RESILIENCE
The 2nd International Workshop on Modelling of Physical, Economic and Social Systems for Resilience Assessment

14-16 December 2017
At the Joint Research Centre
Ispra, Italy
International workshop on Modelling of Physical, Economic and Social Systems for Resilience Assessment

The Joint Research Centre of the European Commission in close collaboration with NIST (National Institute of Standards and Technology, US Department of Commerce) and Colorado State University is organizing the 2nd International Workshop on Modelling of Physical, Economic and Social Systems for Resilience Assessment on 14-16 of December 2017.

This follows the 1st International Workshop on Modelling of Physical, Economic and Social Systems for Resilience Assessment which took place in Washington, DC on 19-21 of October 2016, and was organised by NIST and Colorado State University.

Interest in resilience has been rising rapidly during the last twenty years, both among the policy makers and academia, as a response to increasing concern about the potential effect of shocks to individuals, civil infrastructure, regions, countries and social, economic and political institutions. The objective of the workshop is to bring together the scientific community and policy makers towards developing better policies and practices incorporating the element of resilience in various fields.

The JRC therefore will build on previous experience acquired during the JRC and the European Political Strategy Centre (EPSC) annual conference “Building a Resilient Europe in a Globalised World” which took place in September 2015. This workshop was aimed at identifying strategic needs and providing an outlook of future policy making actions.

This 2nd International Workshop that will take place in 2017 aims at building on the experience gained from these previous events focusing both on the high-level strategic needs and on the current scientific advances on modelling of physical, economic and social systems. The goal is to explore how these are linked in order to support resilience assessment in various dimensions.

It aims to:

- Bring together the most up-to-date knowledge in the field of resilience across different disciplines.
- Establish the dialogue between policy and research with a two-fold scope: to provide scientific advice and support for policies that incorporate the element of resilience, and to provide guidance to the scientific community on the knowledge and tools needed to support current and future policies.
- Contribute towards establishing a coherent resilience assessment framework for communities and societies.
• Identify the constituents for measuring the resilience at various scales (local, regional, national, international) towards establishing the necessary indicators.

• Establish a long-standing partnership among the key actors in the area of resilience at global level that will support the continuous development of models that fit into the assessment framework and consequently the respective training curricula.

The following dimensions will be covered:

• Resilience of technological systems (e.g. electricity, gas, water, transport) that provide essential services to citizens during normal conditions as well as during crises.

• Resilience of the built environment, thus civil engineering structures that need to guarantee a certain level of functionality both in terms of safety as well as in terms of business continuity and socioeconomic services that are supported by these buildings.

• Resilience of communities and societies to cascading effects that propagate across infrastructures and networks of infrastructures.

• Economic and societal resilience of modern societies and communities during shocks but also to longer term adaptations.

• Resilience of individuals, depending on social and economic contexts, as well as interdependency relationships between individuals and the rest of the society (being communities or national institutions) with respect to risk assessment, risk mitigation and post-crisis recovery.

• Resilience to changes brought about by population growth, utilization requirements, and environmental conditions.
# Preliminary Program

