

ROSS  
GEMINI CENTRE  
NTNU/SINTEF

SRA  
EUROPE



TRONDHEIM, NORWAY 17 - 19 JUNE 2013  
THE 22ND SRA-E CONFERENCE

# SAFE SOCIETIE2

COPING WITH COMPLEXITY AND MAJOR RISK

The SRA Europe annual meeting 2013 is arranged by ROSS Gemini centre, a group of researchers from Norwegian University of Science and Technology, SINTEF and NTNU Samfunnsforskning/Social Research.

The annual meeting is supported by the following organizations:

**Main sponsors:**

- Tryg
- Safetec Nordic
- NTNU Samfunnsforskning/NTNU Social Research

**Financial support:**

- NTNU Faculty of Engineering Science and Technology
- NTNU Faculty of Social Sciences and Technology Management

**Sponsors:**

- Routledge/Journal of Risk Research (drinks at poster session)
- City of Trondheim (welcome concert)



**SINTEF**



**SAFETEC**



# TABLE OF CONTENTS

Welcome to the SRA Europe annual meeting 2013 .....	1
Society for risk analysis Europe (SRA-E).....	2
Meeting to discuss a Nordic Chapter of SRA Europe .....	5
ROSS Gemini Centre .....	6
Welcome to Trondheim.....	11
Map over conference venue: Realfagbygget (Building of Natural Science).....	14
Practical conference information.....	15
Events .....	16
Program SRA-E 17-19 June 2013 .....	17
Monday morning .....	19
Monday mid-day .....	20
Monday afternoon.....	21
Tuesday morning.....	22
Tuesday mid-day.....	23
Tuesday afternoon.....	24
Wednesday morning.....	25
Wednesday mid-day.....	26
Keynote descriptions and abstracts .....	27
Gudela Grote, ETH Zurich.....	28
Bjørn Otto Sverdrup, 22 July Commision .....	29
Per Morten Schiefloe, Norwegian University of Science and Technology.....	30
Ann Bostrom, University of Washington.....	31
Nick Pidgeon, Cardiff University .....	32
Paul R. Amyotte, Dalhousie University.....	33
Presentation abstracts.....	35
Monday 17 June .....	36
Tuesday 18 June .....	75
Wednesday 19 June .....	110
Poster abstracts.....	133
Participants SRA-E 2013 with index .....	151

## ORGANIZING COMMITTEE

Prof. Dr. Stein Haugen, NTNU  
Ph.d candidate Inger Lise Johansen, NTNU  
Associate Prof. Dr. Eirik Albrechtsen, NTNU  
Researcher/Ph.d candidate Kristine Vedal Størkersen, NTNU Social Research

With help from Jens N. Kortner and many more

## SECRETARIAT

NTNU Videre:  
Chair: Siren Døhl Himle  
srae2013@videre.ntnu.no





## WELCOME TO THE SRA EUROPE ANNUAL MEETING 2013

It is a great pleasure for us to welcome you to the city of Trondheim and the Norwegian University of Science and Technology, for the 22<sup>nd</sup> Annual Meeting of the Society for Risk Analysis Europe. The conference is being organized by the ROSS Gemini Center, which comprises risk, reliability and safety researchers from several organizations, covering a wide range of disciplines. This is a reflection of the multi-disciplinary nature of our research areas.

To arrange the conference, we have received support from several organizations, which we are very thankful for. The Faculty of Engineering Science and Technology and The Faculty of Social Sciences and Technology Management have both provided financial support, in addition to the University providing conference facilities for free. NTNU Social Research, Tryg, Safetec Nordic, Routledge and Ashgate have also provided financial contributions and NTNU and SINTEF have provided resources to organize the conference. The management committees of SRA Europe and ROSS have also provided assistance, both to review and comment on the plans for the conference and to review abstracts and help structure the program. Finally, we would also like to thank the City of Trondheim for sponsoring the concert in the Nidaros Cathedral.

We hope that this conference will be a worthy successor in the already long list of successful SRA Europe conferences and hope that your time in Trondheim will be both useful and enjoyable.

The organizing committee for SRA-E 2013:

Stein Haugen  
Eirik Albrechtsen  
Inger Lise Johansen  
Kristine Vedal Størkersen

# SOCIETY FOR RISK ANALYSIS EUROPE (SRA-E)

## STUDENT SCHOLARSHIP AWARD

The SRA-E Conference Studentship Scholarships (each worth €500) have been awarded to:

- **Marijke Hermans**, Department of Technology and Society Studies, Maastricht University, Netherlands: The struggle for knowledge: The dynamics of citizen engagement in mobile phone mast siting controversies (Hermans, M.)  
(Session T20: Symposium: Understanding the societal dynamics around risk: learning from siting controversies II)
- **Eva Lermer**, Department of Psychology, Ludwig Maximilian University Munich, Germany: Risks are more likely when thinking concrete – The effect of construal level on risk estimates (Lermer, E., Streicher, B., Sachs, R., Raue, M., & Frey, D.)  
(Session M5: Risk assessment of health and security threats)

## WHAT IS THE SOCIETY FOR RISK ANALYSIS?

The Society for Risk Analysis (SRA), founded in 1981, represents the leading platform for interdisciplinary academic risk research. Its membership is multidisciplinary, interdisciplinary and international.

SRA provides an open forum for those who are interested in all aspects of risk analysis to share experiences, exchange ideas and to build co-operation in research and mutual support. It provides a fruitful opportunity for inter-generational and multinational exchange as well as for communication with stakeholders in industry, politics and society.

## WHY A EUROPEAN SECTION?

The Society for Risk Analysis Europe (SRA-E) was founded in 1987 as a section of SRA international to develop a special focus on risk related issues in Europe. SRA-E aims to

bring together European individuals and organisations with an academic interest in risk assessment, risk management and risk communication.

SRA-E emphasises the European dimension in the promotion of interdisciplinary approaches of risk analysis in science. Our activities are highly relevant to practical application in industry and governance. Since its founding SRA-E has matured and it is now a non-profit organisation with a separate legal status. Our Articles of Association can be found on our website: [www.sraeurope.org](http://www.sraeurope.org).

To foster strong and healthy relations between SRA-E and SRA International there is a "Memorandum of Understanding" that describes key principles of good practice and support. This can also be found on the website. There are a number of other active regional organisations in North America, Japan, Latin America, Australia, New Zealand and Russia.

## WHAT ARE THE ACTIVITIES OF SRA EUROPE?

SRA-E encourages and facilitates the communication among experts in all risk domains via general conferences and target focus meetings. The annual conference of SRA-E offers academics, researchers, students, policy makers, and industry representatives an opportunity to discuss 'state of the art' theory, research and policy relating to risk. We also discuss future directions and challenges in risk analysis and risk management. The annual conference takes place in various countries in Europe in order to enhance the access to SRA-E for members and risk interested people all over Europe. We are always keen to hear from SRA-E members that are interested in hosting the conference. Additional meetings and workshops focus on specific risk topics of SRA-E interest – building links with other associations or institutions helps to communicate, collaborate and develop new methodologies for risk analysis and risk management.

In the past we have addressed issues such as natural hazard, risk communication & electromagnetic fields, risk regulations & the precautionary principle etc. Further, SRA-E provides its members with risk related information with regard to activities & initiatives on scientific, political and industrial level. SRA-E offers also the platform for working groups on particular risk issues which need to be developed and enhanced.



## HOW IS SRA-E ORGANIZED?

An Executive Committee comprising eight members ensures the functioning of SRA-E. For certain tasks (e.g. conference host) coopted members join the committee. A permanent secretariat is established to strengthen the liaison between members and the organization, [sraeurope@eu-vri.eu](mailto:sraeurope@eu-vri.eu).

## WHY BECOME A MEMBER? WHAT ARE THE BENEFITS?

Membership of SRA-E carries automatic membership of the international Society for Risk Analysis, founded in 1981, with over 2000 members worldwide. SRA-E has around 300 members. Being a member of SRA-E offers multiple benefits. Members are part of the scientific community and can stay in touch with the latest news in research and practice in risk analysis. Members will also receive news of events and conferences worldwide. SRA-E helps members to become familiar with national and international policies on risk analysis.

Furthermore, SRA-E encourages members to network and exchange ideas with other professionals working on different areas of risk research. The Newsletter of SRA informs all members several times a year about what's going on in the Society. In addition, SRA-E regularly provides Europe-specific risk related information to its members. All members receive the journal *Risk Analysis* as part of their membership privileges and also have the opportunity to subscribe at a reduced rate to the *Journal of Risk Research*. You can become a member of SRA Europe through the SRA website [www.sra.org](http://www.sra.org) and by selecting the option to belong to the SRA Europe regional organisation.

## HOW CAN MEMBERS BECOME ACTIVE IN THE SOCIETY?

SRA-E welcomes new ideas and initiatives from members. Active members are the basis of the Society and of its future. If you have views or suggestions for improving SRA-E, then please do get in touch.

You could also become involved by standing for election to the SRA-E Executive Committee or by helping us with organizing a conference. You can contact the Executive Committee members directly or through emailing the secretariat: [sraeurope@eu-vri.eu](mailto:sraeurope@eu-vri.eu).

## SRA EUROPE EXECUTIVE COMMITTEE

President, councillor to SRA, website: Margôt Kuttschreuter

Secretary: Mathew White

Treasurer: Sophie Gaillard

President elect; conference organiser 2013: Lars Bodsberg

Conference organiser 2014: Seda Kundak

Awards Committee: Pia Schweizer

Past President: Ann Enander

Member: Michael Siegrist



## MEETING TO DISCUSS A NORDIC CHAPTER OF SRA EUROPE

This is an invitation to discuss the possibility of organizing a Nordic or Northern chapter of SRA Europe on **Monday 17 June 1800**.

The Northern part of Europe has a considerable number of persons, e.g. researchers, practitioners, consultants, administrators, etc., working with risk related issues and tasks (risk, safety, rescue operations, security, etc.) but very few of them are SRA-E members. Instead they may, or may not, be attached to national, other European or international risk related organizations. We believe that a more active SRA-E subdivision in this area could change the situation and contribute to attracting more members as well as stimulate to a more cooperative and active risk research environment in Europe.

The Executive Committee of SRA-E is positive to the initiative and has provided guidelines for the constitution of an individual chapter. Regarding the membership issue, SRA-E states that there will not be extra membership fees involved in this organizational specification within SRA-E. Instead, current and future members in the Nordic countries of SRA-E automatically become members of SRA-N; new members of SRA-N automatically become members of SRA-E by paying the SRA-E membership fee.

However, for organization of etc., SRA-E must allow the Chapter to include a finance function and a finance manager, as well as to apply for and use the raised funds within and for SRA-N activities.

At the meeting the following will be discussed:

1. Is there an interest large enough to organize a Nordic Chapter?

If the first question gets a positive answer:

2. A steering committee representing the Nordic countries that will develop bylaws and suggest Chair and Executive Committee, in time to the SRA-E Annual meeting in 2014.
3. Activities of the chapter e.g. Chapter meetings.

Most welcome!

Britt-Marie Drottz Sjöberg, NTNU, Norway  
Anna Olofsson, Mid Sweden University, Sweden



## ROSS GEMINI CENTRE

SRA Europe annual meeting 2013 is arranged by ROSS Gemini Centre in Trondheim.

### RELIABILITY AND SAFETY STUDIES AT NTNU/SINTEF

The ROSS Gemini Centre is a strategic cooperation between NTNU and SINTEF aimed at developing knowledge, methods and tools that can contribute to preventing accidents causing serious injury to people, damage to the environment and material values or that can threaten critical infrastructure.

The objective of the centre is to provide a solid basis for NTNU and SINTEF together to identify and realize opportunities to build robust and internationally renowned research groups within the safety and reliability area. Together, NTNU and SINTEF have one of the largest groups of researchers in the world within the safety and reliability field. The ROSS Gemini Centre is a contributor to bring together and present the joint resources and competence.

Another important activity for the ROSS Gemini Centre is to coordinate and develop the portfolio of courses and education provided by the ROSS partners. The courses cover safety and reliability aspects from different angles, from engineering and technology, through management and sociology to psychology. This means that all aspects of the Man-Technology-Organization perspectives on safety are covered. These courses are offered to master students and PhD candidates at NTNU, but in addition, a whole range of courses are also offered as continuing education courses.

ROSS also focuses on the development of joint project initiatives. This includes projects for the government and authorities, for industry and the research council and EU projects.

Some of the focus areas that the ROSS partners are working on are system reliability and RAMS, risk-based safety management, risk perception, organizational safety and the vulnerability of critical infrastructure. The knowledge we are developing is used in important areas like integrated operations, oil and gas activities in Arctic waters, protection of infrastructure and maritime industry. To a large extent, the knowledge is, however, generic and can be transferred to other application areas, where relevant.

More information about the ROSS Gemini Centre can be found at [www.ntnu.edu/ross](http://www.ntnu.edu/ross).



*The ROSS group of 2011/2012: Jan Hovden, Lars Bodsberg, Britt-Marie Drottz Sjöberg, Bjørn Egil Asbjørnslett, Jørn Vatn and Per Morten Schiefloe.*

Photo: Ingrid Loeng



The groups in ROSS Gemini Centre:

#### **RAMS GROUP, DEPARTMENT OF PRODUCTION AND QUALITY ENGINEERING, NTNU**

The RAMS (Reliability, Availability, Maintainability and Safety) group provides courses and performs research within reliability analysis, risk analysis and maintenance management. In addition to an extensive range of courses for the 5-year master studies at NTNU, the RAMS group also offers a 2-year international master program and a wide range of continuing education courses.

#### **HEALTH, ENVIRONMENT AND SAFETY GROUP, DEPARTMENT OF INDUSTRIAL ECONOMICS AND TECHNOLOGY MANAGEMENT, NTNU**

The HES group is the only university group in Norway that provides a 2-year master program in HES where engineering students and natural sciences students can apply. Safety, including safety management and risk governance are key areas in the study, covering all aspects of safety from minor occupational accidents to major accidents and catastrophes.

#### **RISK AND SAFETY MANAGEMENT OF MARINE SYSTEMS, DEPARTMENT OF MARINE TECHNOLOGY, NTNU**

The group provides master courses within "Safe Operation and Maintenance" and "Risk Analysis and Safety Management of Maritime Transport", in addition to continuing education courses. The group has established close cooperation with the maritime industry through research projects.

#### **CENTER FOR SAFETY AND HUMAN FACTORS, DEPARTMENT OF PSYCHOLOGY, NTNU**

The group is focusing on development and strengthening of scientific psychology within safety research. The areas the group is working within include different perspectives on safety, human factors research and risk psychology. The aim is to contribute to research on NTNU within these areas and continue to develop a strong international network.

#### **STUDIO APERTURA, NTNU SAMFUNNSFORSKNING/SOCIAL RESEARCH**

Studio Apertura has developed significant activity within safety related research over the last 10 years, with organizational theory as a basis and starting point. The research group is multidisciplinary, with background from i.e. psychology, sociology, anthropology, pedagogy, geography and technology.

#### **ELECTRIC POWER SYSTEMS, SINTEF ENERGY**

The department is working on different aspects of analysis of energy systems and critical infrastructure. Important areas are risk based planning, operation and maintenance of electric power systems (including offshore wind), risk and vulnerability analysis with main focus on High Impact Low Probability events, vulnerability indicators, failure statistics and smart grids.

#### **SAFETY RESEARCH, SINTEF TECHNOLOGY AND SOCIETY**

The department combines engineering science and social science knowledge within risk and vulnerability to perform analyses and develop new knowledge about the interaction of human, technology, organizations and safety.





Tryg | 

Sustainable risk management through collaboration and targeted prevention initiatives



## Major risk reduction since 1984

Safetec is a leading provider of risk management services. With an integrated approach to technical, human and organizational aspects, Safetec is a full range supplier of services within risk, reliability and emergency preparedness.

Safetec has provided services to worldwide offshore, maritime and land based industries since 1984.

Safetec help customers:

**Control risk**

**Increase safety**

**Improve health and environment**

**Enhance profit**







## WELCOME TO TRONDHEIM

Trondheim is situated in the middle of Norway in the county of Sør-Trøndelag, where the river Nidelven flows into the Trondheim fjord. It is the fourth largest city of Norway with a population of around 170 000 people, with an additional population of over 30 000 students that make it a vibrant city with a lively culture and nightlife. Trondheim is one of the oldest and most historically interesting cities in Scandinavia, with the majestic Nidaros cathedral as the most prominent attraction. Other sights are the old wharfs along the salmon river Nidelven, the authentic colorful houses at Baklandet, and the monastery at Munkholmen, which is a small islet that can be reached by a shuttle boat from the local fishmarket Ravnkloa. The city is surrounded by a spectacular nature that invite for recreational activities, such as a promenade along the river Nidelven, hiking in the forrest of Bymarka, or jogging or fishing in the fjord at the natural path Ladestien. Trondheim offers a broad variety of museums, galleries, shops, and restaurants. For more information, visit [www.visittrondheim.no](http://www.visittrondheim.no).












## TRANSPORTATION

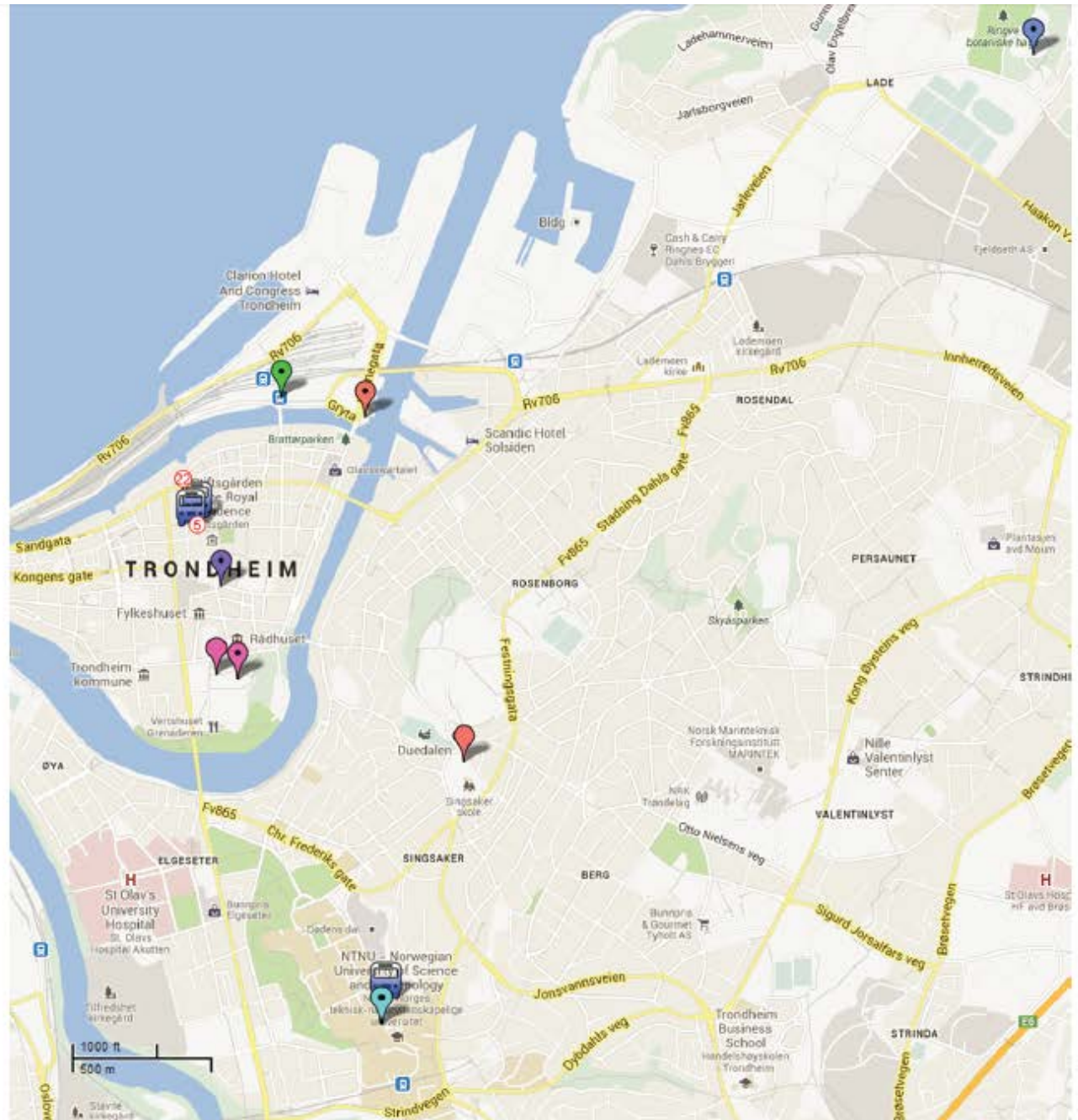
The city center of Trondheim is compact and varied, and is best experienced on foot. An efficient network of buses takes you to interesting sites around the city center (visit [www.atb.no](http://www.atb.no) for more information). There is also a tram line that takes you to the height of Bymarka and a shuttle boat for the islet Munkholmen. Trondheim has 125 city bikes that are available for citizens and tourists, which are found in 12 bicycle racks in and around the city center. In order to rent a bicycle, you need to purchase a subscription card at the Tourist Information Office at the market square. If you are planning to extend your stay to visit other parts of Norway, the railway station and coastal terminal of Hurtigruten and Kystekspresen is located in in the middle of the city center.



