe faces a radical, structural change in the global knowledge economy and must be prepared to cope with the consequences (CRF, p.74). After discussing the trends related to the opportunities of globalisation, trends will be discussed with respect to future skills and technologies.

Rapid Global Trade and Capital Integration with Fragmented Economic Governance

The rapid global integration of trade and capital flows over recent decades has been a key driver of global growth. World trade almost tripled from the early 1990s to 2010, while international capital flows increased almost five-fold over the same period (WEF, 2012, p.6[22]). This globalisation trend will continue, as exports and FDI are expected to grow faster than GDP (Roland Berger, 2012, p.37).

The share of developed countries in global GDP will decline as the real GDP of developing countries will grow nearly four times faster than of the developed countries (Roland Berger, 2012, p.38). Especially the BRIC countries will be the new economic powerhouses by 2030 with a real GDP growth by 7,9% per year over the next 20 years (Roland Berger, 2012, p.40). Also other countries beyond BRIC (such as the 'Next Eleven' or ASEAN5) will be fast growers (Roland Berger, 2012, p.44). As the purchasing power of billions of people in BRICS will rise considerably, a new middle class will emerge with the equivalent of the combined population of Germany, France and the UK (Roland Berger, 2012, p.42). This implies a rising demand for basic and higher priced goods, but also that a big market at the bottom of the income pyramid can be exploited (e.g. Hindustan Unilever that became market leader in India with shampoo that works best in cold water and is sold in affordable small packages) (Roland Berger, 2012, p.42).

However, despite this rapid integration of economic activities, global cooperation on regulating these flows remains limited. The international monetary system remains largely unchanged from its origins in a world that was significantly less economically and financially integrated. This continues to create key global risks such as currency volatility and fiscal crises (see WEF report, 2012). The challenge is to move towards a more balanced international monetary system and more integrated economic governance (WEF, 2012).

Future Skills Needs

Current projections suggest a continuing rise in employers' need for better cognitive and interpersonal skills (OECD New and Emerging Skills)[23]. Employment among low-skilled workers will decline, while employment among highly skilled workers is projected to increase, with a shift from manufacturing to service-based economies. A

[22] http://www3.weforum.org/docs/WEF_FS_EuroDollarYuanUncertainties_Report_2012.pdf

[23] http://skills.oecd.org/hotissues/newandemergingskills.html

foresight study on occupational skills (Cedefop, 2012) predicts strongly increasing demand for highly skilled occupations and service workers as well as elementary occupations (while demand for low or no formal qualifications in employment will decline).[24] Technology rather than people will increasingly carry out routine tasks. Hence, there will be a greater need for skills such as problem solving, planning, organisation and communication, even in elementary occupations (Cedefop, 2012)[25].

The OECD remarks that it is extremely difficult to forecast skills needs beyond general trends.[26] As a result, it is important to make education systems rapidly responsive to new demands and involve employers in forecasting skills needs. Furthermore, education should provide students with the foundation skills that allow them to engage in further (life long) learning (OECD New and Emerging Skills).

Technology to compete in a globalised world

A 2012 study by the Fraunhofer Institute looks at the technologies that are most likely to determine European competitiveness – namely nano-sciences, nanotechnologies, materials and new production technologies (NMP). The following future NMP trends and challenges are identified (Fraunhofer, 2012, p.25-36).

Prices and supply shortages are expected to arise for energy and some materials – raising the importance of resource productivity. Uncertain drivers that could enforce these trends are growth demand in developing countries, protectionism of supply and energy taxation. At the same time, NMP has the potential to reduce the use of critical resources (e.g. through nano-applications), substitute for and re-use critical resources by means of closed-loop production. As human capital can be a restricting factor to NMP development, interdisciplinary researchers and workers need to be trained.

Efforts to increase R&D in Europe are likely to be maintained, yet Europe faces challenges from catching-up of emerging countries and difficult macroeconomic conditions. For commercialisation it is necessary to close the gap between R&D and production. This requires an increasing and more efficient transfer and co-operation of universities, applied research organisations and industry. Furthermore, there is a need for clear market drivers to exploit commercialisation (e.g. industrial problems or global challenges to be solved by NMP applications). Integrating users in the innovation process is also necessary to promote the acceptance and economic success of future NMP applications and products. Governments also have a big role to play in seriously addressing the environmental, health and safety concerns related to NMP. This requires developing enhanced regulatory frameworks (standards, regulations) and more investment in risk research.