## 14 December 2017 Plenary

**Chairs:** Francesca Campolongo / Georg Peter  
**Room:** Auditorium, building 58c

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00-09:15</td>
<td>Resilient Societies</td>
<td>Vladimír Šucha – Director General of the Joint Research Centre, European Commission</td>
</tr>
<tr>
<td>09:15-09:30</td>
<td>Introduction &amp; Background</td>
<td>Howard Harary - NIST Engineering Lab Director, the US DoC</td>
</tr>
<tr>
<td>09:30-10:00</td>
<td>JRC’s Resilience Framework to support EU policies</td>
<td>Anna Rita Manca, Joint Research Centre of the European Commission</td>
</tr>
<tr>
<td>10:00-10:30</td>
<td>US’s Approach to Resilience</td>
<td>Therese Mc Allister – NIST, the US DoC</td>
</tr>
<tr>
<td>10:30-11:00</td>
<td>Coffee break with signature of MoU JRC - INERIS</td>
<td></td>
</tr>
<tr>
<td>11:00-12:15</td>
<td>Resilience in Policy Making</td>
<td>Panel Discussion – chair Peter Benczur, Joint Research Centre of the European Commission</td>
</tr>
<tr>
<td>12:15-12:45</td>
<td>Evaluating Risk from a holistic Perspective to improve Resilience: The United Nations Evaluation Level</td>
<td>Mabel-Cristina Marulanda Fraume – UNISDR</td>
</tr>
<tr>
<td>12:45-14:15</td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>14:45-15:15</td>
<td>The Building Blocks of Resilience</td>
<td>Tabajara Dias de Andrade – Latin America Development Center</td>
</tr>
<tr>
<td>15:15-15:45</td>
<td>The Centre of Excellence for Risk-based Community Resilience Planning</td>
<td>John Van de Lindt – Colorado State University</td>
</tr>
<tr>
<td>15:45-16:15</td>
<td>Coffee Break</td>
<td></td>
</tr>
<tr>
<td>16:15-16:45</td>
<td>The Evolution of Risk Assessment for the Evolution of the future complex and interconnected physical, economic and social Systems</td>
<td>Enrico Zio- Politecnico di Milano</td>
</tr>
<tr>
<td>16:45-17:15</td>
<td>The main challenges of technological systems’ resilience</td>
<td>Samantha Lim Thiébot - Ineris</td>
</tr>
<tr>
<td>17:15-17:45</td>
<td>Wrap-up Plenary Session</td>
<td>Bruce Ellingwood – Colorado State University</td>
</tr>
<tr>
<td>17:45-18:00</td>
<td>Closing First Day</td>
<td>Georg Peter – Head of Unit, Joint Research Centre of the European Commission</td>
</tr>
</tbody>
</table>
Session: Modelling Techniques for increasing the Resilience of Critical Energy Infrastructure

Chair: Heinz Wilkening  Room: Auditorium, building 58c

Rational: Both the gas and electricity grids are belonging to the critical energy infrastructure. Especially the electricity transmission- and distribution-grid is facing a revolution in many ways. The first drastic change in paradigm is that electricity production in the future will not follow demand as it was the case in the past because of the ever increasing amount of intermittent renewables, which have to be integrated. Furthermore, whereas in the past electricity was mainly generated in those places where it was also consumed, in the future this won't be the case anymore for two reasons. Firstly, favorable places for generation of renewable energies are not necessarily those, where the energy is consumed, e.g. offshore-wind. Secondly, the market liberalization will allow for transporting electricity over longer distances, even across borders. One enabler of these changes is an increased level of ICT used at the level of operating the transmission- as well as distribution grids. Nevertheless ICT can also jeopardize the security of supply thus resilience of the energy systems if one thinks about cyber-attacks. There are also other aspects, e.g. at the communication, information and/or socio-economic levels, which need to be considered in this energy revolution ahead. These aspects can also jeopardize the resilience of our energy supply. The overall system has to be seen as a complex multi-level system, which cannot be studied by experiments or traditional modelling techniques. Therefore new modelling techniques are essential to assure resilience during this transition phase. Co-simulation is a new modelling method, which can be used to describe and simulate such complex heterogeneous multi-level systems with an acceptable amount of effort.

Speakers:
- Alfonso Valdes – An ontology model for a Resilient Microgrid Ecosystem
- Heinz Wilkening – Evaluating the potential of demand side management to increase the resilience of the electric distribution grid
- Jianjun Qin – Probabilistic modeling of robustness and resilience of power grid systems
- Mathaios Panteli – Power systems Resilience to high-impact, low-probability events: Probabilistic impact assessment
- Kwabena Addo Pambour – SAINT: A novel simulation and optimization tool for analyzing potential synergies and bottlenecks of interconnected multi-vector energy systems
- Peter Palensky – C-simulation based smart grid fault anticipation and response
- Vytis Kopustinskas – Resilience evaluation of the natural gas transmission network