Photo: Visit Trondheim

# TRONDHEIM AREA

-  SRAE 14 Venue  
Natural Sciences Building at NTNU
-  RICA NIDELVEN HOTEL  
Street address: Havnegata 1
-  Singsaker Summerhotel  
Street address: Rogerts gate 1
-  Tourist Information Office
-  Trondheim Central Train Station
-  Nidaros Cathedral  
Reception / organ concert
-  Café To Tårn  
Reception / drinks and snack
-  Ringve Museum (Conference dinner)  
Street address: Lade Allé 60
-  Starting point for AtB line 22  
"Vestlia/Othilienborg"
-  Starting point for AtB Line 5  
"Lohove"
-  Bus stop at venue : «Gløshaugen Syd»





## TRONDHEIM CITY CENTER



**RICA NIDELVEN HOTEL**  
Street address: Havnegata 1-3



**Tourist Information Office**  
Located in the south-east corner of the city square



**Trondheim Central Train Station**



**Nidaros Cathedral**



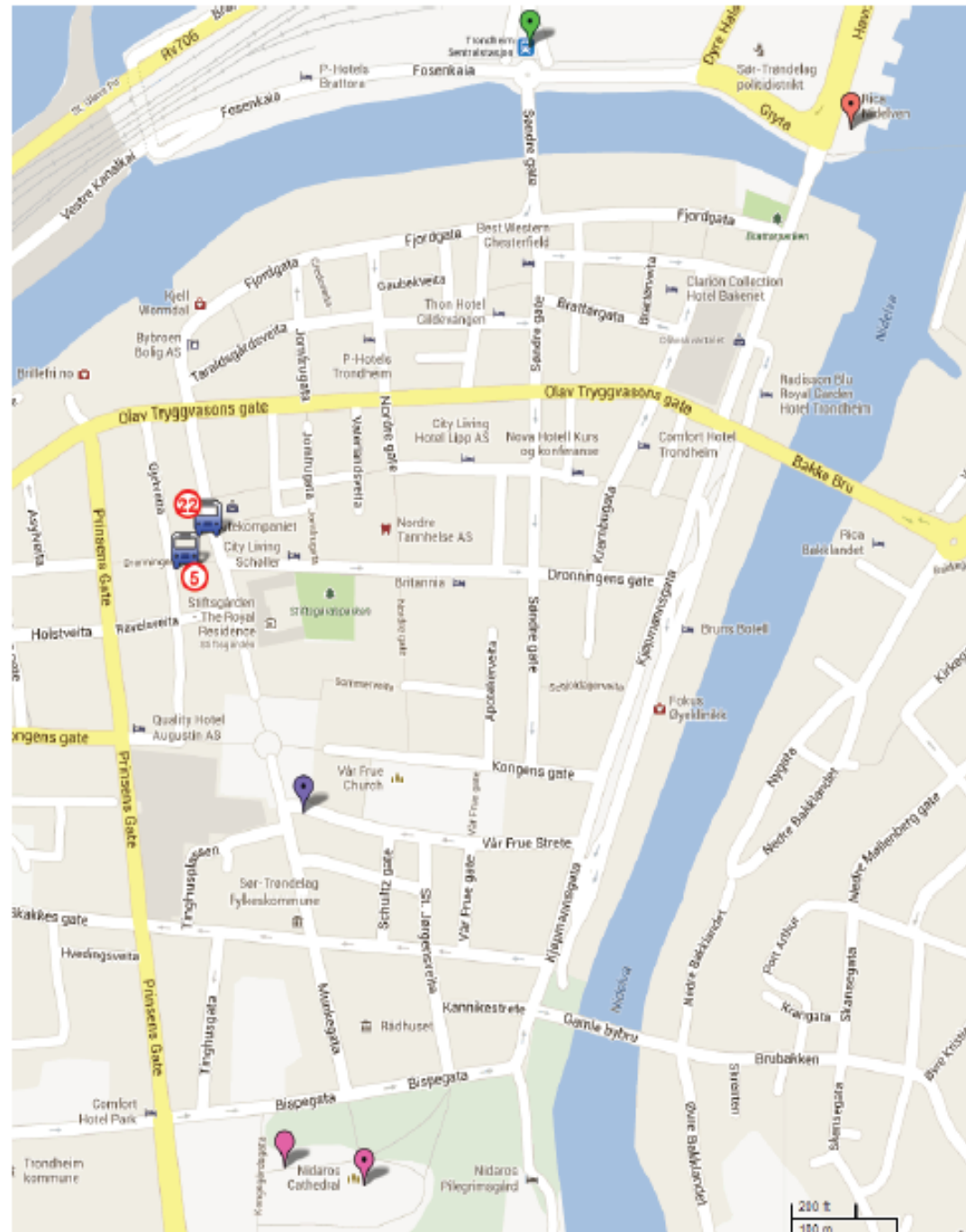
**Café To Tåm**  
Drinks and light food will be served here after the reception in the cathedral.



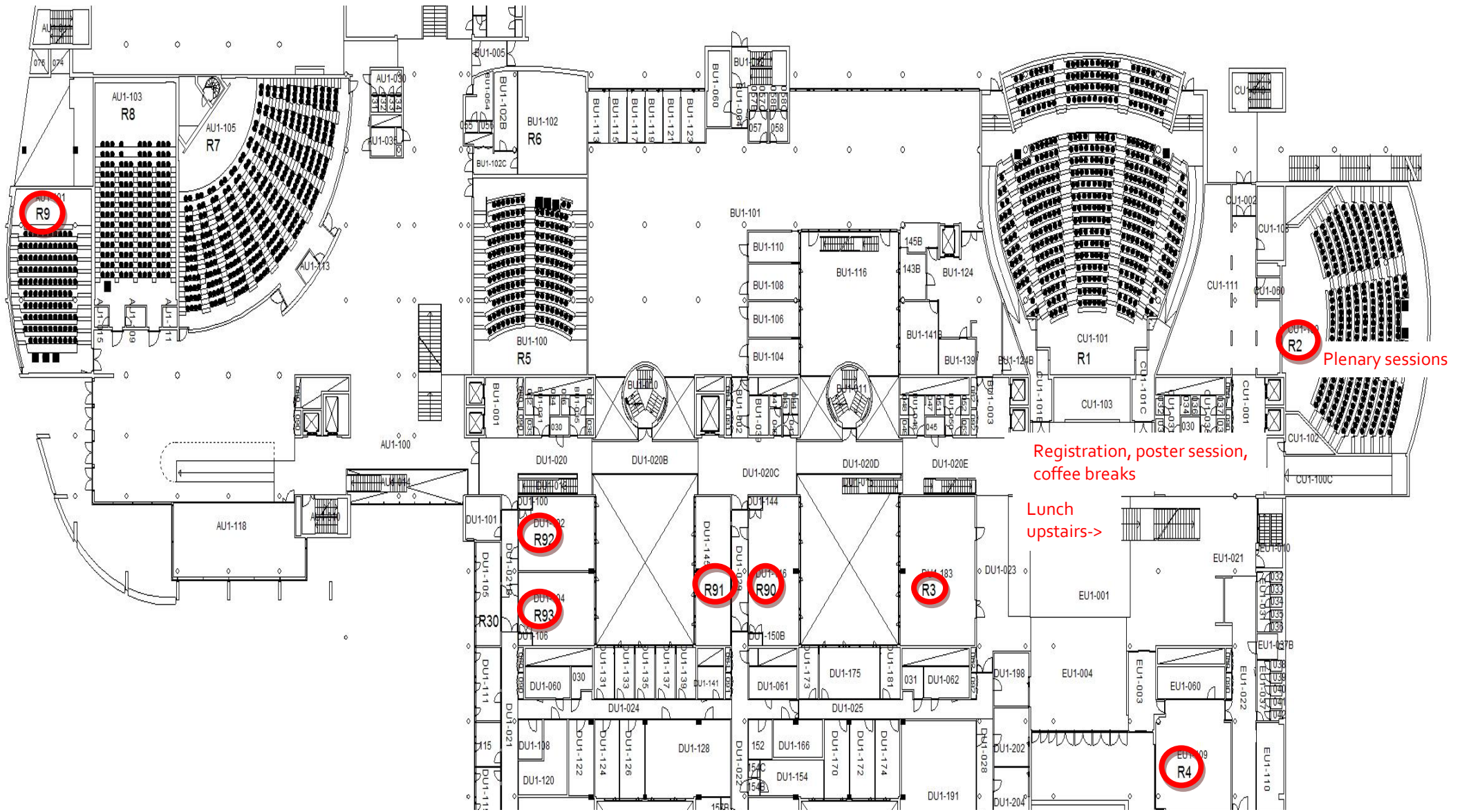
**Starting point for AtB line 22 "Vestlia/Othilienborg"**  
This line will take you to the venue.  
Get off at "Gløshaugen Syd". (Travel time approx. 8 mins.)



**Starting point for AtB Line 5 "Lohove"**  
This line will take you to the venue.  
Get off at "Gløshaugen Syd". (Travel time approx. 8 mins.)



# MAP OVER CONFERENCE VENUE: REALFAGBYGGET (BUILDING OF NATURAL SCIENCE)



## PRACTICAL CONFERENCE INFORMATION

### CONFERENCE VENUE

The conference venue is the building of Natural Science (Realfagsbygget – see [area map](#) on page 12 and [building map](#) on page 14) at the Norwegian University of Science and Technology. You can reach campus and this building by foot from Rica Nidelven Hotel in ca. 30 minutes, which is a beautiful walk through the charming Baklandet. You can also take the buses number 5 and 22 from the center (Munkegata M-2) to the stop Gløshaugen Syd (see bus transporter [atb.no](#) or conference map on [srae2013.no](#)).

Registration for the conference takes place at the conference secretariat, which is located down the stairs from by the main entrance of the building of Natural Science (level U1). Registration will be open at Monday, Tuesday, and Wednesday morning. It is also possible to register on the welcome reception at Café To Tårn Sunday from 1730.

### SESSIONS AND ROOMS

The plenary sessions are held in auditorium R2 and the parallel sessions are held in the rooms R3, R4, R90, R91, R92, R93, and R9. All rooms are located on floor U1.

Coffee and sweets are served in the open area outside R2; lunch is served in the canteen one level up (on the ground floor).

### WIFI ACCESS

As a conference participant you get access to the NTNU guest network. To use this network, you only have to connect, open up a browser, and type in your email address to be given access. The network only allows web traffic (http/https websites), and you can therefore not use programs such as Outlook express.

The eduroam network is also available for eduroam users.



Foto: Stig Sund/NTNU NT

### ORAL PRESENTERS

Each presenter is allocated about 20 minutes including 5 minutes for discussion, depending on the number of presentations in the session. We kindly ask you to bring your presentation on a USB key and show up in the allocated room at least 15 minutes before the session starts to introduce yourself to the session chair and upload and test your presentation.

A PC (Windows) will be available in each session room where powerpoint files can be uploaded.

### POSTER PRESENTERS

The posters walls are located on floor U1 below the canteen. You are encouraged to hang up your poster as soon as possible and leave it hanging during the entire conference. The conference secretariat or the technical staff can be contacted for instructions and equipment for hanging the posters.



## EVENTS

### WELCOME RECEPTION AND CONCERT IN NIDAROS CATHEDRAL

The conference kicks off at 1600 on Sunday 16 June with a concert in the Nidaros cathedral (see [area map](#) page 12) held by the girls' choir of Nidaros and a visiting choir and orchestra from St. Olaf College, US. The concert will be open for paying audience, so you have to bring proof that you are attending the conference. This can be done by bringing documentation showing that you have paid the conference fee. There are not seat reservations for the concert, so that the earlier you come, the better seat you get.

Just after the concert, the welcome reception will in the café To Tårn next to the Nidaros cathedral. We expect this to start around 1730. After a welcome speech by the mayor of Trondheim, you will have the opportunity to get to know the other participants over light food and drinks next to the city's most magnificent attraction.

### POSTER SESSION

The poster session takes place on Monday 17 June between 1700 and 1900 in the coffee break area, outside the plenary auditorium (R2) on floor U1. Participants are offered drinks and light food while mingling in the poster area and discussing with the scholars presenting their research on the posters. Entertainment will be provided by the student society's talented and informal choir, Pirum. Drinks are kindly sponsored by Routledge.

### SRA-E NORDIC

Monday 17 June at 1800 in auditorium R2 a special meeting will be held regarding the establishment of a specific section of SRA-E for the Nordic countries, SRA-E Nordic. All members of SRA are invited along with other Nordic participants that have an interest in the assembly. See invitation text on page 5.

### SRA-E GENERAL ASSEMBLY

All SRA-E members are welcome to join the SRA-E annual general meeting Tuesday 17 June at 1715 in auditorium R2.



Photo of Ringve: Visit Trondheim

### CONFERENCE DINNER

The conference dinner takes place on Tuesday 18 June at 1900 at the manor of Ringve. The manor is situated in the outskirts of Trondheim and is surrounded by a Botanical Garden with a spectacular overview of the Trondheim fjord. After enjoying a small aperitif, a short concert will be given by the Trondheim Soloists (Trondheimssolistene, [trondheimssolistene.no](http://trondheimssolistene.no)), which is a renowned classical ensemble on the international stage. The table is then set for a tasteful dinner based on local food.

Participants will be transported by bus from Rica Hotel Nidelven at 1830. A bus will shuttle back to the hotel from Ringve every twenty minute from 2230.

**PROGRAM SRA-E 17-19 JUNE 2013**

Sunday	Time	Room	Monday June 17.	Tuesday June 18.	Wednesday June 19.
	8-9	U1	Registration	Registration	Registration
	9-1030	R2	Welcome address Keynotes: Grote & Sverdrup	Keynotes: Schiefløe & Bostrom	Announcement SRA-E 2014 Keynotes: Pidgeon & Amyoutte
	1030-11	U1	Coffee break	Coffee break	Coffee break
	11-1230	R3	M1 Novel approaches in assessing and presenting risk	T1 Decision-making in face of complexity	W1 Symposium: Risk governance and safety performance in no failure conditions
		R4	M2 Risk assessment and management of natural hazards	T2 Risk perception I	W2 Risk perception II
		R90	M3 Risk communication I	T3 Risk communication II	W3 Risk communication III
		R91	M4 Learning from major events	T4 Safety management II	W4 Regulation of major risk I
		R92	M5 Risk assessment of health and security threats	T5 Symposium: Visualizing and understanding safety barrier status for risk-informed decision-making	W5 Systemic risk and vulnerability assessment
		R93	M6 Symposium: Helmholtz Alliance Energy-Trans: Future infrastructures for meeting energy demands	T6 Symposium: Robust safety regulation I	W6 Risk in transportation
		R9	M7 Symposium: Scientific Foundations of Risk and Safety		
	1230-1330	Up stair	Lunch	Lunch	Lunch
	1330-15	R3	M8 Societal risk assessment	T7 Coping with major risk	W7 Risk and exposure modeling
		R4	M9 Offshore risk assessment	T8 Symposium: Risk and vulnerability assessment for buildings and critical infrastructures against natural hazards and resilient strategies I	W8 Risk perception III
		R90	M10 Risk, acceptability, and trust I	T9 Emergency preparedness	W9 Risk, acceptability, and trust II
		R91	M11 Civil protection & societal safety	T10 Symposium: Risk analysis in maritime transport and operations I	W10 Regulation of major risk II
		R92	M12 Stakeholder participation and risk discourse	T11 Symposium: Natural Hazards: Risk Interpretation and Action	W11 Symposium: Barrier management in the petroleum industry
		R93	M13 Symposium: On complexity and safety research	T12 Symposium: Robust safety regulation II	W12 Complex systems- applications and challenges
1600: Concert, Nidaros Cathedral (bring proof your attending SRA-E)	15-1530	U1	Coffee break	Coffee break	
	1530-17	R3	M14 Safety management I	T13 Decision making in face of complexity IV	
		R4	M15 Indicators and methodology	T14 Risk governance	
		R90	M16 Symposium: Complexity safari	T15 Symposium: Risk and vulnerability assessment for buildings and critical infrastructures against natural hazards and resilient strategies II	
		R91	M17 Symposium: Understanding risk information seeking in the era of traditional and social media	T16 Symposium: The perception of energy resources in the UK and Switzerland after Fukushima	
		R92	M18 Symposium: Flood fatality risk assessment	T17 Symposium: Risk analysis in maritime transport and operations II	
		R93	M19 Symposium: Understanding the societal dynamics around risk: learning from siting controversies I	T18 Symposium: Understanding the societal dynamics around risk: learning from siting controversies II	
1730: Welcome reception, Café To Tårn	Evening program		18: Meeting about SRA Nordic, R2 17-19: Poster session with food and drinks, U1	1715: SRA-E Annual general assembly, R2 19: Conference dinner, Ringve	

# MONDAY MORNING

8-9 Registration

Location: Outside plenary session auditorium R2, level U1 (see map page 14)

9-1030 Welcome address by Prof. Stein Haugen. Keynote lectures: **Gudela Grote:** Promoting Safety by Increasing Uncertainty: Implications for Risk Management  
**Bjørn Otto Sverdrup:** The 22 July terror attack Oslo and Utøya 2011 Chair: Stein Haugen Location: R2

1030-11 Coffee break Location: Outside plenary session auditorium R2

M1: Novel approaches in assessing and presenting risk	M2: Risk assessment and management of natural hazards	M3: Risk communication I	M4: Learning from major events	M5: Risk assessment of health and security threats	M6: Symposium: Helmholtz Alliance Energy-Trans	M7: Symposium: Scientific Foundations of Risk and Safety
Chair: F. Khan Room: R3	Chair: J.E. Vinnem Room: R4	Chair: B.-M. Drott Sjöberg Room: R90	Chair: J. Hovden Room: R91	Chair: R. Löfstedt Room: R92	Chair: P.-J. Schweiser Room: R93	Chair: T. Aven Room: R9
<b>L. Dai &amp; I. B. Utne:</b> Bayesian networks and back-propagation artificial neural networks as decision-making tools for reducing the risk of wind turbine failure	<b>K. Simmons &amp; D. Sutter:</b> Extreme Weather versus Extreme Vulnerability in the 2011 Tornado Season  <b>M. Sparrevik &amp; F. Nadim:</b> Managing unlikely risks posed by natural hazards to critical infrastructure  <b>D. Bakkour, G. Enjolras &amp; R. Kast:</b> The adaptive governance of natural hazards: Evidence from the 2010 Mount Merapi Eruption in Indonesia  <b>Y. Zhou &amp; J. Xu:</b> Valuation methodology study on flood risk reduction measures in China: pre-flood risk reduction vs. post-flood risk reduction	<b>A. M. Dijkstra &amp; A. Dijkman:</b> Employees' risk perceptions of synthetic nanomaterials and needs for communication: preliminary survey results  <b>A. Bearth, M.-E. Cousin &amp; M. Siegrist:</b> Uninvited Guests at the Table – an Intervention to Increase Awareness of Pathogenic Bacteria and Safe Meat Preparation Behaviour  <b>C. D. Bergeron:</b> Development and Testing of an Evaluation Tool Assessing the Effectiveness of Risk Communication Messages at the Public Health Agency of Canada  <b>N. Boase, M. White, W. Gaze &amp; C. Redshaw:</b> Shellfish: effective communication to promote the benefits and reduce the risks	<b>M. Ibrion, M. Mokhtari &amp; F. Nadim:</b> Risk Reduction in Seismic Zones and Paradigms of Earthquake Disasters: "Lessons-Learned" and "Lessons-Forgotten"  <b>C. Jardine, L. Lechelt, S. Kowal &amp; T. Bubela:</b> The Effect of Affective Messaging: A Case Study of Risk Communication with Vulnerable Populations during the Canadian H1N1 Outbreak and Vaccination Program  <b>S. M. Driedger &amp; S. MacKinnon:</b> Exploring incidental affect-inducing risk communication messages about H1N1 to Manitoba Metis  <b>F. Atun &amp; S. Kundak:</b> Learning from major events in Turkey	<b>A. Janss:</b> A New Practice-oriented Approach for Risk Evaluation Using the Example of Medical Devices  <b>T.-Y. Chang, C.-L. Liu, K.-H. Huang &amp; H.-W. Kuo:</b> Exposure to volatile organic compounds and health risk assessment in residents living near an optoelectronics industrial park  <b>E. Lermer, B. Streicher, R. Sachs, M. Raue &amp; D. Frey:</b> Risks are more likely when thinking concrete – The effect of construal level on risk estimates  <b>F. Boudier, R. Löfstedt &amp; P. Sellke:</b> Influenza antivirals: what are the pros and cons of European stockpiling strategies?	<b>W.-R. Poganietz:</b> Socio-technical scenarios in the context of the German Energy Transition: Potentials – Limitations – Perspectives  <b>D. Ohlhorst:</b> Grid extension as a socio-technical constellation with various interactions and constraints – what are the key elements for policy design?  <b>P.-J. Schweiser:</b> Facilitating the German Energy Transition - Potentials and Limits of Public Participation	<b>T. Aven:</b> Introduction  <b>P. Almklov, R. Rosness &amp; K. Størkersen:</b> When safety science meets the practitioners: Does safety science contribute to marginalization of practical knowledge?  <b>U. Sahlin:</b> Why exchangeability may hinder us to see a black swan  <b>K. Pettersen, J.-C. Le Coze, T. Reiman:</b> Addressing the foundations of safety science – relevance and benefits