[24] http://www.cedefop.europa.eu/EN/Files/5194_en.pdf

[25] http://www.cedefop.europa.eu/EN/Files/5526_en.pdf

[26] See http://skills.oecd.org/hotissues/newandemergingskills.html

Energy Security and Efficiency

This topic discusses trends in energy production and consumption, its impact on energy security as well as the development towards a sustainable energy provision. There is an increasing tension between rapidly growing demand and restricted supplies of petroleum-based resources (oil, gas) (see Oxford research, p.21). This is complicated by the polluting nature of petroleum-based resources and of still abundant coal. These tensions have caused an almost constant rise in energy prices. Increased use of renewable energy, as well as progress in the reduction of energy consumption, can help to contain price rises.

Increasing energy demand and changing structure of power generation

Both total demand for energy and energy prices will rise up to 2030 (Roland Berger, 2012, p.56). Despite technological sophistication, the world's energy demand will have increased by 50% in 2025, relative to 2005 (Oxford Economics, p.21). Primary energy consumption in developing countries will grow about 15 times faster than the developed countries over the next 20 years. This will widen the gap in primary energy consumption: developing countries will be consuming 79% more primary energy than the developed countries in 2030 (Roland Berger, 2012, p.57). Increasing prices and competition for traditional resources create important challenges for energy security.

Oil is expected to remain the most important fuel, although its consumption in 2030 exceeds the current level by only 6% (SESTI, 2011, p.9). Oil demand, however, is expected to increase by 12% due to growing transportation fuel demand. Coal is believed to become the prime energy source between now and 2050 (Oxford, p.21). In general, the structure of power generation shifts away from nuclear and oil in favour of renewables, natural gas and solid fuels (SESTI, 2011, p.21). Biomass use for power generation also rises considerably; solar photovoltaic systems grow fast from a small basis, while the additional contribution from hydropower is small as a result of limited additional potential and environmental restrictions (SESTI, 2011, p.21).

Unexpected events can have significant consequences for future ways of power generation and can support the shift to sustainable energy provision. Good examples are the disaster in Fukushima Daiichi Nuclear Power Plant in Japan, which changed nuclear policy in Germany and Italy (Millennium Project, 2012; Oxford Economics, iKnow, 2011).

Moving towards sustainable energy provision

First, energy research is necessary to develop clean energy technologies (such as Carbon Capture and Storage) and make them cost-effective and available to all income groups (Copenhagen Research Forum, 2012, p.41).

Secondly there is a clear need for an upgrade of energy infrastructure. Most importantly Europe is lacking the grid infrastructure that will enable renewables to develop and compete on an equal footing with traditional sources. Investments of around €1 trillion will be needed by 2020 to replace obsolete capacity, modernise and

adapt infrastructures and cater for increasing and changing demand for low carbon energy (see SESTI, 2011, p.6). The grid of today is primarily based on national grids and not equipped to cope with future requirements. Accordingly, new technical and economic concepts are required to make the transition to a European level (SESTI, 2011, p.6).

More and more energy will be produced locally which needs to be incorporated into the distribution system (decentralisation of energy production). This requires ICT solutions that allow for active demand-side management and direct interchange of information between the provider and customer (e.g. smart metering, control devices) (SESTI, 2011, p.7).

In order to enhance a more efficient use of energy, particular challenges on the demand side will have to be met (See SESTI, 2011, p.7). These include stimulating behavioural changes in the population (requiring a better understanding of personal decision-making for a more effective design of incentives). Also the problem of "rebound effects" needs to be solved. This problem rises when the money that is saved by reduced energy use is used to purchase additional, energy consuming appliances.

Dealing with emerging issues

Beyond the well-known trends in energy policy, the SESTI project has identified a list of emerging issues that might require special attention on the part of policymakers (SESTI, 2010).

A first issue relates to the potential of hybrid nuclear energy (generating power by using a combination of nuclear fusion and fission processes). This technology is safer than nuclear fission (as the process is not self-sustaining) as well as cleaner (as it can utilise spent nuclear fuel from fission reactors and deactivate radioactive waste and weapons). However, the scale and investments that are required can be viewed as regressive in terms of the current trend towards liberalisation of energy markets.

A second issue is the potential of large-scale generation of renewable solar energy from the desert. Despite the clear ecological and economic benefits (both for Europe and the MENA area), there are major political challenges (suitable areas are often unstable) and technical difficulties (mainly regarding the supply connection to Europe).