Session: Social and Economic Resilience

Chair: Anna Rita Manca  Room: IPR-101/1003

Rational: Interest in resilience has been rising rapidly during the last twenty years, as a response to increasing uneasiness about potential shocks that would test the limits of the coping capacities of individuals, regions, countries and institutions (e.g. digital innovation, demographic change, climate change, globalization or immigration and that we cannot hope to eliminate. Political discussions often tackle resilience from the economic perspective. However more and more often it is also recognized that understanding and building resilience requires considering the society as a whole - people, businesses, institutions, as well as the environment - and taking a “system view”. This session presents a collection of papers that contribute to this research avenue.
Speakers:
Tadas Leoncikas – Self-perceived resilience: findings from the European Quality of Life Survey 2016
Elton Beqiraj – Resilience contagion and vulnerability to external financial crisis in CEE countries
Martina Cecchini – On the dynamics of cooperative behavior in social dilemmas and in relevance for more resilient energy systems
Elaina Sutley – What causes housing recovery
Carlo Lavale – A composite policy tool to measure territorial resilience capacity
Michael Faber – On metrics in the modelling and optimization of resilience
Dominic Wittmer – Economic Resilience and raw materials supply of the EU

Session: Resilience of Critical Infrastructures and the Built Environment to Natural Hazards

Chair: Elisabeth Krausmann
Room: IPR-100/1003

Rational: Natural hazards, such as earthquakes, floods, or storms may have significant socio-economic impacts in terms of injuries/casualties, disruption of essential services, reconstruction costs, etc. They can also cause major accidents at hazardous industry (so-called Natech accidents). The session will comprise a set of presentations, where speakers will illustrate the latest developments in the area of resilience of physical assets (critical infrastructures and the built environment) to natural hazards, and a closing discussion, where participants will identify knowledge gaps and challenges for increased resilience.

Speakers:
Guanjie Hou – Dynamic modelling of traffic networks immediately after earthquake using agent-based model
Naiyu Wang – Modelling the post disaster recovery of community building portfolios considering utility disruptions
Charles Nicholson – Modelling engineering, economic and social factors in recovery from natural disaster
Pierre Gehl – Integrated modelling of multi-hazard functionality loss of transport infrastructure and economic cascading effects
Antonis Kostaridis – CIPR: a multi hazard impact assessment software for critical infrastructures
Giulio Zuccaro – All-hazard simulation-based impact scenario assessment methodology as decision support tool in resilience-based planning and emergency management

Session: Resilience to Food Insecurity and Crisis

Chair: Francois Kayitakire
Room: IPR-100/2102

Rational: Taking stock of recent advances and challenges, the session will focus on recent developments of methods to assess and monitor progress on resilience building for food and nutrition security in developing countries. In the last 5 years, several methods have been developed and tested in the field. However, they all face various challenges that prevent them from being globally applied. The sessions would be the opportunity to present recent developments in that field.

Speakers:
Nigussie Tefera – Measuring Resilience: Lessons learned from alternative approaches
Joanna Upton – Food security as resilience: reconciling definition and measurement
Christophe Béné – Reconciling the need for rigour with the reality on the ground in resilience measurement
Mariam Sow Soumare - Building community resilience through agriculture and food insecurity Risk management
Nazia Mintz-Habib – Shaping food innovation systems in responsive to urban food insecurity and climate change
Jose M Rodriguez-Llanes – Measuring food security resilience to droughts in Niger

15 December-Afternoon Parallel Sessions 14:00h-17:30h

Session: Resilience in Migration Policies
Chair: Thomas Barbas Room: IPR-101/1003

Rational: The discussion will aim at investigating what could be the application of the concept of resilience to migration policy. The panel would contribute to a broader JRC project aimed at the establishment of indicators regarding migration vulnerabilities and their possible determinants. It would lay down the ground work for the measurement of resilience by taking stock of the existing knowledge on indicators on shocks and structural changes in areas such as migration and asylum, identifying possible typologies of vulnerabilities and their potential effects on national migration and asylum systems.