# MONDAY MID-DAY

1230-1330 Lunch  
*Location: Realfagskantina – the canteen, level 1, up stairs from the plenary auditorium R2*

1330-15	M8: Societal risk assessment	M9: Offshore risk assessment	M10: Risk, acceptability, and trust I	M11: Civil protection & societal safety	M12: Stakeholder participation and risk discourse	M13: Symposium: On complexity and safety research
	Chair: P.M. Schiefloe Room: R3	Chair: L. Bodsberg Room: R4	Chair: M. White Room: R90	Chair: J. Hagen Room: R91	Chair: T. Aven Room: R92	Chair: K. Laumann & B.-M. Drottz Sjöberg Room: R93
	<p><b>B. Nevhage, E. Veibäck &amp; M. Winehav:</b> National risk assessment in Sweden</p> <p><b>M. G. Mennen &amp; M. C. van Tuyl:</b> The Netherlands Safety and Security strategy and the National Risk Assessment</p> <p><b>J. E. Karlsen &amp; S. H. Jore:</b> When hindsight was utterly wrong - how to overlook a non-plausible future</p> <p><b>N. Rossignol &amp; C. Turcanu:</b> How are we vulnerable? Opening industrial hazards vulnerability analysis to social factors</p>	<p><b>I. Kozine, N. J. Duijm &amp; F. Markert:</b> Assessing risks on offshore platforms by dynamic simulation of accident scenarios</p> <p><b>J. Fan &amp; L. Xue:</b> A Quantitative Method to Assess Well Risk</p> <p><b>N. Khakzad &amp; F. Khan:</b> Bayesian risk analysis of offshore major accidents: Application to hydrocarbon releases</p> <p><b>J. E. Vinnem:</b> Analysis of Hydrocarbon Leaks and verification as an operational barrier</p>	<p><b>S. Ohnuma, K. Sato &amp; K. Ishiyama:</b> Place attachment or protected values? Barriers of public acceptance: A case study of Zenibako Wind Power Plant in Japan</p> <p><b>T. Rundmo, S. H. Jørgensen &amp; T. Nordfjærn:</b> Associations between risk judgements, risk sensitivity, acceptability, priority of safety and risk reduction measures in transportation</p> <p><b>M. Börjesson, C. Wallenius &amp; A. Enander:</b> Risk and safety in the mind of the military leader</p> <p><b>S. Gloaguen, R. P. Lee &amp; F. Allard-Huver:</b> 'Nuclear, or no Nuclear: That is the question.' An investigation of factors influencing energy perceptual divergence in France and Germany</p>	<p><b>G. Geiger, E. Petzel, R. Czaja &amp; C. Blobner:</b> Does lift of liquid ban raise or compromise current level of aviation security in the European Union? - Simulation-based quantitative security risk analysis and assessment</p> <p><b>D. Ormandy, V. Ezratty, A. Dengel, M. Swainson, M. Roys &amp; A. Bone:</b> Adapting Dwellings to Protect Residents from High Indoor Temperatures</p> <p><b>J.-J. Horng &amp; W.-L. W. Lee:</b> Security Vulnerability Analysis of the High-Tech Industries in Taiwan</p> <p><b>C.-P. Chio, T.-H. Yuan, R.-H. Shie &amp; C.-C. Chan:</b> Assessing vanadium and arsenic exposures for residents near a petrochemical complex by two-stage dispersion models</p>	<p><b>G. Wachinger, J. Wuthe, R. Merkt-Kube, J. Rehacek &amp; O. Renn:</b> Early participation as a tool to prepare for health risk conflicts</p> <p><b>M. Aoyagi:</b> Logical understanding and irrational fears about radioactivity impact</p> <p><b>H. B. Andersen, K. D. Grieger, K. Øien &amp; O. Renn:</b> Balancing risks and benefits: local stakeholders' perceptions of the decision-making process in the Barents Sea oil field development</p>	<p><b>M. Rasmussen:</b> Complexity as a Performance Shaping Factor</p> <p><b>T. Wold:</b> Safety Management Systems as Communication</p> <p><b>G. Sætren:</b> Consequences of insufficient focus on human factors in a design phase of new automated technology</p> <p><b>V. Milch:</b> The effect of inter-organizational complexity on the risk of major accidents</p> <p><b>S. Kvalheim:</b> Improving Safety in Offshore drilling operations: Interpretation and communication of abnormalities in drilling data</p>



# MONDAY AFTERNOON

15-1530 Coffee break  
*Location: Outside plenary session auditorium R2, level U1 (see map page 14)*

1530-17

M14: Safety management I	M15: Indicators and methodology	M16: Symposium: Complexity safari	M17: Symposium: Understanding risk information seeking in the era of traditional and social media	M18: Symposium: Flood fatality risk assessment	M19: Symposium: Understanding the societal dynamics around risk: learning from siting controversies I
Chair: T.M. Stene Room: R3	Chair: K.Øien Room: R4	Chair: J.-C. Le Coze Room: R90	Chair: A. Marcu Room: R91	Chair: K. De Bruijn & B. Gouldby Room: R92	Chair: M. Hermans Room: R93
<p><b>H. B. Rasmussen &amp; S. Antonsen:</b> The procedures and working practice. The study from Danish oil and gas industry</p> <p><b>R. Bye, B. Aasprang, S. Haugen &amp; S. Antonsen:</b> Helicopter crashes and risk factors within the domestic helicopter transportation in Norway</p> <p><b>O. Salvi, S. Evanno &amp; B. Caillard:</b> Improving safety management of biogas in Europe</p> <p><b>S. Maslen:</b> Organisational conditions for professionalism and expertise: A case study of the Australian gas pipeline industry</p>	<p><b>S. Ameziane, M. Kishk &amp; J. A. Steel:</b> A new instrument to optimise human factors in the maintenance of oil and gas assets: development and validation of a resilience assessment tool</p> <p><b>R. Bubbico, R. V. Gagliardi, B. Mazarotta &amp; C. Menale:</b> Identifying indicators for assessing the environmental impact of industrial activities</p> <p><b>S. H. Jørgensen &amp; T. Rundmo:</b> Indicators to monitor urban risk</p> <p><b>S. W. Pettersen, B.T. Hellesøy &amp; S. Sæternes:</b> Why efforts to establish early warning indicators to major accidents have failed</p>	<p><b>J.-C. Le Coze:</b> What to do with complexity?</p> <p><b>T. O. Grøtan:</b> A Composite Complexity Model for Sensitization of Safety and Risk Considerations</p> <p><b>I. L. Johansen:</b> Complexity: A conceptual framework</p> <p><b>E. Monteiro:</b> Complex information infrastructures</p>	<p><b>A. Marcu:</b> Asking questions about synthetic meat: The role of information seeking in making sense of a novel food technology.</p> <p><b>M. Kutschreuter:</b> Patterns of channel use in seeking information on food risks and benefits</p> <p><b>F. Hilverda:</b> Online information seeking strategies: visited websites and duration of visit</p> <p><b>J. Barnett, A. Marcu:</b> Making a meal of it? What consumers wanted to know about horse DNA in beef burgers</p>	<p><b>K. De Bruijn:</b> Probabilistic event based assessment of societal flood fatality risks in the Netherlands</p> <p><b>B. Gouldby:</b> Incorporating life loss in a systems based flood risk analysis model</p> <p><b>J. Needham:</b> Practical tools for estimating loss of life from flooding: Which approach should I use?</p> <p><b>V. Krzhizhanovskaya:</b> Assessment of Flood Fatality Risks by Simulation of City Evacuation Coupled to the Inundation Dynamics with Surface and Subsurface Flows</p> <p><b>D. Lumbroso:</b> The use of a Monte-Carlo analysis to assess the uncertainty in the estimates of loss of life from flooding using an agent based model</p>	<p><b>P. Spruijt:</b> Roles and Viewpoints of Scientists as Policy Advisers</p> <p><b>K. Svacina:</b> What uncertainties? Siting geological disposal for high-level radioactive waste in the Czech Republic</p> <p><b>A. Stasik:</b> Siting controversies as a symptom of tension between levels of government: case of shale gas in Poland</p>
<p>17-20 18 Poster session with food and drinks <i>Location: Outside plenary session auditorium R2, level U1</i>            Meeting about SRA Nordic <i>Location: R2</i></p>					

## TUESDAY MORNING

8-9 Registration Location: Outside plenary session auditorium R2, level U1 (see map page 14)

9-1030 Keynote lectures: **P.M. Schiefloe:** The Invisible Safety - Challenges and Dilemmas in Preparing for the Unexpected  
**A.Bostrom:** A mental models study of hurricane forecast and warning production, interpretation and decision making Chair: Lars Bodsberg Location: R2

1030-11 Coffee break  
 Location: Outside plenary session auditorium R2

11-1230 T1: Decision-making in face of complexity I T2: Risk perception I T3: Risk communication II T4: Safety management II T5: Symposium: Safety barrier status for risk-informed decision-making T6: Symposium: Robust safety regulation I

Chair: T.O. Grøtan  
 Room: R3

Chair: N.Pidgeon  
 Room: R4

Chair: M.Kuttschreuter  
 Room: R9o

Chair: T.Steiro  
 Room: R91

Chair: N. Paltrinieri  
 Room: R92

Chair: P. Almklov  
 Room: R93

**C. Blobner:** Providing a structured cost-benefit analysis approach to increase the transparency of security policy decision making

**I. Daskalakis & K. Sapountzaki:** Perceptions of socio-economic drought as causes of hydrological drought mismanagement

**M. De Vocht, V. Cauberghe, M. Uyttendaele & B. Sas:** Communicating emerging food risks: the impact of 1- or 2-sidedness, vividly presented information and spatial distance on message credibility

**E. McGuinness & I. B. Utne:** What safety researchers want to learn from accidents: Proposing an accident reporting system for the fishing fleet?

**N. Paltrinieri:** Coupling of advanced techniques for dynamic risk management

**J. Røyrvik:** Regulating HSE-culture. A literature and document study of the translation of HSE-regulation into corporate SMS-systems

**R. Sachs & M. Wadé:** Managing risk in a complex environment

**R. van Duinen, T. Filatova, P. Geurts & A. van der Veen:** Understanding farmers' drought risk adaptation motivation: empirical evidence from survey data

**M. Hirst, L. Timotijevic, J. Barnett & S. Cox:** Decision-making to uptake screening for inherited cardiac conditions among adolescents: The role of risk perceptions, risk as affect and social context

**G. E.Torgersen & T. Steiro:** Unexpected exercises and training in high risk organizations

**F.Khan:** Dynamic risk assessment: A tool for process safety management

**H. Ryggvik:** Inspections and intelligence. A comparative analysis of offshore regulations in Norway and U.S.

**R. Pramanik:** Understanding coordination: Difference in perception of challenges in inter organization coordination

**F. van Winsen, Y. de Mey, L. Lauwers, S. Van Passel, M. Vancauteran & E. Wauters:** A typology of farmer's risk perceptions and coping strategies

**L. Lin, A. Nilsson, J. Sjölin, M. Abrahamsson & H. Tehler:** Evaluating municipal risk- and vulnerability analyses: how risk is communicated between the municipal and regional level in Sweden

**T. J. Espeland & F. Boudier:** From Fossil Fuels to Biofuels - The Impact of Risk on Compliance

**S.Sarshar:** Visualization of simultaneous activities on an offshore installation

**P. Lindøe:** Risk regulatory regimes in promoting resilience preventing major industrial hazard. Case study of offshore oil- and gas industry

**M. Matsuo, A. Kishimoto, M. Tachikawa, N. Iseki, H. Shiroyama & M. Matsuura:** Fact vs. Fact: the Joint Fact-Finding of the Risk of Radionuclides in Food

**A. Olofsson & S. Öhman:** Experience of crisis and its relation to risk perception and risk behavior

**M. Mobjörk, H. Sonnsjö & M. Wester:** Coping with 'complex' and 'simple' risks in risk assessments

**J. Hagen, A.-K. Valdal, K. Pettersen & B. Gjerstad:** Evaluation of comprehensive security systems for public transport – a methodological framework

**S. Hauge:** Dynamic assessment of the risk picture using indicators

**R. Rosness:** Boxing and dancing: Tripartite collaboration as an integral part of a regulatory regime in Norway

**J. Vatn:** Risk visualization – What is meant by risk picture operators?

## TUESDAY MID-DAY

1230-1330 Lunch

Location: Realfagskantina – the canteen, level 1, up stairs from the plenary auditorium R2

1330-15

<p>T7: Symposium: Natural Hazards: Risk Interpretation and Action</p>	<p>T8: Symposium: Risk and vulnerability assessment for buildings and critical infrastructures against natural hazards and resilient strategies I</p>	<p>T9: Emergency preparedness and risk analysis</p>	<p>T10: Coping with major risk</p>	<p>T11: Symposium: Risk analysis in maritime transport and operations I</p>	<p>T12: Symposium: Robust safety regulation II</p>
<p>Chair: R. Eiser Room: R3</p>	<p>Chair: L. Nie Room: R4</p>	<p>Chair: K.Øien Room: R90</p>	<p>Chair: J. Hovden Room: R91</p>	<p>Chair: I. Utne Room: R92</p>	<p>Chair: P. Lindøe Room: R30</p>
<p><b>R. Eiser:</b> Trust, precaution and interpreting volcanic risk</p> <p><b>A. Bostrom:</b> Seismic risk interpretation and action in port systems</p> <p><b>G. Böhm:</b> Social role and causal structure as determinants of environmental risk perception and behaviour</p> <p><b>S. Capstick &amp; N. Pidgeon:</b> Personal experience of flooding heightens climate change risk perception and mitigation intentions</p> <p><b>B.-M. Drottz-Sjöberg:</b> Communication and Action based on Risk Interpretation</p>	<p><b>K. De Bruijn:</b> A storyline approach and application for flood vulnerability analysis of critical infrastructure</p> <p><b>V. Rosato:</b> A global approach to risk assessment of critical infrastructures</p> <p><b>P. Hokstad:</b> Risk analysis in a subsea road tunnel project</p> <p><b>J. K. Rød:</b> Integrated and validated participatory vulnerability assessment</p>	<p><b>G. Van Pellicom:</b> Benefit of the introduction of standard ISO 22320 in Incident Response Organizations</p> <p><b>J. Rehacek, J. Dlabka, P. Danihelka, B. Baudisova, J. Skrinsky &amp; V. Sluka:</b> Optimization of external emergency planning zones in the Czech Republic</p> <p><b>Y. Dien &amp; C. Duval:</b> Risk Analysis: Beyond Technical Factors</p>	<p><b>C. Mauelshagen, D. Denyer, F. Lickorish, S. Rocks &amp; S. Pollard:</b> The importance of a shared vision to achieve coordinated and consistent risk management: a case study of a central government department.</p> <p><b>M. Kari:</b> Reframing of nuclear communities: Nuclear industry reinterpreting nuclear communities heightened willingness to consider final repository</p> <p><b>M. Ylönen &amp; L. Pellizzoni:</b> Nuclear safety, responsibility and human agency</p>	<p><b>M. Hassel:</b> A Revision Of The Industry Standard Risk Model For Ship Collisions And Groundings</p> <p><b>S. Ruud:</b> Verification of risk and functional requirements of complex marine system</p> <p><b>K. HyungJu:</b> Quantitative Risk Analysis for New IMO Rule - Safe Return to Port</p>	<p><b>P. Almklov:</b> Regulating infrastructures in the face of coupling and fragmentation</p> <p><b>J. Kringen:</b> Implementing vague rules. Transformations, translations and controversies</p> <p><b>T. O. Nævestad:</b> Increasing foreign actors in road and sea transport of goods in Norway: safety challenges and regulatory measures</p> <p><b>T. Kongsvik, S. Antonsen &amp; K. Størkersen:</b> The relationship between regulation, safety management systems and safety culture</p>

# TUESDAY AFTERNOON

15-1530 Coffee break  
 Location: Outside plenary session auditorium R2, level U1 (see map page 14)

1530-17

T13: Decision making in face of complexity II	T14: Risk governance	T15: Symposium: Risk and vulnerability assessment for buildings and critical infrastructures against natural hazards and resilient strategies II	T16: Symposium: The perception of energy resources in the UK and Switzerland after Fukushima	T17: Symposium: Risk analysis in maritime transport and operations II	T18: Symposium: Understanding the societal dynamics around risk: learning from siting controversies II
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Chair: M.White  
 Room: R3

**C. Bennett:** Multiple hazards, impossible choices, difficult decisions - perceptions of risk and safety in the NHS

**A. Kiste:** Perceived Unfair Randomness in Gambling; the Tilt Reaction and Effects of a Negative, Unexpected Outcome

**H. Marynissen & B. Brughemans:** The process of decision-making in a burning crisis situation: A multiple sequence approach of decisiveness

**F. van Winsen, Y. de Mey, L. Lauwers, S. Van Passel, M. Vancauteran & E. Wauters:** Combining risk perception and risk attitude: A comprehensive individual risk behaviour model

Chair: L.Bodsberg  
 Room: R4

**S. Vanhaeren:** Risk communication and food safety policies: the case of the case of risk governance with a grain of NaCl

**J. Devilee, J. Verhoeven, M. Beekman & A. B. Knol:** Can a pre-assessment help us to properly manage controversial risks of chemicals? A discussion on the potential improvement of the REACH restriction process

**T. Litmanen, B. Solomon & M. Kari:** Risk regulation regimes in action: Analyzing Finnish and Swedish spent nuclear fuel repository licensing processes

**G. Prpich & S. Pollard:** Assessing the Environmental Risks of Shale Gas Development: A UK Story

Chair: V. Rosato  
 Room: R90

**D. Serre:** Advanced methodology for risk and vulnerability assessment of interdependency of critical infrastructure in respect to urban floods

**N. Linmei:** Risk and vulnerability assessment and resilient strategies for urban flood risk management

**K. Stone:** One step forward in flood risk assessment also results in one step forward for policy development. Or not?

Chair: V. Visschers  
 Room: R91

**C. Keller:** A comparison of spontaneous associations with nuclear power before and after the Fukushima disaster, and of associations with nuclear and solar energy resources

**C. Jones:** Reconciling Risk: How did supporters and opponents of nuclear power in the UK respond to the Fukushima nuclear accident?