A third emerging issue relates to bio fuels, biomass and bio mimicry. While first and second generation bio fuels create conflicts in land-use with food crops, new techniques in genetic engineering might enable biomass production on areas that are not suitable for food production. Recent developments in nanotechnology allow for artificial processes that mimic photosynthetic reaction utilised in plants.

A fourth issue refers the unknown risks of the hydrogen economy. Hydrogen can be used to drive fuel cells to generate electricity in electric cars and are assumed to be environmentally friendly as only water vapour is emitted. However, a possible risk is that hydrogen leaks into the atmosphere. As it is lighter than air it can reach the stratosphere where it can react with ozone, recreating the ozone hole.

A final issue concerns the huge economic and ecological risks related to digging deeper and farther into more hostile and challenging environments (for example deep-sea

drilling in the Arctic ocean). Diminishing oil and gas reserves has pushed energy companies to push the frontiers of drilling technology, while accidents will be much harder to handle due to remote location extreme weather conditions and dynamic sea ice.

RESOURCES

Several drivers (population growth, industrial growth of emerging economies, etc.) are increasing the extraction and use of these resources. Extensive use and dependence on resources brings challenges on different levels: ecological (overconsumption and environmental pressures), political (material security) and economical (material costs) (EIO, 2011, p.4-8).

This section focuses first on trends and challenges related to the extraction and consumption of specific resources (raw and critical materials, water and land)[27]. Subsequently trends related to eco-innovations and resource efficiency will be discussed. Energy resources are dealt with in topic 6; Ecosystems related to water in topic 4; Food and land use related to food in topic 8; Land use related to urbanisation in topic 3.

Increasing consumption of raw and critical materials

Material extraction and consumption is directly and indirectly related to a large number of environmental impacts, including resource depletion, climate change, land-use change, soil erosion and loss of biodiversity (EIO, 2013, p.32).

Today, humans extract more material resources than ever before in history. The strongest increase can be observed for construction minerals, followed by ores and industrial minerals and fossil energy carriers (EIO, 2013, p.29). Resource extraction and consumption is expected to increase, mainly driven by global population growth and urbanisation, as well as growing needs from emerging economies.[28]

In addition, the large-scale adoption of certain new technologies will lead to increased demands for particular commodities from the mining and metals industry (ICSU, p.12). For example, demand for gallium for use in emerging technologies such as thin layer photovoltaic is projected to rise 20-fold from current use of almost 30 tonnes to about 600 tonnes by 2030 (ICSU, p.12). The non-availability of these critical metals could endanger entire sectors. High-tech industries, particularly the electronic industry, will be affected by the declining availability of precious metals (EIO, 2011, p.55).

However, over the coming two decades, geological scarcity is not considered to be the critical issue; technological developments in exploring, mining and processing mineral raw materials will be the key in keeping up the supply with demand" (ICSU, p.12). A complication is still that these critical resources are often located in only a limited number of regions that are often political unstable (ICSU, p12). This means rapid, unexpected demand growth and high supply risks (EIO, 2011, p.55). To meet these challenges, eco-innovation could play a major role (see below).

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[27] Carbon can be considered as another category of resources, but will be covered in the topic "Climate change and eco-system management").

[28] See, among others: http://www.academia.edu/190057/Resource_efficiency_for_sustainable_growth_global_trends_and_European_policy_scenarios

Water as a resource

Water is an essential resource for humans, their economic activities and health. Freshwater represents only 3% of existing water on the planet, of which 0.3% is available for humans (EIO, 2013, p.35). However over the past 50 years global freshwater withdrawals have tripled (UNEP, 2012). The OECD estimates that nearly 3.9 billion people will be living under conditions of severe water stress by 2030 (OECD, 2007a). Without changing practices, conflicts over trade-offs among agricultural, urban, and ecological uses of water are likely to increase, along with the potential for mass migrations and wars (Millennium Project, 2012).

In reference to the sources of water abstraction and consumption in Europe, the EEA (2010c) reports that 45% of freshwater abstraction in Europe is for cooling in energy production, followed by agriculture (22%), public water supply (21%), and industry (12%) (EIO, 2013, p.32). The inefficient water use in industry and public consumption has led to an increase of droughts over the past 30 years. The number of areas and people affected by droughts grew by almost 20% between 1976 and 2006 (European Commission, 2007a). In the EU, water scarcity is also manifested through increasing external water resource dependency (EIO, 2013, p.33). Accordingly, increasing efficiency in water use is necessary both through new industrial technologies for fresh water 'production' (e.g. desalination plants)[29] and through reusing freshwater and eco-innovations (see below).

