



The challenge of resilience in a globalised world

Report by the
Joint Research Centre
the European Commission's
in-house science service



If you would like to learn more about the activities of the JRC,
please contact:

Geraldine Barry

European Commission
Joint Research Centre
Communication Unit
Head of Unit
CDMA 04/167
1050 Brussels
Belgium

Brussels

Tel. +32 (0)2 29 74181
Fax +32 (0)2 29 85523

Ispra

Tel. +39 0332 78 9889
Fax +39 0332 78 5409

Contact: <https://ec.europa.eu/jrc/en/contact>

Website: <https://ec.europa.eu/jrc>

A great deal of additional information on the European Union
is available on the internet. It can be accessed through the
Europa server (<http://europa.eu/>).

Contents

Foreword by European Commissioner T. Navracsics	2
1. Setting the Scene	
A more resilient Europe and the role of science <i>V. Šucha</i>	6
Why resilience matters <i>M. Wahlström</i>	8
A business perspective <i>B. Stigson</i>	10
A climate perspective: cutting emissions and creating jobs <i>A. Wijkman</i>	12
2. The concept of resilience	
The concept of resilience: a European perspective <i>S. Lechner</i>	16
3. Resilience of supplies – the basic needs	
Modelling the Energy Union: mission impossible? <i>M. Masera</i>	20
Towards a resilient food production system <i>N. Hubbard</i>	22
Water resilience: addressing water pressures and disruptions and the drivers behind them <i>G. Bidoglio</i>	24
4. European resilience in action	
Civil protection: better together – within Europe and globally <i>F. Fink-Hooijer</i>	28
Nuclear safety: joint European reaction to the Fukushima accident <i>S. Abousahl</i>	30
Financial solidarity <i>K. Regling</i>	32
The Banking Union: calculating systemic risk across Europe <i>F. Campolongo</i>	34
The EU Stability and Growth Pact: a multidimensional modelling challenge <i>M. Ratto</i>	36
Health and pandemics: efficient EU responses by sharing knowledge <i>C. Nicholl</i>	38
5. Upcoming challenges	
Social resilience <i>G. Fischer</i>	42
Geopolitics: common platforms for efficient EU crisis response <i>D. Al Khudhairy</i>	44
Climate change: how to address a creeping crisis <i>M. Porter</i>	46
Migration: European cooperation for resilience of the blue borders <i>A. Zampieri</i>	48
Counter-terrorism: EU collaboration <i>O. Luyckx</i>	50
6. Emerging technologies	
Big data and the ‘Internet of Things’: research for Europe’s digital resilience <i>J-P. Nordvik</i>	54
Can Europe become quantum-safe? <i>G. Lenhart</i>	56
The Internal Market: protecting European innovation <i>A. Campinos</i>	58
7. Conclusions and next steps	
Measuring resilience to design innovative policies <i>E. Giovannini</i>	62
Managing complexity: the key to resilience <i>S. Lechner</i>	64
Global risk and global resilience <i>W. J. Ammann</i>	66
Resilience through trilateral collaboration <i>J. Jacometti</i>	68
Authors	70

Foreword

T. Navracsics
European Commissioner



As the EU recovers from the deepest economic crisis since the Great Depression, we have some time to reflect on how to better deal with the shocks and stresses our economies, societies and environment are increasingly being exposed to. We can now see more clearly how these shocks and stresses interact and sometimes reinforce each other. Therefore, we need to reflect on how to improve resilience in a more holistic way, systemically addressing all the risks to the safety and well-being of European citizens, whether they are threats to our economy, our society or our environment.

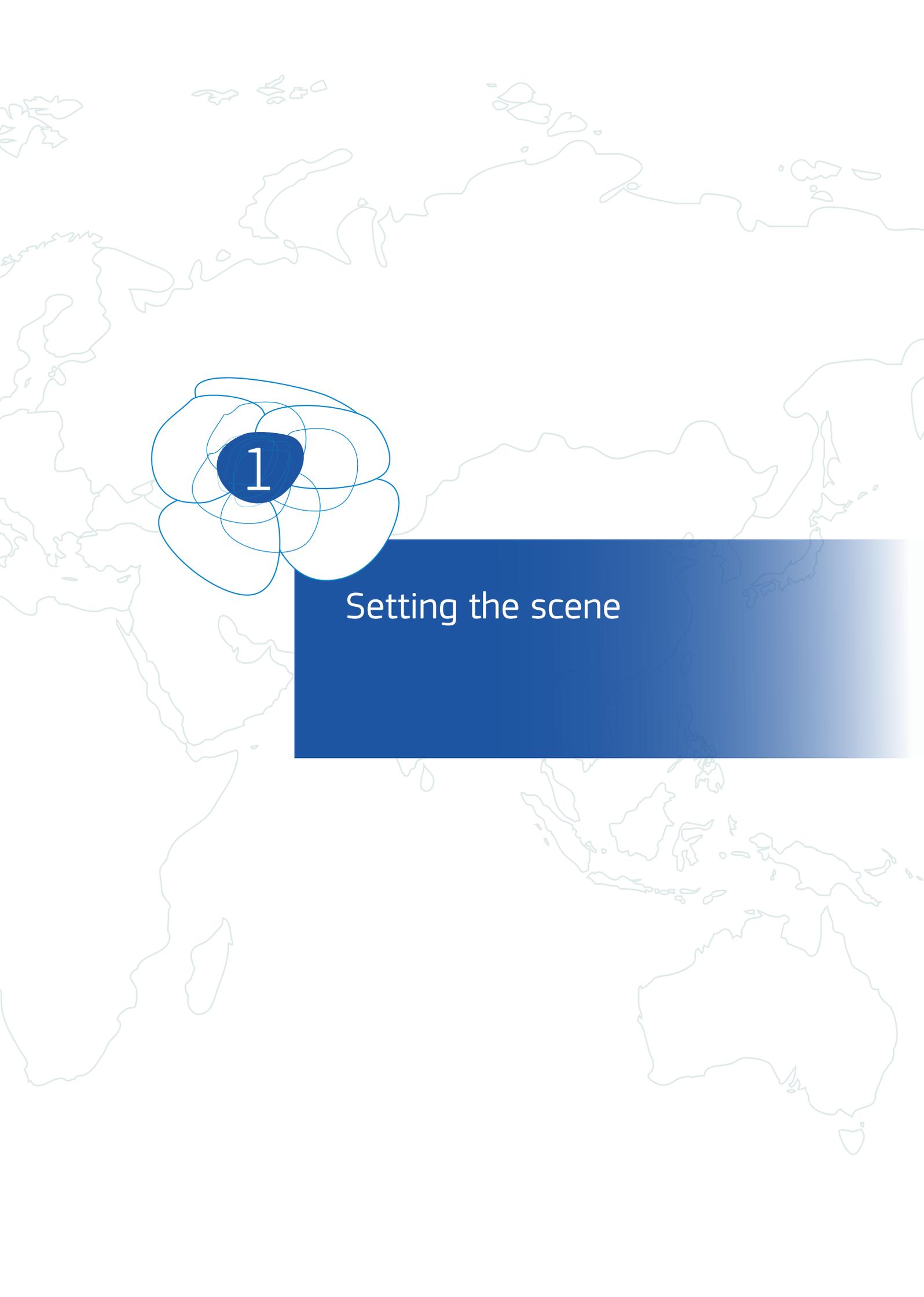
Resilient economies and societies are able to absorb shocks and stresses, even those as serious as the recent economic crisis. They are organised in a way which strikes the right balance between economic and societal stability on the one hand, and knowledge-driven innovative dynamism on the other, without which the EU cannot thrive. This balance is fundamental to job creation, economic growth and environmental sustainability. And it is a common challenge for everyone: EU institutions and EU Member States, the private sector, universities and research bodies, NGOs and European citizens.

Today's challenges strongly test our capacity to cope with shocks and grow more resilient in the face of acute stress. Global change is taking place in an unpredictable way, and at an increasing pace. But we will have to prepare for the next economic or physical 'tsunami', the nature of which may currently be unknown to us. Faced with more and more difficulties in navigating the complexity

of security, resource, climate and technology issues, individual countries cannot achieve everything – difficult choices have to be made and we need to work together.

Developing our knowledge base, exchanging experiences, pooling resources and cooperating at EU level are therefore important ways to build a more resilient Europe. The added value of such an approach will depend on our ability to strike the right balance between reaping the gains in the efficiency of a common approach and maintaining the diversity of our national systems to address specific national vulnerabilities.

DG JRC's Resilience Report is the first-ever attempt to deepen our knowledge and develop a holistic approach by analysing various strategies for building resilience in the EU. The objective is to help EU Member States to better focus scarce resources on key vulnerabilities and, where beneficial, to join forces in building a more robust, resilient and prosperous EU.



1

Setting the scene

A more resilient Europe and the role of science

V. Šucha

European Commission, Joint Research Centre

Over the last decade, the resilience of the EU and its Member States has been tested by unprecedented economic shocks, major geopolitical shifts, climate-change-related disasters and transnational security threats no one had foreseen. Against this backdrop, the EU has proved its resilience and demonstrated its capacity to provide collective and coordinated responses both internally and externally. Within the Union, it has undertaken a number of reforms which were necessary to protect the safety, security and well-being of its citizens. As a global actor, it has not shied away from playing a prominent role in international processes and in building consensus around a common agenda, as was the case in the Sendai Framework for Disaster Risk Reduction. Nonetheless, more needs to be and can be done to build a more resilient Europe.

The European Commission's contribution to building a more resilient EU

Man-made threats (e.g. cyber-attacks, terrorism, external conflicts, major accidents), natural hazards, financial and economic instability, epidemics and pandemics, energy insecurity, as well as global factors such as irregular migration, environmental degradation and climate change, continue to hover over the European project, with the potential to threaten the well-being of our societies and the wider world. Therefore, a sustained effort in “enhancing the EU’s resilience to crises, as well as its capacity to anticipate, prepare and respond to risks”, including transnational threats and global challenges, is essential to reach the ‘objectives of the Europe 2020 strategy’¹.

Since 2010, the European Commission has been working in at least 16 different policy areas related to resilience. It has been developing new frameworks for disaster risk reduction and civil protection (i.e. forest fires, floods, droughts and other hazards), food security and other humanitarian crises – especially in Africa – structural measures and instruments to improve financial and economic stability within the EU, responding to epidemics and pandemics, as in the recent Ebola crisis, stress tests for nuclear plants, the safety of critical infrastructures, etc.

Despite these laudable efforts, “current investments and policy responses remain insufficient to effectively address existing risks, let alone to keep pace with emerging challenges”². For a more resilient Europe, it is essential to set the right priorities and to focus scarce resources on key vulnerabilities. Scientific knowledge can play an important role in this regard by supporting European policy- and decision-makers.

The role of science

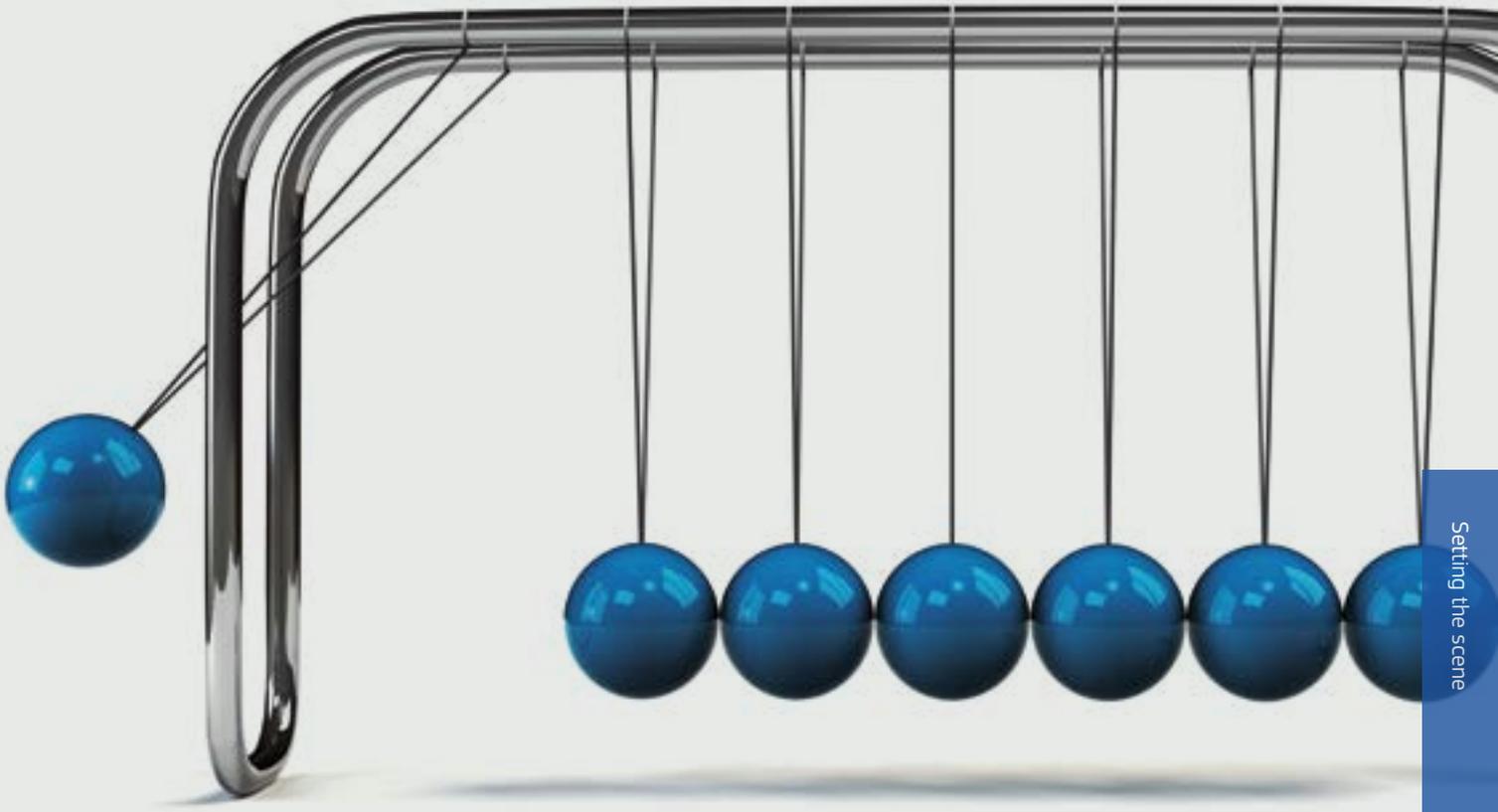
Most policy processes follow a linear logic: they aim to optimise the desired outcome while seeking to reduce redundancies in the name of efficiency gains. This approach, geared towards reaching and maintaining the equilibrium, undermines the capacity “to absorb disturbance and reorganise while undergoing change”³ within a system – be it social, economic or ecological in nature. As a result, the system “becomes brittle; vulnerable to unforeseen perturbations”⁴.

1 - COM(2010) 2020 final, ‘EUROPE 2020. A European strategy for smart, sustainable and inclusive growth’ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF>

2 - COM(2014) 216 final, ‘The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience’, page 4

3 - Walker, B., Resilience: Interdisciplinary Perspectives on Science and Humanitarianism, Volume 1, March 2010

4 - Ibid.



Preventing these unintended consequences of our policy interventions requires a thorough understanding of the dynamics and interconnectivity of our economy, society and environment. This is only possible by developing comprehensive and multidisciplinary approaches based on solid scientific evidence.

Science cannot entirely insulate societies from the adverse effects of imminent or latent risks. It can, however, provide data, knowledge, methods and tools critical to underpin well-informed policies and decisions, which can enhance the implementation of effective risk reduction, response and recovery measures by helping to set evidence-based priorities. Sound policies, preventive measures and timely interventions are crucial: they address vulnerabilities and allow systems to adapt and restore themselves, enabling them to retain their essential structures and functions.

The Joint Research Centre (JRC) – as the scientific arm of the European Commission – has been contributing to efforts at all stages of the EU policy process by providing scientific evidence and data to anticipate and reduce potential risks; analysis, scenario modelling and consultations to assess different policy and intervention options to adapt to changes induced by shocks;

impact assessments; methods and tools to assist with the implementation of recovery measures and appraisal of policy frameworks and interventions, fostering learning to increase the EU's adaptive capacity.

The way forward

Transdisciplinary scientific and technical know-how has proven particularly useful in building the EU's resilience capacity, given the interconnectivity between our social, economic and ecological systems, on the one hand, and the need for multi-hazard approaches to tackle separate but reinforcing risks, on the other.

To further strengthen synergies and better exploit complementarities, DG JRC will bring together, and further develop in an interdependent manner, all its resilience-related research, expertise and activities. Together with the European Political Strategy Centre (EPSC) and the Directorate-General for Humanitarian Aid and Civil Protection (DG ECHO), DG JRC is organising a dedicated conference on 'Building a Resilient Europe in a Globalised World' in September 2015. This conference aims to deepen the debate and to identify new activities that will help the EU in its efforts towards elaborating a comprehensive, collective and integrated approach to resilience.

Why resilience matters

M. Wahlström

United Nations Office for Disaster Risk Reduction (UNISDR)

One of the key learnings of the last 40 years of formal work on promoting and spreading a culture of disaster risk reduction around the world is how essential the concept of resilience has become to that work.

This was explicitly recognised by UN member states in 2005, following the Indian Ocean tsunami, when they adopted the *Hyogo Framework for Action (HFA) 2005-2015: Building the resilience of nations and communities to disasters*⁵. The formula they came up with for building resilience consisted of five priorities focused on strong risk governance for overall HFA implementation; enhancing early-warning systems; using knowledge, innovation and education to build a culture of safety and resilience; reducing underlying risk factors; and strengthening disaster preparedness for effective response at all levels.

The reality of implementation over the last ten years has helped to deepen our understanding of where the gaps lie in building resilience and, hopefully, the adoption this year of the *Sendai Framework for Disaster Risk Reduction 2015-2030*⁶, the successor instrument to the HFA, will guide the world towards filling those gaps.

Within weeks of adopting the Sendai Framework at the Third UN World Conference on Disaster Risk Reduction, the international community received a nasty reminder of why resilience matters.

The earthquake on 25 April 2015, which claimed thousands of lives in Nepal and left millions homeless, told us why in an

era of rapidly expanding cities and towns, and a growing population, it is essential that we have a better understanding of risk so we can make the essential shift from disaster management to disaster risk management.

A country like Nepal, in the lower reaches of the Human Development Index⁷, has the benefit of a reservoir of resilience among its people, built up over centuries of experience in coping with floods, earthquakes and other natural hazards, but the pace of urbanisation allied with other factors such as population growth, climate change, environmental degradation and political instability, has overwhelmed that natural ability to respond and cope with disasters. In the case of Nepal, local solutions have been found to make communities resilient to earthquakes. The work of the Nepal Risk Reduction Consortium⁸ and the Nepal Society for Earthquake Technology⁹ has, for example, been essential in ensuring that hundreds of schools were able to withstand the impact of the 7.8 magnitude earthquake which struck in April.

This was achieved by recognising the fact that in an earthquake-prone country where engineers are rarely involved in supervising construction projects, the key to resilience was to train thousands of masons in simple but effective techniques for making schools safe and, at the same time, to give the children regular drills so they understood how to respond to disaster events and brought that knowledge into the broader community. Unfortunately, that effort was not brought to scale quickly enough and

5 - The United Nations Office for Disaster Risk Reduction (UNISDR), *Hyogo Framework for Action (HFA) 2005-2015: Building the resilience of nations and communities to disasters*, <http://www.unisdr.org/we/inform/publications/1037>

6 - United Nations Office for Disaster Risk Reduction (UNISDR), *Sendai Framework for Disaster Risk Reduction 2015-2030*; Document A/CONF.224/L.1, <http://www.unisdr.org/we/coordinate/hfa-post2015>

7 - United Nations Development Programme (UNDP), *Human Development Index (HDI)*, <http://hdr.undp.org/en/content/human-development-index-hdi>

8 - Nepal Risk Reduction Consortium: <http://un.org.np/coordination-mechanism/nrrc>

9 - Nepal Society for Earthquake Technology: <http://www.nset.org.np/nset2012/>



the failure to have in place a mechanism to ensure compliance with the building code has had tragic consequences.