**V. Visschers:** Explaining the public's acceptance of five energy technologies: Differing effects of perceived benefits, perceived risks and protected values

**C. Demski:** Evaluating energy technologies in context of whole systems: Public preferences for future energy pathways and their underlying values and risk perceptions

Chair: I. Utne  
 Room: R92

**M. Hänninen:** Feasibility of collision and grounding accident data for probabilistic accident modeling

**S. Randrup-Thorsen:** Bridge crossings at Sognefjorden - Ship collision risk studies

**T. Lehn-Schøler:** VTS a Risk Reducer, A Quantitative Study of the Effect of VTS Great Belt

Chair: M. Hermans  
 Room: R93

**F. Karimi:** A Comparative Socio-Cultural Analysis of Risk Perception of Carbon Capture and Storage in Finland, Netherlands, UK and Poland

**B. de Graaff:** 'Should I be worried?' - citizens perceptions of mobile phone technology health risks over time

**M. Hermans:** The struggle for knowledge. The dynamics of citizen engagement in mobile phone mast siting controversies

1715 SRA-E Annual general assembly Location: R2

19 Conference dinner Location: Ringve

# WEDNESDAY MORNING

8-9 Registration  
 Location: Outside plenary session auditorium R2, level U1 (see map page 14)

9-1030 **Announcement** SRA-E 2014. Keynote lectures: **N. Pidgeon:** Risk Perceptions and Future Energy System Changes  
**P. Amyotte:** Warnings Only Work When They Are Heeded Chair: Margôt Kuttschreuter Location: R2

1030-11 Coffee break  
 Location: Outside plenary session auditorium R2

11-1230  
 W7: Symposium: Risk governance and safety performance in no failure conditions  
 W2: Risk perception II  
 W3: Risk communication III  
 W4: Regulation of major risk I  
 W5: Systemic risk and vulnerability assessment  
 W6: Risk in transportation

Chair: A.W. Heskestad  
 Room: R3

Chair: M.White  
 Room: R4

Chair: M.Siegrist  
 Room: R90

Chair: R.Rosness  
 Room: R91

Chair: T.Aven  
 Room: R92

Chair: B.E. Asbjørnslett  
 Room: R93

**M. Schiefloe, T. Hauan & A. W. Heskestad:** Loss of science as a benchmark of hazard for conduction of human spaceflight experiments

**M. Kosugi:** Perception and Attitude Changes toward Science and Technology in Japan after the Earthquake

**G. Mascarello, S. Crovato, A. Pinto & L. Ravarotto:** Communicating risks to young consumers. The raw milk experience in Italy

**R. Schwebs & P. Lindøe:** How may dialogue based authority supervision improve safety standards? A case study on HSE regulation in the Norwegian petroleum sector

**C. Rivera:** Analyzing the governance of disaster risk from a system perspective: A case study in Nicaragua

**F. Atun:** What if the emergency system fails? Focusing on complex transportation system in London

**A. B. Mohammad, J. P. Johansen & P. Almklov:** Risk governance and safety in complex organized high reliability organizations: balancing formal structures versus needs for flexibility in of human space flight missions

**R. P. Lee:** Stability of energy imageries and affects following shocks to the global energy system: The case of Fukushima

**P. Månsson, H. Tehler, M. Abrahamsson & H. Hassel:** On Common Terms with Shared Risks - studying the communication of risk between the local and regional level in Sweden

**R. Justo-Hanani:** The Role of the State in Transnational Nanomaterials Risk Regulation: Analyzing the Expansion of State-Centric Rulemaking in the EU and the US

**V. Kopustinskas, S. Contini & P. Praks:** Network reliability benchmark study with application to gas transmission system

**B. E. Asbjørnslett, J. G. Rakke & I. Norstad:** Estimating Resilience in Maritime Transport Systems

**L. H. F. Coelho, B.-E. Danielsen & T. M. Stene:** Human space flight - Training to ensure successful operations and safe performance in control rooms

**W. Poortinga:** Public Perceptions of Climate Change and Energy Futures Before and After the Fukushima Accident: A Comparison between Britain and Japan

**M. Raue, B. Streicher, E. Lermer & D. Frey:** Psychological distance and risky decisions: How risk communication needs to highlight hidden influences

**J. Sithipolvanichgul, J. Ansell & R. Agarwal:** Enterprise Risk Management: Internal Accountability?

**V. Lesnykh, A. Bochkov & T. Timofeeva:** Qualitative Analysis and Typing Intersystem Accidents

**R. Bye, S. Antonsen & J. Seljelid:** Helicopter pilots and perceived risk

**H. Bjelland, O. Njå, G. S. Braut & A. W. Heskestad:** Fire safety management and sosio-technical relationships: Exploring theories of safety constraints and coherence principles

**S. Kundak:** Risk Perception Studies on Istanbul

**I. Stevens, S. Aerts, T. Evens, L. De Marez, W. Joseph & L. Martens:** 'Risk as analysis and risk as feelings' in practice: segmentation based on the reconciliation of objective RF-EMF exposure measurements and subjective risk perception profiles

**C. Taylor, S. Pollard, A. Angus & S. Rocks:** Better by design: Rethinking interventions for better environmental regulation - a case study of environmental policy making in the UK

**T. Rundmo, H. Klempe, S. H. Jørgensen, J. Granskaya & T. Nordfjærn:** Examination of a cultural theory of transport risk

## WEDNESDAY MID-DAY

1230-1330 Lunch  
 Location: Realfagskantina – the canteen, level 1, up stairs from the plenary auditorium R2  
 1330-15

W7: Risk and exposure modeling	W8: Risk perception III	W9: Risk, acceptability, and trust II	W10: Regulation of major risk II	W11: Symposium: Barrier management in the petroleum industry	W12: Complex systems-applications and challenges
<p>Chair: P.Amyotte Room: R3</p> <p><b>J. Bierkens, T. Fierens, M. Van Holderbeke, C. Cornelis, A. Standaert &amp; L. I. Panis:</b> Demonstration and exploitation of the 2-FUN human exposure model identified as a promising tool derived from European research activities; A case study on Pb in the environment</p> <p><b>V. Van der Vlies:</b> A qualitative approach to risk management of hazardous materials in the Netherlands: lessons learned from 7 sluice cases</p> <p><b>E. Brezhnev, V. Kharchenko &amp; A. Boyarchuk:</b> The approach for cyber common cause failures risk assessment of smart grid substation with a critical load</p> <p><b>E. H. Blix &amp; R. Ekle:</b> The role of maintenance management in managing major accident barriers</p>	<p>Chair: M.Siegrist Room: R4 <b>M. Siegrist &amp; B. Sütterlin:</b> The use of the symbolic significance heuristic as a source of biased decisions</p> <p><b>I. Stevens, T. Evens &amp; L. De Marez:</b> PRIC: Introducing an augmented model of Perceived Risk Information Control in the context of electromagnetic field risks</p> <p><b>M. Dhum, C. Moser, P. Kruetli &amp; M. Stauffacher:</b> The gender gap in risk perception is the result of a task-dependent high-level cognitive process</p> <p><b>C. Merk, G. Pönitzsch, C. Kniebes, K. Rehdanz &amp; U. Schmidt:</b> Towards an integrated model of risk perception: The case of Solar Radiation Management</p>	<p>Chair: B-M. Drottz-Sjöberg Room: R90</p> <p><b>K. Sato &amp; S. Ohnuma:</b> Public acceptance under low-trust situations: A case study of Zenibako Wind Power Plant in Japan</p> <p><b>E. Lebret, T. Istamto &amp; D. Houthuijs:</b> Effect of risk perception, environmental concern and trust in policy on monetary valuation of health effects from traffic-related air pollution and noise in five European countries</p> <p><b>S.Ohtomo, H.Osawa, Y. Hirose &amp; S. Ohnuma:</b> The impacts of Fukushima nuclear accident on public acceptance of geological disposal of high level radioactive waste</p>	<p>Chair: L.Bodsberg Room: R91</p> <p><b>R. Ø. Skotnes &amp; O. A. Engen:</b> Internal control regulations – a challenge for the management of ICT safety and security in Norwegian electric power supply network companies?</p> <p><b>R. Molarius:</b> Co-operation of authorities to prevent major risk – Finnish case study</p> <p><b>P. Bentata:</b> The role of environmental civil liability: an empirical analysis of the French legal system</p> <p><b>L. Fisher &amp; M.-V. Florin:</b> Planning for Future Crises: Governance Principles for Slow-Developing Risks That May Have Potentially Catastrophic Consequence</p> <p><b>M. Elmontsri &amp; I. Hadud:</b> Safety in the Petrochemical Industry: Review of Libyan Safety Regulations to Major Risks</p>	<p>Chair: O. M. Nyheim Room: R92</p> <p><b>O.M.Nyheim:</b> Introduction</p> <p><b>M. Søndrol:</b> Development of a barrier management system – both on an overall and installation specific level</p> <p><b>S. Sklet:</b> Operation Condition Safety – a method for verification of operational and organisational barriers</p> <p><b>S. Antonsen:</b> Integrated barrier management</p>	<p>Chair: P.Hokstad Room: R93</p> <p><b>J. F. David:</b> Visible risk and high sensitivity in urban planning and real estate development. Judicial action and social acceptance</p> <p><b>R. van Poll, M. Kraaij &amp; E. Lebret:</b> Animal husbandry in The Netherlands. An explorative study</p> <p><b>S. Holen, I. M. Holmen, T. Thorvaldsen, A. M. Lien &amp; I. B. Utne:</b> Health, safety and environmental challenges in exposed aquaculture production – an investigation of fish farmers' experiences</p>

15- Coffee break, catching flights home or enjoying Trondheim

# **KEYNOTE DESCRIPTIONS AND ABSTRACTS**

## GUDELA GROTE, ETH ZURICH

Gudela Grote is a full Professor of Work and Organizational Psychology at the Swiss Federal Institute of Technology Zurich (ETH), Department of Management, Technology, and Economics. Prof. Grote has studied psychology at the University of Marburg and at the Technical University in Berlin. She has a Ph.D from the Georgia Institute of Technology, Atlanta. The main objective of her research is to provide psychologically based concepts and methods for integrative job and organizational design, taking into consideration the changing technological, economic and societal demands and opportunities. A special interest are the increasing flexibility and virtuality of work and their consequences for the individual and organizational management of uncertainty. Application fields for Prof. Grote's research are e.g teamwork and standardization in high-risk systems, management of the psychological contract, career development, effects of new technologies on work processes, and collaborative planning within an between organizations. Prof. Grote is associate editor of the journal Safety Science and member of the editorial board of several other journals. She has published widely on topics in Organizational Behavior, Human Factors, Human Resource Management, and safety management. She has worked with companies such as the Swiss Railways, Swiss Re and various public organizations. Together with Prof. Bruno Staffelbach from the University of Zurich she publishes annually the "Schweizer HR-Barometer".

In the plenary session on Monday 17 June at 9-1030 in R2 Gudela Grote will present:

### PROMOTING SAFETY BY INCREASING UNCERTAINTY: IMPLICATIONS FOR RISK MANAGEMENT

Both strategic and operational decision-making in high-risk environments entails high amounts of uncertainty. Some of that uncertainty is quantified in terms of risk, while other uncertainty exists in broad qualitative terms or as error bounds in risk assessments. Much research has been devoted to the human capability of dealing with risk and

uncertainty in decision-making, showing that in many instances people handle risk inappropriately and dread uncertainty. However, this research also indicates that people can develop astonishing expertise in making judgments in the face of risk and uncertainty, often using some mix of what Daniel Kahneman has called slow and fast thinking. In the talk I will argue that in order to capitalize on this expertise and to design work processes and organizational safety management systems around it, it is crucial to broaden the scope of our thinking about uncertainty and risk.

To date, the main aim in risk management is to reduce uncertainty and risk to some acceptable amount, implying that once this is achieved even the most complex socio-technical systems can be fully controlled. Fukushima is a recent example of how fickle our presumed mastery of technological risk is. Interestingly, the expert report on the causes of the nuclear disaster point to a lack of tolerance for ambiguity and uncertainty in the Japanese culture which prevented proactive handling of uncertainties. This points to the main proposition I will discuss: safety is not only about reducing risk and uncertainty, but entails deliberately increasing uncertainty in certain circumstances. A straightforward example of the beneficial effects of increased uncertainty is improved decision-making by empowering people to speak up and voice concerns and doubts about a chosen course of action. Another example concerns rule-making where yet again appropriate rules often are not the ones that are most restrictive and thereby uncertainty-reducing, but the ones that support adaptive action through providing options and degrees of freedom which initially raise rather than reduce uncertainty for the decision-maker. This concerns operational decision-making just as much as strategic decisions involved in designing, employing and monitoring high-risk systems.

Consequences of the suggested approach to risk management, which requires balanced consideration of costs and benefits embedded in reducing, maintaining or even increasing uncertainty, will be discussed. These range from team training supporting adaptive coordination and design of flexible rules for operational decision-making to major strategic concerns. Risks need to be modelled in ways that do not unwillingly increase unaccounted for uncertainties, thereby rendering control of these risks an illusion. Also, a





more courageous public understanding of living with risk is required and forms of risk communication that supports this courage instead of frightening or belittling all of us.

## BJØRN OTTO SVERDRUP, 22 JULY COMMISSION

Bjørn Otto Sverdrup was the head of secretariat for the Norwegian 22 July Commission. The independent commission's mandate was to review and learn from the attacks on the Government Complex and Utøya Island on 22 July 2011. The commission's report answers three main questions: What happened on 22 July? Why did it happen? How could our society have let this happen? An important part of the commission's report is recommendations for societal safety. Sverdrup has a cand polit in political science from the University of Oslo, Norway. He has many years of experience from management, emergency and crisis handling in Hydro and as a part of the top management in Statoil's activities at the Norwegian continental shelf. He is currently a vice president communications at Statoil's international operations.

In the plenary session on Monday 17 June at 9-1030 in R2 :Bjørn Otto Sverdrup will present the work of the 22 July Commission's review of the terrorist attacks on the Government Complex and on the Labour Party Youth camp on Utøya Island:

### THE 22 JULY TERROR ATTACK OSLO AND UTØYA 2011

The tragedy of 22 July seems a paradox: On the one hand, few had envisaged that anything so unreal could become a reality. Thousands suffered human losses, and the material damages are hard to comprehend. On the other hand, we were prepared for several aspects of 22 July.

The contrast between the inconceivable and the conceivable presents a challenge for a commission appointed to gain knowledge from 22 July. Hindsight was not a viable option, and no one wants a terrorist to be able to change what is unique, transparent and worthwhile about this 'little country of ours'. Meanwhile, it is a fact that through public



reports, white papers and legislative work, the Storting (Norway's parliament) and the Government have had security and emergency preparedness high on their agendas for the past 15 years. New directorates and oversight bodies are in place, and clearer expectations have been posed to the authorities. Thus the Commission's role was to compare the actual efforts of society and the authorities on 22 July against this, Norway's adopted level of security and emergency preparedness. Have the expectations been absorbed sufficiently, and been implemented? Did the system and the human resources function as expected?

The Commission had access to a vast, comprehensive body of material, which also dates back in time. We have seen our task as being to document the determining events prior to 22 July and the events that day, in as much detail and as transparently as possible. At the same time, we have not hesitated to ask: Would the outcome have been significantly different under marginally different circumstances? This question sheds light on how much of the result can be ascribed to coincidence, good luck and bad luck, and thus speaks to the robustness of society's systems and the decisions that were taken. This is an important source of learning.

## PER MORTEN SCHIEFLOE, NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY



Per Morten Schiefloe (Dr.philos., University of Trondheim, sociology) is professor at the Department of Sociology and Political Science, Norwegian University of Science and Technology. He is also founder of and Research Director at Studio Apertura, NTNU Social Research, a part of the Reliability and Safety Studies network (ROSS), which is organizing the SRA-E conference 2013. His main fields of research are sociology of organizations (organizational culture, change processes, innovation, safety, project management), societal safety, networks and social capital. He is member of several committees, including the technical committee of Center for integrated operations in the petroleum industry and the scientific committee of the International CCS Research Centre. He has published a range of research papers and books, for example reports and papers from the evaluation of the gas blowout at the oil installation Snorre A in 2004, and the introductory textbook to sociology used at all Norwegian universities (last edition 2011). One of his current research interests comprises societal safety after the terror attacks in Norway July 22. 2011.

In the plenary session on Tuesday 18 June at 9-1030 in R2 Per Morten Schiefloe will present:

### THE INVISIBLE SAFETY - CHALLENGES AND DILEMMAS IN PREPARING FOR THE UNEXPECTED

22.07.2011 a single terrorist parked a van full of explosives just outside the main entrance of the central government buildings in the middle of Oslo, ignited the fuse and left. The result was devastating.

The attacker had a relatively easy job. There were no physical barriers which could have prevented him from driving up to the entrance and no police or armed guards present.

With minor exceptions no measures were installed to protect the buildings from damages caused by explosions.

The terrorist attack was not something which could not have been foreseen. Plans for closing the street in front of the buildings had been made and discussions on whether this was necessary or not had been going on for years. A risk and vulnerability analysis made in 2004 described a scenario of a car bomb exploding in front of the entrance, with damages very close to what really happened seven years later.

Weick (1991) has described safety as a "dynamic non-event", whereas Hollnagel (2006) says that "safety is the sum of accidents that do not occur". One of the main challenges in risk management on a societal level is that safety is "invisible". This is especially the case when accidents or incidents occur so seldom that they are "out of mind". A main dilemma in political decision-making is that investing in safety in such situations gives no visible results and therefore tends to loose in the competition for political attention and for economic resources.

## ANN BOSTROM, UNIVERSITY OF WASHINGTON

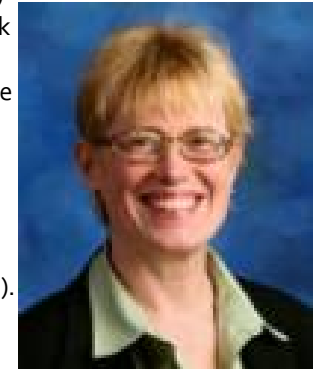
Ann Bostrom is a Professor of Public Affairs at Evans School of Public Affairs at the University of Washington. Bostrom holds a Ph.D. in public policy analysis from Carnegie Mellon University, an MBA from Western Washington University, a BA in English from the University of Washington, and completed postdoctoral studies in Engineering and Public Policy at Carnegie Mellon University and in cognitive aspects of survey methodology at the Bureau of Labor Statistics. She has authored or contributed to numerous publications, including *Risk Communication: A Mental Models Approach* (Cambridge University Press, 2002), *Risk Assessment, Modeling and Decision Support: Strategic Directions* (Berlin: Springer, 2008), and National Research Council, Institute of Medicine, U.S. EPA Science Advisory Board, and U.S. EPA Board of Scientific Counselors reports. Bostrom is currently a member of Integrated Research on Disaster Risk Scientific Committee, the National Oceanic and Atmospheric Administration Science Advisory Board Environmental Information Services Working Group, and the National Academies Standing Committee on Use of Emerging Science for Environmental Health Decisions. She is the current President of the Society for Risk Analysis, and is a member of the Association for Public Policy Analysis and Management, the Society for Judgment and Decision Making, and the American Association for the Advancement of Science. Her research focuses on risk perception, communication, and management; and environmental policy and decision making.

In the plenary session on Tuesday 18 June at 9-1030 in R2 Ann Bostrom will present:

### A MENTAL MODELS STUDY OF HURRICANE FORECAST AND WARNING PRODUCTION, INTERPRETATION AND DECISION- MAKING

In the study reported here, mental models research integrates behavioral, social and decision sciences to address three critical risk management tasks: (1) understanding the risk decision and action context, (2) understanding the commonalities and conflicts in

interpretations of that context and associated risks, and (3) exploring the practical implications of these insights for risk management. To understand the risk decision and action context, we first developed a decision-focused model of the hurricane forecast and warning system on the basis of results from individual mental models interviews, surveys, and a group decision modeling session with forecasters from the National Hurricane Center and the Miami-Dade Weather Forecast Office (n=8), and as well as individual interviews with broadcasters (n=5) and public officials (n=6). Forecaster interviews included probes about their use of hurricane information in creating and communicating hurricane warnings, and their perceptions of how flash flood



forecast and warning information (including uncertainty) is interpreted and used by public officials, media personnel and the general public. We then elicited the mental models of potential hurricane warning recipients, through mental models interviews with a random public sample (N=28) from Miami-Dade County in Florida and a follow-on web-based survey of coastal residents in Florida (N=460). The decision model derived initially from the forecaster group modeling session comprised the foundation of the coding scheme for content analyses of interviews. Content analysis of verbatim interviews was employed to explore the similarities and differences in how stakeholders conceptualize hurricanes (including exposure, effects, mitigation), and use forecast and warning information. Comparisons across groups reveal numerous shared perceptions and some critical differences, including greater concern about storm surges among forecasters. While forecasters' perceptions tend to be detailed with regard to storm development and tracking, they differ considerably by level of experience and are relatively sparse with regard to the physical and social consequences of storms. Public responses illustrate high hurricane awareness, a sense of media saturation during hurricane season, and high concern about wind, flying debris, and precipitation-related flooding, but low awareness and concern about storm surges. Implications for improving extreme weather event forecast and warning systems and risk communication conclude.

*Collaborative research with: R.E. Morss, J.K. Lazo, J.L. Demuth, R. Hudson, H. Lazrus and K. Childers. Acknowledgements: Funding from the U.S. National Science Foundation (NSF 0729302) is gratefully acknowledged. Partial support for this research came from a Eunice Kennedy Shriver National Institute of Child Health and Human Development research infrastructure grant.*

## NICK PIDGEON, CARDIFF UNIVERSITY



Nick Pidgeon (Ph.D. University of Bristol, Psychology) is professor of environmental psychology at Cardiff University, where he is director of the research group Understanding Risk. His field of research comprises risk, risk perception, and risk communication in the interdisciplinary interface of social psychology, environmental sciences, and science and technology studies. He is coauthor of pioneering books on the communication and understanding of risk, such as, "Man-made disasters (Second edition)" (1997) and "The social amplification of risk" (2003). Dr. Pidgeon is a member of the advisory group for the UK Department for Energy and Climate Change, has led numerous policy oriented projects for UK government departments and research councils, and is awarded fellowship of the Society for Risk Analysis International. He is currently engaged in research on public responses to energy technologies such as nuclear power and renewable energy, climate change risks, and climate geoengineering.