Land

Land is a limited resource. On-going competition between forestry, agriculture, infrastructure and natural ecosystems and the continuous increase in global population and economic growth limit the supply of productive land (EIO, 2013, p.33).

Lambin and Meyfroidt (2011) analyse global land use change and economic globalisation and underline that different land uses will be competing for the available land. Feeding a growing world population may require an additional 2.7–4.9 Mha of cropland per year on average (in 30 years: 81 to 47 Mha). However, converting this land to agriculture to feed the world would generate environmental and social costs because it is generally rich in biodiversity and used, for example, by agro-pastoralist populations (Lambin and Meyfroidt, 2011). So there is a clear and growing dramatic competition of land use categories on the global level (see EIO, 2013, p.35).

The UK's Land Use Futures Foresight Project (2010)[30] argues for a coherent and consistent approach to managing land use (given the complexity and inter-links with issues ranging from climate change adaptation to agriculture and preserving historical landscapes).

[29] See Oxford Economics foresight study, p.20.

[30] See http://www.bis.gov.uk/assets/foresight/docs/land-use/luf_report/8614-bis-land_use_futures_exec_summ-web.pdf

Paradigm shift to eco-innovation: resource efficiency and dematerialisation

As mentioned before, the extensive use of resources creates ecological, political and economic challenges. (See EIO, 2011). From an environmental perspective, increasing global consumption of resources leads to the risk of overexploitation and potential collapse of resource availability and ecosystems. This relates to the political challenge of material security, as resource availability will become a strategic issue and source of conflict. Diminishing availability furthermore leads to rising material costs, which makes resource efficiency relevant for businesses (EIO, 2011).

Resource efficiency is an important stem towards reaching the economic and environmental objectives. However, this is not sufficient when efficiency gains are offset by growth in total consumption of natural resources (EIO, 2011, p.9). Accordingly, both improved resource efficiency and absolute dematerialisation are necessary aspects of the eco-innovation challenge. Resource-efficiency efforts are hence a critical first step towards more radical innovations along the material supply chain and also argue that the potential for "saving resources" with this type of innovation is high. However, more radical types of systemic change are also needed.

FOOD

Three big trends that will have an impact on food security are considered as inevitable: a fast growing world population, climate change and the increasing scarcity and rising prices of fossil fuels. The big challenges that result from these trends are the possible stagnation of crop yields, the deterioration of ecosystems and corresponding threat to eco-services. As a result of price volatility and impact of the competition between food and bio fuel production, the threat of food riots is re-occurring as a main concern (See EFP, 2011, p.1).

Rising food demand and Nutritional Transition

The future of global agricultural and food systems is today at the heart of numerous intertwining debates. They stem from the increasingly widespread certainty that the continuation of current trends in food consumption and production is unsustainable and that radical changes in behaviour, policies and technologies are necessary (MA 2005, World Bank 2008, IAASTD 2009).

Food demand will increase as a result of population growth, as well as a rise in per capita consumption (RS). While malnutrition currently affects 2 billion people in the world, this number is expected to increase by 2025 (Oxford research, p.18). Hence there is the challenge of food security to a growing world population.

A range of drivers affects food consumption – not just through increasing demand but also through affecting the dietary patterns. The change of dietary patterns is knows as nutritional transition: energy-rich foods (such as meat and those with a high concentration of vegetable oils and sugar) replace grains, roots, etc. (See Royal Society, 2010a)[31]. The shift from a high prevalence of under-nutrition to a situation where nutrition-related non-communicable diseases (NR-NCDs) predominate arises where you have increased consumption of unhealthy foods along with increased prevalence of overweight and obesity in middle-to-low-income countries of the world (See Royal Society, 2010b)[32]. It can have serious implications in terms of public health outcomes, economic growth and international nutrition policy.

Conflicts between rising demand and other objectives

Rising demand requires more agricultural output. Yet this might increase the conflict between agriculture and several other objectives. This section first discusses resource competition (with respect to water, land, etc) and subsequently the relation between agriculture and climate change.