These shortcomings are not peculiar to Nepal. We live in a world where loss of life from man-made and natural hazards is unacceptably high in both developed and developing countries. Economic losses whittle away development gains year after year, impacting on critical infrastructure, food security and vital services.

The Sendai Framework tells us there are four priority areas for action if we are to build on the achievements of the HFA decade and succeed in bringing about substantial reductions in loss of life, economic losses and the numbers of people affected by disasters.

First, disaster risk management needs to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment.

Second, while a lot has been done to strengthen disaster risk governance over the last ten years, further work is required at the national, regional and global levels to guide, encourage and incentivise the public and private sectors to take action and address disaster risk.

A third requirement is public and private investment in disaster risk reduction through structural and non-structural measures which can also result in co-benefits such as economic growth and job creation. Target areas include early-warning systems, protecting productive assets, and ensuring the safety and functionality of critical infrastructure.

Finally, experience indicates that disaster preparedness needs to be strengthened for more effective response. Disasters have also demonstrated that the recovery, rehabilitation and reconstruction phase is an opportunity to build back better in a disaster-proof way. The world looks to the scientific community to help deliver much of this agenda, thereby ensuring that we make progress on reducing existing levels of risk and avoiding the creation of new risk. Scientific enterprise is key to supporting mitigation, preparedness and response measures, and the development of policy at the highest levels of government and providing the evidence of the benefits which ensue from investing in disaster risk reduction. Knowledge needs to be shared across all levels of society. No group should be excluded. Inclusion is the hallmark of a resilient society.

A business perspective

B. Stigson

*Former President, World Business Council
for Sustainable Development*

In today's world, the technical, economic, social and political landscapes are changing fast and profoundly, and innovation in areas such as information technology, energy, biotechnology and life sciences are changing the agendas of both governments and business. In addition, demographic trends show a tremendous growth, primarily in the emerging economies which are expected to represent 85 % of the global population by 2050. The focus in these emerging economies will be on reducing poverty and improving the quality of life, so a substantial increase in consumption and emissions can be expected to burden a planet which is limited in its coping capacity.

An ageing population and urbanisation are adding to the picture and will introduce additional stresses: by 2050, the number of people aged 65 and over will globally rise from around 500 million to 1.6 billion, creating severe pressure on the societal infrastructure, and the degree of global urbanisation will rise from today's 50 % to 70 % by then. Designing and building adequate social infrastructures and urban environments will therefore be a crucial issue for a future resilient society. The leading economies and companies have realised early that these needs will result in a strong future demand for resource-efficient, low-polluting products and services.

A green race is on

As a consequence, a green race has started about who will be the leading suppliers of these products and services. To win this

race, countries need to transform their home market and build competence and scale in implementation that can underpin their exports to future global markets. For example, China has taken a determined effort in this sense, investing more than anybody else in transforming its economy and society. Their 13th Five-Year Plan, starting in 2016, has a clear focus on resource efficiency and pollution reduction.

The EU has been a global leader in green technology exports. However, in the view of the author, the overall transformation of the EU's internal market towards higher resource efficiency and lower pollution needs to be accelerated to avoid losing global market shares. The traditionally strong exporter Germany might be an exception, but has strategically entered into a major bilateral cooperation with China on the theme of innovation.

Business and resilience

Resilience is the ability to adapt to major changes in the surrounding world, and resilience of ecosystems, society and business are closely linked. Business cannot succeed in societies that fail, and the global society cannot be sustainable and resilient without flourishing business, offering jobs and providing solutions to society's needs. So for sustainable business, companies need to understand the resilience of societies on all levels, and CEOs have realised that a good knowledge of societies' resilience mechanisms is essential to address new markets, build company strategies and develop sustainable business models.



Transformational changes in society can appear rapidly and make business models obsolete quickly, as the German ‘Energiewende’ has painfully shown to the nuclear power plant operators.

WBCSD Vision 2050

In 2010, the World Business Council for Sustainable Development (WBCSD)¹⁰ presented its report ‘Vision 2050’¹¹, describing the future world with a vision formulated as “9 billion people living well within the limits of the planet”. Individual companies like DNV GL¹² or Unilever¹³ have formulated similar ideas in the meantime. Vision 2050 outlines a pathway with major transformational changes to all aspects of the global society required for a sustainable future world. Analysing how these changes could happen, WBCSD concluded that the markets on their own were too slow to drive these transformational changes and that supportive government regulations were needed to succeed. As a consequence, WBCSD published a further report in 2012 called *Changing Pace: Public policy options to scale and accelerate business action towards Vision 2050*¹⁴.

Partnerships

No part of society can create a sustainable world on its own. Instead, we need new partnerships between governments, busi-

ness, civil society and academia where each part is delivering on their specific responsibilities and roles:

- Governments must create the regulatory framework that can stimulate actions towards resilient societies;
- Business must innovate and implement actions for a resource-efficient, low-polluting world;
- Civil society has a crucial role to support the difficult trade-offs between conflicting priorities that governments and business will be facing in their actions to build a resilient future;
- Academia must educate leaders who can lead society toward a resilient world and stimulate science and innovation of new solutions;
- Bringing all of the stakeholders together requires a coordinated action. The EU, based on its global leadership in green technology exports, has a major opportunity to take the lead.

¹⁰ - World Business Council for Sustainable Development (WBCSD): <http://www.wbcd.org/home.aspx>

¹¹ - World Business Council for Sustainable Development (WBCSD), *Vision 2050: The new agenda for business*, Atar Roto Presse SA, Switzerland, 2010, http://www.wbcdpublications.org/cd_files/datas/vision_action/vision_2050/pdf/Vision2050-FullReport.pdf

¹² - DNV GL: <https://www.dnvgl.com/>

¹³ - Unilever: <http://www.unilever.com/>

¹⁴ - World Business Council for Sustainable Development (WBCSD), *Changing Pace: Public policy options to scale and accelerate business action towards Vision 2050*, 2012, http://www.wbcdpublications.org/cd_files/datas/vision_action/vision_2050/pdf/ChangingPace-FullReport.pdf

A climate perspective: cutting emissions and creating jobs

A. Wijkman
The Club of Rome

It is more than 40 years since the Club of Rome¹⁵ published its seminal study on the outlook for humanity, *The Limits to Growth*¹⁶. Its key message was that a combination of resource depletion and pollution, if un-tackled, would ultimately bring the global economy down.

Unfortunately, this remarkable book was quickly seen as a threat to vested interests and the message fell on hostile ears. But the warning was prescient and the Club of Rome has remained committed to the task of crafting solutions to humanity's systemic problems ever since.

At the centre of our current economic, social and environmental troubles lies a system of human development which – while seemingly productive in the short run (decades) – is essentially self-destructive in the long run. The need for continuous growth in material throughput – resources into the system, waste out of the system – promotes resource destruction, rising pollution, widening economic inequality and, because it is fixated on increasing labour productivity, structural unemployment.

Worse, this system is greatly unjust. Today's ecological overshoot stems mostly from meeting the demands of the wealthiest fifth of the population, who consume almost 80 % of the world's economic output. The poorest fifth survive on just 2 %. With billions in poverty – and billions more to come – how can anyone honestly believe we can continue business as usual?

Economics as a discipline is based on a warped version of 19th century thinking. To quote William Rees: "Its intellectual founders, motivated by the remarkable success of Newtonian physics, set out explicitly to model economics as the 'mechanics of utility and self-interest'. The discipline consequently lost sight of the social context and purpose of economies and became totally abstracted from biological reality."¹⁷

For many decades, the scale of human activity was small relative to 'the environment' and hence conventional economists could continue to ignore biophysical reality. But that is no longer possible. The combination of a rapidly changing climate, overstretched ecosystems and looming resource constraints should force even the most hard-nosed economists to reconsider their ideas. Yet most continue to describe our economies as a money flow with little or no reference to the world around us. This is like describing human physiology in terms of the circulatory system, ignoring the rest of the body.

We cannot address our social and ecological challenges unless we reform our economic thinking. We need to overhaul economics as an academic discipline and change the way nature is perceived. Our economies need to be seen as a sub-system of nature, not the other way around.

That will take time.

In the meantime, we have to reduce the damage we are doing to the planet

15 - The Club of Rome: <http://www.clubofrome.org/>

16 - Meadows D. H., Meadows D. L., Randers J., Behrens W. W. III, *The Limits to Growth*, New American Library, New York, 1972

17 - Rees, W., *Economics vs. the Economy*, 23 June 2015, Post Carbon Institute: <http://www.postcarbon.org/economics-vs-the-economy/>



and make our economic systems more resilient. The best way to achieve this is to cut our rate of industrial metabolism through decoupling.

Decoupling refers to the ability of an economy to grow without any corresponding increases in energy- and resource-use or environmental pressure. This is not a new concept, and there are many good examples of relative decoupling. But the gains made have often been eaten up by further economic growth and the so-called rebound effect. Examples of absolute decoupling are still rare.

This is where the circular economy comes in, where products are specifically designed for recycling, reuse, disassembly, and remanufacturing – rather than the ‘take, make and dispose’ model we have today.

The European Commission launched a flagship initiative *A resource-efficient Europe*¹⁸ in 2011. Strong signals were sent to the business community that a shift towards the circular economy should be an important priority in the coming years.

The Juncker Commission has suggested withdrawing this proposal in the pretext of ‘better regulation’, which would have shown little understanding of the social and ecological challenges that lie ahead. Fortunately, the Commission has promised

to relaunch the circular economy package before the end of 2015.

It is vitally important that president Juncker and his team fulfil this promise.

Recent studies by the Ellen MacArthur Foundation¹⁹, by McKinsey²⁰ and by the Club of Rome illustrate the enormous benefits of a circular economy.

The Club of Rome study, for example, proves convincingly that it not only reduces carbon emissions but creates new jobs at the same time. Instead of mining coal and drilling oil, people are employed in building and maintaining clean-energy systems. There is vast potential to create millions of new jobs repairing, maintaining and updating products, too.

The shift towards a circular economy will not happen by itself. It needs governments to lower taxes on labour, increase them on raw materials, and to stop subsidising conventional energy.

18 - A resource-efficient Europe – Flagship initiative of the Europe 2020 Strategy: <http://ec.europa.eu/resource-efficient-europe/>

19 - Ellen MacArthur Foundation: <http://www.ellenmacarthurfoundation.org/>

20 - McKinsey & Company: <http://www.mckinsey.com/>



2

The concept of resilience

The concept of resilience: a European perspective

S. Lechner

European Commission, Joint Research Centre

The term *resilience* is used in literature in many different ways, but generally describes the property of a system (a society, a network, or even an individual) to successfully cope with changes. Such changes may originate from sudden shocks or crises, or may arise in small incremental steps which accumulate over time and impose severe stress on the system. A resilient system will cope with both types of change – shock *and* stress.

Resilience is not equivalent to *sustainability*, which addresses the ability to cope with the predictable evolution of a system, and is currently often used to describe a system's capacity not to be dependent on the indefinite availability of natural resources.

Resilience also goes beyond robustness which, by design, means stability and solidity, but does not necessarily imply flexibility when exposed to unforeseen changes. A resilient system should be robust against small changes and sustainable over both time and the predicted evolution of society. However, it should also be able to adapt dynamically to major changes while continuing to function, albeit in a modified way. A resilient system should also have enough flexibility to cope with *black swan*²¹ events – unpredictable threats which are beyond our experience-based imagination.

The most *resilient* systems are not based on a single central control or on monoculture structures, as such approaches would create a single point of failure. A truly resilient system deploys a healthy combination of micro

and macro structures, enabling it to react and adapt dynamically.

While investigating the resilience of different systems (marine environments, the financial sector, the internet, the power grid and even terror networks)²², two additional mechanisms have been suggested as being important for resilience: the principle of *clustering* and willingness to embrace *collaboration*.

Clustering ensures short distances between entities, which enables them to support each other quickly in case of need. This means that in an emergency no time is lost by knocking on the doors of partners we are not familiar with, and that the structures which enable effective support are already in place.

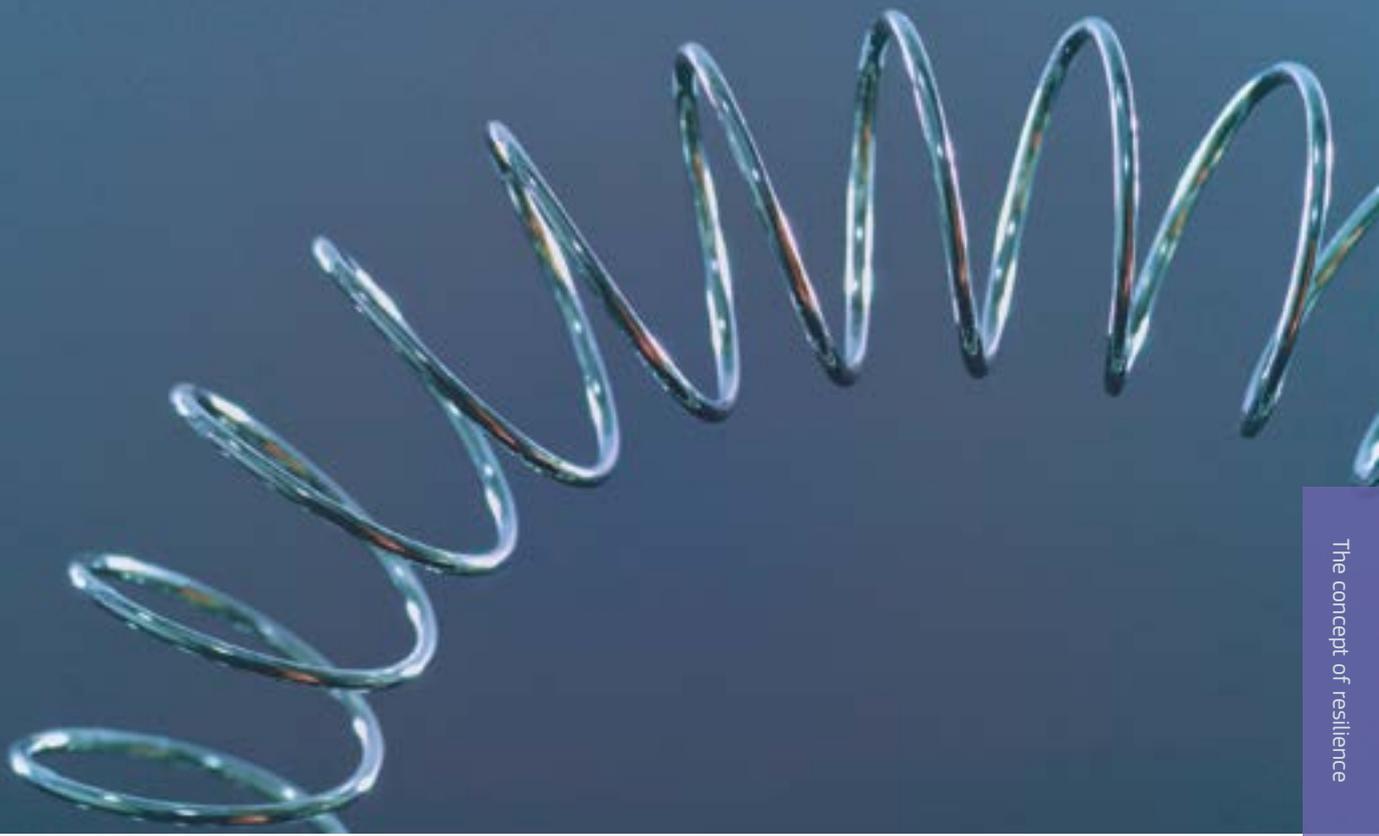
Collaboration is a more general concept, involving sharing good practices, learning from each other's actions and mistakes, and deploying diverse resources to address situations which require complementary capabilities, or even just a scaling-up of the response.

Interestingly, the European Union has structures which support several aspects of resilience:

- The EU's subsidiarity principle (as well as its motto 'united in diversity') are examples of a combination of centralised and national efforts, providing a unique basis for a balanced reaction to global shocks and stresses;
- In addition, the *cluster* principle is reflected well in the EU, where Member

21 - Nassim, Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable*, second edition, Penguin Books, 2010, ISBN 978-0-141-03459-1

22 - Zolli, A., Healy, A.M., *Resilience: Why Things Bounce Back*, Headline Publishing Group, London, 2012, eISBN: 978-0-7553-6035-2



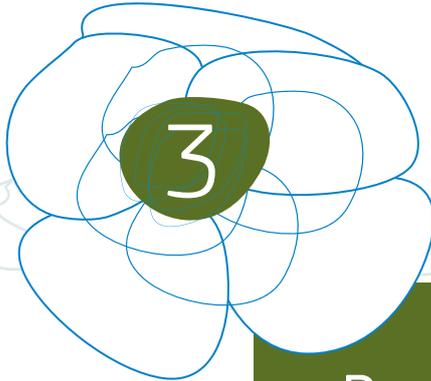
States are geographically close to each other. The short distances within Europe allow for regular contact, good neighbourhood relations within the Union, and for getting together quickly if so required. Also, the European Treaties have brought the EU Member States together under commonly agreed governance and, equally important, under shared values;

- *Collaboration* is also reflected well in the EU, which has been established as a solidarity union and maintains a government system within its three main institutions (European Commission, European Council and European Parliament), reflecting the needs and positions of all EU stakeholders.

Although these points are not sufficient to ensure the resilience of the EU, they do provide a strong (and globally unique) basis for an efficient and balanced reaction to global shocks and stresses. The continuing challenge is to develop these capabilities over time and to apply them efficiently and effectively when required. Throughout its 50-year history, the EU has shown many times that it can respond positively and resiliently to major challenges.

We have even seen this in recent years: for both the financial crisis of 2008-9 and the 'ash cloud' crisis of 2010 it was clear that an international response was required both for policy and for operation, and

although the detailed policies and actions had not been defined in advance, the EU institutions provided a natural framework in which they could be developed. Many other examples could also be cited, ranging from the solidarity mechanism for mutual civil protection assistance, to exchanging information on pandemics, and to negotiating a gas deal with Russia during the winter of 2014-15. It is clear that in this highly complex interconnected world, no single EU Member State could have achieved these results alone. That is the nature of resilience, which requires accepted mechanisms and a trusted team.



3

Resilience of supplies - the basic needs

Modelling the Energy Union: mission impossible?

M. Masera

European Commission, Joint Research Centre

The resilience of the European energy system presents many challenges that derive from its complexity. It was formed from the integration of existing national infrastructures and markets. Those national systems differ not only in their use of resources, but also in their management and regulation, in the formation of prices and in their practices regarding protection and security of supply. This diversity has been at the origin of the challenges concerning its integration. While national energy systems have been subjected to few major disruptions – exceptions being the 2003 blackout in Italy and the gas disruptions caused by the Russia-Ukraine disputes – it is clear to policy-makers and industry alike that the central role of energy in society requires a deep understanding of all the causes and consequences of potential disturbances to the security of supply.

In the light of this, the transition towards an Energy Union²³ demands a major assessment. On the one hand, the energy system has been exposed to dramatic changes in recent decades, including technological, regulatory and market transformations. On the other hand, the Energy Union has the ambition to further the EU's capability to ensure secure, affordable and climate-friendly energy across Europe.

Evolution of the European energy system has the following main characteristics:

i) Increasing interconnections among the national systems, resulting in more possibilities in terms of access to energy supplies while, at the same

time, creating an opportunity to spread problems across borders;

ii) The growing use of electricity generated from renewables – features of these intermittent sources include significant variability, poor predictability, and their non-dispatchable nature, producing an electricity system which is becoming less reliable;

iii) The unbundling of energy system operations, which originated in the liberalisation policies that requested the separation of functional activities in the previously vertically integrated industry; this multiplied the number of industrial actors, thereby discontinuing the former direct technical and market links between the various industrial stages;

iv) The escalating use of information and communication technologies at all stages of the energy industry, inside installations, across the value chain, and in the links with all stakeholders, including end-users. This massive introduction of ICT expanded the possibilities for operations and efficiency, but created opportunities for new cyber-threats.