In the plenary session on Wednesday 19 June at 9-1030 in R2 Nick Pidgeon will present:

### RISK PERCEPTIONS AND FUTURE ENERGY SYSTEM CHANGES

Although wider publics are deeply implicated in multiple aspects of the ways that energy systems are configured (e.g. as producers of energy, as citizens with voting powers, or as active protesters or proponents of energy infrastructures), their visions and perceptions of 'whole system' transitions are not so well studied or understood. Much of the research examining public perspectives on energy system transitions and their risks and benefits has focused on particular aspects such as nuclear energy or energy consumption, rather than the energy system as a whole. In this paper, I discuss findings from a recent major UK

study of public perspectives on whole energy system change, including social, technical and economic aspects. This research involved members of the public in creating their own future energy system scenarios using a mixed-methods design. Two phases of research were conducted: 1) deliberative workshops undertaken with six groups of people (participant n total = 68) across the UK (England, Scotland and Wales); 2) a survey and interactive energy modelling tool with a representative sample (participant n total = 2,441). Through the research analysis we have been able to create a generalised picture of UK public(s) values, criteria and conditions of acceptability of energy system change, its risks and benefits. The analysis will show where the public visions meet and diverge with current policy perspectives and examine the possible implications for energy risk communication in the UK and European context.

## PAUL R. AMYOTTE, DALHOUSIE UNIVERSITY

Paul P. Amyotte (PhD Technical University of Nova Scotia) is a professor in industrial safety and loss management at the Department of Chemical Engineering at the Dalhousie University in Canada. His research addresses issues of industrial safety and loss management through a combination of careful experimentation, phenomenological modeling, and analytical tool development. The long-term goal of his research programs is to provide engineering methodologies for the enhancement of industrial safety. His research topics include dust explosion prevention and mitigation; hybrid mixture explosions; process safety management; inherent safety; human factors and quantitative risk assessment. He has published a range of scientific papers within these topics. Dr. Amyotte is a member of the Canadian Engineering Qualifications Board and is a chair in the Canadian Society for Chemical Engineering.

In the plenary session on Wednesday 19 June at 9-1030 in R2 Paul R. Amyotte will present:

### WARNINGS ONLY WORK WHEN THEY ARE HEDED. PREVENTING LOW PROBABILITY/HIGH CONSEQUENCE PROCESS INCIDENTS

The prudent textbooks give it  
In tables at the end –  
The stress that shears a rivet  
Or makes a tie-bar bend –  
What traffic wrecks macadam –  
What concrete should endure –  
But we, poor Sons of Adam,  
Have no such literature,  
To warn us or make sure!

From *The Hymn of Breaking Strain* By Rudyard Kipling (1935)

This presentation examines low probability/high consequence events, their associated warning signs, and how these warning signs can be detected. The objective is to provide insight as to why precursor signals may not be heeded in a manner that facilitates prevention of major process incidents.

A low probability/high consequence event can be defined in many ways, whether by fatalities, property loss, production loss, or financial loss (or some combination thereof).

Whichever definition is chosen to describe such an event, these events are unexpected and rare, carry an extreme impact, and involve warning signs that can be subsequently identified [1]. The Center for Chemical Process Safety [2] states that warning signs can occur in any of the following areas of an organization: leadership and culture, training and competency, process safety information, procedures, asset integrity, risk analysis and management of change, audits, and learning from experience.

There are currently many tools available for process safety assurance, including: process hazard analysis (PHA), Probabilistic Risk Assessment (PRA), Quantitative Risk Assessment (QRA), layer of protection analysis (LOPA) and Bayesian networks. While these methodologies can help detect process incident warning signs, the more important question we seek to address is why warning signs often go unseen and thus unheeded. Are we truly unable to see these signs until after-the-fact, as some have proposed? Are the signs strong enough to notice? Do we perceive signs as non-dangerous because our expectations are so strong as to cause distortions to the indicators that are right in front of us [3]? Finally, are we empowering our employees through training and generation of trust in company leadership to genuinely care about process safety in the workplace [4]?

We will discuss how educating employees to become risk-aware can help prevent low probability/high consequence occurrences. By beginning at the individual level, the result will be improvements in the safety management system, the promotion of a culture of safety, the creation of inherently safer designs, and the implementation of an effective communication system. It is hoped that the suggestions made in the presentation will allow organizations to become more mindful that if a collection of small warnings in the workplace are not properly heeded, the low probability of a high consequence event occurring may become a severe reality.

Collaborative research with Alyssa Margeson (Dalhousie University, Canada) & Faisal Khan (Memorial University, St. John's, Canada)





# **PRESENTATION ABSTRACTS**

# MONDAY 17 JUNE

## M1 NOVEL APPROACHES IN ASSESSING AND PRESENTING RISK

Monday 1100-1230, R3  
Chair: Faisal Khan (Memorial University)

### **Bayesian networks and back-propagation artificial neural networks as decision making tools for reducing the risk of wind turbine failure**

*Lijuan Dai, Ingrid Bouwer Utne (Norwegian University of Science and Technology)*

The rapid development of wind energy industry has drawn much attention to operation and maintenance (O&M) issues. The reliability and maintainability of offshore wind turbines, in particular, get significant impact from the harsh operating environment. In order to detect component failures before they reach a catastrophic stage and to reduce the risk of production interruption, a lot of investigation has been carried out in the area of condition monitoring.

The condition of a wind turbine is monitored for different subsystems and components, and in different locations (Figure 1). A large number of data can be collected, which may bring the analysis a challenge to correlate machinery related information with other operational information such as machine speed, electrical load, and wind speed.

Different data-mining based approaches for failure prediction and diagnosis have been proposed, among which Bayesian networks (BN) and back-propagation artificial neural networks (BP-ANN) are two most used ones. The applications of BN show its strength to probabilistically assess the condition and the reliability of deteriorating components [1]. BPANN is proved efficient to make an early detection of component failures in wind turbines [2]. Figure 1. Examples of condition monitoring in a wind turbine However, there lacks of a clear indication of which types of components the two approaches are specialized in, respectively? Is there any overlapping analysis that both approaches can do and what are their advantages and disadvantages by comparison? Would it be more efficient that the two approaches are applied simultaneously? To answer these questions, the current study discusses the concepts and patterns of two approaches in parallel, and uses vibration signals collected from the sensors mounted on an experimental blower to evaluate and

compare the efficiencies of two approaches. Suggestions are given for better employing these supporting tools and making proactive decisions regarding maintenance, scheduling, and safe operation of wind turbines.

### **An Analysis of an Offshore Accident: a Chaos Approach in Risk Assessment**

*Maryam Ashrafi, Hamid Davoudpour (Amirkabir University of Technology, Iran)*

Risk and safety management theories and methods such as other scientific disciplines are fundamentally influenced by thinking paradigms under which theories and methods are developed. The reductionism (Newtonian) and chaos (Post-Newtonian) paradigms are different paradigms which can result in different risk and accident analysis methods. Taking into account Newton's rules of movement, reductionism assumes the entire world as a machine controlled by robust and predictable rules. Based on this paradigm, system identification is limited to its components identification and inter-components cause and effect relationships are ignored or assumed simple and linear.

Technology increasing growth, enhancement of the modern world's communications and interactions and the development of complex technological systems lead to the emergence of complexities that methods based on traditional Newtonian paradigm are not capable of comprehensive risk analysis and management in complex technological systems. Almost all traditional hazard or risk analysis techniques, such as FMEA, HAZOP, FTA, and PRA rely on a chain of linear cause and effect analysis. Specifically, they are not suited to handle complex systems with nonlinear cause and effect relationship, and emergent characteristic.

Considering traditional paradigm limitations, the scientific flow of risk and safety management should shift to a new paradigm. Chaos theory as the basis of this modern paradigm can provide us with a more accurate analysis of complex technological systems accidents. Based on chaos paradigm, systems' trajectories constantly fluctuate among various attractors and sometimes a micro change in a part of system can result in deep and macro changes in the whole system.

We propose a novel conceptual approach of risk assessment in complex technological systems based on the concept of chaos theory, evolution over time and taking into account nonlinear nature of cause and effect relationships. The main premise of the proposed approach claims that employing a non-classical thinking approach of risk assessment in will result in a higher and more accurate awareness of the overall system.

We analyze an offshore accident based on the chaos-based approach and its features consisting of sensitiveness to initial condition, nonlinearity, and



dynamic adaptation. Finally, the challenges with which we may encounter in chaos-based accident analysis are discussed and its advantages and disadvantages are concluded.

### **Risk, a Hopeless Obsession?**

*Ali Hessami & Derek Fowler (VegaGlobalSystems)*

Most rational and purposeful activities in life are undertaken with a positive personal or collective goal in mind. These range from the pursuit of activities in fulfilment of needs such as food, shelter, comfort, security, progression and happiness to adventure, discovery, recognition and enlightenment. In all these endeavours, the immediate focal point is the achievement of a desirable outcome in physical or intangible form. The potential gain and purpose is therefore often the driver and motive force only

countered by the degree of sacrifice and loss that the undertaking may entail within the context of a value system.

Against a purposeful and positive general framework, mere focus on the possibility of loss at the expense of a richer picture is paradoxical and at odds with reality. Whilst prudence implies anticipation and preparedness for these, a degree of dynamic balance between loss and gain is the more worthwhile and realistic aim. In this setting, gain and loss resemble the Taoist's polar opposites that inherently co-exist to varying degrees requiring optimal balance, which is considered acceptable by the individual or group pursuing a goal.

Whilst risk is technically indicative of a future gain or loss, the common parlance and usage tends to view it largely as an undesirable and negative outcome. To remedy this, a systems framework is proposed to ensure a transparent and balanced perspective is taken into account in forecasting future outcomes in any context. This is based on equitable consideration of two fundamental influencing factors:

- Risks &
- Rewards.

It is only realistic to consider the outcome of an endeavour after all significant risks and rewards are assessed and the net balance is estimated.

In this paper, we explore the philosophical underpinnings and develop a systems framework for a more balanced and holistic approach to assessment of outcomes than currently portrayed by the risk based paradigm.

### **A proposal for the improved treatment and communication of uncertainty in quantitative risk assessments**

*Erik Sælen, Mary Ann Lundteigen, Andreas Falck (DNV, Norway)*

Quantitative risk assessments (QRA) are important decision support tools in many industry sectors, and are widely used in the offshore industry [1]. The QRA frames many decisions related to design and operation of oil and gas facilities. Unfortunately, authorities as well as the oil companies themselves have given limited attention to the subject of uncertainty in QRA inputs, models, scope and results, and hence thoroughly knowledge about the robustness of the analysis is not known to the decision-makers when a decision is to be made.

Uncertainty is introduced at many different levels and phases of a QRA. First, the QRA builds on a number of assumptions associated with the scope of the analysis, the model used, and the data used to support the model. Second, the level of uncertainty may be impacted at which stage of the oil and gas facility the QRA is carried out, i.e., whether the analysis is carried out in an early design phase, in detail design, or if the QRA is updated in the operational phase with operating experience.

Despite the degree of uncertainty, the effects of the uncertainty on the risk picture are not well communicated in the QRA reports. The main approach has been that uncertainty is treated by using conservative best estimates, however, such estimates may only account for a certain fraction of the total uncertainty in a risk assessment. For example, uncertainties related to the model used or restrictions in the analysis scope may not be accounted for. Therefore, it may be claimed that conservative best estimates are not well suited for treating or communicating uncertainty in QRAs.

The main purpose of this work is to present a methodology for identifying, evaluating and communicating sources and impacts of uncertainty in a QRA. The approach builds on the research by Aven and Flage [2] and the U.S.NRC approach to classification of uncertainty [3]. More specifically, the approach:

Assess parameter uncertainty a semi-quantitative approach, by first identifying key sources of uncertainty and then performing sensitivity analyses to study their effects

Assess model and completeness uncertainty a qualitative manner, with identification and ranking of the key model and completeness uncertainties. The approach is partly operationalized via new tasks in the QRAs, and partly by

carrying out a formal uncertainty assessment in relation to presenting the results of the QRA to the key stakeholders/facility owner.

## M2 RISK ASSESSMENT AND MANAGEMENT OF NATURAL HAZARDS

Monday: 1100-1230, R4

Chair: Jan Erik Vinnem (Norwegian University of Science and Technology)

### **Extreme Weather versus Extreme Vulnerability in the 2011 Tornado Season**

*Kevin M. Simmons (Austin College, US), Daniel Sutter (Troy University, US)*

Natural disasters are a product of the underlying natural events and human vulnerability. The question naturally arises then whether an extreme event was the result of the magnitude and location of the event or extreme societal vulnerability. The answer allows policy makers to assess whether the disaster was due to similar factors in other recent disasters or perhaps due to some special vulnerability or breakdown. The U.S. experienced its deadliest year for tornadoes since 1925, with the greatest level of property damage on record. We explore whether the 2011 tornado death toll was a function of extreme weather or societal vulnerability by applying a regression model of the determinants of tornado casualties for out-of-sample fatality predictions. In general the model predicts the fatality totals observed reasonably well, with the actual total often within the 95% confidence interval for the point estimate. Generally 2011 fatalities are what would have been expected given the pattern of fatalities for tornadoes in the US over the past twenty five years.

### **Managing unlikely risks posed by natural hazards to critical infrastructure**

*Farrokh Nadim, Magnus Sparrevik (Norwegian Geotechnical Institute, Norway)*

Critical infrastructure is designed to withstand the impact of natural hazards according to a set of regulations specified by codes and standards or by an owner/stakeholder. These standards are often set through probabilistic evaluations with the objectives to reduce risk to an acceptable level, see figure. This evaluated risk will then be in accordance with what the society can accept of

losses in loss of life, environmental damages and loss of assets through definition of acceptance criteria subsequently incorporated into regulations.

The design rules implicitly accept that there is a residual risk associated with rare, extreme events that is neglected because of the (objectively calculated or perceived) very low probability of occurrence. In addition, neglected risks emerge due to uncertainties in model predictions and lack of available data for accurate probability assessments. Both of these may introduce uncertainties giving room for fatal design errors as for examples was seen in the 2011 Fukushima Dai-ichi accident in Japan.

This paper proposes use of stress testing as an examination of the safety of a system under the particularly unfavourable scenarios that fall outside the design basis specified by the regulatory regime or by the operational institution. This means that the stress test can test the system to see response to scenarios expected to be in the residual and neglected risk areas. With this respect it is not a substitute for conventional risk or safety assessments, but it does provide additional valuable insight for extreme situations.

Stress tests can then be used to evaluate how systems can be made more robust under extreme events. For example can factors of exposure and social vulnerability as well as an assessment of the changes of critical infrastructures accompanying the demographic and socio-economic trends be included.

### **The adaptive governance of natural hazards:**

#### **Evidence from the 2010 Mount Merapi Eruption in Indonesia**

*Darine Bakkour (Université Montpellier, France), Geoffroy Enjolras (Aix-Marseille Université, France), Robert Kast (CNRS, French Institute of Pondicherry, India)*

An adaptive governance of natural hazards takes the challenge of enhancing the capacity to create suitable cross-scale and cross-level links between institutions. As such, the main objective of an adaptive governance model facing natural disasters would be to put in place learning by experience processes. However, we notice a strong gap between the theoretical foundations of adaptive governance and its application.

Using a field survey which was conducted after the 2010 volcanic eruption in Mount Merapi, we show that the local governance model is away to be considered an adaptive governance system. Seven key determinants of the adaptive capacity of a system have been suggested and applied to the Merapi

case study: context description, institutions, infrastructure, economic and financial resources, technology, information and skills and equity.

The contribution of this paper is twofold: to exploit the adaptive governance model in the field of natural hazards and to explore the governance structure of the 2010 Mount Merapi volcanic eruption in Indonesia. Beside, the thrust of this paper consists of establishing an assessment framework for the adaptive capacity of a system. This constitutes a significant step toward enhancing our understanding of the applicability of adaptive governance in the context of natural hazards in developing countries.

Keywords: Adaptive governance, adaptive capacity, natural hazards, discourse analysis, Indonesia.

#### **Valuation methodology study on flood risk reduction measures in China: pre - flood risk reduction vs. post - flood risk reduction**

*Yuyang Zhou, Jianhua Xu (Peking University, China)*

Floods are one of the most destructive natural hazards in the whole world. In the last 50 years, damages were increased because of these extreme floods. From 1985 to 2009, 40 percent of catastrophes were floods and it caused 13 percent of the deaths among all the natural disasters. Recently, the tsunami caused by the earthquake in the Pacific Ocean led to a huge flood in the East of Japan in 2011. Floods can be defined as temporary water covering on land outside its normal confines and they can be caused by heavy rains, storms and hurricanes, melting snow, inadequate drainage facilities, as well as failed protective devices such as levees and dams. China is also a multi - disaster country, which always suffers the frequent and severe flood risks. The worst floods account for nearly \$50 billion losses in a decade. Facing flood risks, flood risk management occurs as a decision-making and development process of actors. Because of the different process modes, flood risk management can be distinguished in the pre-flood and post-flood modes. Both pre-flood and post-flood modes are kinds of flood risk reduction activities. Pre-flood interventions include structural protection of vulnerable elements and behavioral preparation for the flood risks like flood map, zoning, building construction prevention and polders and dams protection. In contrast, post-flood interventions mainly refer to the recovery as relief and reconstruction like coverage of flood damages by insurance. Expenditures for flood protection in the environmentally hazardous places can benefit the residents who are living in a flood prone area. However, it

is still important for the public policy decision makers to know how much the society would be willing to pay for the flood risk reduction measures due to the negative influences brought by flood hazards. Considering the limited resources accessible to mitigate the flood risks and effect of flood risk reduction measures, economic valuation of flood risk reduction measures can help to solve this public policy question.

### **M3 RISK COMMUNICATION I**

Monday: 1100-1230, R90

Chair: Britt-Marie Drottz Sjöberg (Norwegian University of Science and Technology)

#### **Employees' risk perceptions of synthetic nanomaterials and needs for communication: preliminary survey results**

*Anne M. Dijkstra (University of Twente, The Netherlands), Anja Dijkman (TNO, The Netherlands)*

Currently, there exists an extensive body of literature studying public's perceptions of nanotechnology. While more and more nanomaterials are being used and applied to a wide variety of fields, still, not many studies have looked at people who work with synthetic nanomaterials (SNMs) on a regular basis. It is expected that in the future the use and application of these SNMs will increase. People who come into contact with SNMs on a regular basis, due to their professions, are the ones that will be dealing with any potential risks. Therefore, we developed a survey questionnaire.

In our study we focused on employees' perceptions of SNMs. More in particular, we asked employees how (often) they work with (what) SNMs, what their (risk) perceptions of nanomaterials are, and, in addition, where they get their information about risks and benefits from and what information and communication needs they have. In February and March 2013, employees holding various positions at different companies and research institutes in the Netherlands were approached via Internet and asked to participate. In our presentation, we present and discuss preliminary findings in relation to current views of risk governance.

### **Uninvited Guests at the Table - an Intervention to Increase Awareness of Pathogenic Bacteria and Safe Meat Preparation Behaviour**

*Angela Bearth, Marie-Eve Cousin, Michael Siegrist (Consumer Behavior, Switzerland)*

**Background:** In the past few years, incidence rates of foodborne illness, caused by pathogenic bacteria such as *Campylobacter*, have risen in Switzerland. Home cooked chicken meat is believed to be the most common transmission source. It appears that an increasing number of food preparers do not follow basic precautions when preparing raw chicken. A group that is particularly prone to contract foodborne illness comprises young people that have little cooking experience and have recently established their own household, such as first-year university students. Therefore, the goal of the present longitudinal study was to implement an informational intervention in a sample of first-year university students. The intervention aimed at increasing participant's knowledge of safe meat preparation and encouraging safe meat preparation behaviour in the kitchen.

**Design:** The study comprises three measurement points (t<sub>1</sub>, t<sub>2</sub>, t<sub>3</sub>) with the intervention implemented at t<sub>2</sub>. At t<sub>1</sub>, baseline behaviour and knowledge were assessed and the participants were randomly assigned to one of three conditions, two experimental and a control condition. At t<sub>2</sub>, both experimental groups received an informational leaflet and a behavioural cue of varying intensity (postcard, two cutting boards). At t<sub>3</sub>, follow-up behaviour and knowledge were assessed for all three groups. 366 first-year students (45% male, mean age 20.5 years) took part in the complete study and were included in the analysis.

**Results:** The results suggest that the intervention had a significant impact on the knowledge of the participants. Both experimental groups exhibited significantly more knowledge at t<sub>3</sub> than the control group. Additionally, the cooking novices in the experimental groups exhibited a significant increase in reported safe meat preparation behaviour from t<sub>1</sub> to t<sub>3</sub>.

**Discussion:** The study identifies several prevalent knowledge gaps related to meat preparation behaviour. Additionally, it provides evidence for the efficacy of knowledge provision to increase cooking novice's awareness of and willingness to implement safe meat preparation behaviour.

### **Development and Testing of an Evaluation Tool Assessing the Effectiveness of Risk Communication Messages at the Public Health Agency of Canada**

*Caroline D. Bergeron (University of South Carolina, US)*

**Background:** The Public Health Agency of Canada (PHAC) is responsible for promoting health among Canadians and preventing and responding to public health threats. During a public health emergency such as an E.coli outbreak or a flu pandemic, how does PHAC ensure that it meets its risk communication objective of providing Canadians the information they need to protect themselves and their families? It is challenging, especially during an emergency, to assess whether their risk communication messages are well developed, received, understood, and acted upon by its target audiences.