Agriculture is globally one of the greatest consumers of water and shortages of water may have a major effect on food production (RS, 2010). As discussed in other topics, water is crucial for other users (such as industry and domestic consumers) and for maintaining functioning ecosystems. This competition will severely affect agriculture in the next decades hence increasing water-use efficiency will be an important priority

[31] http://rstb.royalsocietypublishing.org/content/365/1554/2769.full

[32] http://rstb.royalsocietypublishing.org/content/365/1554/2793.full

(RS, 2010). This for example through efficient irrigation and using treated waste-water (EEA, 2013)[33].

For many centuries increasing demand for food was met by bringing more land into agriculture (RS, 2010). However, competition over the use of land has severely increased. Population growth and urbanisation require more land for cities, increasing encroachment of agriculture into natural habitats threatens biodiversity and ecosystems, deforestation and other land use changes lead to greater emissions. This requires limiting land conversion and increasing crop yields per piece of land (RS, 2010).

Besides the impact of agriculture on climate change through its impact on ecosystems, agriculture directly affects the emissions of greenhouse gasses (e.g. cattle, inputs requiring fossil fuels, deforestation) (RS, 2010). To reduce the impact of agriculture on climate change, energy efficiency needs to increase (e.g. on-farm bio-mass production), more efficient fertiliser use is required, agro-forestry schemes should be used, etc.

Food supply and the 'competing risks' approach to agricultural innovation

The overriding challenges of increasing demand, competition for land use and other resource scarcities put massive pressure on agriculture and the food and feed industry to produce significantly more per unit of resource (CRF, p.29). This requires innovations in the whole value chain to increase intensive (more production for the same piece of sea/land or resources).

An emerging theme is the importance of taking a 'competing risks' approach to regulation in the food system—it is too easy to close off options by applying naive versions of the precautionary principle (see Royal Society, 2010a). The world is going to have to produce more food, and unless much of the Earth's remaining biodiversity is to be destroyed, this will need to be done without expanding the area under cultivation. Achieving higher yields from the same acreage without severely impacting the environment requires a new way of approaching food production—sustainable intensification.

There is, however, no consensus on the direction of agricultural innovation. The iKnow report points at different approaches, which seem to diverge rather than converge (See iKnow, 2011). In one corner is the technology innovation approach, with biotech, precision farming and total quality management of supply chains. In another corner is a critical perspective on the agric-food business, with an alternative model of sustainable rural or urban development, with local production, holistic livelihoods, perma-culture approach to multi-functional land use.

The intensification methods used to produce more food matters both for environmental reasons and health reasons. With respect to environmental consequences, main concerns are damaging (but possibly more efficient) use of fertilisers, use of fuels and

[33] http://www.eea.europa.eu/articles/water-for-agriculture

using less land for agriculture to increase carbon storage (See Euractive, 2012)[34]. Health concerns related to agricultural intensification stem from increased exposure to toxic substances such as pesticides, a higher incidence of infectious diseases associated with expansion of irrigation systems and the use of wastewater for irrigation, and increased human exposure to infectious agents as tropical forests and other ecosystems are converted to agricultural land (WRI, 1999)[35].

[34] http://www.euractiv.com/cap/intensive-farming-ecologically-s-linksdossier-506029

[35] http://www.wri.org/publication/content/8331

SECURITY

Several aspects of security have already been discussed in different sections, including references to resource security, energy security, food security or adaptation to climate change. The focus in this topic will be on safety and security issues that emerge as a consequence of new technologies, the increased dependence on ICT and the increased risk of natural disasters for national security.

Occupational health and safety challenges resulting from new technologies

Meeting the EU 20-20-20 targets on renewable energy and energy efficiency alone has the potential to create over 1 million new jobs (See EU OHSA, 2013). However, if not enough consideration is given to occupational safety and health (OSH) in these new 'green' jobs, the health and safety of many workers will be compromised. This requires forward looking efforts to anticipate new and emerging risks in those developing green jobs.

The first of these challenges is an increasing trend towards decentralised work processes and a widely distributed nature of the work (e.g. small-scale renewable energy installations). As workplaces are therefore getting more dispersed and more difficult to reach, monitoring and enforcing good OSH conditions and safe working practices is likely to become more challenging.

Greening the economy also means a fundamental transformation in terms of business processes and skill sets. Knowledge on 'old' OHS risks might not be automatically sufficient for new green jobs that require new skills or combinations of old skills (for example the installation of PV elements involves both construction risks and electrical risks). A similar issue is the shortage of skilled workers, forcing low-skilled workers into more difficult and dangerous jobs.