On the one hand, the Energy Union will require a robust investment effort into new infrastructure to improve the free flow of energy across borders, mainly from renewable sources. This investment will have to be accompanied by new regulation of the retail market, with greater emphasis on citizens' capabilities, and a low-carbon economy; and innovation in new business processes and the insertion of new technologies (e.g. storage).

23 - Energy Union: http://ec.europa.eu/priorities/energy-union/index_en.htm



All these factors justify the initial statement above: the European energy system is already a complicated socio-economic and technical system, and is becoming more complex. Consequently, the resilience of the Energy Union is not responsive to simple answers and cannot be summarised in one judgement or one indicator. Modelling the Energy Union from the resilience standpoint requires taking into consideration the energy system's many layers and their interactions, including: the physical infrastructure required from the energy source to the end consumer; the cyber infrastructure; the regulatory and institutional aspects that define the procedures and rules governing the system; the retail and wholesale markets; the industrial actors and end-users (households, industry, commerce) and their behaviour; and the environmental context that defines factors such as the capacity of renewable sources (solar, wind, hydro) and emission limits.

In addition, the models will have to include the vulnerabilities of the different elements, the potential hazards and threats that can affect the system, and the ability of both the Member States and the energy industry to prevent adverse events, including the mitigation of their effects. Of these elements, the technical systems are the best understood, based on the operators' direct knowledge and the national regulators' follow-up. EU energy

markets have been the subject of different studies, but their evolving character limits what can be said today about their future resilience. However, their weak point remains the integration of the many components, as previously discussed.

In addition, from the experience gained in the study of critical energy infrastructure during the last decade by the Member States and industry, one can highlight the challenges regarding the sharing of information on vulnerabilities, hazards and threats. These constitute very sensitive pieces of information that touch national security.

Therefore, producing an overall model of the Energy Union that can help in identifying issues and potential solutions to its resilience is not a straightforward task. It will require advanced science in various fields, but also political resolution and the confluence of Member States and industry on this objective.

Towards a resilient food production system

N. Hubbard

European Commission, Joint Research Centre

Food security exists when "... all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life..."²⁴

The main issues for EU food security

Being the world's largest producer and exporter of food, the EU is self-sufficient in meat, dairy products and cereals. But it is also the second largest global importer of food, comprising mainly fish, vegetables, fruit and animal feedstuff. Ensuring supply-chain stability in the countries of origin, many of which are developing countries, is as essential as ensuring the EU's financial capacity to afford imported products at international market prices. Domestic agricultural production is sensitive to extreme weather events which are expected to become more frequent if the current trends in climate change continue. An additional critical weakness is the dependence on imported energy and agricultural inputs such as fertiliser.

The majority of households within the EU can afford sufficient and high-quality food. Nevertheless, approximately 50 million people (9 % of the population) in Europe face difficulties in obtaining enough high-quality food, a situation partly addressed by the rise in charitable services such as 'food banks'. Within this 9% figure, there are large disparities between countries, ranging from 40 % in parts of Eastern Europe to as low as 3 % in the Netherlands

and Sweden, generally reflecting inequalities in household income levels. Important issues in the EU food system include food safety and the rise in obesity, both often resulting from individual choices (lifestyle, sanitation, dietary habits) rather than from supply and provision.

Towards a resilient food production system

The EU food balance sheet is largely positive in most essential food products, with food *availability* being achieved through local production and imports. Food access refers to the physical and economic access to food, including the quality and efficiency of the food distribution system. Generally speaking, poorer people buy food of lower quality, and the nutritional content and safety of food has an impact on the body's effective use of it.

Availability, access and utilisation are three key pillars of food security, to which *stability* can be added. Stability means having adequate food at all times, while the resilience approach emerged as the appropriate framework to address the capacity of countries and households to cope at all times with shocks that affect the food system. Shocks and threats relate to weather variability, economic crises, climatic change and price volatility, security risks affecting the supply and distribution chain, and to food safety issues including crop/animal diseases and safety within the processing chain. European integration helps to diffuse the impact of most shocks by providing solidarity

²⁴ - UN Food and Agriculture Organization (FAO), *Rome Declaration on World Food Security and World Food Summit Plan of Action*, (Rome, 13 November 1996), UN Doc. WFS 96/3 (1996), para. 1, <http://www.fao.org/docrep/003/w3613e/w3613e00.htm>



mechanisms if one or more Member States should be affected by a crisis.

Across the 28 EU Member States, the common agricultural policy²⁵ (CAP) enables shortfalls in production in one area to be balanced by excess production elsewhere. By operating across a large geographical area, the related risks (particularly weather-related ones) can be more evenly spread. The policy is increasingly market-oriented, enabling market forces to respond to actual supply and demand. Monthly production forecasts, successfully developed by the JRC over 20 years, enable timely information to be fed into the management of stocks and included in the market outlook. Building resilience for food security is about providing countries and households with the means to develop three capacities: the capacity to absorb a shock, the capacity to adapt to a change induced by a shock and, ultimately, the capacity to transform the system to better resist shocks in the future.

Future challenges

The answer to achieving greater resilience in our food supply is dependent upon the global situation of producers, prices and trade. The extension of crop forecasting to the global scale allows for greater transparency as regards what is happening, leading to fewer market

shocks (sudden price fluctuations), and a reduction in the damage that can be caused by market speculation.

The EU is the largest donor of support to sustainable agriculture and food security in those developing countries that are prone to recurrent shocks. The resilience approach provides the framework to tackle food insecurity with long-lasting solutions aiming to alleviate poverty and ensure economic growth in the least-developed countries. Other benefits include creating a favourable environment for trade and the reaffirmation of the EU's commitment to human rights and solidarity. The resilience approach to development is nascent, seeking to guide the programming, monitoring and evaluation of interventions and policies. The JRC is contributing to two respective EU initiatives: 'Supporting the Horn of Africa's Resilience' (SHARE)²⁶ and 'Global Alliance for Resilience (AGIR) – Sahel and West Africa'²⁷.

25 - CAP: <http://ec.europa.eu/agriculture/cap-post-2013/>

26 - Supporting the Horn of Africa's Resilience (SHARE): http://ec.europa.eu/echo/what/humanitarian-aid/resilience/horn-of-africa-share_en

27 - Global Alliance for Resilience (AGIR) – Sahel and West Africa: <http://www.oecd.org/site/rpca/agir/>

Water resilience: addressing water pressures and disruptions and the drivers behind them

G. Bidoglio

European Commission, Joint Research Centre

Water is essential to life, and one of the first concerns in any form of organised society has always been to secure a reliable supply of clean water. In recent decades, however, there has been an increasing realisation that human activities significantly modify the water cycle at different levels from local to global. A recent global risk-perception survey has ranked water crises as the top driver of societal risk in terms of their far-reaching economic and environmental consequences²⁸.

Water resilience is about maintaining water resources in a condition enabling societal development in the face of the severe disturbances induced by humans. Such disruptions in water supply may be caused by changes in the capacity of the land to feed precipitation through plant transpiration, soil sealing, deforestation or excessive water abstraction causing the collapse of aquatic ecosystems²⁹. In the past, such changes occurred extensively and we are now in urgent need of preserving the remaining functioning systems, and rehabilitating those that have been degraded.

In order to build water-resilient societies, water-resource management must address not only the pressures on water, but also their drivers, beginning with the global economy itself. The global production of commodities needs to comply with the principles of sustainable and efficient water use, ensuring that water demand from the different economic sectors meets water availability. If we keep allowing parts of the

world to disrupt the water cycle, this will eventually affect Europe through the global climatic impact of change, and the resulting socio-economic instability that may arise in several regions. Individual European countries do not have the capacity to influence global markets, but the EU has already demonstrated that common policies may have a strong global outreach (as in the case of chemical regulation, whereby importing substances to Europe requires the global industry to undertake sound environmental compatibility testing).

Another aspect of water resilience that requires supra-national governance is the fact that, from the local perspective of a region or river basin, it is always possible to some extent to offset impacts on water resources through 'piracy' on water resources in a bordering region. One revealing example is the North American West³⁰, where economic development has put entire water systems at risk of collapse. Until now, water has been assured in that region at the cost of depleting resources needed by users downstream, which will not be possible over long periods in the future. Similar examples can be found all over the world. Only internationally agreed, transboundary water governance ensures protection from this ever-emerging risk.

River basins in Europe are, for the most part, transboundary. Just like energy, carbon and steel in the aftermath of World War II, joint governance of water management is an essential prerequisite

28 - World Economic Forum. 2015. Global Risks 2015, 10th Edition. Geneva: World Economic Forum; <http://www.weforum.org/reports/global-risks-report-2015>

29 - Rockström, J., Falkenmark, M., Folke, C., Lannerstad, M., Barron, J., Enfors, E., Gordon, L., Heinke, J., Hoff, H., Pahl-Wostl, C., Water Resilience for Human Prosperity, Cambridge University Press, Cambridge, May 2014

30 - Reisner, M., Cadillac Desert: The American West and Its Disappearing Water, Revised Edition, Penguin Books, June 1993



for development to avoid controversies that may turn out to be highly divisive if not addressed at a continental rather than national scale.

European legislation on water is highly advanced and integrated. The Water Framework Directive (WFD)³¹ and related directives provide for the key principles of water governance at the catchment scale. These include the obligation for Member States to preserve the status of all water bodies in good ecological condition so that they may contribute a sufficient supply of good-quality water as required for sustainable, balanced and equitable water use. With all EU Member States committed to achieving the objectives of the WFD, countries are addressing domestic water supply issues while preserving resources equitably for downstream regions.

While the WFD's aims are clearly set out, its practical implementation requires consideration of a broad array of scientific, technical, economic and governance aspects, and calls for an in-depth understanding of the socio-ecological systems defining European river basins. This requires extensive research that attains to both the advancement of individual scientific disciplines (e.g. better characterisation of what is 'good ecological status'), and to the capacity to deliver cost-effective solutions (e.g. use

of natural processes to regulate water quantity and quality). Working together on comparable methods of water resource assessment and solutions appraisal is a significant value added from the EU dimension in terms of efficiency.

In future, water will increasingly demonstrate its nature of limiting factor on all human activities. Therefore, management of water will become more and more interlinked with that of land, energy, food and ecosystems, and consequently water resilience will become a fundamental challenge to be addressed through cross-cutting approaches at EU level.

31 - Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, *Official Journal L 327*, 22/12/2000 P. 0001 - 0073: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060>



4

European resilience in action

Civil protection: better together – within Europe and globally

F. Fink-Hooijer

European Commission, DG Humanitarian Aid and Civil Protection

In recent years, the world has been hit by a series of mega-disasters: from a destructive typhoon in the Philippines, to severe flooding in the Western Balkans, the Ebola epidemic or the recent Nepal quake.

Multi-hazard disasters, such as the triple disaster (earthquake, tsunami and nuclear incident) that hit Japan a few years ago, can have long-lasting, devastating effects on the people, their livelihood, the environment and economic resilience.

Climate change, population growth, urbanisation and industrial development mean that disasters strike more often and cause more harm to people and economies. As the world is increasingly connected, and our economies interdependent, disasters can have damaging cross-border effects. At the same time, the economic crisis squeezes resources available for disaster management. By all accounts, these trends are likely to continue and the EU is not spared. The average economic cost of disasters in Europe is approximately EUR 10 billion/year.

In the face of such challenges, cooperation in civil protection is more important than ever. Since 2001, the EU, together with the Member States, has been developing the Union Civil Protection Mechanism (UCPM)³², which provides a comprehensive framework for EU civil protection cooperation in disaster prevention, preparedness and response.

The operational heart of the UCPM is the Emergency Response Coordination Centre (ERCC)³³, which is available on a 24/7 basis

and is primarily responsible for the EU's civilian disaster response coordination both inside and outside the European Union. As part of the UCPM, the EU has also developed a network of 24/7 contact points in all Member States, a common information exchange system, has organised the Member States' assistance into interoperable and flexible emergency intervention modules, and provides for trainings and exercises.

EU cooperation makes sense and a real difference. First, vital assets and expertise can be deployed, providing the most effective response possible. Second, the EU is in a position to efficiently coordinate the deployment of different types of resources. Well-intentioned, but uncoordinated assistance may be ineffective or get in the way of response efforts. Third, joint efforts can be more cost-effective. Finally, for disasters in third countries, the better the EU organises itself internally, the easier it can integrate into an overall relief effort coordinated by the United Nations.

The need for cooperation in disaster response has been further emphasised with the introduction of the EU Treaty-based Solidarity Clause³⁴, which sets out an option for the Union and its Member States to provide assistance to another Member State which is the victim of a terrorist attack or a natural or man-made disaster. Response is only one part of disaster management. An important effort within our civil protection work is to contribute to building resilient societies. In this respect, we are taking a leading role by

32 - EU Civil Protection Mechanism (UCPM): http://ec.europa.eu/echo/what/civil-protection/mechanism_en

33 - The Emergency Response Coordination Centre: http://ec.europa.eu/echo/what/civil-protection/emergency-response-coordination-centre-ercc_en

34 - Joint Proposal for a Council Decision on the arrangements for the implementation by the Union of the Solidarity clause / * JOIN/2012/039 final - 2012/0370 (NLE) */: <http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52012JC0039>



contributing to a comprehensive disaster management strategy through different initiatives on prevention, preparedness and response, all aiming to enhance the Union's resilience. The prevention and preparedness efforts have in particular been put in the spotlight with the new UCPM legislation, in effect since 2014.

The new legislation makes preparedness and prevention mandatory. By the end of 2015, all Member States will have to carry out risk assessments so as to know the threats to citizens and economies. Member States will also need to assess how well equipped they are to deal with these threats. This will in turn allow any gaps in the collective European response to be identified. In cases of temporary shortcomings to deal with extraordinary disasters, the EU can co-finance the standby of necessary assets. In case of structural gaps, the EU can provide financial support to fill these gaps. In addition, to further increase our response, a voluntary pool of preidentified Member States' assets has been set up. It is available for immediate deployment. In the EU's quest to build a more resilient society, cooperation is the only way forward.

No country is rich or fit enough to deal with this new reality on its own. Therefore, the EU also cooperates with candidate

countries and potential candidates, other neighbouring countries, and major partners such as China and the United States.

Cooperation with all levels of the government and with partners such as the scientific community is another important element. The challenge is to find effective ways of linking up all the players that have a responsibility for disaster management and to foster an exchange of knowledge and best practice at all levels, from local communities, to scientists and researchers to international organisations.

Strengthening resilience is and will continue to be at the heart of the EU's disaster risk management policy. Through cooperation, the EU has built the foundations that allow us to successfully address the increasing fragility of our world.

Nuclear safety: joint European reaction to the Fukushima accident

S. Abousahl

European Commission, Joint Research Centre

Fukushima illustrated that the probability of severe nuclear accidents should not be seen as negligible. Until 2011, the enhanced safety records of modern nuclear power plants tended to show that events that would lead to a major detrimental impact on the environment were somewhat hypothetical. The major accident at Three Mile Island in the United States in the late 1970s had only marginal consequences outside the plant in the end. And although lessons were also learnt from Chernobyl, this accident occurred in an installation which, to a certain extent, was considered 'out of the scope' – its intrinsic design and operation mode dating back to the Soviet era were considered as much less safe.

Very soon after the Fukushima accident, the European Council called for a comprehensive review of the safety of EU nuclear power plants. 'Stress tests' were conducted under the auspices of the European Nuclear Safety Regulators Group (ENSREG)³⁵ and the European Commission. They were aimed primarily at investigating the resistance of the installations to all types of external hazards, of natural or man-made origin, and to undertake an in-depth assessment of the consequences of a possible incident. In the course of these stress tests, several areas were identified for improvement in all EU installations. National nuclear regulatory authorities have drawn up action plans on this basis, which have been peer-reviewed by experts from EU countries and the European Commission.

The European Council further amended the Nuclear Safety Directive³⁶ to strengthen

safety standards and improve supervision of nuclear facilities. For the first time the prevention of significant radioactive releases is set as a clear nuclear safety objective. The new legislation also introduces a system of European peer reviews. The effectiveness of the combined way in which the stress tests were conducted showed European resilience, and several countries outside the EU either participated in, or took inspiration from, the European approach.

But Fukushima and the stress tests also demonstrated that there is still much work to be done to better prepare us for a nuclear emergency. In the case of a major accident, a release of radioactivity can have geographically widespread consequences. And experience shows that, even when long-distance contamination is measured at levels far below the threshold to have an effect on health, authorities must still be prepared to address public concern. Being jointly prepared for nuclear emergencies is a key issue for the EU. With relatively small countries situated close together, dense populations and high concentrations of nuclear installations in some areas, any accident causing a significant radioactive release is likely to impact on adjacent countries within a short period.

The revised Council Directive laying down basic safety standards for protection against the dangers of exposure to ionising radiation was adopted at the end of 2013³⁷ and includes several requirements aiming to better coordinate and communicate radiation monitoring, prevention and

35 - European Nuclear Safety Regulators Group (ENSREG): <http://www.ensreg.eu/>

36 - Council Directive 2014/87/EURATOM of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0087&from=EN>

37 - Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2014:013:FULL&from=EN>



post-accident actions. The Directive has to be implemented by the Member States by February 2018. As a consequence, EU Member States are assessing the practical ways of harmonising and integrating the coordination of nuclear emergency response arrangements.

For many years, the JRC has provided both operational and scientific support to nuclear emergency preparedness and response in Europe, and can thus play an active role in current developments. JRC expertise and tools range from the EU's system for early notification of a nuclear accident or event (ECURIE)³⁸, the assessment of reactor accidents, the potential damages and releases, and the real-time collection of environmental radiation levels at a European scale (EURDEP)³⁹, to the harmonisation of measurement methods and information exchange for radiological monitoring of the environment and food chain.

The JRC has rapidly addressed some new specific R&D needs, which were triggered by the accident and the actual situation in Fukushima, including a better understanding of the behaviour of both the reactors and the releases, and the characterisation of damaged components to facilitate a safe recovery.

Four years after Fukushima, Japan is recovering step by step from the major

nuclear accident that has affected the country. Of all the issues to be addressed, confidence among the Japanese population in the measures taken is probably the most delicate endeavour. In the case of any major crisis within Europe, a coordinated EU approach will not only make the response and subsequent recovery more effective, but it will also improve public understanding in the actions undertaken.

38 - European Community Urgent Radiological Information Exchange (ECURIE): <http://rem.jrc.ec.europa.eu/RemWeb/activities/Ecurie.aspx>

39 - European Radiological Data Exchange Platform (EURDEP): <https://eurdep.jrc.ec.europa.eu/Basic/Pages/Public/Home/Default.aspx>

Financial solidarity

K. Regling

European Stability Mechanism

Macroeconomic and financial resilience is a public good that requires collective action in a monetary union. It relies on the ability to weather shocks, minimise losses and, in a more dynamic manner, to guide the economy towards recovery and growth. The great European recession revealed economic and financial vulnerabilities and institutional weaknesses in the monetary union's design. European leaders reacted promptly, reviewed the crisis management strategy and devised remedial solutions, such as strengthening the rules on deficit and debt, and addressing weaknesses of the financial sector through the Banking sector through the Banking Union⁴⁰.

European policy-makers rapidly established the European Financial Stability Facility (EFSF)⁴¹ to provide financial support to Member States that lost market access, and later on the European Stability Mechanism (ESM)⁴² as the euro-area's permanent crisis-resolution mechanism. The ESM has been in operation since 8 October 2012. It has a maximum lending capacity of EUR 500 billion, more than EUR 450 billion of which is still available.

The ESM's mission is to provide financial assistance to ESM members experiencing or threatened by severe financing problems to safeguard the financial stability of the euro area as a whole and of its members. By the end of 2014, in less than four years, EUR 233 billion had been disbursed by the two institutions to five countries. This is three times as much as the International Monetary Fund (IMF)⁴³ disbursed globally in the same period. The ESM raises funds

by issuing debt instruments, which are purchased by investors all over the world. The proceeds enable the ESM to provide loans or credit lines to countries when they face uncertain market access or cannot finance at affordable prices. The ESM can also help to break the link between financial problems in the banking sector and the government. It can extend loans to the government to rescue banks, or in very extreme cases, also invest itself in banks.