**Methods:** Based on evidence and international best practices, an evaluation tool was developed to assess the effectiveness of PHAC's risk communication messages during an emergency. This tool can be used to gain feedback on current messages and make mid-course adjustments. It is currently being tested with policy, program, and communication experts in the Government of Canada's Health Portfolio.

**Findings:** Preliminary findings suggest that content, reach, and understanding are the three main components of effective health emergency risk communication messages. Low literacy/numeracy of the target audiences as well as public perception of risks must be considered when crafting emergency risk communication messages. The media channels used to communicate the messages should be consistent with target audiences' preferences and media consumption. Comprehension of the messages should be examined using public opinion research, social media analysis and other important feedback mechanisms.

**Discussion:** While assessing actual behaviour change based on risk communication messages requires assistance from several risk management functions such as health surveillance, other important steps can be taken by PHAC to evaluate the effectiveness of its health emergency risk communication messages. The more effective the risk communication messages, the greater its impact on public health.

### **Shellfish: Effective Communication To Promote The Benefits And Reduce The Risks**

*Nick Boase, Mathew White, William Gaze (University of Exeter Medical School, UK), Clare Redshaw (University of Exeter Medical School, University of Plymouth, UK)*

The Mental Models (MM) approach to risk communication has been successful in developing communications that increase people's understanding of, and hopefully reduction in exposure to, unequivocally negative hazards such as Radon and HIV. Despite the fact that, in many instances, individuals need to balance risks against possible benefits, the MM framework been applied less often to consider such cases, and the greater complexity this has for risk/benefit communication. The current project uses the consumption of shellfish as a case study. Shellfish contain important minerals and nutrients that play a part in a healthy diet. They also offer a potentially sustainable form of protein compared to farmed/wild fin-fish – resulting in potential benefits to both human health and the environment. Despite attempts to promote shellfish as a healthy and sustainable food source, many consumers in the UK are wary of eating shellfish often citing possible health risks (e.g. norovirus) as a factor in their avoidance.

The aims of the current project are to: a) better understand these risk/benefit beliefs about shellfish among UK consumers; and b) develop communications which reflect scientific knowledge about the benefits and risks in ways in which most effectively reduce misperceptions. The project also considers perception of risks and benefits relative to other food types. The project uses the three step MM approach. Phase 1 semi-structured interviews (n = 20-30) investigate lay and "expert" beliefs, and influence diagrams will be developed to represent the mental models of each of these groups. The experts include representatives from the shellfish supply chain and other organisations (e.g. government) involved in working with the shellfish industry. Phase 1 is currently underway and results will be presented at the conference. Several key misperceptions and misunderstandings about both the benefits and risks of eating shellfish have been revealed. In addition information about the Phase 2 survey, which will be informed by these influence diagrams and will aim to determine the prevalence of beliefs amongst the public, will also be presented. Finally, some information about the strategy for Phase 3 will be discussed, where we will develop and test a new communication based on the results of the first two phases.

## **M4 LEARNING FROM MAJOR EVENTS**

Monday: 1100-1230, R91

Chair: Jan Hovden (Norwegian University of Science and Technology)

### **Risk Reduction in Seismic Zones and Paradigms of Earthquake Disasters: "Lessons-Learned" and "Lessons-Forgotten"**

*Michaela Ibrion (Norwegian University of Science and Technology), Mohammad Mokhtari (International Institute of Earthquake Engineering and Seismology (IIEES), Iran), Farrokh Nadim (International Centre for Geohazards / Norwegian Geotechnical Institute (ICG/NGI), Norway)*

Earthquakes are dynamic and stochastic phenomena which seriously affect our complex societies having multiple, dynamic vulnerabilities. Earthquake disasters dramatically influence human life, however in the same time encourage efforts for a better preparedness, mitigation, and recovery. An omnipresent paradigm after an earthquake disaster is represented by "Lessons-Learned". In this paper, deconstructions were performed for "Lessons-Learned" and "Lessons-Forgotten" paradigms. Necessity of a paradigmatic shift toward "Lessons- Remembered" of the earthquake disasters was investigated and an algorithm for earthquake disaster lessons-learning process was proposed. Research approach was through case studies of Iranian seismic zones, part of active seismic world regions and with a long history of catastrophic earthquakes. Outcomes pointed out to necessity for a long-term memory of learned lessons. Research conclusions recommend that learning lessons from earthquake disasters needs to be done in a sustainable way, for a long term, and with continuous updates. In this regard, encouraging and building an earthquake culture is emphasized. It is vital that lessons from earthquake disasters to be remembered and not to be left beyond to be forgotten and awareness cultivated. This approach has potential for disaster risk reduction and open further research path towards reducing uncertainty in seismic zones, improving capacity of adaptation and mitigation.

### **The Effect of Affective Messaging: A Case Study of Risk Communication with Vulnerable Populations during the Canadian H1N1 Outbreak and Vaccination Program**

*C.G. Jardine, L. Lechelt, S. Kowal and T. Bubela (University of Alberta, Canada)*

In recent years, the role of affect in shaping risk perspectives has been increasingly recognized and explored. However, relatively few studies have assessed the effect of affective risk communication strategies and messages. The role of affect in risk messaging can be particularly important during high profile health risk events, such as the 2009 H1N1 influenza pandemic, where clear, complete, consistent and effective risk communication is required to both apprise the public about the outbreak and promote informed decision-making on appropriate health protection behaviours. This research explored the effects of affective messaging around the H1N1 outbreak and subsequent vaccination program on pregnant women and seniors in Alberta, Canada. These two population groups were deemed particularly vulnerable because of their increased likelihood to become seriously ill or die if infected. Sixteen focus groups were conducted in six locations throughout the province between October 2010 and April 2011. Semi-structured telephone interviews were also conducted with three prominent Canadian newspaper health reporters from March to June, 2011. Affect was shown to be induced through both integral (explicit) and incidental (indirect) means. Both the health reporters and focus group participants commented that media messaging during the H1N1 pandemic focused primarily on fear induction. The majority of the seniors assessed information as being 'sensationalized' or the result of 'fear mongering', with many believing it was either a deliberate move to sell newspapers or an abdication of journalist ethics and social responsibility. However, those with underlying health issues responded with increased feelings of anxiety and vulnerability. In contrast, most of the pregnant women participants reacted to fear-based messaging by seeking further information from sources they deemed to be less sensationalistic and biased. The health reporters interviewed were also concerned that the use of fear-inducing affective messaging by public health agencies and the media may have resulted in increased confusion and/or dismissal of the risk by the public. Based on these results, affective messaging based on invoking fear is not generally effective in informing people about a risk, and may in fact 'backfire' as a means promoting specific protective behaviours such as vaccination.

### **Exploring incidental affect-inducing risk communication messages about H1N1 to Manitoba Metis**

*S. Michelle Driedger, Shauna MacKinnon (University of Manitoba, Canada)*

A recent review of risk communication research has suggested that more empirical examination of the impact of incidental affect-induction is needed. Affect-inducing has been defined as those emotions that are stimulated by communication materials or a situation as opposed to a specific risk itself. Exploring affect-inducing reactions for one population group during pandemic H1N1 is the objective of this presentation. During pandemic H1N1, public health risk communicators often had to provide information that was frequently evolving due to the inherent uncertainty in the situation: various experts were uncertain about both the severity and the spread of H1N1 (e.g. how virulent the virus would be or how different groups – based on age, ethnicity, people with underlying health conditions, etc. – might respond to being exposed to the virus. Through the use of 15 focus groups held with Manitoba Metis, we examine how affect was induced through different risk communication recommendations that were provided to the general public. Risk recommendations provided advice about how the public could minimize their exposure to and to protect themselves from more serious consequences from exposure to the H1N1 virus. Risk recommendations also included advice on getting the H1N1 vaccine once it was available. An important methodological dimension of these focus groups is that we never explicitly asked people how they 'felt' about the pandemic. In order to examine how risk messaging contributed to an affect-inducing response, we investigate how conversational triggers provide insights into the emotional responses expressed by Metis.

### **Learning from major events in Turkey**

*Funda Atun (Politecnico di Milano, Italy), Seda Kundak (Istanbul Technical University, Turkey)*

Even the most disastrous events have been noted as earthquakes that Turkey experienced in the last years, seasonal floods, landslides and storms emphasize the diversity of hazards in this regions and as well as gradually growing drought threat is currently propagating through the country. It is worthy to note that large scale earthquake disasters have been milestones in the regulatory system; however, there are still lack of awareness and interventions on the rest. This

study considers four major disasters in Turkey, these are: 1999 Izmit and Adapazari earthquakes, 2009 flooding in Istanbul and 2011 Van earthquake. It examines the failures with all their facets considering re-adjustments, accomplishments and malfunctioning. Thinking over the gathered information, four main points come into the prominence. First two points signalise some positive aspects in the system, whereas, the last two reveal some challenges. First, these major disasters in Turkey revealed new regulations that added new duties and guidelines for the pre-disaster activities as risk mitigation measures and processes to the postdisaster response activities. Second, the responsibility of risk mitigation is appointed to local administrative bodies by law, which increases the efficiency of implementations, as local bodies stay close to public and aware of their problems. Moreover, the major problem that is not being able to combine development plans with disaster management plans. Disaster management related plans have to be supported by development plans. Otherwise provided solutions could be short-lived. Lastly, Turkey seems to have many fragments within its system with highly similar responsibilities that may lead to confusion among institutions. In such a "the more the better" logic, without proper share of responsibilities, one can expect a task to be tackled by multiple institutions along with orphaned tasks. There is a need of producing a checklist for every institution with a special priority order of tasks to evade exaggerations on the bright side or shortcomings more realistically. Therefore, this paper discusses lessons from major events and examines whether they have been considered as lessons to learnt or lessons to ignored in regulatory and planning system of Turkey.

Key words: Major disasters, disaster risk management, Turkey

## M5 RISK ASSESSMENT OF HEALTH AND SECURITY THREATS

Monday: 1100-1230, R92

Chair: Ragnar Löfstedt (King's College London)

## A New Practice -oriented Approach for Risk Evaluation Using the Example of Medical Devices

*Armin Janss*

The Failure Mode and Effects Analysis (FMEA) is the most commonly used risk analysis method. Especially in risk - sensitive areas such as nuclear technique, aviation, automotive engineering and medical context the application of the FMEA is state of the art. In the framework of a FMEA application the risk is evaluated with the so called risk priority number (RPN). Although this technique is standard, there are several deficiencies mentioned in literature concerning comparability and accurate rating of risks. The proposed approach follows the FMEA procedure closely in order to maintain ease of use.

The RPN technique consists of ranking the potential failures with respect to their severity (S), probability of occurrence (O) and likelihood of detection (D). Then the rating factors are multiplied to calculate the risk priority number ( $RPN = S \times O \times D$ ). This procedure shall allow the comparability of risks. But 88% of the RPN range is empty (when using a range from 1 to 1000) and e.g. 900 is the second largest number. Moreover, several RPNs with the same value can result from different combination of S, O and D, which makes it difficult to compare risks (although e.g. the two combinations  $8 \times 8 \times 1$  and  $1 \times 8 \times 8$  result in the same  $RPN=64$ , they have a totally different meaning, as the severity differs significantly). Additionally, different scales (interval and ordinal) are used within the various factors' rating, which leads to inaccurate evaluation outcome.

The new risk evaluation method is partially based on previous works of Sankar and Prabhu. Derived from this approach, we propose the use of risk priority numbers from 1 to 1000 and each number is mapped to a Severity- Occurrence - Detection combination. In practice, the risk assessor can rate the severity, occurrence and detection and afterwards look up the result in a free accessible list. Here, the basic idea is the simplicity and effectiveness for the practical use. The underlying concept is to ask experts in risk analysis (in medical engineering) to evaluate and tabulate a slight percentage of selected combinations and subsequently to generate a mathematical function which interpolates missing combination values and additionally considers e.g. different weighting of the variables severity, occurrence and detection.

First tests with different interpolation functions in MATLAB show approximately equiprobable RPN values and their combinations of severity, occurrence and detectability in the range of 1 - 1000. The design of a



standardized expert query and the way of using the generated results remain to be discussed. The results could either be used to generate one Risk- Priority - Ranking list for broad application in different use contexts or either to develop a function which fits any expert appraisal, subject to the choice of its included parameters or to create specific lists on demand.

### **Exposure to volatile organic compounds and health risk assessment in residents living near an optoelectronics industrial park**

*Ta-Yuan Chang, Chin-Lin Liu, Kuei-Hung Huang (China Medical University, China), Hsien-Wen Kuo (National Yang-Ming University)*

Optoelectronic industrial activities are associated with the increasing concentrations of volatile organic compounds (VOCs) in the Central Taiwan Science Park (CTSP), but residents' VOCs exposures and potential health risks are unknown. This study aimed to determine outdoor and indoor levels of VOCs and to assess health risks among residents living near the CTSP during 2006-2007. We conducted the outdoor sampling of VOCs at ten sites near the CTSP and collected indoor samples from nine houses located at five communities. The steel canisters were used to perform 24-hour outdoor and indoor sampling every season. Qualitative and quantitative analyses were conducted by using the gas chromatography with a mass-selective detector. The self-administered questionnaire was used to record residents' time activity information in the outdoor and indoor environment. The chronic hazard index (HIC) and the cancer risk were used to assess the non-carcinogenic and carcinogenic risks of VOCs in residents. The average concentrations of the total VOCs and 14 specific VOCs in the indoor environment were significantly higher than those in the outdoor environment every season. Ethanol ( $77.8 \pm 92.8 \mu\text{g}/\text{m}^3$ ), toluene ( $67.0 \pm 36.7 \mu\text{g}/\text{m}^3$ ) and acetone ( $37.7 \pm 27.5 \mu\text{g}/\text{m}^3$ ) were three dominant components in the indoor air samples. These three VOCs were also the main outdoor pollutants with the average concentrations of  $56.9 \pm 19.0 \mu\text{g}/\text{m}^3$  for toluene,  $26.8 \pm 49.6 \mu\text{g}/\text{m}^3$  for ethanol and  $25.8 \pm 9.8 \mu\text{g}/\text{m}^3$  for acetone, respectively. Residents exposed to VOCs had the mean HIC values ranged  $2.8 \times 10^{-4}$  ~  $1.3 \times 10^{-1}$  and the mean cancer risk of exposure to benzene was  $3.8 \times 10^{-4}$  based on time-weight patterns. Residents living near the CTSP exposed to the higher levels of indoor VOCs and might have the estimated cancer risk above the general acceptable level ( $1 \times 10^{-6}$ ) due to benzene exposure. We suggest that the log-term

monitoring of VOCs and reducing benzene exposure in residents should be performed to prevent the public health.

Key words: Central Taiwan Science Park, Health Risk Assessment, Volatile Organic Compounds.

### **Risks are more likely when thinking concrete – The effect of construal level on risk estimates**

*Eva Lermer, Bernhard Streicher, Martina Raue, Dieter Frey (Ludwig Maximilian University Munich, Germany), Rainer Sachs (Munich Re, Germany)*

People's subjective risk estimates and in particular their accuracy in estimating risks is important for insurance industry, economy, science and overall in everyday life. However, although people are confronted with probability considerations every day in professional and private contexts research has shown that humans are not good intuitive statisticians. A large body of research literature reveals that probability estimates are influenced and systematically biased by many different factors. A rather new perspective to investigate how people mentally represent future events which influences their decisions is Construal Level Theory (CLT; Liberman and Trope, 2010). Research on CLT has shown that mental representations of events are influenced by the perceived psychological distance. That means that people tend to represent targets that are perceived as proximal, in kinds of low-level construals (concrete), compared to distal perceived targets, which are more likely to be represented in kinds of high-level construals (abstract). Interestingly, this phenomenon is bi-directional. That means that the kind of mind-set (concrete vs. abstract) people have adopted (e.g., after priming) influences the perceived psychological distance and thereby mental representations. Furthermore, CLT research revealed that also probability estimates are influenced by the current mind-set. Recent study findings suppose that thinking in a high-level manner (abstract) leads to a lower estimated probability of occurrence of an event compared to a low-level manner (concrete). This was shown for instance by Wakslak and Trope (2009) who manipulated participants thought processes (i.e., letting participants adopt an abstract or concrete mind-set via priming) and investigated participants' estimates regarding the probability of occurrence of neutral future events. In our research we applied the idea of different construal level (CL) mind-sets to the risk context and asked participants to estimate risks from different domains (e.g., health, accidents). The current research explored the influence of CL

regarding: A) the overestimation of small probabilities and underestimation of large probabilities (Study 1, N = 94); B) unrealistic optimism (higher risk assessments for an abstract person than for self) (Study 2, N = 117); C) risk assessments of risk experts (risk managers) and how these could be improved by CL manipulation (Study 3, N = 85). Three important findings emerge from this research: Firstly, all three studies confirmed that CL influences risk estimates. Secondly, unrealistic optimism seems to be unrelated to CL influences. Thirdly, CL manipulation appears to be useful to improve risk managers risk estimates accuracy. Theoretical and practical implications will be discussed.

### **Influenza antivirals: what are the pros and cons of European stockpiling strategies?**

*Frederic Bouder (Maastricht University, The Netherlands), Ragnar Löfstedt (King's College, UK), Piet Sellke (Dialogik)*

The world is subject to seasonal influenza epidemics and pandemics the most recent high profile occurrences being the H5N1 ('bird flu') and H1N1 ('swine flu'). In addition to preventive vaccination, many European governments have pandemic contingency plans that involve the use of influenza antivirals to combat the spread and mitigate the severity of the infection. Such antivirals include Oseltamivir (Tamiflu®) and zanamivir (Relenza®). Unlike the use of seasonal flu vaccines, the prescription and stockpiling of antivirals as a risk-reduction strategy remains largely understudied. This paper presents the first results of a study of the pros and cons of European governments antiviral stockpiling strategies to combat influenza. The project was developed in 2012-2013 and concentrated on weighing the benefit and risks of existing approaches, how they are assessed by governments and what are their implications in terms of risk communication to patients and public trust. Elite interviews were conducted in five European countries (France, Germany, The Netherlands, Sweden and UK) as well as an opinion survey targeting over 3000 European citizens in the same countries plus Spain, carried out in co-operation with Dialogik and Ipsos Mori. The paper:

- Reviews the range of antiviral stockpiling strategies adopted in Europe
- Evaluates the quality of the risk assessment underpinning these strategies
- Presents an analysis of and suggest improvements to the risk communication of the different strategies, with a view to building rather than destroying trust among critical actors (Industry, government and patients).

## **M6 SYMPOSIUM: HELMHOLTZ ALLIANCE ENERGY-TRANS: FUTURE INFRASTRUCTURES FOR MEETING ENERGY DEMANDS**

Monday: 1100-1230, R93

Chair: Pia-Johanna Schweizer (University of Stuttgart, Germany)

The German energy transformation implies an accelerated phase-out from nuclear energy, a considerable increase of renewable energy in both electricity and heat production and greatly extended energy efficiency. These challenges call for innovative research, policy making and infrastructural planning. The Helmholtz Alliance *Energy-Trans* has been established to meet these challenges and to work on novel solutions. This research alliance was launched by the German Helmholtz Foundation as a research program which investigates the systemic interactions between technology, organizations and consumer behavior in Germany within a European and international context. The alliance builds on expertise from various scientific disciplines, constantly trying to bridge the boundaries between natural, technical and social sciences. The Helmholtz Alliance *Energy-Trans* aims at policy-oriented knowledge for building efficient, sustainable, and socially acceptable energy infrastructures.

The session will focus on three crucial elements of scientific investigation within *Energy-Trans* – scenario-building, policy instruments and public participation – thereby demonstrating the Alliance's interdisciplinary research.

### **Socio-technical scenarios in the context of the German Energy Transition: Potentials – Limitations – Perspectives**

*Jürgen Kopfmüller, Witold-Roger Pogonietz, Jens Schippl (Karlsruhe Institute of Technology (KIT), Germany), Wolfgang Weimer-Jehle (University of Stuttgart, Germany)*

The transformation of complex and dynamic socio-technical systems, such as energy infrastructures goes along with a high degree of uncertainty and incomplete knowledge. This complexity arises because the transition of an energy system is not only a technical process but goes along and interacts with changes in various non-technical factors, such as (new) regulatory regimes, (new) institutions, changes in societal preferences and individual lifestyles. If the transformation additionally aims at meeting sustainability goals in a comprehensive, integrative way, complexity increases even more.

In the last decades, scenarios have become a prominent tool to support decision making in such complex transformation processes. Also for the German energy transition, numerous scenarios have been produced over the last years. They differ in several respects, such as the assumptions made, the selected thematic or regional focus, or the general methodology applied. This variety reflects well that the term scenario is covering a broad range of different approaches that do all have their specific advantages and disadvantages.