Speakers:
Robert Stojanov – What is the role of environmental factors in current immigration flows to Europe?
Christof Roos - What is resilience in migration governance? A concept across sectors and jurisdictions
John Hummel – Understanding the physical, environmental, economic and social factors that contribute to environmentally driven migration
Lucie Cerna – Resilience of immigrant students
Marco Scipioni - Identifying and Measuring Disproportionate Migratory Trends in a Regional Polity: The Case of the European Union
Sara Grubanov-Boskovic - Labour market resilience: new challenges for labour market integration of migrants in the era of automation

Session: Conflict Resilience in post-conflict societies: Urban and rural dynamics
Chair: Matina Halkia Room: IPR-100/2102

Rational: In the context of EU resilience, effective crisis response is a tool to sustaining the pressures EU faces from external stressors in the process of upholding its socio-economic and political principles. In the context of violent conflict, conflict resilience is a tool to effective crisis response. Conflict resilience has fundamental specificities: i) it constitutes of positive factors, and strengthening strategies, not only of vulnerabilities and fragilities; ii) depending on the context, it has endogenous characteristics which may not be easily quantifiable, and depend on unseen linkages and connections; iii) it does not easily fit into the engineering concept of resilience, as the "original state" is not a desired outcome, but rather it is the transformation opportunities which provide successful resilience outcomes; iv) chronic stresses are fundamental to measuring conflict resilience, as duration models and fatigue are considered key to conflict resilience modelling. v) it can be identified as negative and positive resilience, the former being an undesired type of resilience to a subjective viewpoint.

Speakers:
Vincent Stueber – Tipping point of conflict dynamics  
Nils Metternich - Conflict resilience in post-conflict societies: Urban and rural dynamics  
Mayeul Kauffmann - Resilient to oppression and to violent conflict escalation through nonviolent action  
Justin Ginetti – Internally Displaced People: Temporal indicators and conflict resilience  
Speaker TBC - Quantitative dimensions of conflict resilience in urban conflict  
Matina Halkia - Conflict resilience in the Global Conflict Risk Index (GCRI)

Session: Resilience Decision Support Tools

Chair: Therese McAllister Room: IPR-100/1003

Rational: A number of decision support systems have been developed with the scope to improve resilience. Some of the target community actors, some policy actors, some the company boards etc. Some others target specific hazards or infrastructures. Should we strive towards the ultimate decision support tool? And what can each tool learn from the others?

Speakers:
- Linda Bellamy – The resilient bow-tie and decision-making under uncertainty
- Francisco Perales – Method RM2: A different way of assessing resilience
- Marco Cinelli – Classification models for the risk assessment of energy accidents in the natural gas sector
- Jennifer Helgeson – Modeling the resilience dividend: an approach for quantifying co-benefits of community resilience planning
- Richard Little – Restoration of community services following an extreme event: the interdependencies of social and civil infrastructures
- Ken Harrison – Math programming to facilitate exploration of decision alternatives for community resilience planning

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Chairperson/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 December</td>
<td>Plenary</td>
<td>Auditorium</td>
</tr>
</tbody>
</table>
| 17:30-18:30  | Wrap-up & Closure 2nd day          | Bruce Ellingwood – Colorado State University  
|              |                                    | Dan Chirondojan – Director, Joint Research Centre of the European Commission |

16 December-Morning Parallel Sessions 9:00h-12:30h

Session: Engineering Methods for Earthquake-Resilient Cities

Chair: Giorgos Tsonis Room: IPR-101/1003
Rational: Earthquakes are a major threat to communities in several parts of the world and a number of events that have hit densely populated areas or ones where significant economic activities were hosted, have shown that the consequences, e.g. casualties, economic losses and disruption of services, may be disproportionate to the damage of the built environment and that significant time and resources are necessary to regain pre-event conditions. In response to this, the earthquake engineering research community has made significant progress, well beyond the elaboration of conceptual resilience frameworks, towards the development of methods to design for resilience. The session will illustrate the state-of-the-art on engineering methods to increase the resilience of individual structures and urban areas to earthquakes.