Challenges increase when the pursuit of green objectives and OHS clash and achieving green outcomes takes priority (e.g. exposure to dangerous substances). In general, there could be increasing potential for the release of novel, difficult-to-identify and potentially hazardous materials all along the lifecycle of green technologies and products (e.g. nano- or biomaterials. They will need to be closely monitored over their entire lifetime.

The study highlights the need for a systematic, prior OSH assessment of any new technology, product and process at the development stage and for considering its entire lifecycle, from 'cradle to cradle' (meaning from the design, including manufacture, transport, installation, operation and maintenance, and into decommissioning, waste treatment and later reuse).

Security problems resulting from new technologies and ICT

Next to safety and health consequences, new technologies also imply security challenges requiring active risk management.

Several new technologies and materials can have non-military potential adverse effects. Nanotechnology, for example, can create risks for ecosystems when they are increasingly released in larger quantities (See NATO, 2005[36]). Other risks relate to potential toxicity of nano-particles but also concerns with respect to privacy (e.g. virtually invisible video cameras, microphones and transmitters). More familiar are risks related to biotechnology (e.g. GMOs). Furthermore, the development of new technologies also poses new concerns with respect to its military possibilities. One example is the dual use of plant biotechnology to produce large quantities of protein toxics for bioweapons (FAS, 2011). Also nanotechnology can be directly used to improve warfare (e.g. lighter, stronger, heat resistant nano-materials could be used in producing all kinds of weapons, making military transportation faster, strengthening armour and saving energy), or indirectly through smaller computers, sensors and other devices. The future development of molecular nanotechnology will require an active risk management program to achieve huge technical and economic benefits with minimum negative security and environmental impacts (see for example IMM, 2007)[37].

Increasing dependence on ICT may have unwanted consequences and make cyber security an increasingly important challenge (ICSU, 2011, p.14). Cyber-security is now a serious issue, especially in the view of recent cyber-attacks conducted against countries. The most serious and far-reaching consequences occur from information infrastructure disruptions at the global, national and regional level (See Oxford Research, 2012). Secret intelligence operations are currently conducted using existing internet technologies and can be vulnerable. Taking the above into consideration European defence services will require extensive support from the available technologies and, most of all skilled specialists need to be available at the European market (Oxford Research).

Also for people and businesses trusting their data and software to "cloud computing" on distant Net-connected servers rather than their own computers, privacy and reliability questions are raised (Millennium Project, 2009). Other privacy questions follow from the increasing possibilities of public surveillance through gene databanks and CCTV.

Security challenges resulting from natural hazards and disasters

As a result of population growth, urbanisation and climate change (discussed in different topics), people are increasingly vulnerable for natural hazards and disasters, raising public security issues. During the next decade, climate change could have wide-reaching effects on everything from food, water, and energy supplies to critical infrastructure and economic security.

The key challenge for science-based decision-making in disaster management is to bridge the knowledge gap between available real-time scientific analysis supporting

[36] http://www.nato-pa.int/Default.asp?SHORTCUT=677

[37] http://www.imm.org/publications/reports/repnj9902/

early warning and actions triggering early response (See JRC, 2012)[38]. In many countries, this knowledge is fragmented among different scientific and technical communities (meteorology, hydrology, geophysical, GIS). Moreover, the approaches utilising this knowledge are diverse and would be more effective with improved coordination across operational agencies (national disaster management centres, civil protection, public health, transport, economy, security), across-borders.

[38] http://ec.europa.eu/dgs/jrc/index.cfm?id=1410&obj_id=4260&dt_code=EVN

GOVERNANCE

This topic will cover the trends and challenges concerning good governance and governmental transformation. These include the challenges that result from ICT developments, from changing expectations by citizens and by increasing necessity for innovation in the public sector.

ICT as a driver for governmental transformation

Information and communication technologies (ICT) have already driven public sector transformation and have stimulated the Information Society (OECD, 2007[39]). The Joint Research Centre has identified the following 'hot spots' of governmental transformation that are expected to result from ICT improvements by 2020 (JRC, 2007)[40].

ICT is generally supposed to stimulate transparency with a wide range of impacts. More information symmetry will increase the possibilities for citizens to exert effective control on governments. Government agencies will have to better align their policies and procedures and open up closed hierarchies. Related to transparency, increased access to public sector information will force authorities to be more accountable. Governments themselves can use ICT (e.g. workflow systems) as effective tools to fight corruption.