Against this background, this presentation has two objectives: In a first part, it will highlight from a theoretical and conceptual perspective the potentials and limitations of different scenario methods for supporting the German energy transition. It will be argued that the existing scenarios are strongly focusing on technical and economic parameters. But the analysis and governance of energy system transition processes needs to take into account in a more comprehensively way societal and institutional actors and dynamics between the actors as well – in particular if the temporal perspective is 2050. Based on that reflection, in its second part, the presentation will describe scenarios which explicitly take into account such societal dynamics. These scenarios were produced within the Helmholtz-Alliance ENERGY-TRANS, a research initiative mainly characterized by applying a stronger demand-side perspective on the German energy transition. It will be outlined and discussed how these scenarios were developed, how this approach corresponds to the theoretical and conceptual reflections about scenarios, and which will be the next steps in applying these scenarios within the Alliance.

#### **Grid extension as a socio-technical constellation with various interactions and constraints – what are the key elements for policy design?**

*Doerte Ohlhorst (Environmental Policy Research Centre, Germany)*

Many challenges of the energy transition result from the decentralized and dispersed structure of a power supply with a high share of renewable energy. Site selection for the production plants is dominated by the yield of wind and sun as well as availability of locations with minimal potential land use conflicts. Decentralized generation leads to a high demand for electricity transport and the need for comprehensive expansion and restructuring of the electricity grids. Transmission grid expansion is a key prerequisite for integrating a growing renewable energy share and for cross - border transport of energy. However, grid expansion is subject to significant restrictions that threaten to bottleneck a

high portion of renewable energies in the electricity supply, and this in turn may end up jeopardizing the envisaged climate change objectives.

The presentation will provide insight into the complex design of grid strengthening for high shares of renewable energies. Focusing on the transmission grid, a cross - system perspective on various technical, social, political, administrative and economic dependencies, interactions and constraints will be taken. The factors that affect the reinforcement and expansion of the electricity grid are designed as a socio - technical constellation, elaborated with the methodology of the ‘constellation analysis’ . By zooming into different parts of the constellation it will be shown that the current socio - technical arrangement is challenged by a number of different uncertainties and controversies.

One part of the constellation reveals the lack of acceptance for new electricity grids and fragmentation of responsibilities as restrictive factors. They are closely linked to unsolved technical and economic issues as well as uncertainties. There is, for example, uncertainty about the future development of important capacity - relevant parameters such as energy generation and consumption, pace of the grid expansion, spatial distribution of renewablebased generation plants and the development of costs. This is connected with difficulties concerning predictability, but is also due to fundamentally different views on the future of energy supply.

Restrictions and policies to address them are constantly challenged, reframed and reconsidered in view of high complexities and uncertainties and in the face of multiple level interests and actor perspectives. The presentation will address the complexity of the constellation and the resulting question of how to advance the innovation process. Finally, key elements for policy design and adjustments will be proposed.

#### **Facilitating the German Energy Transition - Potentials and Limits of Public Participation**

*Pia-Johanna Schweizer (University of Stuttgart, Germany)*

The German energy transition implies the radical transformation of energy production for electricity and heat. Decisions about large-scale infrastructural changes with far-reaching consequences for various social subsystems will have to be made in the near future. As a result, the German energy transformation will not proceed without societal debates and controversies. Some of the debatable

issues refer to questions of equity, such as how (financial) burdens but also benefits should be allocated across society, resolution of conflicts regarding values, and diverging societal preferences. Consequently, stakeholder involvement and public participation are crucial factors of success for governing the transition process. The presentation will focus on the potentials and limits of discursive approaches for facilitating the German energy transition. It draws on results from a research project which is part of the Helmholtz Alliance Energy-Trans. The project "Potentials and Limits of Discursive Approaches" explores and empirically investigates the prospects and limits of deliberative, group-based approaches in online and offline formats. The talk will present explorative results from the project.

## M7 SYMPOSIUM: SCIENTIFIC FOUNDATIONS OF RISK AND SAFETY

Monday: 1100-1230, R9

Chair: Terje Aven (University of Stavanger, Norway)

### *Introduction: Terje Aven*

The subject for the symposium is the foundations on which risk analysis and safety science stand as scientific fields. The symposium is related to ongoing activities within the SRA, where a specialty group on Foundations of risk analysis is proposed, and follows a successful roundtable on the foundations of safety science at the Working-On-Safety Conference 2012 held in Sopot, Poland. A special issue on the subject is expected in the Safety Science Journal late 2013. The aim of the symposium is to combine these two initiatives in the fields of risk and safety in order to, first, give support broadly to foundational issues and second, to initiate a dialogue to establish and strengthen the links between these two threads, developed so far independently.

In spite of the maturity of practices and use of risk analysis and safety methods, the fields as a whole still struggles with establishing solid scientific platforms. Foundational issues for risk analysis have been less thoroughly explored by the scientific community than foundations of related disciplines (such as probability, statistics and decision science). Nor are they usually

discussed in journal publications and presentations at scientific conferences. Many applications exist, but their foundations are often shaky.

Similarly, safety as a particular science can be claimed to have emerged in relation to social ambitions for increased safety and security; developing, experimenting and testing practical methods, tools and models with the aim of understanding and managing unwanted actions or events. Although established as a particular domain of knowledge, the status of safety science is in many ways contested. This can be at least partly due to its holistic character, being constituted by a mix of researchers coming from different scientific traditions, and to its relatively young age as a scientific community. Moreover, safety science has over the last two decades been questioned in different ways and from different perspectives, for example finding it to be incoherent in its approach to risk, showing a disregard of safety as a social construct and controversies over the role of culture in contributing to human actions in organisations. In addition to the concerns of safety science in particular, such questions are related to fundamental issues within scientific disciplines and the philosophy of science, such as the possibility for social modelling, the workings of the human mind, and the objective existence of the phenomenon of culture. The symposium addresses fundamental concepts, principles, goals, and methods for the fields. Work on these foundational issues contributes to the development, investigation, and scrutiny/clarification of ways to conceptualize, assess, describe, manage, govern, and communicate risks and safety.

### **When safety science meets the practitioners**

*Petter Almklov, Kristine Vedal Størkersen (NTNU Social Research), Ragnar Rosness (SINTEF)*

In this paper we explore the proposal that knowledge generated by safety scientists may displace or marginalize existing local or system-specific safety knowledge embedded in operational practices. The proposition is based on theory about relationships between knowledge and power, complemented by organizational theory on standardization and accountability. We suggest that the increased reliance on self-regulation and international standards in safety management may be drivers for a shift in the distribution of power regarding safety, changing the conception of what is valid and useful knowledge. Case studies from two Norwegian transport sectors, the rail and the maritime sectors, are used to illustrate the proposition. In both sectors we observe a more generic

approach to safety management as a discipline and an accompanying disempowerment of the practitioners and their perspectives.

We discuss some contributing elements to this development: for example, the roles of external and internal HSE-specialists and the increased importance of international standards. We propose that the search for broad generalizations and the widespread adoption of cybernetic thinking in safety science may resonate with societal trends towards standardization and bureaucratic control.

We conclude that safety scientists, safety professionals, and organizations that hire safety professionals need to be sensitive to the possibility that their well-intentioned efforts to promote safety may lead to a marginalization of local and system-specific safety knowledge.

### **Why exchangeability may hinder us to see a black swan**

*Ullrika Sahlin (Lund University, Sweden)*

Assessments of uncertainty in future states of environmental systems of concern are usually based on both empirical data and expert judgment. Predictive inference following from a probabilistic model that link the data observation process to the system process is made assuming exchangeability between observed and unobserved quantities. The scientific basis to produce knowledge is challenged by the urgent need to provide solutions in the face of both uncertainty and complexity. In order to assure quality in scientific advice to policy there is a need to look at the process behind the production of knowledge, including both qualitative and quantitative uncertainties. To contribute we here ask when the assumption of exchangeability may be questionable in a typical management problem of an environmental system, and in what way it may deteriorate quality in the following scientific advice if the solution was left unchanged. We find arguments to why exchangeability may hinder unexpected events and unknown unknowns to be considered in the assessments. Thus, a non-critical use of the assumption of exchangeability in risk assessment may prevent us to see possible black swans. The discussion is illustrated by a solution to a generic problem in environmental management where uncertainty is described by probabilities assigned by Bayesian predictive inference through a state-space model, based on historical observations of the system combined with expert judgment. Environmental systems may undergo large scale changes, such as climate and land-use changes, which may drive the system into states outside the range of historical observations or different from what we have

experienced before. Non-exchangeability can be dealt with in several ways, e.g. by changing the model of cognitive assimilation, decision criteria or through design of the management strategy. As an example, we show that a questionable assumption of exchangeability related to the inference from empirical data can be addressed by designing management strategies to have an active learning process where knowledge is updated through time.

### **Addressing the foundations of safety science – relevance and benefits**

*Jean-Christophe Le Coze (INERIS, France), Temmu Reiman (VTT, Finland), Kenneth Pettersen (UiS, Norway)*

In this paper we argue for the importance of addressing the foundations underpinning the field of safety science<sup>1</sup>. Through our own research we have come to acknowledge that there is no unitary standard for doing safety research and that how science views safety management and practice is dependent on the philosophical and methodological foundations of the scientists doing the research. Leaving these questions to themselves reveals a lasting influence of a positivist view of science, which attempted to establish a clear separation between science and philosophy. The scientific revolutions of the past century (most notably quantum physics) have led historians and philosophers to indicate quite the opposite (e.g. Hanson, 1959, Kuhn, 1962).

Sciences embody and rest on underlying philosophical conceptions. Consequently, we need more focus on the foundations we use to model our approaches to safety, as explicitly or implicitly they do influences how safety is defined and what actions are considered necessary for controlling risk. As Dennett, a cognitive and evolution philosopher puts it “there is no such thing as philosophy-free science; there is only science whose philosophical baggage is taken on board without examination? (Dennett, 1996, p7). Safety as an academic discipline is to a large extent missing the insights from various fields including discussions in the areas of philosophy, sociology and history of science and technology to fuel its own developments.

We believe these are important issues to be raised and that safety researchers should aim to be more reflective regarding their (scientific) foundations. However, in order to approach questions such as these we need to have a more detailed understanding of what are relevant foundational issues that concern the safety science community and in which ways can we expect a more reflexive science to impact and develop our research. Consequently, this paper

concentrates on the importance of addressing foundational issues, presenting some more detailed and relevant issues of concern and, finally, suggesting how working on foundational issues may prove to be beneficiary if moved higher up on the agenda within the community of safety scientists.

## M8 SOCIETAL RISK ASSESSMENT

Monday: 1400-1530, R3

Chair: Per Morten Schiefloe (Norwegian University of Science and Technology)

### **National risk assessment in Sweden**

*Björn Nevhage, Ester Veibäck (FOI, Sweden), Magnus Winehav (MSB, Sweden)*

A national risk assessment (NRA) can help us to better understand and manage the risks that may affect our country. It can serve as a decision-making support in the planning of societal safety, capability and continuity.

In this project, MSB (Swedish Civil Contingencies Agency) together with FOI (Swedish Defence Research Agency) developed a model for NRA in Sweden. We conducted literature studies, interviews with experts, and workshops with representatives from other governmental agencies.

The developed NRA-model consists of seven consecutive steps: 1) What should be protected, 2) Risk identification, 3) Selection of risks for analysis, 4) Scenario development, 5) Analysis, 6) Synthesis and 7) Measures.

In the model's first step, we define what the Swedish values are that always should be protected. This is followed by risk identification, where we identify events that may cause harm to those values. The risk identification usually results in a long list of possible events. However, we cannot analyse all events, since the analytical resources are limited also. Therefore, we select the most serious events, and make rough estimates of their probabilities, consequences and uncertainties, which allow us to treat the events as risks and develop risk scenarios. A risk scenario puts the event in a certain context; for instance, the time of year, geographic spread, direct consequences and probability. An in-depth analysis of each scenario is then performed. The analysis focuses on the indirect consequences and vulnerabilities and assesses how well Sweden's

society could handle the scenario. The results of each of the scenario analyses are synthesized and then plotted in a risk matrix, for comparison. The scenario analyses do not represent the entire risk picture for the country, but highlight some parts of it; they can be useful in determining what Sweden as a nation should be able to manage. The final step in the model aims at identifying appropriate measures for dealing with the scenarios.

In 2012, MSB and FOI completed the first Swedish national risk assessment and successfully applied the NRA-model described above. That showed that further research and development are needed, in order to enhance the applicability of the model. This may include its use in strengthening the links between NRA and other existing processes within the Swedish crisis management system; developing effective methods for aggregation of results and uncertainty assessment; as well as new, more adequate, risk matrixes.

### **The Netherlands Safety and Security strategy and the National Risk Assessment**

*M.G. Mennen (National Institute for Public Health and the Environment (RIVM), The Netherlands), M.C. van Tuyl (Ministry of Security and Justice, The Netherlands)*

Threats to our safety and security are continuously changing and are becoming increasingly intertwined. Relatively minor threats can, through interdependencies, lead to societal disruption. In order to classify potential risks, threats and hazards and enhance adequate preparation and capacity building, the Dutch government approved a National Security Strategy. With this Strategy the government is able to continually improve its overview of risks and to determine priorities regarding the allocation of resources for the prevention of, preparation for, and response to threats. This instrument for multi-hazard risk management is intended to contribute to the prevention of societal disruption as a consequence of a disaster or a crisis in the Netherlands. The Strategy comprises an All Hazard approach, which implies that both natural hazards, hazards caused by technical failure and malicious threats are included. Analysis of potential threats and hazards is performed using a methodology called the National Risk Assessment (NRA). In this methodology threats and hazards are described in scenarios, which are assessed in terms of likelihood and impact using a uniform scoring method and are therefore rendered comparable. The impact criteria reflect the five vital interests of the Netherlands: territorial

security, physical safety (public health), economic security, ecological security and social and political stability. The NRA is produced by an expert network consisting of research institutes, universities, civil services, public service corporations and consultancy firms. Together, these organisations have the knowledge, expertise, skills, models and instrumentation covering all aspects related to national safety and security risks. In this way, a multidisciplinary and scientifically sound approach is guaranteed. On the basis of the NRA, a capabilities analysis is performed. This analysis assesses whether the country (government, private sector and civilians) has sufficient capabilities (people, material, knowledge, skills, and procedures) at its disposal to adequately deal with the threat, and considers which capabilities should be strengthened or developed. For example: The national risk assessment of the occurrence of a pandemic flu (2007/2008) showed that a pandemic flu could have crippling effects for the continuous functioning of critical infrastructure processes, because of the large number of people staying at home due to sickness, recovery or care for family members. As a response, Government and critical infrastructure companies developed business continuity plans for pandemic situations, thus reducing the risk of disruption of critical infrastructure processes.

#### **When hindsight is utterly wrong - how to overlook a non-plausible future**

*Jan Erik Karlsen, Sissel Haugdal Jore (University of Stavanger, Norway)*

This paper explores the applicability of the concept of societal resilience in relation to extreme events and malicious acts such as terrorist attacks. The aim is to contribute to theory building by assessing the inherent ontological and epistemological presumptions in the concept and practice of resilience.

We discuss the applicability of the concept of resilience in the light of the 22 July 2011 attacks in Norway. Totally 77 people were killed in two sequential lone wolf terrorist attacks; a bomb blast at the Government complex in Oslo and a serial killing spree at Utøya Island approximately 40 kilometers outside Oslo. The 22 July 2011 terrorist attack revealed that the Norwegian emergency authorities were not prepared to meet and respond to such an incident. Proper exercises had not been executed to imagine and rehearse the unlikely event prior to the incident, nor were the civil and military authorities coordinated to respond to this when it happened.

Resilience is the idea that an individual, a technological or social system has the capacity to handle events that challenge boundary conditions. It encompasses

the ability to prevent something dysfunctional from happening, or the ability to prevent something dysfunctional from worsening, or the ability to recover from something dysfunctional once it has happened. We may say that resilience is a phenomenon which is not expected to be activated, i.e. it is not foresighted to have a future. However, if a breakdown happens it is expected to serve as a safety net recovering the capacity of the system or the individual. This process of resilience did not take place in the case of the 22 July terrorist attack. The question we raise is - in such extreme cases and dealing with malicious act - is the concept of (societal) resilience of any use at all? The key point is whether such exercises ever may help producing images of the 'really unthinkable'.

This paper puts the terrorist incident into the concept of 'wild cards', 'hindsight' and 'societal resilience'. Wild cards and 'hindsight', as used in foresight studies, are seen as a form of organizational sensemaking, and resilience is seen as the capacity to bounce back to normal operations after a catastrophe or some other major mishap.

The methodological approach is a conceptual analysis of theoretical assumptions embedded in resilience and foresight studies. Using sociological lenses, including concepts like anticipation, latency, and the concept of time, uncertainty, complexity, ambiguity, change and plurality of images, this paper offers clarity to both foresight and resilience studies.

Key words: Societal resilience, time, anticipation, terrorism preparedness

#### **How are we vulnerable? Opening industrial hazards vulnerability analysis to social factors**

*Nicolas Rossignol (Belgian Nuclear Research Center, University of Liège), Catrine Turcanu (University of Liège, Belgium)*

There are many ways to analyze and try to mitigate the potential consequences of a hazard threatening a complex socio-technical system (e.g. a plant, a city). Classically, the risk analysis framework is used to address the uncertainty of a potential hazard by bypassing the system's safeguards and protection. In its simplistic form, it consists of the evaluation of the probability and the magnitude of the consequences of the undesired events that can transform the hazard into actual damage. Nevertheless, some risk analysis models recognize now widely the importance of integrating social aspects into the analysis, in particular by using participation tools. Another way to deal with potential consequences of hazards is to analyze the vulnerability of the system



considered. This paradigm overcomes the shortcomings of risk analysis in situations when the knowledge about the probabilities and the outcomes is incomplete or insufficient. In addition, studies in the literature, especially the more recent ones considering natural hazards, show that socio-economic factors are integrated more often and in a natural way in vulnerability analysis models. Nevertheless, it seems that such considerations are missing into models aiming at evaluating the vulnerability to an industrial hazard, especially at a very local level (e.g. a laboratory, a technical building) where the technical aspects seem to be predominant. What can we learn from the analysis of the models addressing vulnerability to natural hazards in terms of the integration of social factors? How can we apply participation to assess the vulnerability to industrial hazards at a very local level? These are the questions we address in this contribution. To do so, we realized a systematic literature review from scientific journal papers on vulnerability analysis published in the last two decades. We synthesize this review and based on it we propose an integrated vulnerability analysis model; in order to test this models we chose as a case-study the analysis of incident reports collected in a nuclear facility in Belgium. This confrontation allows us to highlight important factors to be taken into account for a vulnerability analysis conducted in such context. To conclude, we propose tentative research directions opening new ways to consider vulnerability in the industrial field.

## M9 OFFSHORE RISK ASSESSMENT

Monday: 1400-1530, R4  
Chair: Lars Bodsberg (SINTEF)

### **Assessing risks on offshore platforms by dynamic simulation of accident scenarios**

*N.J. Duijm, I. Kozine, F. Markert (Technical University of Denmark, Denmark)*

A conventional approach to assessing risks on offshore platforms due to releases of hydrocarbons is to develop static scenarios of events following a loss of containment, to assess the volume and spread of the hydrocarbons and to predict their impact on people. The prediction of the impact and consequences in terms of serious injuries and fatalities is based either on deterministic (often

conservative) assignments to the characteristics of the system, physical and environmental phenomena and workers responses or averaged/expected values of those.

The approach we advocate is to simulate in a computer environment the dynamic interaction between concurrent phenomena following loss of containment, specifically:

- The physical processes (outflow, dispersion, ignition, heat radiation, explosion)
- Detection, alarming and emergency shutdown
- Escape and evacuation
- Impact on persons, escalation and impairment of safety functions

The simulation model mimics the deployment of stochastic events in time with random delays, durations, instances of occurrences and others. It runs repeatedly imitating loss of containment scenarios and accompanying events. The output data – basically related to injuries and fatalities – are collected over all the simulated scenarios and based on those Individual Fatality Risk (IR), Potential Loss of Life (PLL), Fatal Accident Rate (FAR, at platform and workplace level), and group risk (distribution of number of simultaneous fatalities) are assessed.

This way of tackling the problem allows capturing a great deal of specific characteristics of different platforms, dynamic change of people responses and other characteristics. Scenarios with severe consequences can be 'played back' to learn from them and can be animated, which except for the learning effect provides better validation and, as a consequence, higher confidence to the model. Except this, our experience shows that the simulation models are a good communication tool between system analysts and domain experts. As the models simply mimic the behaviour of the system and people responses, this is well understood by the domain experts and positively contributes to the confidence to modelling results and model validation.

The approach as a whole and the computer model are the tools improving risk assessment by providing an overall framework to describe and simulate the interactions between concurrent chains of events under the hazardous scenarios and produce probabilistic risk measures.