There are four important results of the EFSF's and ESM's activities:

First, several countries would have left the euro area without the financial support from the EFSF and ESM, and Europe would be in a different situation today. During the crisis, investors had lost confidence in some peripheral euro-area economies and European financial support allowed these countries to finance the budget, and to protect their banking system and operate within the common monetary system.

Second, EFSF and ESM programmes have helped countries to become reform champions. ESM financial assistance is linked to beneficiary Member States addressing weaknesses in their economies through reforms which are jointly agreed by that Member, the European Commission, in liaison with the European Central Bank⁴⁴ and, where applicable, the International Monetary Fund. These reforms may be painful in the short-run, but they are indispensable to regain competitiveness and overcome macroeconomic fiscal imbalances which built up over time, and

40 - Banking Union: http://ec.europa.eu/finance/general-policy/banking-union/index_en.htm

41 - European Financial Stability Facility (EFSF): <http://www.efsf.europa.eu/about/index.htm>

42 - European Stability Mechanism (ESM): <http://www.esm.europa.eu/>

43 - International Monetary Fund (IMF): <http://www.imf.org/external/index.htm>

44 - European Central Bank (ECB): <https://www.ecb.europa.eu/home/html/index.en.html>



to strengthen the economy's growth potential. According to international institutions, the EFSF/ESM programme countries are among the top reformers in the EU and even among industrialised OECD countries overall⁴⁵. Therefore, they are best positioned for economic growth if they continue their reform paths.

Third, the ESM and EFSF assistance not only provides emergency financing against conditionality, but also includes substantial solidarity. Both institutions provide loans at very favourable conditions which create fiscal space in beneficiary countries and improve a country's ability to repay its debt. The maturities of our loans became very long, stretching from an average of 12.5 years for Spain to more than 32 years for Greece. Moreover, the interest rate charged is very low, currently amounting to an average of 1.5 %. For Greece, payment obligations to European creditors over the years until 2023 have become minimal. Based on results for 2013, EFSF lending produces annual budget savings of EUR 8.5 billion per year, or the equivalent of 4.5 % of Greek GDP year after year.

The EFSF and ESM are part of the multi-pronged crisis response, which more broadly reduces the risk of future crises. The strengthening of fiscal and economic governance aims

to strengthen coordination of fiscal policies, tightens monitoring of national budgets and increases the possibilities of the European Commission to enforce its views. The financial system, and in particular the banking sectors, have been made more secure; supervision has been strengthened through new European institutions, and investors have participated in the burden-sharing when problems emerged. This sets the right incentives for more responsible behaviour and avoids as much as possible bank rescues with taxpayers' money.

The cumulative effect of the ESM as an effective future firewall and of these reforms has substantially improved the resilience of the euro area.

45 - Organisation for Economic Co-operation and Development (OECD): <http://www.oecd.org/>

The Banking Union: calculating systemic risk across Europe

F. Campolongo

European Commission, Joint Research Centre

During the turmoil that has characterised the world's financial markets over the past few years, the EU's financial system encountered a breakdown in trust and functionality that spilled over into the economy at large, undermining economic development, growth and prosperity.

In reaction to the crisis, European financial regulators have been working together across national borders to secure a resilient financial system. It needs the ability to bounce back or recover quickly from the effects of systemic shocks so that the consequences of widespread failures and the spillover effects are felt less intensely by those affected, whether they are financial institutions that have become insolvent, non-financial businesses enduring a freeze in the supply of bank credit, or households with value stored in failed financial institutions. The need for ensuring a resilient financial system is especially prominent in the EU, where the banking sector is huge. The sector's total assets amount to roughly 349 % of the EU's GDP, in contrast to 78 % of GDP in the USA and 174 % of GDP in Japan. Hence, there is an even more pressing need to ensure a financial system able to withstand possible future shocks of the magnitude of the 2008 banking crisis.

Many of the very substantial regulatory changes in response to the financial crisis have aimed at making banks more stable and resilient and, subsequently, the banking system safer and better able to contribute to sustainable growth. All of these changes were commonly agreed on the basis of

treaties signed by the members of the EU. The amount and quality of capital and liquid assets that banks must hold has been substantially increased. The protection for depositors has been enhanced. The intra-bank interconnections have also been simplified with significantly more central clearing of derivatives. Standards across all EU trading venues and transparency requirements have been strengthened.

Moreover, a major step towards a resilient banking system has been undertaken by countries in the euro zone (and any other EU countries that choose to join) to establish a Banking Union in the euro zone, with a Single Supervisory Mechanism (SSM)⁴⁶ and a Single Resolution Mechanism (SRM)⁴⁷. The Banking Union significantly enhances the supervision of banks, both at a micro and macro level, in the euro area and other participating Member States, and helps to remove the strong link between banks and national governments that weakened banks and sovereign debt in some Member States during the crisis. This framework guarantees stronger, safer banks, and brings an end to the 'too-big-to-fail' paradigm, ensuring that the banking sector is in a good position to fulfil its role in funding the real economy, as well as contributing to deep and liquid capital markets, which are key for economic growth.

The Banking Union is an obvious example of European added value: acting autonomously, Member States would not be able to achieve the same goal. The rising globalisation of financial services

46 - Single Supervisory Mechanism (SSM): http://ec.europa.eu/finance/general-policy/banking-union/single-supervisory-mechanism/index_en.htm

47 - Single Resolution Mechanism (SRM): http://ec.europa.eu/finance/general-policy/banking-union/single-resolution-mechanism/index_en.htm



has strengthened the interconnection between financial institutions, with positive effects on the efficiency of the global financial system but also increasing the risks of cross-market and cross-country disruptions, highlighting the need to act at central level to ensure a financial system that is entirely resilient. The Banking Union promotes financial integration, thereby reducing systemic risk and the likelihood of a new crisis. It also guarantees a mega insurance plan that covers banks and countries against the materialisation of systemic risks, thus reducing the magnitude of any crisis that might occur.

The Banking Union is an important achievement, and regulators and scientists are continuing to work to strengthening its effectiveness by uncovering and reducing systemic risk. Given the complexity of the banking system's structure, the identification and quantification of systemic risk remains very challenging. The scientific community has largely contributed to and is continuing to support regulators in better identifying and measuring such risk, understanding its drivers, and putting in place regulation to reduce and mitigate it.

While the immediate crisis has passed, building lasting confidence in the global economy means addressing the causes

of the crisis and making the system more resilient against future shocks. Through the Banking Union, European regulators took an important step towards a safer, more resilient global financial system, ensuring that if a new crisis were to arise, Europe would be better prepared to respond, while common efforts are continuing to further improve EU resilience.

The EU Stability and Growth Pact: a multidimensional modelling challenge

M. Ratto

European Commission, Joint Research Centre

In macroeconomics, resilience refers to the capacity of a society to minimise welfare losses following adverse shocks such as worldwide oil price rises or turbulence on global currency markets. High resilience implies economic stability, which is most desirable since stability encourages economic growth, prosperity, and employment. Economic stability is one of the main objectives enshrined in the management of the Economic and Monetary Union (EMU)⁴⁸.

One important variable that influences the degree of resilience of EU economies is the level of public debt. EU Member States with higher debt levels were less resilient to the 2008-2009 financial crisis⁴⁹ as high debt levels reduce the room to implement discretionary fiscal policies and increase uncertainty about the direction of future policies, thus preventing smoother adjustments. Conversely, countries with lower debt levels benefit from better access to financial markets and have more room for short-term stabilisation policies to smooth the impact of shocks. Thus, fiscal prudence in good times is an important factor in economic resilience. Moreover, as the recent crisis has demonstrated, spillover effects between individual countries and the rest of the Union also imply that resilience needs to be addressed in a coordinated manner at EU level. Economic decisions related to individual Member States need to be evaluated taking into account the interplay with all the other countries. In addition, the commitment of each individual state matters a lot for the proper functioning of the EU as a whole.

According to the rules set out in the Stability and Growth Pact, EU Member States must keep their government deficit and total government debt within specified limits, namely 3 % and 60 % of GDP, to ensure sound and sustainable public finances. Economic and fiscal governance in the EU and the euro area has been fundamentally strengthened with the 'six-pack', the 'two-pack' and the Treaty on Stability, Coordination and Governance (TSCG)⁵⁰. This strengthened framework aims to detect, prevent and correct problematic economic trends, such as excessive government deficits or public debt levels, which can stunt growth and put economies or the whole EU at risk, if not corrected. According to the strengthened Stability and Growth Pact⁵¹, Member States' budgetary balance will converge towards the country-specific medium-term objective. This medium-term objective takes into account the economic cycle and excludes the impact of one-off measures. The underlying logic is that Member States should achieve and maintain a budgetary position that will allow automatic stabilisers to play their full role in mitigating possible economic shocks.

An essential ingredient for monitoring and enforcing convergence towards the medium-term objective is the estimation of potential output (or GDP) and the output gap. Potential output growth constitutes a summary indicator of the economy's fundamentals whilst the output gap is the difference between actual and potential output and provides an indication of the degree of overheating or

48 - Economic and Monetary Union: http://ec.europa.eu/economy_finance/euro/emu/index_en.htm

49 - Canova, F., Coutinho, L., Kontolemis, Z., 'Measuring the macroeconomic resilience of industrial sectors in the EU and assessing the role of product market regulations', *European Economy, Occasional Papers no. 112*, European Commission, 2012

50 - Treaty on Stability, Coordination and Governance (TSCG): <http://www.consilium.europa.eu/european-council/pdf/Treaty-on-Stability-Coordination-and-Governance-TSCG/>. See also EU economic governance: http://ec.europa.eu/economy_finance/economic_governance/index_en.htm

51 - Stability and Growth Pact: http://ec.europa.eu/economy_finance/economic_governance/sgp/index_en.htm



slack relative to this growth potential. Measuring potential growth provides a fundamental element of flexibility in the Stability and Growth Pact, by accounting for temporary or cyclical adverse shocks hitting economies. This coordinated framework at EU level contributes to developing resilience: commitment about fiscal discipline is addressed by balancing central agreement and local flexibility.

Potential output cannot be directly observed and needs to be estimated by statistical/econometric methods. This sensitive and possibly controversial element requires a robust and sound methodological framework. The European Commission monitors convergence towards the medium-term objective by applying a methodology that is commonly agreed between the Member States⁵². The JRC is contributing to this fiscal surveillance exercise with the development and continuous upgrade of Program GAP⁵³, the 'official' software platform used by policy-makers and Member States to estimate potential output and the output gap. This commonly agreed methodology is another indicator of resilience: if each EU Member State calculated potential growth in a different way, economic governance would be much less efficient and more prone to discretionary fiscal policy decisions.

In addition, this demonstrates how enforcing and monitoring general commitments within the framework of economic resilience also requires a sound and robust methodological and scientific contribution. It is clear, too, that the 'European hat' plays a key role in ensuring equal treatment and consensus regarding the implementation of the common rules.

The Stability and Growth Pact and its recently reformed framework have proven effective in coordinating EU Member States' efforts to consolidate public finances in difficult economic conditions. Recent experience suggests that the reformed EU fiscal rules have indeed played a role in achieving progress as regards fiscal consolidation. In the EU-28, the average fiscal deficit has been falling and many countries have exited the Excessive Deficit Procedure⁵⁴. Moreover, macroeconomic imbalances are being corrected. The commitment to sound and sustainable public finances is a commitment to ensuring economic growth and employment in the longer term, and to developing the resilience of the European economy as a whole.

52 - Havik, K., Mc Morrow, K., Orlandi, F., Planas, C., Raciborski, R., Röger, W., Rossi, A., Thum-Thyssen, A., Vandermeulen, V., 'The Production Function Methodology for Calculating Potential Growth Rates & Output Gaps', European Economy, Economic Papers no. 535, European Commission, 2014

53 - GAP: <https://ec.europa.eu/jrc/en/research-topic/monitoring-fiscal-imbalances>

54 - Excessive Deficit Procedure: <http://ec.europa.eu/eurostat/web/government-finance-statistics/excessive-deficit-procedure>

Health and pandemics: efficient EU responses by sharing knowledge

C. Nicholl

European Commission, Joint Research Centre

Epidemic and pandemic outbreaks of communicable diseases test the resilience of health systems as well as health threat risk assessment, preparedness and response structures worldwide. Examples such as the Ebola virus disease in West Africa in 2014, the Middle East respiratory syndrome coronavirus in 2012, the E.coli outbreak in 2011, the H1N1 influenza pandemic in 2009, the H5N1 avian influenza pandemic in 2004 and the outbreak of severe acute respiratory syndrome (SARS) in 2003 have all illustrated how quickly diseases can spread across borders, due in part to the global transport of people and goods. These outbreaks put an additional strain on health systems that already need to deal with a rise in chronic diseases and ageing populations and the subsequent increase in healthcare costs.

In the EU, the main responsibility for health policy and the provision of healthcare to European citizens lies with the Member States. The European Commission plays an important role in areas where the Member States cannot effectively act alone and where cooperative action (EU added value) at community level is indispensable^{55, 56, 57}. Stronger cooperation on health technology assessment within the respective EU network established under Directive 2011/24⁵⁸, further development of information flows in the Member States' health systems, the establishment of an integrated EU health information system, and stronger cooperation between EU Member States on eHealth (facilitated by the European eHealth network and the 2012-2020 eHealth action plan⁵⁹) are needed.

Furthermore, as regards health emergencies, the European Commission's Decision⁶⁰ of 2013 on serious cross-border threats to health strengthens the EU's planning capacity preparedness, improves risk assessment and management of cross-border health threats, allows for the development and implementation of a joint procurement of medical countermeasures and enhances the coordination of response at EU level. Risk assessment is carried out by specialised EU agencies: the European Centre for Disease Prevention and Control⁶¹ (founded in 2004 in the aftermath of the SARS outbreak) identifies, assesses and communicates current and emerging threats to human health posed by communicable diseases, and the European Food Safety Authority⁶² (founded in 2002) provides scientific advice and communication on risks associated with the food chain, ensuring a high level of consumer protection and maintaining confidence in food and feed safety. Alert systems have been established to facilitate cooperation and coordination between the EU Member States, the EU agencies and the European Commission.

The 2014 outbreak of the Ebola virus disease in the West-African region is an example of an epidemic that put enormous stress on the health systems in the countries most badly affected (Guinea, Liberia and Sierra Leone), claimed many lives, and had a negative impact on economies, the provision of food and development within the region.

The threat of a global health crisis triggered international actions which

-
- 55 - 'Building resilient and innovative health systems', EURO-HEALTH, Vol. 19, No. 3, 2013, European Observatory on Health Systems and Policies, Brussels, Belgium: http://www.euro.who.int/__data/assets/pdf_file/0006/216843/Euro-health_v19-n3.pdf
 - 56 - 'White Paper - Together for Health: A Strategic Approach for the EU 2008-2013, COM(2007) 630 final: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52007DC0630>
 - 57 - 'COM(2014) 215 final, on 'effective, accessible and resilient health systems': <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2014:0215:FIN>
 - 58 - 'Directive 2011/24/EU of the European Parliament and of the Council of 9 March 2011 on the application of patients' rights in cross-border healthcare, OJ L 88/45, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:088:0045:0065:en:PDF>
 - 59 - 'eHealth Action Plan 2012-2020 - innovative healthcare for the 21st century, COM(2012) 736 final: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0736:FIN:EN:PDF>
 - 60 - Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health, and repealing Decision No 2119/98/EC, OJ L 293/1: http://ec.europa.eu/health/preparedness_response/docs/decision_serious_crossborder_threats_22102013_en.pdf
 - 61 - European Centre for Disease Prevention and Control (ECDC): <http://ecdc.europa.eu/en/Pages/home.aspx>
 - 62 - European Food Safety Authority (EFSA): <http://www.efsa.europa.eu/>



were eventually able to contain the disease. The EU set up a dedicated task force which contributed to the containment of Ebola via the coordination of Member States' efforts. Web-based media monitoring tools were used for surveillance during the crisis⁶³. The world's major health organisations are still evaluating the lessons to be learned and how to cope with similar outbreaks in the future. Important key elements have been identified, such as an adequate number of trained health workers, the availability of medicines, robust health information systems including surveillance, appropriate infrastructure, global investment in research and development for medical products, sufficient public financing and a strong public sector to deliver equitable services of high quality.

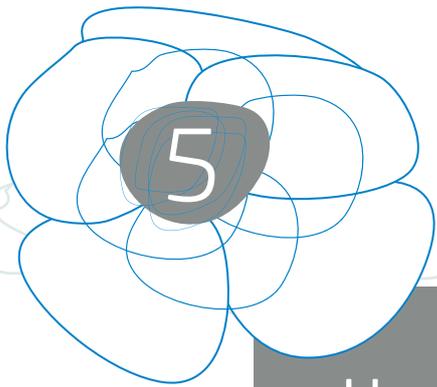
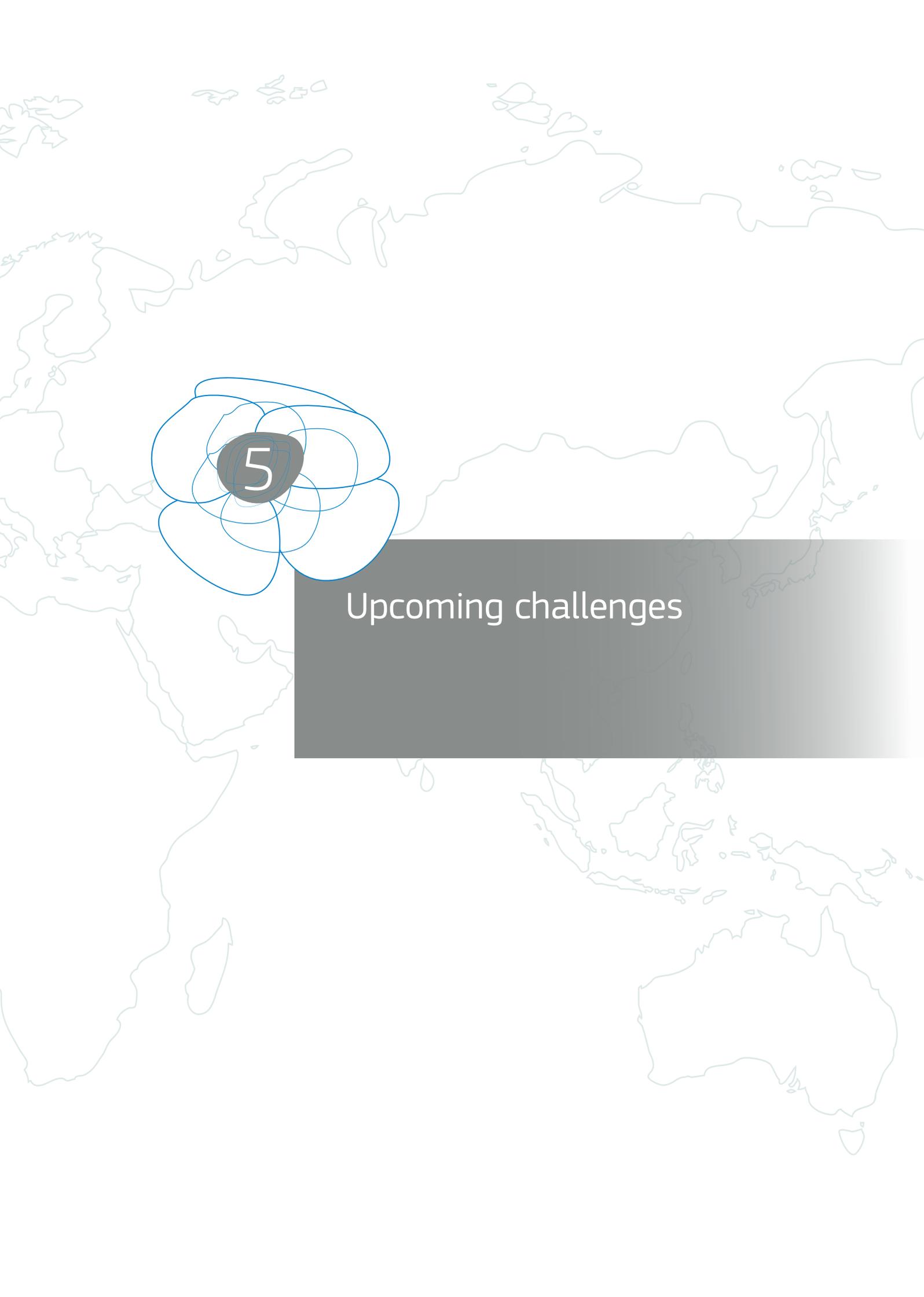
In addition to the health shocks related to communicable diseases, long-term stresses, such as rising obesity rates in both developed and emerging countries, have taken on a huge dimension. Over 1.5 billion people worldwide are overweight or obese while more than 40 million children under the age of five are overweight.