Several ICT increase the surveillance capabilities of governments (such as digital cameras and sensors), but also change the set of actors involved in law enforcement tasks. Both private organisations (such as security firms) and citizens will increasingly be involved in law enforcement tasks. Most technologies are enables of sophisticated and unnoticed data and information gathering, raising potential privacy issues. They enable the gathering of very detailed personal data, the construction of profiles that may be used to identify specific groups of people, as well as the tracking and tracing of people.

New types of countervailing power emerge as ICT show a potential to open-up traditional forms of democratic involvement in governance (e.g. social networks) and to develop new ways to engage with individual citizens, communities, and advocacy/interest groups. The horizontal, decentralised and location/time independent character of technologies will increasingly drive networked, decentralised and multi-stakeholder models of government. Technologies that give governments greater to collect, store, process and apply information enables them to provide more intelligent and responsive services, tailored to meet the needs of specific individuals or groups.

Dealing with changing expectations by citizens

Complex policy issues cannot be solved by government alone, citizens have a major role to play in contributing to high-quality and cost-efficient public services and

[39] http://www.oecd.org/governance/eleaders/43340370.pdf

[40] http://ftp.jrc.es/EURdoc/22897-ExeSumm.pdf

achieving shared public policy goals (OECD, 2009). However, changing expectations create challenges for governments in order to engage citizens in policy-making.

First, the state is increasingly seen as a service provider with citizens as its customers who ask for a high level of service and participation. Responding to those rising demands for better quality services, despite tight budgets, requires governments to work with their own citizens and other stakeholders to find solutions (OECD, 2009, p.13).

Secondly, if the current trends continue, there might be a continuing decline in the proportion of the electorate voting in elections and participating in conventional political forums and roles (See Sigma Scan, 2011)[41]. Without popular support and trust, public bodies and the representative system may find their mandate challenged as they struggle to remain legitimate, relevant and enact policy. New forms of participation may prompt re-evaluation of the citizen's relationship with society.

Thirdly, it is also about the configuration of identity and accountability at every level – national, regional, municipal, local community, and right to the household and personal level (see iKnow, 2012). The apparent divergence of 'function' and 'territory' implies that many now identify more with global networks and interest groups, rather than with any one administrative unit. The public sector increasingly competes with other actors, yet at the same time it is increasingly recognised that the free market can be quite dysfunctional and government support needed.

One response to these challenges, given among others by the OECD, is that in favour of an open and inclusive society (See OECD, 2009). Openness means providing citizens with information and making the policy process accessible and responsive. Inclusion means including as wide a variety of citizens' voices in the policy making process as possible.

Public Sector Innovation as response to budgetary and societal challenges

Governments are under sustained political pressure to come forward with radical new solutions to protecting services while cutting costs dramatically (See Technopolis, 2012). Public sector innovation is seen as a means to address growing budgetary pressures, through more efficient administration or service delivery, and new societal demands, through different and more effective service design. Three central categories of drivers and barriers for public sector innovation can be identified: internal factors, external factors and political factors.

Regarding internal factors, two internal drivers and barriers have been identified. First, human resources-related factors play an important role. For example, education and training offered to public officials can be a key driver, as well as the presence of incentive schemes for motivating public servants to be more innovative. Furthermore, there is a need for leadership, good management and 'inspiring' public managers to motivate staff and allow scaling up of initiatives. Secondly, bureaucracy and

[41] http://www.sigmascan.org/Live/Issue/ViewIssue/126/1/opting-out-declining-trust-and-engagement-in-conventional-politics/

organisational structures and design can both enable and hamper public innovations. Also performance management and monitoring and evaluation practices are considered as drivers of public sector innovations.

A series of aspects in the external environment can stimulate public innovations. First, collaboration between the public and private sector, as well as co-creation and involvement of service users in the process of designing services, are potentially disruptive elements that can bring renewal to public services. Secondly, the presence of national awards and the existence of international rankings and good practices may drive innovations in a public sector. Also European public administration is important for knowledge transfer and exchange.

One of the main political factors that drive public sector innovations is the shortage of financial resources or budget restrictions. However, the availability of financial resources and increased flexibility of the use of public funds is required. EU requirements and funds can also serve as an external political driver (or barrier). Other political drivers for public sector innovation are political support and new laws and regulations as this allow for more flexible activities within the government.

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