Speakers:
- Bruce Ellingwood – The role of performance-based engineering in achieving community resilience
- Juan Gutierrez – Displacement-based design of earthquake robust/resilient buildings
- G. Cimellaro – Smart cities to improve resilience of communities
- Anna Bozza – A multi-scale approach to infrastructural resilience: from urban environment to the building scale
- Hussam Mahmoud – Effect of seismic fragilities on resilience quantification of a steel hospital
- Himmet Karaman – Optimum shelter location tool development
- Daria Ottonelli – The seismic resilience of the built environment: the case of the masonry buildings

Session: Resilience Metrics

Chair: Megan Clifford Room: IPR-100/1003

Rational: The currently greatest challenge of resilience is its measurement. How much resilient is a community or infrastructure is almost impossible to answer today. The measure is missing as well as the measuring reference system. Recovery could be a possible measure however not everything needs to be recovered sometimes adaptation to new conditions maybe a more resilient path to take. Ecology and sociology cannot be compared with engineering and though a community needs to be resilient in all these aspects. In this session we shall talk about efforts to develop metrics for resilience and will try to conclude on what are the most important challenges still to be tackled.

Speakers:
- Maria Dillard – Developing an assessment methodology for community resilience
- Max Didier – Quantifying civil infrastructure system disaster resilience using the Re-CodeS framework
- Xiangyang Guan – Operationalising resilience as a process: introducing resilience triangle for empirical quantification of resilience
- Ellie Graeden – Linking risk to resilience: a quantitative method for communities to prioritise resilience
- Martha-Liliana Carreno – Measuring resilience using a comprehensive approach to assess disaster risk management performance
- Alexander Jovanovic – Comparing approaches of resilience assessment in the EU and the US: how to move towards a more aligned solution
- S. R. Uma – Engineering for resilience

Session: Complex Systems for Resilience

Chair: Giorgos Giannopoulos Room: IPR-100/2102

Rational: Understanding complex systems is a prerequisite for achieving resilience at community level. In fact modern societies rely heavily on critical infrastructures and lifelines for their functioning but also in the aftermath of a disruptive event (man-made, natural hazards, climate change) in order to support response
actions. However, modern infrastructures exhibit an intrinsic complexity that needs to be thoroughly understood in order to be in a position to forecast the extent of cascade effects through the network of interconnected and interdependent infrastructures. Although several approaches have been developed and proposed during the last years there is still a lot to be done in order to address this issue. This session will aim at shedding light on this hot topic by providing an overview of approaches, methods and tools that can be implemented by the relevant stakeholders. In addition, aspects such as interdependencies modelling, complex network theory as well as the links among technological and societal systems will be presented.

Speakers:

- Luca Galbusera - Control theory and resilience in CIs: a review
- Hussam Mahmoud – Community resilience assessment using discrete finite elements
- Robert Hanson – NextGen Decision support and visualisation for infrastructure protection
- Athanasios Sfetsos – How interconnected critical infrastructures can support societal resilience under future climate: The EU-CIRCLE approach
- Nathanael Rosenheim – Integration of detailed household characteristic data with critical infrastructure and its implementation to post-hazard resilience modelling
- Mateusz Dubaniowski – A framework for modelling flow of goods and services between businesses, households and infrastructure systems
- Andrea Meligi - The economic impact of the 2016-2017 Italian earthquakes with a Bi-regional IEMM approach

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Chairperson/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 December</td>
<td>Plenary</td>
<td>Auditorium</td>
</tr>
<tr>
<td>12:30-14:00</td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>14:00-15:00</td>
<td>Panel Discussion: Session Conclusions and Policy Relevance</td>
<td>Bruce Ellingwood – Colorado State University</td>
</tr>
<tr>
<td>15:00-15:10</td>
<td>Closure</td>
<td>Georg Peter – Head of Unit, Joint Research Centre of the European Commission</td>
</tr>
</tbody>
</table>
JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre’s mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub
EU Science Hub - Joint Research Centre
Joint Research Centre
EU Science Hub