The health and economic burdens (US\$ 2 trillion annually worldwide or 2.8 % of global GDP⁶⁶) are testing the resilience of our health systems. In Europe, in

2010, one in three 6-9-year-olds were overweight and/or obese, marking an increase of more than 30 % compared to 2008. The European level also adds resilience and value to countering these long-term trends.

The European Commission has established a coherent and comprehensive community strategy to address the issues of overweight and obesity and set up a High Level Group on Nutrition and Physical Activity⁶⁴ to facilitate the sharing of policy ideas and practice. This group recognises that the fight against the obesity epidemic⁶⁵ requires a special focus on childhood obesity and has therefore designed an EU action plan on childhood obesity for the period 2014-2020. This approach is also underpinned by scientific work: in 2014, the JRC conducted a school-based study on physical activity, mapped EU school food policies⁶⁶, and published a foresight study on tomorrow's healthy society, indicating research priorities for foods and diets⁶⁷.

- 63 - Barboza, J., Vaillant, L., Le Strat, Y., Hartley, D. M., Nelson, N. P., Mawudeku, A., Madoff, L. C., Linge, P., Collier, N., Brownstein, J. S., Astagneau, P., 'Factors influencing performance of internet-based biosurveillance systems used in epidemic intelligence for early detection of infectious diseases outbreaks', *PLOS One*, 9(3):e90536, 2014: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0090536>
- 64 - A Strategy for Europe on Nutrition, Overweight and Obesity related health issues, COM(2007)279 final: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:279:FIN:EN:PDF>
- 65 - High Level Group on Nutrition and Physical Activity: http://ec.europa.eu/health/nutrition_physical_activity/high_level_group/index_en.htm
- 66 - Storcksdiek genannt Bonsmann, S., Breda, J., Caldeira, S., Nelson, M., Wollgast, J., School Food and Nutrition in Europe: policies, interventions and their impact, European Commission, 2014. ISBN 978-92-97-39657-1: <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC91433/school%20food%20policy%20workshop%20report%20online%29.pdf>
- 67 - Bock, A.-K., Maragkoudakis, P., Wollgast, J., Caldeira, S., Czimbalmas, A., Rzychon, M., Atzel, B., Ulberth, F., Tomorrow's Healthy Society - Research Priorities for Foods and Diets, European Commission, 2014, ISBN 978-92-79-40070-4: <https://ec.europa.eu/jrc/sites/default/files/jrc-study-tomorrow-healthy-society.pdf?uri=COM:2007:0279:FIN:EN:PDF>



Upcoming challenges

Social resilience

G. Fischer

European Commission, DG Employment, Social Affairs and Inclusion

Resilience is the ability to adjust easily to or cope with internal changes or external shocks. The economic resilience of the EU as a whole, and all individual Member States, should be strengthened by the fundamentals of the Common Market underpinning it: the ‘mobility’ factor, guaranteed by the four freedoms – free movement of goods, services, capital and people – makes the EU’s economy more efficient and better able to reallocate resources effectively in the face of changing circumstances. Economic resilience should translate very closely to social resilience as societies use growing wealth to ensure high employment and socially inclusive outcomes; the mobility factor should help all members to cope better with large economic shocks. But if insufficient attention is paid to ‘how the benefits of growth are shared’, rising wealth can actually reduce resilience in the long run.

The use of growing wealth to increase social resilience is not an automatic process. The EU treaties show that the EU is intended to be not just an economic entity but also a Union of common values and social objectives, and addressing social resilience is a legitimate instantiation of those common values and objectives. Indeed, certain types of EU instruments are specifically designed to promote social resilience. Employment and social standards, enacted to ensure a competitive level playing field, are an evident example. Rules on occupational safety and health lead to a healthier and more productive workforce better able to do new jobs as old ones are phased out by new technology or global competition.

Information and consultation obligations, and the general commitment to social dialogue, can reinforce the capacity of both the economic actors and the Member States to adjust in a socially balanced manner, further strengthening resilience. Social benchmarks enable Member States to enact policies enhancing their resilience. The EU’s Youth Guarantee requires all countries to ensure that any young person is offered a job or a place in education or training within four months of leaving school or becoming unemployed. It is designed to ensure that the young are better equipped to adjust to the huge changes that the crisis brought about, to cope with the lack of jobs in many countries still rebalancing, and to have the skills for when recovery brings new jobs.

To ensure free movement of all workers, the EU has several legislative rules in place. These rules prohibit discrimination against workers from another Member State and cover social security payments to non-nationals or to nationals in another Member State. There are also many non-legislative initiatives to overcome the barriers to mobility. The Erasmus programme⁶⁸ financing student exchanges and the EURES programme⁶⁹ facilitating job search in other Member States are two such actions.

The EU’s social Structural Funds enhance resilience by investing in people, preparing them for change or to confront shocks as they happen. The European Social Fund⁷⁰ (ESF)’s EUR 80 billion for the seven years (2014-20) are targeted to help poorer

68 - Erasmus+ programme: http://eacea.ec.europa.eu/erasmus-plus_en

69 - EURES: <https://ec.europa.eu/eures/public/en/homepage>



countries, or poorer regions and vulnerable groups in richer ones, and to reinforce their resilience. ESF funding pays for upgrading the skills of millions of workers, as well as active labour market measures for the unemployed. The European Globalisation Adjustment Fund (EGF)⁷¹ finances retraining for workers made redundant by global changes.

The decade before 2007-8 had seen growing convergence of employment and social performance outcomes, but the crisis set off strongly divergent trends. The more socially resilient Member States quickly returned to good performance in terms of jobs and social inclusion. However, others are still today below their pre-crisis performance levels, and EU membership is less obviously a source of resilience for them. The European Semester, backed up by legislation ensuring public debt and deficit limits for members of the Economic and Monetary Union (EMU)⁷², seeks to maximise the conditions for economic, employment and social resilience in each country.

Every year, a number of country-specific social recommendations are addressed to most if not all Member States. However, social resilience requires continued adaptation to the changing situations. While structural reforms are key to improving social resilience, the

workings of the EMU with a single currency and single interest rate but very different institutional settings in different Member States may mean that the mobility factor could actually exacerbate rather than temper divergent forces and weaken resilience in those already more fragile countries. A much discussed option to temper this, a common Union-level fiscal capacity with automatic stabilising functions, is a 'European unemployment benefit mechanism'. There is a wide variety of models for such a system but clearly it could in the long run be a major force for social resilience in individual countries, the euro area and the EU as a whole.

Being in a Union has created the capability for the Member States to initiate and develop together measures that actively promote convergence and thereby strengthen social resilience across the entire Union.

70 - European Social Fund (ESF): <http://ec.europa.eu/social/main.jsp?catId=325>

71 - European Globalisation Adjustment Fund (EGF): <http://ec.europa.eu/social/main.jsp?catId=326>

72 - Economic and Monetary Union (EMU): http://ec.europa.eu/economy_finance/euro/emu/index_en.htm

Geopolitics: common platforms for efficient EU crisis response

D. Al Khudhairy

European Commission, Joint Research Centre

Since the last two world wars, the EU has been a beacon for peace, security and prosperity. Successful enlargements have increased the Union's international weight and established it as the largest integrated economic area in the world, with strengthened democracy, stability, security and human rights in its own territory. In its vital interest to address risks and crises outside its borders, the EU has developed and now deploys a wide array of policies, tools and instruments, spanning the diplomatic, security, defence, financial, trade, development cooperation and humanitarian aid fields⁷³. Together, their external impact and those of international obligations on EU policy-making have led to the EU being considered as an influential global actor⁷⁴.

However, the Council conclusions on Common Security and Defence Policy in 2014⁷⁵ identified ongoing conflicts and instability in the Union's neighbourhood, from Iraq and Syria to the Ukraine, as a cause for great concern that is threatening the Union's security and which may have longer-term effects on international peace and stability. Furthermore, the recent terror attacks in Europe and growing regional instability near Europe's borders and consequential migration have brought home the geopolitical circumstances of these external crises and instabilities.

This complex geopolitical environment makes it difficult to draw distinct lines between security and defence, or between internal and external security.

This has created a momentum for the further integration of the Union's external action instruments and linking them with its internal policies⁷⁶. The President of the European Commission, Jean-Claude Juncker, stated repeatedly that Europe has to do more to get its act together, to better manage migration and to enhance its foreign and security policy⁷⁷. He also underlined the importance of a more united and influential Union on the international stage by making this one of his 10 political priorities. Achieving this not only depends on deploying all of the EU's actions at national and European level, but it also requires the EU and its Member States to combine their efforts and to work with the EU's strategic partners, including the United Nations and the African Union.

In this regard, the EU is making progress through its comprehensive approach combining its relevant internal and external action instruments. The EU Maritime Security Strategy⁷⁸ is considered to be the first integrated strategy of this approach, bringing together internal and external security issues as well as civilian and military maritime concerns. The EU plans to extend its comprehensive approach to further strengthen the linkages between the internal and external dimension of migration policy. Another example is the EU's comprehensive approach to external conflict and crises, which has defined a concrete set of actions for implementation by the Commission, the European External Action Service and EU Member States^{79, 80}.

73 - Bomberg, E., Peterson, J., Corbett, R. (Eds.), *The European Union – How does it work?*, 3rd Edition, Oxford University Press Inc., New York, 2012

74 - Wallace, H., Pollack, M. A., Young, A. R. (Eds.), *Policy-Making in the European Union*, 7th Edition Oxford University Press, Oxford, 2015

75 - http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/EN/foraff/145824.pdf

76 - Council conclusions on the EU's comprehensive approach: http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/EN/foraff/142552.pdf

77 - *The European Security and Defence Union*, Volume No. 20, ProPress GmbH, Bonn, 2015

78 - *European Union Maritime Security Strategy*, as adopted by the Council on 24 June 2014: <http://register.consilium.europa.eu/doc/srv?l=EN&f=ST%2011205%202014%20INIT>

79 - Joint Staff Working Document, 'Taking forward the EU's Comprehensive Approach to external conflict and crises – Action Plan 2015', SWD(2015) 85 final: <http://data.consilium.europa.eu/doc/document/ST-7913-2015-INIT/en/pdf>

80 - Joint Communication to the European Parliament and the Council, 'The EU's comprehensive approach to external conflict and crises', JOIN(2013) 30 final: http://www.eeas.europa.eu/statements/docs/2013/131211_03_en.pdf



The EU's comprehensive approach recognises that enabling the Union to confront geopolitical uncertainties also necessitates operational actions and capabilities.

These include developing more structured information sharing and shared situational awareness, application of existing and new EU early-warning systems, and more joined-up analysis across all relevant domains of EU internal and external actions. The EU's Integrated Political Crisis Response platform⁸¹, for example, enhances cooperation, information sharing and analysis by linking up the situational awareness and emergency management centres of the Union, EU agencies and the Member States. The EU Crisis Platform⁸² and the Emergency Response Coordination Centre⁸³ provide the means for coordinated EU crisis preparedness and response.

Needless to say, a stronger impact of the EU's external action goes hand-in-hand with more coherence in internal security issues within the Union. The Stockholm Programme⁸⁴ and the Lisbon Treaty⁸⁵ both provide the opportunity for strengthening EU competence in internal security areas, with the political framework being updated when required.

In 2015, the EU High Representative and Vice-President of the European Commission, Federica Mogherini, launched a strategic review to assess the impact of changes in the global environment to guide the EU's new Foreign and Security Strategy⁸⁶. The new strategy for mid-2016 is expected to bring EU institutions and Member States even closer together to strengthen the EU's resilience through addressing the challenges of a world that is more connected, more complex and more contested than at the time of the 2003 European Security Strategy.

-
- 81 - Council of the European Union, General Secretariat of the Council, Integrated Political Crisis Response (IPCR) Web Platform, European Union, Brussels, 2013, ISBN: 978-92-824-3973-9 <http://bookshop.europa.eu/en/the-eu-integrated-political-crisis-response-arrangements-in-brief-pbQC0313314/>
- 82 - EU Crisis Platform: http://www.eeas.europa.eu/crisis-response/what-we-do/crisis-platform/index_en.htm
- 83 - Emergency Response Coordination Centre: http://ec.europa.eu/echo/what/civil-protection/emergency-response-coordination-centre-ercc_en
- 84 - Stockholm Programme – An open and secure Europe serving and protecting the citizens, 2 December 2009, 17024/09: http://ec.europa.eu/anti-trafficking/sites/antitrafficking/files/the_stockholm_programme_-_an_open_and_secure_europe_en_0.pdf
- 85 - Lisbon Treaty: Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community, signed at Lisbon, 13 December 2007, C 306/1: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:12007L/TXT>
- 86 - European Security Strategy: <http://www.eeas.europa.eu/csdp/about-csdp/european-security-strategy/>

Climate change: how to address a creeping crisis

M. Porter

European Climate Foundation

Given the pervasive, multifaceted and significant nature of the effects of climate change, not just on our environment but also on our economies and societies, the challenge of developing resilience to it is clearly one of the most urgent, complex and central ones for the world as a whole.

This is not the place to repeat the overwhelming scientific evidence of the effects already now happening or on those effects we can expect in the years and decades ahead – those have been abundantly well explored and set out by the UN's work in particular. Adaptation strategies, such as the one adopted by the European Commission in 2013⁸⁷, are fundamentally resilience strategies, designed to help us cope with a world that, will be in all probability at least 2 degrees warmer on average than pre-industrial times. And we should remember that even limiting temperature increase to this is still only judged to give us a 50-50 chance of avoiding dangerous impacts, so the need to 'prepare for the worst' is unfortunately already necessary, too.

From a European perspective, it is clear that whilst these resilience-building activities need to be pursued at various levels of government, with local, regional, city and national activities all important, and with considerable private-sector involvement as well as that of civil society, the role of the EU is an important integral part of an effective overall strategy. In helping to coordinate, build and share knowledge, address specific cross-border environmental impacts and future-proof EU policies related, for example,

to infrastructure development, agriculture, or disaster planning and crisis response, the Union's role is an indispensable one.

In light not just of the anticipated further impacts, but also of the lack of sufficient progress to date, the need for this role which will only grow over coming years. Recent studies of the European private sector⁸⁸ demonstrate that although climate change is already impacting businesses and changing risk profiles and decision choices for activities ranging from infrastructure investment and location, capital market access, supply chain management, employee engagement and corporate reputation, responses to this vary widely and depend on many factors. And they are still inadequate to address the urgency let alone the severity of the changes anticipated. The EU's role in encouraging greater attention to this falls squarely within its adaptation strategy but importantly, only covers resilience through adapting to the problem itself.

Equally important is the need to understand and exploit opportunities arising from needing to solve the underlying problem. The undoubted severity of the impacts that lie ahead, and our ability to develop resilience to them, also requires resilience from our ability to tackle the causes of climate change, namely the pattern of production and consumption that leads to emissions of so-called greenhouse gases, notably carbon dioxide, released when we burn fossil fuels.

The transition to a low- and ultimately no-carbon economy that is necessary for

87 - COM(2013) 216 final, 'An EU Strategy on adaptation to climate change': http://ec.europa.eu/clima/policies/adaptation/what/docs/com_2013_216_en.pdf

88 - Carbon Disclosure Project (CDP), *Climate Change Resilience in Europe – A Snapshot of the Private Sector*, CDP, London, 2014: <https://www.cdp.net/CDPResults/climate-change-resilience-europe.pdf>



us to deal with the likely effects of even 'only' a two-degree increase in average global temperatures is as fundamental a part of our developing resilience to climate change as the need for our societies to adapt and develop resilience to the impacts of changes we have already set in motion. And whilst we are rightly concerned with avoiding certain environmental thresholds or 'tipping points', there are conversely such thresholds that we need to cross in order to see the transformational and rapid change in our economies that will lead to resilience from decarbonisation. And there are some positive signs here, for example, in the now incredibly rapid penetration of renewables and 'post-Fukushima' politics that have developed so quickly in Germany, in particular.

Indeed, it is in the energy area that the case for an EU-level strategy is clearest from a resilience perspective. The recent 'Energy Union'⁸⁹ initiative from the European Commission represents perhaps the clearest contemporary example of an area where greater integration amongst EU countries will increase resilience. In a highly interdependent, interconnected environment, Europe's energy grid and market still remain largely fragmented along national lines – even though resilience to shocks from dependence on imported fuel or the balancing necessary

from greatly increased use of renewable energy across the EU would be clearly enhanced by greater integration – a goal at the heart of the Energy Union.

In other areas of economic activity, rather than dealing with the potential negative impacts of climate change, resilience will also be achieved through anticipating and exploiting the potential competitive advantages of leading the industrial and technological innovation as we rapidly transition to a new climate economy.

These various climate-resilience benefits of a more integrated system of co-operation within Europe are ones that its Member States must balance against familiar reliance on national systems aiming at the same objectives. But with innovation at the core of the transition to a new, climate-resilient economy and society, the need for change in the governance of such common problems is clear – and possibly a defining one for the EU in coming decades.

89 - COM(2015) 80 final, 'A Framework Strategy for a Resilient Energy Union and a Forward-Looking Climate Change Policy': <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52015DC0080&from=EN>

Migration: European cooperation for resilience of the blue borders

A. Zampieri

European Commission, Joint Research Centre

The free flow of people, goods and capital within the EU has stimulated its economy immensely. The Schengen Area⁹⁰ in particular allows the free circulation of people without checks at the internal borders; as a consequence, Schengen states have to tighten controls at their common external borders to ensure security inside the area. External borders are expected to stop the entrance of illegal or unsafe goods, protect against unfair competition, and prevent unchecked immigration.

One way to enter the EU unseen is by sea: seaborne migration to the EU's southern shores has become a major issue, making tragic headlines with too many lives being lost at sea. Wars, instability and bad economic conditions in the EU's neighbourhood have been inducing people to seek a safe haven and prosperity in Europe. But while the EU is trying to define an improved policy with its European Agenda on Migration⁹¹, criminal organisations are sabotaging it, making migrants cross the sea in unseaworthy vessels. This is a huge and increasing challenge for Europe, which is calling for enhanced resilience through a rapid response and intervention capacity both at the political and technical level.

Part of this response lies in better monitoring of the European southern maritime borders. Vessels hoping to reach EU shores undetected or unsafe boats carrying migrants must be identified at an early stage, although this is not an easy task. In the first place, they are small objects in a vast sea. Searching wide

areas of sea requires significant capacity from maritime surveillance aircraft or patrol boats, which are both very costly options. Secondly, the European seas are quite busy and most of the traffic is legal. The question is, how can one small boat with illegal cargo be distinguished from hundreds of similar vessels? The decision to single out a particular ship for further inspection, or to approach it for rescue operations, must be based on information on the target – from observations, analysis of its behaviour, tracing it back to its point of departure, etc. This requires powerful sensors, plus the integration of information from many sources and analytic capacity. Thirdly, perpetrators need to be apprehended and brought to justice, which requires the appropriate means and procedures for gathering and securing evidence. There is also a need to identify migrants, who are often paperless.

Europe as a whole is more resilient than individual countries to respond to many of these challenges. By pooling patrol boats and aircraft from individual Member States, such assets can be targeted at areas where, and during periods when pressure is highest, thus focusing surveillance capacity where it is most needed. This is already being achieved in joint operations organised by the EU's external borders Agency Frontex⁹². It is one aspect of the European Border Surveillance System (EUROSUR)⁹³, which came into operation in 2013 to reinforce control of Europe's external borders. Another aspect EUROSUR looks at is the exchange of information between all EU border authorities (land and

90 - Schengen Area: http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/borders-and-visas/schengen/index_en.htm

91 - COM(2015) 240, final, 'A European Agenda on Migration', http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/european-agenda-migration/background-information/docs/communication_on_the_european_agenda_on_migration_en.pdf

92 - Frontex, European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union: <http://frontex.europa.eu/>

93 - European external border surveillance system (EUROSUR): http://europa.eu/legislation_summaries/justice_freedom_security/free_movement_of_persons_asylum_immigration/14579_en.htm and <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52008DC0068>



sea), making information available where it is needed. EUROSUR also considers common surveillance tools, like satellites, which would be too expensive for one single country to operate but can be afforded by the EU as a whole. Of even wider scope is the Common Information Sharing Environment (CISE)⁹⁴ for the surveillance of the EU maritime domain, intended to achieve effective data exchange between all maritime authorities across sectors and borders. By 2020, this EU initiative will enable about 400 maritime administrations to exchange maritime surveillance information in order to increase efficiency and improve decision-making concerning actions at sea. Furthermore, the EU has its flagship programme ‘Copernicus’⁹⁵ for Earth observation, which is being used for security and maritime surveillance applications, while EU-wide information systems such as the Schengen Information System enable Member States to properly manage requests for entry into or stay in the Schengen Area. Finally, enhanced collaboration between civil and military authorities is being put in place, significantly augmenting the EU response at a lower cost.

In spite of all these EU efforts, the flow of migrants across its ‘blue border’ continues, which calls for further enhanced and cost-efficient surveillance; R&D is part of the answer. The EU’s

Horizon 2020 programme⁹⁶ – which also includes the JRC – funds and pools R&D efforts, including border surveillance. It helps EU industry to improve products for operational use, including sensors, platforms, data processing and analysis methods. It leverages national and industrial R&D budgets, avoiding unnecessary duplication of development efforts through cooperation. Current technical issues concerning maritime surveillance that are challenges for R&D include the detection of small boats, authentication of reported ship positions, persistent surveillance, and unambiguous identification through biometrics. Improved civil-military interaction to avoid duplications in areas where R&D requirements overlap is another aspect receiving attention.

The recently adopted European Agenda on Migration shows how to better manage migration and, in turn, to enhance EU resilience. Operational authorities, policy-makers and the scientific community, including the JRC, are joining forces to achieve this ambitious EU objective.

94 - Common Information Sharing Environment (CISE): http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/cise/index_en.htm

95 - Copernicus, European Programme for the establishment of a European capacity for Earth Observation: <http://www.copernicus.eu/>

96 - Horizon 2020, The EU Framework Programme for Research and Innovation: <https://ec.europa.eu/programmes/horizon2020/>

Counter-terrorism: EU collaboration

O. Luyckx

European Commission, DG Migration and Home Affairs

Terrorism is not a new phenomenon in Europe. It poses a threat to our security, to the values of our democratic societies, and to the rights and freedoms of European citizens. While national security remains the responsibility of Member States, the phenomenon of terrorism must be confronted at both a national and international level since it does not recognise borders. When designing measures to build resilience against terrorism, a comprehensive approach is needed to maintain the security of citizens in Europe in accordance with fundamental rights. Building EU resilience against terrorism aims to combat terrorism globally while respecting human rights, and to make Europe safer, allowing its citizens to live in an area of freedom, security and justice.

Addressing the threat of terrorism

The fight against terrorism is principally a matter for national authorities. Nevertheless, the EU Member States are committed to jointly fighting terrorism and providing the best possible protection for its citizens. In this context, concerted and collective EU-level action is indispensable. Therefore, the Council has adopted the EU Counter-Terrorism Strategy⁹⁷ in 2005 and The European Agenda on Security for 2015–2020⁹⁸ was adopted on 26 April 2015.

Countering terrorism at EU level is focused on four main pillars: prevent, protect, pursue and respond. EU actions aim at strengthening national as well as collective capabilities and enhancing cooperation, supporting EU Member States in carefully

targeted actions and initiatives. The EU mechanisms are based on the knowledge that the terrorist threat can most effectively be countered through the extensive use of cooperation and partnerships.

- The establishment and application of a robust risk assessment methodology is a fundamental requirement for the effective management of security risks supporting the decision-making process and ensuring a better informed allocation of resources.
- Under *prevent*, the EU aims to prevent people from being radicalised and recruited for terrorist purposes. To address this issue, the Commission has launched an EU-wide Radicalisation Awareness Network⁹⁹ programme which aims at connecting practitioners and front-liners from across the EU to give them the opportunity to exchange information and best practice, and equip them with the skills and expertise to deal with those who have been radicalised or are at risk.
- On *protect*, the European Commission has developed different proactive initiatives, e.g. in countering terrorist financing and hindering access to explosives and to chemical, biological, radiological and nuclear materials. The Commission is also responsible for the European Programme for the Protection of Critical Infrastructure¹⁰⁰ and the EU-US Agreement on Terrorist Finance Tracking Programme¹⁰¹.
- The solidarity clause in the Treaty on the Functioning of the European Union¹⁰² introduces a legal obligation on the EU and its States to assist each other when

97 - EU Counter-Terrorism Strategy: <http://register.consilium.europa.eu/doc/N&f=ST+14469+2005+REV+4>

98 - The European Agenda on Security for 2015-2020: http://ec.europa.eu/dgs/home-affairs/e-library/documents/basic-documents/docs/eu_agenda_on_security_en.pdf

99 - Radicalisation Awareness Network (RAN): http://ec.europa.eu/dgs/home-affairs/what-we-do/networks/radicalisation_awareness_network/index_en.htm

100 - European Programme for Critical Infrastructure Protection (EPICIP): http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/crisis-and-terrorism/critical-infrastructure/index_en.htm

101 - EU-US Agreement on the Terrorist Finance Tracking Programme: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:22010A0113%2801%29>

102 - Treaty on the Functioning of the European Union: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:12012E/TXT>



an EU Member State is the object either of a terrorist attack or a natural or man-made disaster. In recent years, different crisis coordination mechanisms have been set up to enhance the EU's crisis management capacity. At European Commission level, the ARGUS¹⁰³ general rapid alert system has been created to better coordinate the Commission's response capacity. ARGUS brings together all relevant Commission services to coordinate efforts, evaluate the best options for action, and decide on the appropriate response measures during an emergency.

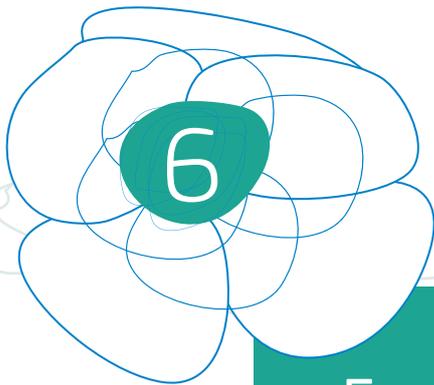
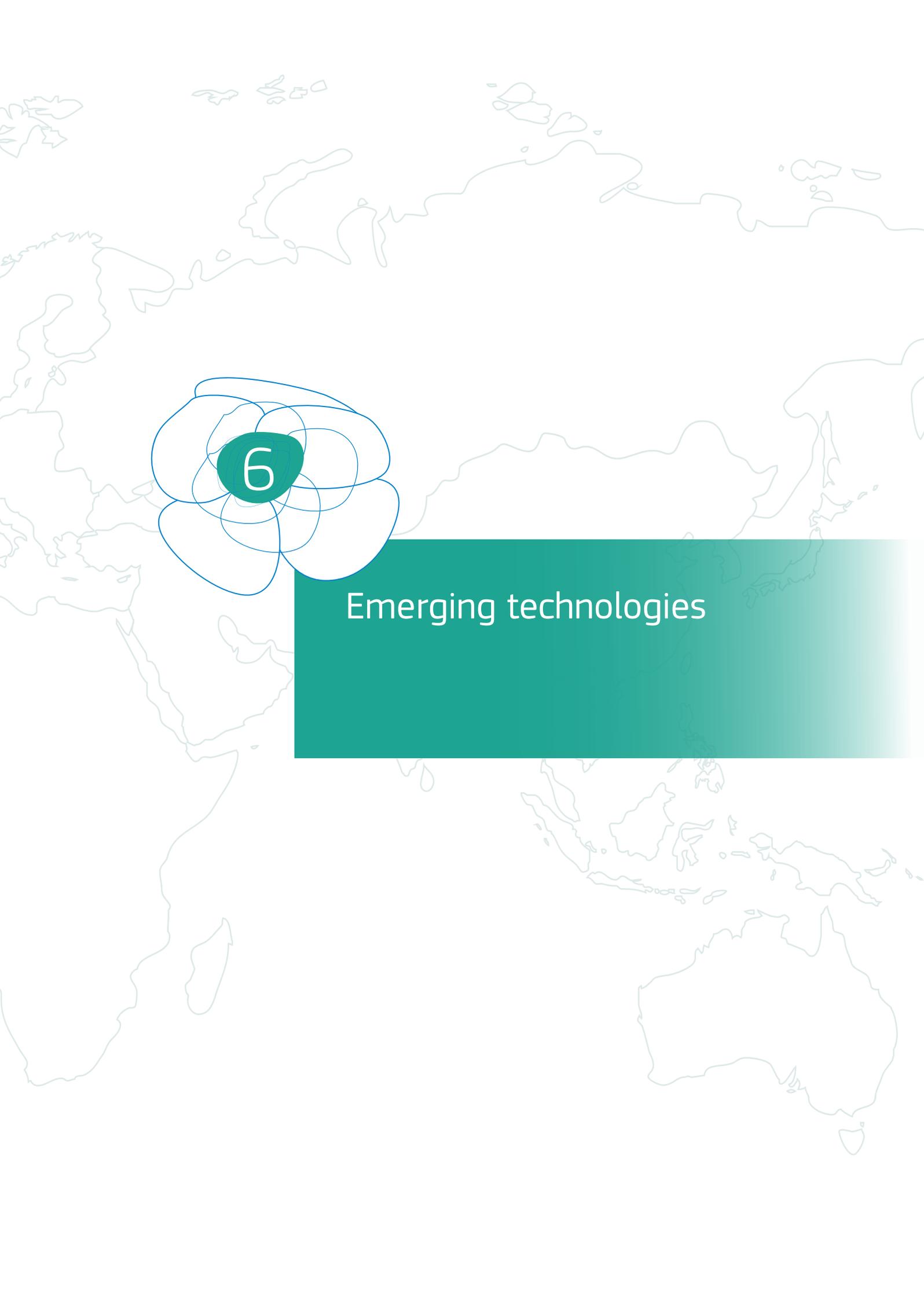
Outlook

The threat from terrorism in Europe remains strong, manifesting itself in various forms and driven by diverse motives. The EU's increasingly open area of free movement could be abused by terrorists to pursue their objectives. Foreign terrorist fighters from Europe travelling to different locations to fight jihad, and the security threat they may pose inside the EU when they return, are also likely to persist in the coming years. This phenomenon adds a new dimension to the existing threat situation in the EU, since it provides new groups within Member States with both terrorist intentions and capabilities, which may

result in terrorist attacks with unexpected targets and timings.

The EU has given Member State authorities an important set of tools that should be used to their full extent to meet the challenges posed by terrorist threats. The European Union will continue to enhance building EU resilience against terrorism.

103 - ARGUS, a general European rapid alert system: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52005D0662:EN:HTML>



Emerging technologies

Big data and the ‘Internet of Things’: research for Europe’s digital resilience

J-P. Nordvik

European Commission, Joint Research Centre

Our world is rapidly becoming digital. Information and communications technology (ICT) is no longer just one economic sector among others, but rather the foundation of all modern innovative economic systems. The internet and digital technologies are transforming our life – as individuals, in business, and in our communities – as they become fully embedded across all sectors of our society, including health, education, transport, energy and recreation. Key to this digital transformation is the tremendous amount of data being generated, collected and aggregated at unprecedented levels: the ‘Big Data’ phenomenon. This trend is being accelerated even further with the advent of the Internet of Things (IoT)¹⁰⁴, that is the pervasive presence of smart objects, connected medical devices, wearable sensors, and smart home appliances, which will increasingly become extensions of the human body and will generate autonomously mountains of data.

This digital revolution will bring many benefits but also new threats to the resilience of our society. Digital systems and services, like any technology, are not 100 % reliable and can fail. Moreover, they present new risks of malicious attacks targeting their vulnerabilities. As ICT becomes more and more ubiquitous, successful attacks or digital outages will have impacts that spread outside the technical sphere and extend into all areas of our economy and daily life.

The 2013 Cyber Security Strategy of the European Union¹⁰⁵ addresses these risks. The strategy, towards an open, safe and

secure cyberspace, contains provisions to promote cyber resilience in the EU, in particular by establishing common minimum requirements for Network and Information Security (NIS)¹⁰⁶ at national level which would oblige Member States to designate national competent authorities for NIS, set up well-functioning Computer Emergency Response Team (CERT)¹⁰⁷, and adopt a national NIS strategy and a national NIS cooperation plan. ENISA¹⁰⁸, the European Union Agency for NIS, supports the European Union, the EU Member States and the business community in analysing, preventing and responding to NIS problems. The European standardisation organisations (ETSI¹⁰⁹, CEN¹¹⁰, CENELEC¹¹¹) are working on the development of standards for cyber security and, together with the European Commission, are stimulating the adoption by industry of standards ensuring minimum security requirements.

Of course, big data analytics, with its capacity to process heterogeneous and large amounts of data, can offer extensive support to law enforcement and border management. EU databases, such as the Schengen Information System (SIS)¹¹², the European Union Visa Information System (VIS)¹¹³ or the European fingerprint database for identifying asylum seekers and irregular border-crossers (EURODAC)¹¹⁴ are tangible examples of large-scale IT systems databases supporting Member State authorities in the area of freedom, security and justice.

At the same time, the digital revolution must not be allowed to create serious

104 - The Internet of Things: <http://www.theinternetofthings.eu/>

105 - Cybersecurity Strategy of the European Union: An Open, Safe and Secure Cyberspace: http://eeas.europa.eu/policies/eu-cyber-security/cybsec_comm_en.pdf

106 - Network and information security (NIS): <http://ec.europa.eu/digital-agenda/en/news/commission-proposal-directive-concerning-measures-ensure-high-common-level-network-and>

107 - Computer Emergency Response Team (CERT-EU): http://cert.europa.eu/cert/plainedition/en/cert_about.html

108 - European Union Agency for Network and Information Security (ENISA): <https://www.enisa.europa.eu/>

109 - European Telecommunications Standards Institute (ETSI): <http://www.etsi.org/>

110 - European Committee for Standardization (CEN): <https://www.cen.eu/Pages/default.aspx>

111 - European Committee for Electrotechnical Standardization (CENELEC): <http://www.cenelec.eu/>

112 - Schengen Information System (SIS): http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/borders-and-visas/schengen-information-system/index_en.htm

113 - EU Visa Information System (VIS): <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV:114517>

114 - EURODAC: <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32013R0603>

imbalances between business entities, governments and citizens. An adequate balance between healthy business growth, national security and individual privacy has to be maintained. Since 1995, the EU has benefited from solid European legislation on the protection of personal data. In 2012, in view of the challenge raised by the digital evolution, the Commission proposed a comprehensive reform of the EU's data-protection rules to strengthen online privacy rights, increase public trust and therefore boost Europe's digital economy. This proposal aims to simplify and streamline data-protection rules across Europe, through increased harmonisation and a one-stop shop for enforcement. Each business will be accountable to just one data protection authority, and both businesses and individuals will have a single point of contact. A 'right to be forgotten' will help people better manage data protection risks online. Whenever consent is required for data processing, it will have to be given explicitly, rather than be assumed. In the energy sector, smart metering systems are an essential stepping stone towards smart grids. They also represent the first large-scale deployment of IoT in Europe. To maintain the fundamental right to protection of personal data and to privacy, the European Commission issued a recommendation on Data Protection Impact Assessment¹¹⁵ in smart grids

and smart meters. In this way, European competitiveness and fundamental rights are maintained, and resilience is created in both areas when new technologies enter the market.

Reinforcing trust and security in the processing of personal data is a key element for the creation of the successful conditions and a level playing field for advanced digital networks and innovative services. The EU is addressing these challenges through the European Strategy for developing a secure and transparent Digital Single Market¹¹⁶, one of the key objectives of the current Commission agenda. Research in Big Data and IoT is an important driver to support the competitiveness of European industry and to provide a secure and safe environment for the European citizen. Research will maintain and further consolidate Europe's innovative and competitive edge and underpin the necessary regulatory framework adjustments needed to ensure sustainable benefits for the EU from the Big Data and IoT revolution.

115 - Commission Recommendation 2014/724/EU of 18 October 2014 on the Data Protection Impact Assessment Template for Smart Grid and Smart Metering Systems: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.300.01.0063.01.ENG

116 - Digital Single Market (DSM): <http://ec.europa.eu/priorities/digital-single-market/>

Can Europe become quantum-safe?

G. Lenhart

European Telecommunications Standards Institute (ETSI)

Cyber-attacks are a major issue, and cyber security is built upon cryptographic algorithms, based on hard mathematical problems. Such mechanisms are used all across the globe to create digital identities, to protect digital transactions, or to keep the content of electronic messages confidential. Hackers do not stop at national borders, and in the recent years the success of digital technologies has introduced vulnerabilities in all areas of our daily life.

Specialists have even managed to gain access to a WLAN installation by hacking a 'smart' light bulb. This is both a security issue and a market issue: consumer trust is essential for a successful and strong digital market, as service providers, technology vendors and public authorities know well. Knowing the weaknesses of the ever-increasing number of IT systems and sharing knowledge about how to fix them is essential for efficient cyber resilience.

For this purpose, computer emergency response teams (CERTs) have been established in industry and in the public sector in recent years. Keeping knowledge up to date in a sector where hundreds of thousands of attacks are happening every day is not straightforward. CERTs need to collaborate, but sharing sensitive information requires trust. The EU recognised this issue early, and created the European Network and Information Security Agency (ENISA) in 2004. To fight cybercrime, the European Cybercrime Centre¹¹⁷ was established at Europol in 2012. In addition, the EU issued the EU Cyber Security Strategy and the Network

Information Security Directive¹¹⁸ in 2013 with the objective of making the EU's online environment the safest in the world. All these steps have provided the basis for trusted information exchange across borders in the continued European efforts for strong cyber security in a quickly changing technology environment.

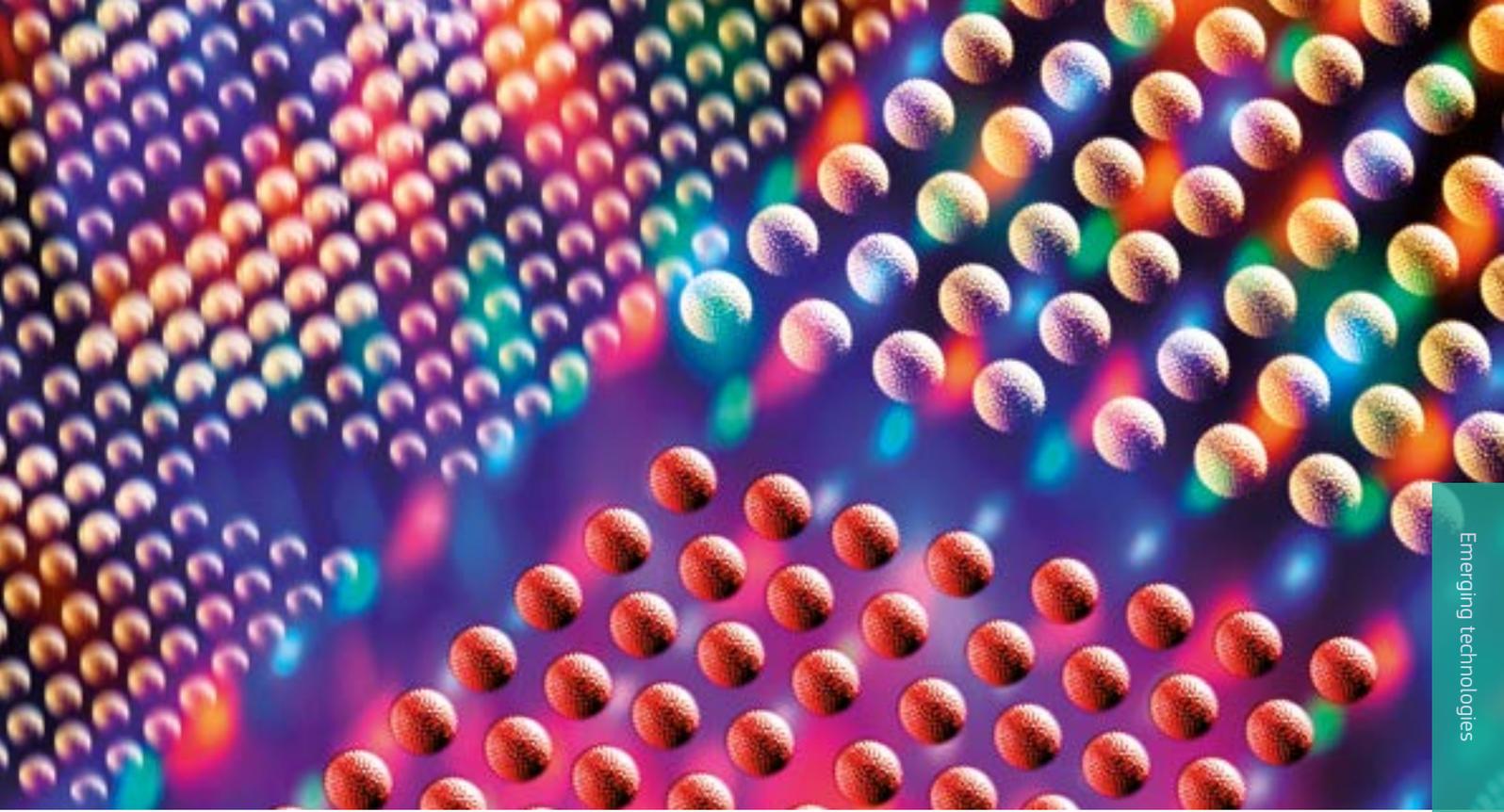
But cyber resilience also requires looking ahead and confronting new challenges together. One of these challenges might be bigger than anything we can imagine today: all across the world, researchers are working towards a universal quantum computer.

Such a computer could change the nature of computing in profound ways: future generations may look at today's computers in the way we look at an abacus. One possible effect of such a quantum computer would be that it could very rapidly break most or all of our current cryptographic algorithms. Of course, a quantum computer does not exist yet, and if it can be built it will certainly take some years to do so – but once such a machine was operational, no electronic bank transaction, no credit card payment, no mobile phone call and no computer login would be secure any more. This risks creating a global economic crisis of unprecedented dimensions.

Recent progress in quantum experiments has led some experts to believe that a quantum computer could be operational as early as 2030. Although even this optimistic guess sounds quite far away, there is little time to protect ourselves, as developing quantum-safe cryptography will

117 - European Cybercrime Centre (EC3): <https://www.europol.europa.eu/ec3>

118 - Network and Information Security (NIS) Directive: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=1666



take several years. Even the theoretical underpinning for such cryptography is a challenge: how can we work out algorithms robust against technological attacks which do not yet exist? And even if a solution could be found, it would have to find broad distribution to work globally and should be standardised to be interoperable.

Also here Europe has acted. A new working group on quantum safe cryptography¹¹⁹ was established in 2014 at ETSI, which aims to create global technology standards.

Experts have started working against the clock to define and agree standards to provide robustness against a completely new type of attack well before such an attack appears. This and other aspects of cyber-resilience mechanisms have to reach forward for at least 30 years. Europe has shown its capability to join forces on cyber security and cybercrime successfully over the first decade of the 21st century, and has made the first step towards an initiative to provide cyber resilience against major disruptive technology developments in the decades to come.

These developments show the importance of the trusted environment and shared governance provided by the EU.

119 - Campagna, M., Chen, L., Dagdelen, Ö., Ding, J., Fernick, J., Gisin, N., Hayford, D., Jennewein, T., Lütkenhaus, N., Mosca, M., Neill, B., Perlmutter, R., Ribordy, G., Schanck, J., Stebila, D., Walenta, W., Whyte, W., Zhang, Z., Kaiser, S., Pecen, M., Petzold, A. and Smith-Tone, D., ETSI White Paper *Quantum Safe Cryptography and Security; An introduction, benefits, enablers and challenges*, ETSI, Sophia Antipolis, 2014, ISBN 979-10-92620-03-0

The Internal Market: protecting European innovation

A. Campinos

Office for Harmonization in the Internal Market (OHIM)

Continuous innovation is considered essential for competitiveness, and one component of economic resilience is the creation and protection of new ideas. But new ideas and innovative products or services are vulnerable in their early stages, and without a proper environment might not make it to the market even in cases where they are economically promising: competitors who have shied away from investing in innovation might copy the approaches or even gain an illegal advantage over the intentional production of counterfeit products. An environment where the results of investing into innovation cannot be adequately protected will keep large companies, SMEs and creative individuals from innovating. The easy establishment and strong protection of intellectual property rights is therefore of central importance for sustainable innovation at the European scale.

For this purpose, a protective framework is assured across the European Internal Market by the coexistence of national and European systems, providing options for the users and cooperation between enforcement authorities. The creators of new technologies, designs or brands cannot only count on a well-defined intellectual property process at the EU level, but also on a stable and effective regime for its enforcement against infringements. In addition, the EU-wide framework is being reviewed and adjusted to reflect industry's needs and maintain stability for European entrepreneurship, and all major EU institutions are involved: for example, a provisional agreement

between the European Commission, the European Parliament and the European Council has just recently been reached on the trademark reform package¹²⁰, and the foreseen reform will lead to lower costs, increased speed, more predictability and greater legal certainty. But also the enforcement side is addressed, to make sure that legal provisions are implemented efficiently. The reform also means for the fight against counterfeits, in particular, of goods in transit through the EU's territory. In addition to protecting the EU's internal market, this will prevent abuse of the EU as a distribution hub for illegal fake goods to worldwide destinations.

Also on patents a political agreement has been reached, laying the ground for the creation of unitary patent protection and a unified patent court in the EU. The EU patent reform package will provide significant advantages for European business, enabling companies to receive protection in all the 25 participating Member States with just one application and enforcing this protection under a single and specialised patent jurisdiction¹²¹.

But European activities for making the innovation process more resilient do not stop at the level of legal frameworks. As a practical implementation, EU Member States and other stakeholders are developing the European Trade Mark and Design Network¹²², in which common practices and tools are built and put in place across Europe and beyond. The achieved assurance of service quality, efficiency, predictability and consistency

120 - Trade mark reform package: http://europa.eu/rapid/press-release_IP-15-4823_en.htm

121 - Unified Patent Court: <http://www.unified-patent-court.org/>

122 - European Trade Mark and Design Network: <https://www.tmdn.org/>



across the EU are major elements of stability for the holders of intellectual property rights.

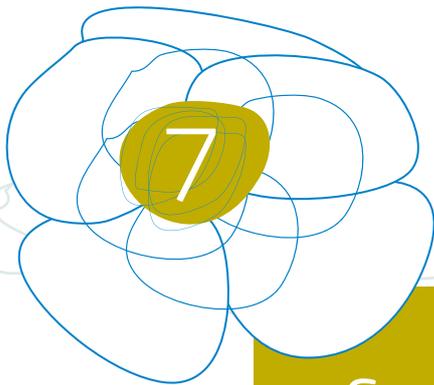
Flagship tools like TMview¹²³ or Design-View¹²⁴, the largest free trademark and design databases in the world, enable searching for applications and registered rights in the EU Member States and beyond. The respective benefit to companies has been calculated to be up to EUR 236 million annually, based on a scenario of full substitution of current similar or identical fee-based commercial search services. Moreover, European-level fast-track electronic filing tools allow for fast and user-friendly access to registration of trade marks and designs in the EU, including pre-clearance functionalities. Introduced only in November 2014, the fast-track tool has already been used for more than 27 % of the relevant applications in the first quarter of 2015.

All of these tools and collaborations facilitate a user-driven system for intellectual property rights with a level playing field where businesses can operate unhindered and well protected in all EU Member States. In other words, they are making European innovation more resilient.

This system is complementing Horizon 2020, the EU Framework Programme for Research and Innovation, aimed at strengthening the innovation capacities of European companies and at boosting the creation of new knowledge and products. Protecting and managing intellectual property rights is important for turning this innovation and knowledge into market benefits. A strong respective national and EU-level system is an essential component of the European Internal Market, which in turn makes the EU economy stronger and more resilient.

123 - ETMview: <https://www.tmdn.org/tmview/welcome>

124 - EDesignView: <https://www.tmdn.org/tmdsview-web/welcome>



Conclusions and next steps

Measuring resilience to design innovative policies

E. Giovannini

University of Rome Tor Vergata

In the recent analytical note ‘Preparing for Next Steps on Better Economic Governance in the Euro Area’¹²⁵, the concept of resilience appears several times, with reference to the capacity of the Economic and Monetary Union to react to external shocks. Moreover, the final part of the paper poses the question: “Is the current governance framework – if fully implemented – sufficient to make the euro area shock resilient and prosperous in the long run?”

The frequency with which the concept of ‘resilience’ is used in analytical and policy papers has increased greatly over the last few years¹²⁶. It is derived from a concept originally developed in material science: “the ability of a material to absorb energy when it is deformed elastically, and release that energy upon unloading”. From a *psychological* point of view, resilience is defined as “an individual’s ability to properly adapt to stress and adversity”. In *ecology*, resilience can be used either as “the rate at which a system returns to a single steady or cyclic state following a perturbation” or “the magnitude of the disturbance which can be absorbed before the system changes to another regime of behaviour”. Finally, in *economic* terms, resilience is “the ability of an economy to retain function, employment and prosperity in the face of the perturbation caused by a shock”.

The 2014 Human Development Report ‘Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience’¹²⁷, published by the UNDP, recognised that:

“While globalisation has brought benefits to many, it has also given rise to new concerns, manifest at times as local reactions to the spillover effects of events far away. Preparing citizens for a less vulnerable future means strengthening the intrinsic resilience of communities and countries.”

The concept of resilience referring to people, economies, environment, institutions, etc. is especially attractive from a political perspective as it communicates a positive message, emphasising the key role of policies in building a better future even if shocks affect a community. Policies to build resilience are especially important given the risks highlighted by the medium- to long-term scenarios which led the UN countries to agree, in September 2015, on the Sustainable Development Goals¹²⁸. As highlighted by the 2015 WEF¹²⁹ Global Risks report¹³⁰: “Since its inception, the report has raised awareness that the world is increasingly interconnected and that global risks cannot be seen in isolation. On the contrary, they can have far-reaching cascading effects as demonstrated by the financial crisis in 2008 and its socio-economic consequences. The year 2014 alone witnessed several such risks with potentially broad implications in the years to come if history serves as a benchmark ... Successfully addressing these complex and interconnected issues necessitates greater multi-stakeholder cooperation to increase the capacity to foresee, manage and mitigate global risks and to strengthen society’s preparedness and resilience to them.”

125 - The note was prepared by the President of the European Commission, in close cooperation with the President of the Euro Summit, the President of the Eurogroup and the President of the European Central Bank: http://ec.europa.eu/priorities/docs/analytical_note_en.pdf

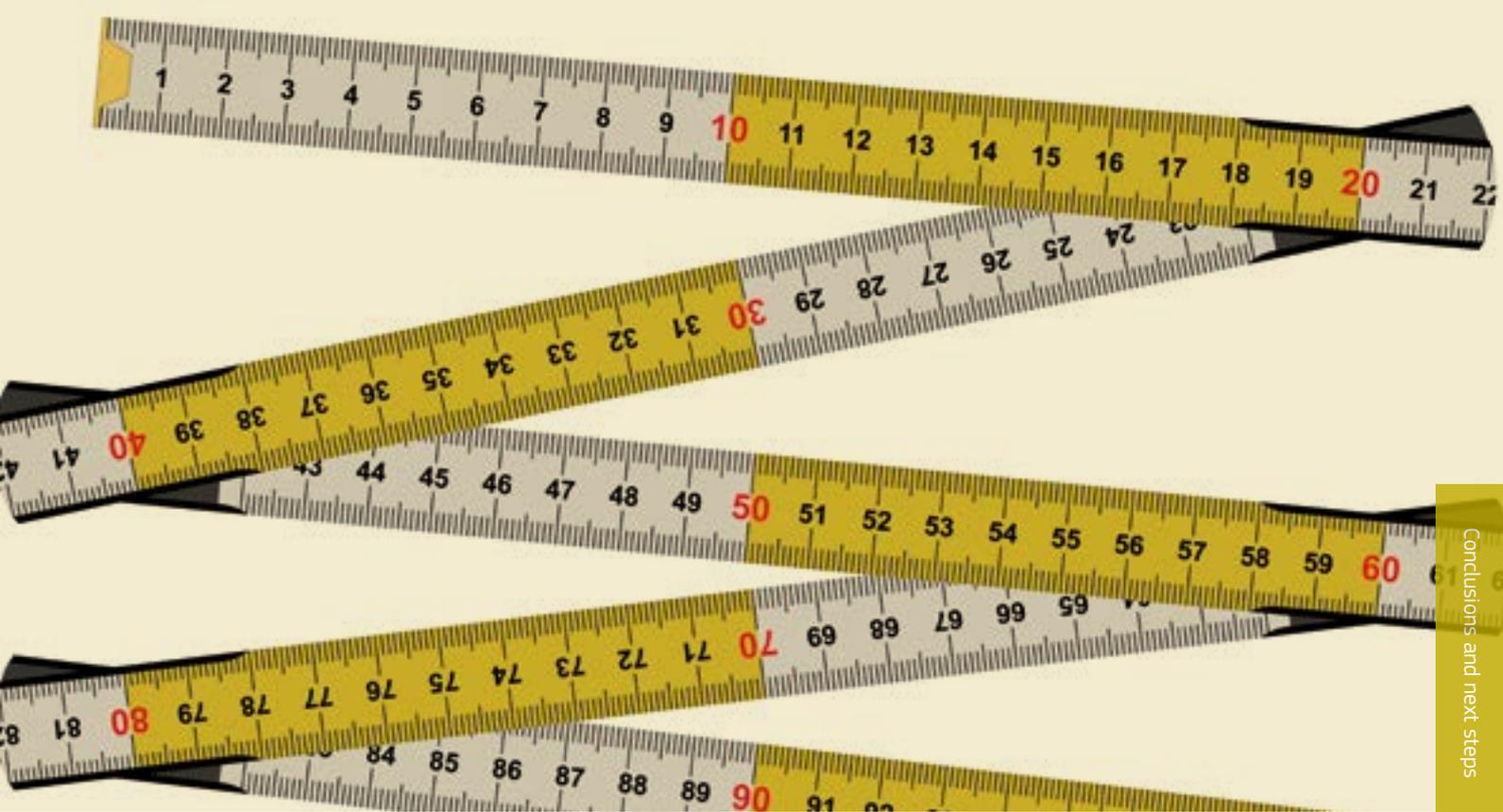
126 - The President of the ECB used this concept again in May 2015: <https://www.ecb.europa.eu/press/key/date/2015/html/sp150522.en.html>

127 - United Nations Development Programme (UNDP), Human Development Report 2014 – Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience. UNDP, New York, 2014: <http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf>

128 - Sustainable Development Goals: <https://sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals>

129 - World Economic Forum (WEF): <http://www.weforum.org/>

130 - World Economic Forum (WEF), Global Risks Report, 10th edition, WEF, Geneva, 2015: <http://www.weforum.org/reports/global-risks-report-2015>



In Europe, concerns about the social and the political situations make it very urgent to identify and implement innovative solutions to stimulate sustainable growth, reduce unemployment and social exclusion, increase energy efficiency and restore sustainable environmental conditions. In such a context, the EU institutions have to further develop their capacity to foresee future opportunities and risks, as well as to develop forwardlooking policies, able to reduce vulnerabilities and increase resilience, at all levels.

To do that, a truly interdisciplinary approach to resilience has to be developed, putting people at the centre of future developments. Available studies show that there are several elements that can help developing people's resilience or making an economy or a society react quickly to crises. This is why the first step to identify and implement policies for fostering resilience is to better define the concept, from both conceptual and statistical points of view.

A working group should be established by the European Commission on this topic, involving academic experts and international organisations active in this field, with the aim of developing sectoral and overall statistical indicators of resilience. The group should also develop research to evaluate how structural reforms and

other policies can build a fully resilient Europe, integrating economic, social and environmental perspectives in a more coherent framework.

Managing complexity: the key to resilience

S. Lechner

European Commission, Joint Research Centre

The financial crisis has demonstrated that it is already difficult to assess systemic risk in a *single* business sector. The creation and uncontrolled dispersion of complex financial ‘products’ together with the highly dynamic market obfuscated the general picture across the sector, and led to a situation where market players were simply not aware of their critical interdependencies.

But the real big picture needs to span across sectors in both business and policy. It is clear that today’s global interconnections are not simply sectorial. Almost every sector of business and policy is connected to many other sectors at a time, and most of these sectors are already very complex when considered individually. Between 2005 and 2015, we have seen many examples of effects across sectors and across geographic areas:

- Automated information technology algorithms produced a ‘flash crash’ at the stock exchanges in 2010, destroying billions in different sectors¹³¹;
- The default of a key US financial market player (Lehman Brothers) finally led to several government turnovers in Europe;
- Government turnovers in Ukraine and in North Africa created geopolitical tensions, leading to energy supply and migration problems – and to enormous costs;
- A natural disaster off the coast of Japan hit a (nuclear) energy installation and subsequently changed the energy policy in Germany. In addition, it temporarily interrupted the production of black cars by several producers in the US.

The OECD has underlined the interconnectedness between sectors in its study on ‘Future Global Shocks’¹³² (2011), and the World Economic Forum regularly maps¹³³ the complex interconnections between economic, environmental, social, geopolitical and technological risks in its annual Global Risks Report¹³⁴, which is now in its 10th edition.

Globalisation creates opportunities but it also creates highly complex dependencies, and not all of these interdependencies are useful in terms of resilience. A resilient Europe needs to strategically build its network of interconnections via a smart combination of all available tools across policy sectors. Introducing additional global interconnections just to realise short-term profit and without understanding the implications for future generations does not create resilience, but rather increases the stress on the system.

But there are limits to interconnections. Living on a confined planet, it needs to be acknowledged in all resilience considerations that today’s simplistic focus on growth cannot carry on forever. Scientific modelling and simulation are essential to analyse this complex picture, to understand what the limits are, and to provide a robust basis for solid policy decisions.

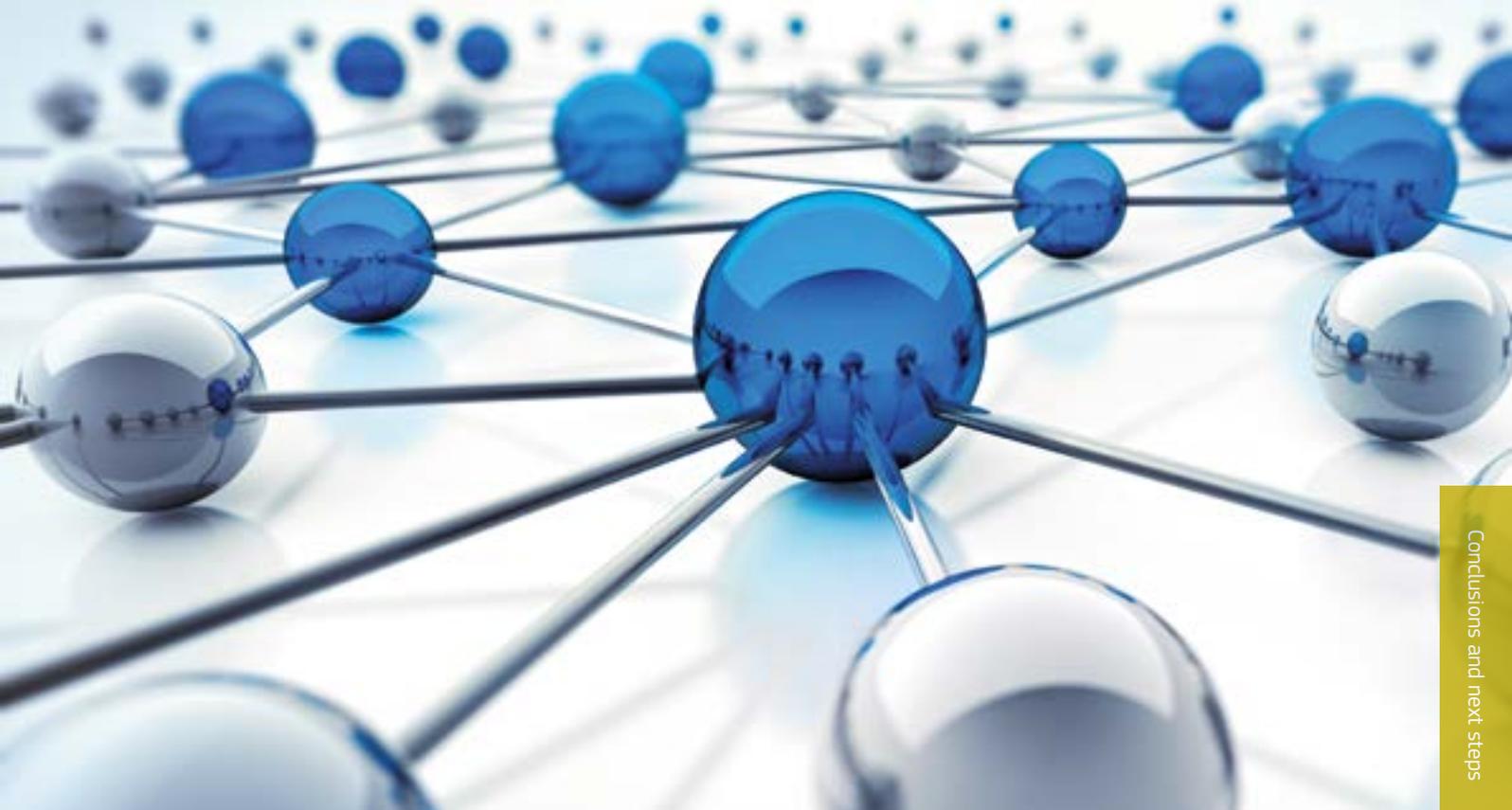
The EU has demonstrated on many occasions (and in many policy areas) that it is able to establish resilience procedures, providing significant benefits to its Member States. While some mechanisms inevitably work better than others, at

131 - U.S. Commodity Futures Trading Commission (CFTC) and U.S. Securities and Exchange Commission (SEC), Findings regarding the market events of May 6, 2010: report of the Staffs of the CFTC and the SEC to the joint advisory committee on regulatory issues, CFTC and SEC, Washington, September 2010: <http://www.sec.gov/news/studies/2010/market-events-report.pdf>

132 - OECD Reviews of Risk Management Policies, ‘Future Global Shocks: improving risk governance’, OECD, Paris: <http://www.oecd.org/governance/48329024.pdf>

133 - The Global Risks 2015 Interconnections Map: <http://reports.weforum.org/global-risks-2015/#frame/10e05>

134 - World Economic Forum (WEF), Global Risks Report, 10th edition, WEF, Geneva, 2015: <http://www.weforum.org/reports/global-risks-report-2015>



the very least the EU provides a strong platform for collaboration among its 28 Member States, and sometimes beyond. This platform supports existing policy areas and can also be used to address future issues, including cross-cutting ones. At the core of the platform are the EU Treaties, signed by all 28 EU Member States, which provide common, trustworthy governance for all, based on common values, and the institutions created and supported by these Treaties. The EU is well prepared, and has proven its resilience on many occasions. In many other regions of the world, nations would have to start from scratch if they wanted to come to a supranational agreement on just one urgent policy issue.

Under future tight global competition and with an essential need for collaboration among trustworthy partners, staying resilient will not be easy. It will require a suitable political framework and a forward-looking approach towards the close alignment of policy instruments in different areas. And it will need continued solidarity among like-minded, reliable partners.

The next step for European resilience considerations could be to try to cut across policy areas and to mainstream resilience into all of them. This will demand a good understanding of the limits of the planet's resources and of the

impact of measures in one policy sector on neighbouring sectors. In tomorrow's world, which can be expected to be even more complex and interconnected than that of today, this task will only be feasible with solid scientific support in terms of modelling and simulation.

Global risk and global resilience

W. J. Ammann
Global Risk Forum

The combination of the world's growing economy, accelerated urbanisation and expanding globalisation is leading to increased vulnerability and thus aggravating the risk potential for all communities and nations worldwide.

Fukushima has impressively revealed how a single natural hazard can trigger cascading effects, which can mount up to drastic losses for people and cause enormous damage to people and the economy, and erase technologies – not to forget about the very-long-lasting impact on ecosystems, the foundation for our human life and welfare. The overall risk landscape is constantly changing and becoming more and more complex at an accelerating pace. The exponential demand in energy, water, and resources in contrast to their limits, emerging new political constellations, increasing migration due to economic and social disparities or environmental degradation, the still growing divergence of the financial markets and the real economy, the decoupling of production and markets, respectively of the primary, secondary and tertiary sector, emerging diseases and a healthcare infrastructure stressed by pandemics economic volatility, risks to cyber-infrastructure, decaying physical infrastructure, demographic changes with a constantly ageing population, and many other reasons are increasingly causing national, regional and global tensions and risk patterns, which ask for new strategies and alliances. Yet we have no choice, but must also accept that climate change, desertification and loss in biodiversity

will heavily influence global risk patterns, affecting all sectors of our communities in every region of the world, and gravely increase humanity's overall vulnerability to risks.

It is obvious that our societies have not had the time to adapt to such rapid global change. We live in a world of increasing dynamism and volatility, where technology and greater interconnectedness have accelerated change and altered the way people live. It is therefore necessary to adapt current practices and develop strategies that adequately respond to modern critical threats, and to the limits of our planet in terms of resources and waste absorption capacity.

Despite the many emerging risks with an alarming increase of human and economic losses in recent times, fortunately there are also many new achievements in risk reduction and disaster management strategies in recent years. A unified process for global collaborative risk reduction and disaster management efforts is increasingly gaining acceptance. In May 2014, the OECD adopted recommendations on the governance of critical risks¹³⁵. The UN World Conference on Disaster Risk Reduction, held in March 2015 in Sendai, Japan, has led to promising commitments of the many member states on how to cope with risks and disasters on national, regional and even global scales¹³⁶. And there is hope that the UN Climate Change Conference COP21¹³⁷ in Paris at the end of 2015, the debates on the UN Sustainable Development Goals, and the UN World Humanitarian Summit¹³⁸ in the next couple

135 - OECD (2014): Council Recommendation on the Governance of Critical Risks: http://www.oliverwyman.com/insights/publications/2014/may/oecd-recommendation-on-the-governance-of-critical-risks.html#_VV4f1kawkhQ

136 - UNISDR, *Sendai Framework for Disaster Risk Reduction 2015-2030*, UNISDR, 2015; document A/CONF.224/CRP.1, 18 March, 25p: http://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

137 - UN Climate Change Conference COP21: <http://www.cop21.gouv.fr/en>

138 - UN World Humanitarian Summit: <https://www.worldhumanitarianism.org/>



of months will further progress and enable promising solutions towards a resilient society.

As some of the threats listed above have the potential to substantially destabilise or even lead to the partial collapse of our global economy and social welfare, it is important to strengthen their stability by all means, in particular by favouring resilient systems and procedures.

Following the Rockefeller Foundation's definition for resilience¹³⁹, it is "the capacity of individuals, communities and systems to survive, adapt, and grow in the face of stress and shocks, and even transform when conditions require it".

Building resilience requires joint action and shared responsibilities at local, national and international levels, by the public and private sectors, local communities and nongovernmental organisations – a trilateral cooperation. Such a holistic, trans-sectorial approach will facilitate the development of systems and processes that will allow for economic, political, and structural resilience and stability. Governments have a responsibility to develop and resource strategies to support the resilience of their populations and infrastructure, and to meet the needs of future generations.

Concerted action is thus required. The European Commission, with its dedicated focus on 'Better Regulation'¹⁴⁰, is in an excellent position to provide the necessary platform for a trilateral partnership and cooperation between the Commission and Member States, the private sector, and civil society to develop the necessary strategy for a holistic resilience approach. And as substantial research efforts are still needed, the Commission and its Member States can also provide a valuable test bed to study the most effective and efficient measures to strengthen resilience. In the future, transborder and trans-sectorial effects will increase in frequency and intensity. Member States, the private and the civil sector can substantially profit from a concise EU resilience strategy, which recognises and rewards the value of resilience to individuals, households, communities and countries. It also requires a commitment to a new vision that includes shared responsibility for resilience and one that puts resilience at the forefront of the European Union's public policies.

139 - Rockefeller Foundation, *Building Climate Change Resilience*, Rockefeller Foundation, 2009: see <http://www.rockefellerfoundation.org/our-work/topics/resilience/> accessed 15 March 2015

140 - Better Regulation: http://ec.europa.eu/smart-regulation/index_en.htm

Resilience through trilateral collaboration

J. Jacometti

Jacometti Associates

In our modern and globally interconnected world, it is clear that no country can work towards resilience in splendid isolation. Developing resilience strategies means building reliable alliances with others, based on a profound understanding of the limits of our planet.

As a supranational organisation, using its right to propose European legislation, the European Commission is uniquely positioned to significantly improve resilience in EU Member States by engaging collaboration and solidarity mechanisms across all policy domains.

This was a main finding of the workshop 'Thinking the Impossible' hosted by the JRC in May 2014. Stakeholders from academia, NGOs and industry came together to discuss resilience issues and to consider predictions of possible societal collapse.

The workshop participants discussed the interactions between environmental challenges, limits on natural resources, instabilities in the economy and in financial markets, and challenges to social cohesion. The approach of most economic actors at present is that of maximising short-term profit and leaving 'others' – whoever they are – to manage the risks. To change this approach will require a step change in the collaboration between governments, industry and NGOs.

Several prominent voices^{141,142,143} have raised similar opinions in the recent past. Their concerns are being acknowledged

more and more, recognising that there are major challenges ahead, and that the time to address them is short.

Trilateral collaboration and the Commission's Better Regulation initiative

The regulatory framework in which businesses operate is a key factor for a successful future. The European Commission's Better Regulation initiative and its objective "to deliver EU policies and laws, which bring the greatest benefits to people and businesses in the most effective way", should consider resilience as one of its elements. This would create a regulatory framework targeted at solidarity and collaboration in all policy domains, providing significant added value for the EU Member States.

But the governmental approach alone will not be sufficient. A collaboration between the private sector, public services and NGOs is required, as presented in our workshop 'Global Resilience – Trilateral Collaboration' in January 2015, with participants from the European Commission, national government, the corporate sector (including energy, chemicals, financial, public relations and business assurance) and NGOs, (including The Transition Network, the European Climate Foundation, the Fraunhofer Society, the Global Risk Forum and the Institute for Integrated Economic Research private-sector work on resilience was also presented and discussed on this occasion^{144,145,146}. The goal of close collaboration across different stakeholder communities is achievable, given inspiring leadership. The successful collaboration in

141 - Professor Sir John Beddington, <http://www.govnet.co.uk/news/govnet/professor-sir-john-beddingtons-speech-at-sduk-09>

142 - Wolf, M., *The shifts and the Shocks: What we've learned – and have still to learn – from the financial crisis*, Penguin Press, New York, 2014

143 - 'Is global collapse imminent?', *Research Paper Series No. 4*, August 2014, Melbourne Sustainable Society Institute, University of Melbourne, Melbourne, 2014: http://sustainable-dev.unimelb.edu.au/sites/default/files/docs/MSSI-ResearchPaper-4_Turner_2014.pdf



the period around 2003-2009 between government, business and civil society, focusing on sustainable mobility, is an example, which led to fuel efficiency improvements well beyond those expected. The regulations implementing these improvements have had a major global impact, since they have become an important point of reference for countries outside the EU.

Creating a step change in trilateral collaboration across the EU and beyond

To significantly enhance resilience in the light of global systemic risks, it is necessary to build on the initiatives mentioned above, and develop a step change in trilateral collaboration.

Concrete next steps must be embedded into an institutional setting and should include:

- Selection of 'change agents/champions' in government, the corporate sector and civil society
- Cooperating with these change agents to engage their organisations and their respective sectors in the analysis of resilience
- Development of an in-depth understanding of what lifestyle changes are needed, including decarbonisation and relocalisation, and of how to ensure they happen

- Assessing the potential of the internet, social media, etc. to initiate global change and to enhance the convergence of social and technological innovation, whilst involving both the public and private sector
- Developing senior leaders' understanding of resilience analysis. An example could be taken from the military sector, which uses immersive scenarios, in combination with a 'war-gaming' approach, to effectively address complex challenges.

Concerted efforts are required, and the ideal starting point for a resilient and competitive future for Europe could be the new European Commission's focus on Better Regulation.

In the eyes of the author, the European Commission should take the lead.

144 - Shell Scenarios: <http://www.shell.com/global/future-energy/scenarios.html>

145 - DNVGL Group, *Next – a safe and sustainable future*, DNV GL Group, 2014: http://issuu.com/dnvgl/docs/next_a_safe_and_sustainable_future/1

146 - European Climate Foundation initiatives: <http://europeanclimate.org/home/how-we-work/>

Authors

Important note:

Many of the JRC contributions in this report were compiled in a team effort, headed by the lead author mentioned in each contribution. For clarification, the list of authors below is limited to individual authors and lead authors.



Said Abousahl
Head of Unit, Nuclear Safety and Security
European Commission
Joint Research Centre



Florika Fink-Hooijer
Director, Strategy, Policy and International
Co-operation
European Commission
DG Humanitarian Aid and Civil Protection



Delilah Al Khudhairy
Head of Unit, Global Security
and Crisis Management
European Commission
Joint Research Centre



Georg Fischer
Director, Analysis, Evaluation,
External Relations
European Commission
DG Employment, Social Affairs and Inclusion



Walter J. Ammann
President/CEO
Global Risk Forum GRF Davos



Enrico Giovannini
Professor of Statistical Economics
University of Rome Tor Vergata



Giovanni Bidoglio
Head of Unit, Water Resources
European Commission
Joint Research Centre



Neil Hubbard
Head of Unit, Monitoring Agricultural
Resources
European Commission
Joint Research Centre



Antonio Campinos
President, Office for Harmonization
in the Internal Market (OHIM)



Jack Jacometti
Partner
Jacometti Associates



Francesca Campolongo
Head of Unit, Financial and Economic Analysis
European Commission
Joint Research Centre



Stephan Lechner
Director, Institute for the Protection
and Security of the Citizen
European Commission
Joint Research Centre



Gaby Lenhart
Senior Research Officer, Innovation
European Telecommunications Standards
Institute (ETSI)



Marco Ratto
Scientific/Technical Project Officer,
Financial and Economic Analysis Unit
European Commission
Joint Research Centre



Olivier Luyckx
Head of Unit, Crisis Management
and Fight against Terrorism
European Commission
DG Migration and Home Affairs



Klaus Regling
Managing Director
European Stability Mechanism (ESM)



Marcelo Masera
Head of Unit, Energy Security,
Systems and Market
European Commission
Joint Research Centre



Björn Stigson
Former President,
World Business Council
for Sustainable Development



Tibor Navracsics
European Commissioner for Education,
Culture, Youth and Sport,
responsible for the JRC



Vladimír Šucha
Director-General
of the Joint Research Centre,
European Commission



Ciarán Nicholl
Head of Unit, Public Health Policy Support
European Commission
Joint Research Centre



Margareta Wahlström
Special Representative
of the UN Secretary-General
for Disaster Risk Reduction
The United Nations Office
for Disaster Risk Reduction (UNISDR)



Jean-Pierre Nordvik
Head of Unit, Digital Citizen Security
European Commission
Joint Research Centre



Anders Wijkman
Co-President
The Club of Rome



Martin Porter
Fellow
European Climate Foundation



Alessandra Zampieri
Head of Unit, Maritime Affairs
European Commission
Joint Research Centre

The challenge of resilience in a globalised world

European Commission
Joint Research Centre
<https://ec.europa.eu/jrc>

Abstract

Resilience determines the capacity to successfully deal with difficult events and to adapt and overcome adversity. It creates stability in a changing world which in turn promotes job creation, economic growth and environmental sustainability. Resilience is a fundamental prerequisite for Europe as the largest integrated economic area in the world and has an important social dimension which requires the active cooperation of all stakeholders; citizens, the private sector, governments and NGOs included.

This report discusses the concept of resilience from different perspectives and the role of science in the continuous process of building a resilient, stable, competitive and prosperous Europe.

All images copyright European Union except:

Page 7 © maimu – Fotolia.com
Page 9 © der chris87 – Fotolia.com
Page 11 © TTstudio – Fotolia.com
Page 17 © demarco – Fotolia.com
Page 21 © gkrphoto – Fotolia.com
Page 23 © Mikael Damkier – Fotolia.com
Page 25 © Shaiith – Fotolia.com
Page 31 © Spacekris – Fotolia.com
Page 33 © Jürgen Fälchle – Fotolia.com
Page 35 © Kange one – Fotolia.com
Page 37 © Julien Eichinger – Fotolia.com
Page 39 © Zsolnai Gergely – Fotolia.com
Page 43 © kuzmafoto – Fotolia.com
Page 45 © FA – Fotolia.com
Page 47 © Courtesy of Richard Burton – Pixabay.com
Page 49 © Marina militare
Page 51 © Minerva studio – Fotolia.com
Page 55 © Courtesy of Michael Schwarzenberger – Pixabay.com
Page 57 © Science photo library
Page 59 © Brian Jackson – Fotolia.com
Page 63 © Mila Grigoric – Fotolia.com
Page 65 © psdesign1 – Fotolia.com
Page 67 © Sondem – Fotolia.com
Page 69 © Dragonimages – Fotolia.com
Page 70-71: all authors' images copyright of each author

EUR 27280 EN - The challenge of resilience in a globalised world

2015 - pp. 72 – 21.0 x 29.7 cm

JRC 96313

EUR – Scientific and Technical Research series

Print	PDF
ISBN 978-92-79-48438-4	ISBN 978-92-79-48439-1
ISSN 1018-5593	ISSN 1831-9424
doi: 10.2788/010872	doi: 10.2788/771635
LB-NA-27280-EN-C	LB-NA-27280-EN-N

Luxembourg: Publications Office of the European Union, 2015

© European Union, 2015

Reproduction is authorised provided the source is acknowledged. For any use or reproduction of individual photos, permission must be sought directly from the copyright holders.

Legal Notice

Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

The opinions expressed are those of the authors only and should not be considered as representative of the European Commission's official position.

JRC Mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society
Stimulating innovation
Supporting legislation



JRC Science Hub
ec.europa.eu/jrc

 [Science@EC](https://twitter.com/Science@EC)

 [JRCAudiovisuals](https://www.youtube.com/JRCAudiovisuals)

 [JRC Company Page](https://www.linkedin.com/company/jrc)

  [EU_ScienceHub](https://www.facebook.com/EU_ScienceHub)



Publications Office

ISBN 978-92-79-48439-1