### **A Quantitative Method to Assess Well Risk**

*Jianchun Fan, Luning Xue (China University of Petroleum, China)*

Two-well barrier principle is the consensus in the oil/gas industry to ensure well integrity. However, the principle does not differentiate wells with different risk levels. For example, offshore wells, especially deepwater wells, are more dangerous than similar onshore wells. Some researchers have claimed that there should be at least three tested well barriers in an offshore well. However, three well barriers will inevitably increase costs. In other hand, two well barriers are enough to ensure integrity of low or medium-risk wells. Therefore, it is necessary to build a method to assess risk of a certain well to confirm if two barriers are adequate to ensure its integrity. Such method is proposed in this article. Three kinds of indexes are proposed to assess well risk, which are reservoir indexes, well structure indexes, and technology indexes. Reservoir indexes contain permeability, pressure, temperature, and reservoir abundance. Well structure indexes include case numbers and open hole area. Technology indexes are reflected by technology safety and maturity. Risk values of the former two kinds of indexes equals their original values divided by the relevant average values. Technology safety value is determined by purposes of the technology. If the primary purpose of a technology is to promote product efficiency, it is determined to be more dangerous. Technology maturity value is determined by completeness of relevant rules or standards and its application times. The more mature technology is considered to be safer. The total well risk is calculated by risk values and weights of different indexes. Finally, layer of protection analysis is used to determine if two barriers are enough to ensure a well's integrity.

### **Bayesian risk analysis of offshore major accidents: Application to hydrocarbon releases**

*Nima Khakzad, Faisal Khan (Memorial University of Newfoundland, Canada)*

Major accidents are low frequency high consequence events which are not well supported by conventional statistical methods due to data scarcity. Quantitative risk analysis (QRA) and accident sequence precursor (ASP) analysis have been used to model major accidents. In the present work, a major accident is disintegrated into a set of subsystems and components for which enough data are available to estimate respective probabilities. These probabilities are then reintegrated using QRA methods to estimate the frequency of the accident. Indicating and lagging risk indicators are also used in the form of accident precursors for predictions and probability updating through Bayesian analysis. To consider the dependencies existing among correlated components, copula

functions are applied to develop joint probability functions. In this way, the precursor data of a more frequent event can indirectly be used to update the probability of another less frequent event for which a few or no precursor data is available. The methodology is then applied to risk analysis of offshore major releases.

Key words: Major accident, Quantitative risk analysis, Bayesian analysis, Precursor data, Copula

### **Analysis of Hydrocarbon Leaks and verification as an operational barrier** *Jan Erik Vinnem, (Preventor/Norwegian University of Science and Technology)*

Prevention of hydrocarbon leaks is important; they are the most critical precursor events that may lead to major accidents, such as the Piper Alpha.

The number of hydrocarbon leaks on offshore production installations on the Norwegian Continental Shelf peaked just after year 2000, with more than 40 leaks per year with initial rate above 0.1 kg/s. The Norwegian Oil and Gas Association ran a reduction project from 2003 until 2007, which resulted in ten hydrocarbon leaks above 0.1 kg/s in 2007. The number of leaks increased in the years after 2007, and was in average 15 in the period 2008 – 2010, without any significant increase in the number of installations. The Norwegian Oil and Gas Association initiated a new initiative early in 2011 in order to reduce the number of hydrocarbon leaks further. The initiative will be completed at the end of 2013.

A study performed by the project concludes that more than 50% of the leaks are associated with failure of operational barriers during manual intervention into the process systems. Human and organizational factors are dominating with respect to circumstances and root causes.

The study has further demonstrated the high importance of verification as an operational barrier, and has shown that many of the failures do not have multiple operational barriers in the form of several verifications and a leak test at the end. This finding is crucial in order to understand the criticality of performing the planned verifications, perform them in an independent manner according to the procedures and make sure that the focus is on detecting failures during the verification.

This paper presents the analysis of hydrocarbon leaks, with emphasis on operational barriers and importance of verification. The verifications are also used in order to discuss the suitability of development of indicators for operational barriers.

## M10 RISK, ACCEPTABILITY, AND TRUST I

Monday: 1400-1530, R90

Chair: Matthew White (European Centre for Environment & Human Health)

### **Place attachment or protected values? Barriers of public acceptance: A case study of Zenibako Wind Power Plant in Japan**

*Susumu Ohnuma, Kosuke Sato, Kiichi Ishiyama (Hokkaido University, Japan)*

Objectives: People are more likely to accept wind power plants than the other power plants in general. However, the opposition movement for wind power plants sometimes arises. It seems because of not only protection of the nature but place attachment and protected values. Place attachment is mental bonds between individuals and a certain place (Altman & Low, 1992). Protected values are those that resist tradeoffs with other values, particularly economic values (Baron, 1997). We hypothesized that the interaction of these would be crucial for the approval of the plan.

Case: Zenibako coast seemed to be a good candidate for siting the wind power plant. However, a group of residents who performed natural observation, considered having the attachment to the place, began the opposition movement claiming that there is scarce coast vegetation. The opposition movement grew into the broader area in Japan. The environmental assessment was carried out and inspected by the third party committee, which concluded that there is little possibility to destroy the coast vegetation. Even after this process, the movement did not settle down.

Method: To examine how people think about the Zenibako case, a mail-out survey was conducted in February 2012 to 900 random samples of residents living in 4-8 km distance from the site. Among these samples, 430 valid responses were obtained (47.9% collection rate).

Results: Place attachment slightly correlated with protected value ( $r = -.09$ ), which means these two are different concepts. The results of multiple regression analysis showed that a comprehensive evaluation had the strongest effect on the approval. Place attachment also had a significant effect, but protected value was not significant. Furthermore, the interaction between comprehensive

evaluation and place attachment had significant effects on the approval, which indicated that those who had stronger place attachment were influenced more by comprehensive evaluation. In addition, the interaction between place attachment and protected value was marginally significant, indicating that those with higher place attachment and higher protected value tended to disapprove the plan, while those with only higher protected value did not necessarily disapprove.

Discussion: The results suggested that, once those who have stronger place attachment evaluate the plan deliberately, then they might support the plan if they can judge it good. Moreover, even those with strong protected value may not always oppose the plan when they had weaker place attachment. The consensus process with dialogues of stakeholders should be designed considering the factors analyzed in this study.

### **Associations between risk judgements, risk sensitivity, acceptability, priority of safety and risk reduction measures in transportation**

*Torbjørn Rundmo, Stig H. Jørgensen (Norwegian University of Science and Technology), Trond Nordfjærn (Gediz University, Turkey)*

The core aim of the current research was to examine associations between risk judgements, risk acceptability, and trust in authorities on the one hand and priority of safety and demand for risk reduction measures in transport on the other hand. An additional aim was to compare priority of safety and demand for risk reduction among lay people, politicians and safety experts. The results are based on two self-completion questionnaire surveys carried out among national samples of the Norwegian public ( $n=510$ ) and ( $n=1716$ ). In addition, samples of Norwegian politicians ( $n=146$ ) and safety experts ( $n=26$ ) were included into the analysis. Risk judgements included technological risks, health-related risks, criminality, natural disasters, war and terror, as well as transport-related risks. Contrary to research carried out previously, the present study did not find support for the hypothesis that general risk judgements were significant predictors, neither of priority of safety, nor of demand for risk reduction in transport. However, as expected, perceived risk was strongly associated with the respondents' worry. Worry was a significant predictor of priority of safety as well as for demands for risk reduction measures. Personal worry did not have the same effect on demand for countermeasures as general worry. Safety experts gave less weight to severity of consequences if a negative event should take

place compared to lay people and experts, and they also gave lower priority to countermeasures.

### **Risk and safety in the mind of the military leader**

*Marcus Börjesson, Claes Wallenius, Ann Enander (Swedish National Defence College, Sweden)*

Today's complex military missions require military personnel, and in particular leaders, to handle a broad spectrum of risk and threat situations. There is, however, surprisingly little research in the field of risk psychology relating to military applications. A major challenge in the military environment involves combining elements of risk taking with a need for high safety awareness. Thus military leaders need the ability to balance safety-oriented and risk-promoting behaviours in order to handle their tasks effectively.

The aim of this paper is to examine how military personnel perceive risk and safety issues in relation to their responsibilities, and to identify challenges and dilemmas they might experience in trying to balance these issues both during military training and international missions.

Qualitative interview data were gathered from employed officers (N = 17). Half of the interviewees were from the army and half from the navy. The informants were all men in the age between 28-46 years old (median = 33 years) at platoon leader level. They all had experience from international military missions.

The qualitative analysis identified a broad range of risk issues relevant for the military leaders, relating to mission aspects but also to individual and social factors. Reflections on challenges in the military context included the taking of unnecessary risks and factors promoting such actions, difficulties in maintaining high levels of safety during long and sometimes boring mission periods and limitations in drawing lessons from experiences. Various considerations in achieving a sound risk/safety balance in military settings are identified and discussed, highlighting in particular the role of the military leader. The implications should be of interest for recruiting processes and educational communication for all professions where there is a need to balance elements of risk-taking with safety concerns.

### **Nuclear, or no nuclear: That is the question. An investigation of factors influencing energy perceptual divergence in France and Germany**

*Silke Gloaguen, Roh Pin Lee (Technische Universität Bergakademie Freiberg, German Centre for Energy Resources, Germany), François Allard-Huvert (Université Paris-Sorbonne, France)*

Especially in democracies where public opinion carries significant weight, the success of energy policies and technological implementation plans is dependent on public support and acceptance of the energy sources and technologies in question. This is illustrated vividly in Germany, where considerable public opposition and protests in the aftermath of the Fukushima nuclear accident led to the government's decision to phase out nuclear energy by 2030. In contrast, nuclear energy continues to dominate France's energy mix. Additionally, while coal plays a significant role in Germany's energy mix, it has a minimal role in France's mix. Two of Europe's energy powerhouses, Germany and France, thus have distinctly different energy profiles and development strategies. This is suggestive of a significant divergence in how energy sources, in particular nuclear and coal, are perceived and accepted in these two countries. Insights into where energy perceptions differ and factors contributing to such divergence could therefore provide a deeper understanding of the underpinnings of public support for different energy sources and the influence of national and cultural contexts.

Research on energy perceptions have focused predominantly on quantifying energy perceptions. Despite the additional insights they can provide, qualitative investigations remain the exception rather than the norm. In the present research, we therefore utilize a mixed methodology approach to (1) quantitatively investigate divergence in energy perception between France and Germany, and (2) qualitatively examine factors which play a key role in shaping energy perception.

Participants are engineering students undergoing tertiary education. 223 German students and 59 French students took part in a quantitative survey on energy perception and knowledge between May 2012 and January 2013, where they are asked about their affects and cognitive beliefs toward nuclear and coal energy sources. Additionally, approximately 40 students from each country took part in qualitative focus groups to discuss factors influencing their energy perception.

Quantitative analyses indicate that in comparison to their German counterparts, French participants exhibit more positive affects toward nuclear energy and more negative affects toward coal. Moreover, they also believe nuclear to be significantly less harmful socially and environmentally. In contrast, German participants view coal as considerably less harmful socially and environmentally. Furthermore, they also see coal as being more socially, economically and environmentally beneficial. Qualitative analyses of focus group discussions further facilitated the identification of specific factors playing a role in shaping such perceptions. Findings are discussed drawing on insights from institutional as well as path dependence theories.

## M11 CIVIL PROTECTION AND SOCIETAL SAFETY

Monday: 1400-1530, R91

Chair: Terje Aven (University of Stavanger)

### **Does lift of liquid ban raise or compromise current level of aviation security in the European Union? - Simulation-based quantitative security risk analysis and assessment**

*Erhard Petzel, Roman Czaja (Institut für Risiko- und Prozessmanagement, Germany), Gebhard Geiger (Technische Universität München, Germany), Christian Blobner (Fraunhofer Institute for Factory Operation and Automation (IFF), Germany)*

To protect aviation security against terrorist attacks using liquid explosives aboard aeroplanes, passengers are currently limited to taking 100ml containers of liquids onto aircraft. International stakeholders in aviation security increasingly agree that modern screening technology is an effective alternative approach to mitigate the risk posed by explosives based on liquids, aerosols and gels (LAG). Thus, the EU Commission has decided to remove LAGs restrictions at European airports from April 2013 on, subject to technological solutions for liquid screening. While suppliers of Liquid Explosive Detection Systems (LEDS) have been developing equipment in compliance with specific standards set by the

European Civil Aviation Conference (ECAC), there is ongoing controversy on whether the lift of liquid ban raises or compromises the current level of aviation security in the European Union. The present paper treats basic problems of the effectiveness and cost-efficiency of the liquid screening technologies within a rigorous, methodological framework of quantitative security risk measurement and assessment. The analysis is part of the ValueSec security research project carried out under the EU FP7 (2012-2014, Grant Agreement Number 261742). It is intended as an application example of how to approach infrastructure security management problems on a systematic, quantitative basis. It proceeds in four steps. First, characteristic security incidents, or attack scenarios involving LAG explosives, are designed to simulate liquid screening technologies and operational procedures employed in security checks of passengers and carry-on luggage at European airports. Secondly, the operational constraints and consequences of security incidents are modelled as random events, using software-based business process modelling techniques. Sequences of incidents occurring under randomly varying (technical, operational) conditions are simulated on the computer to generate the required statistical data (distributions of loss or damage incurred in the incidents). In particular, they include detailed simulations of the impact LEDS false clear signals make on the fatality numbers likely to be incurred in in-flight terrorist incidents. Thirdly, the experiments are carried out with and without the different screening technologies/security procedures in place and, therefore, lead to different loss/damage distributions. Finally, different frequency distributions are evaluated, in quantitative terms, using risk assessment techniques recently developed in the operational sciences. Less dangerous risks lead, in the simulation experiments, to outcome distributions with a larger "certainty equivalent" (numerical indicator of risk preference). Different airport security solutions are simulated in the experiments. Their effectiveness in risk reduction can be directly inferred from the decreased certainty equivalents of the reduced risks to which they give rise in the scenarios and incident simulations. Estimating the procurement and operational costs of the security management measures analysed in the experiments and dividing the amount of risk reduction (decrease of the certainty equivalent) achieved by these measures per Euro invested, the cost-efficiency of the risk management measures can be directly calculated.

### **Adapting Dwellings to Protect Residents from High Indoor Temperatures**

*D. Ormandy (University of Warwick, UK), V. Ezratty (Medical Studies Department, EDF, France), A Dengel, M Swainson, M Roys (Building Research Establishment, UK), A. Bone (Health Protection Agency, UK), N. Malhotra (Wolverhampton Primary Care Trust, UK)*

Introduction: There will be an increase in extreme weather events, including heat waves affecting the UK and other European countries. During the heat wave in France in August 2003, unprecedentedly high day and night-time temperatures resulted in 15,000 excess deaths. In England there were over 2,000 excess deaths in the same month, and it is projected that this number will increase dramatically over the 21<sup>st</sup> century.

These countries have adopted plans involving the health and social sectors reacting to heat waves by providing support for susceptible individuals. There is also research and development on designing new dwellings to incorporate protection against excess high indoor temperatures. However, there appears to be little work on identifying existing dwellings that provide little protection to occupiers during heat waves, and on the adaptation of such dwellings.

Objectives: This project will –

- provide guidance on the characteristics that could contribute to excessive high temperatures in existing dwellings during heat waves
- devise a survey protocol to identify those dwellings which provide little protection and the assessment of potential threat to health in such dwellings
- give guidance on appropriate preventative measures to minimise the effects of the characteristics and improve the protection for residents

Methods: The Housing Health and Safety Rating System has been used in England since 2006 to assess housing conditions. The HHSRS lists 29 potential housing hazards, including Excess Heat. Based on a review of the literature, the HHSRS profile for Excess Heat is being updated and expanded. It will cover the impact on health, the vulnerable population, the causes of the hazard, and the preventative measures.

A protocol is being developed to give surveyors an aide memoire of dwelling characteristics to be evaluated, the process for assessing the likelihood and severity of a threat to the health of occupants from excessive high temperatures. The protocol will be field-tested during the summer of 2013, and, following debriefing, will be revised and finalised. The field-testing will be carried out in

England and in France to ensure that the guidance and protocol are international.

Conclusion and Perspectives: The outputs from this project will inform the development of heat wave protection programmes geared to providing interventions for the adaptation of existing dwellings. Such programmes should focus on those dwellings least likely to give adequate protection against high outdoor temperatures. This need for long-term protection should be recognised and the funding of mitigation programmes investigated.

### **Security Vulnerability Analysis of the High-Tech Industries in Taiwan**

*Jao-Jia Horng (National Yunlin University of Science and Technology, Taiwan), Wen-Lian William Lee (Chung Shan Medical University Taichung, Taiwan)*

The prevention of disasters from man-made attacks has risen in attention since the multiple-terrorist attacks in United States on September 11th, 2001. The United States Department of Homeland Security has since promulgated the Chemical Facility Anti-Terrorism Standards and related legislature, requesting manufacturers with hazardous production processes to implement Security Vulnerability Analysis (SVA) as a part of their preventive management measures in addressing major disasters from terrorist attacks. The analysis evaluates the safety concerns of the plant area, manufacturing processes, and information technology, as well as integrating emergency and rescue measures to address possible threats, assess vulnerability, and implement safety measures.

Using a series of questionnaires, we investigated the safety management, emergency response, joint prevention measures and implementation of SVA of Taiwan's optoelectronic and semi-conductor industries that employ chemicals in their production processes. Our results have shown that most industries in Taiwan are deficient in preventing man-made sabotage and consequence analysis of disasters, demonstrating the need for SVA promotion and better preventive measures. Our analysis of the hazardous chemical accidents between the years 2006 and 2010 has also shown that most accidents occurred in industrial and science parks that are close to populated areas. Since high-tech industries are the main economical backbone of Taiwan, we recommend that plants should employ SVA assessment and risk management to improve their infrastructure, and ensure the safety of important manufacturing assets to prevent growing risks of chemical hazards and disasters



Key words: Security Vulnerability Analysis; questionnaire; high-tech industry; optoelectronic; semiconductor

### **Assessing vanadium and arsenic exposures for residents near a petrochemical complex by two-stage dispersion models**

*Chia-Pin Chio, Tzu-Hsuen Yuan, Chang-Chuan Chan (Institute of Occupational Medicine and Industrial Hygiene, Taiwan), Ruei-Hao Shie (Industrial Technology Research Institute, Hsinchu, Taiwan)*

Background: The application of Industrial source complex (ISC) to estimate spatial distribution of air pollution levels in impacted areas when emission rates data are unavailable, a common problem in resource-limited developing countries, has not been successfully verified before. The purpose of this study is to demonstrate that a two - stage dispersion model can be built empirically to estimate air pollution levels from well-designed ambient air monitoring in the impacted areas. Methods Our study area is the No.6 Naphtha Cracking Complex , which is situated in the west coast of central Taiwan with an area of 2603 ha , and an oil refinery capacity of 25 million tons per year and electricity generating capacity of 1.8 million kW per year by coal-fired power plants. Our target pollutants are vanadium (V) of refinery emissions and arsenic (As) of coal - fired power plants. The first stage dispersion model applied a backward fitting technology to derive possible emission rates of V and As from 192 filters collected during 2009 - 2012 at 14 sampling sites in 19 sampling campaigns m which covered our dispersion modeling domain of 50 km × 50 km. The least square method and the maximum likelihood approach was used to estimate model's optimum fitting and uncertainty. The second stage dispersion model applied Kriging interpolation and shift weighting averages to calculate V and As concentrations at resident's geocoded addresses. The predicted and measured V and As concentrations were averaged at three zones of 0 - 10 km, 10 - 20km and 20-30 km and regressed to test their comparability. Results Our first-stage models estimated emission rates of V and As (median and 95% confident intervals at 0.0202 (0.0040 – 0.1063) and 0.1368 (0.0398 – 0.4782) g/s, respectively. The se estimated emission rates were relatively comparable with the estimated values from Taiwan Source Composition Library and USEPA SPECIATE 4.3 database , which were 0.0023 – 0.1120 (mean – maximum) g/s for V and 0.0004 – 0.0368 g/s for As . The predicted zone - average concentrations from our second stage model showed a strong correlation for V (R 2: 0.85 –

1.00), whereas a poor correlation was shown for As (R 2: 0.20 – 0.39). Our findings concluded that two - stage dispersion models can be used to estimate V levels with relatively good precision but not As levels at residents ' addresses near the petrochemical complex. The predicted V concentrations from the two-stage dispersion model can be used to estimate individual biological doses, such as urinary V levels, by linking their values to physiological-based pharmacokinetic model in future application.

## **M12 STAKEHOLDER PARTICIPATION AND RISK DISCOURSE**

Monday: 1400-1530, R92

Chair: Terje Aven (University of Stavanger)

### **Early participation as a tool to prepare for health risk conflicts**

*Gisela Wachinger, Jürgen Wuthe, Regine Merkt-Kube, Jakub Rehacek, Ortwin Renn (University of Stuttgart, Germany)*

Although health related risks are still in decline in Germany, the development is becoming unstable: Due to demographic changes and due to high level of technologies used in medical care, the health care becomes ever more expensive. Therefore activities have been launched to restructure present health care system in terms of prevention and preparedness, but in the same time safety and availability to reach medical facilities for all people must be ensured. This is a prerequisite even if as a result of restructuring some of the hospitals will be closed. Planning processes for hospitals are usually triggered by occupational and economic pressure, and often by a combination of both. These aspects are in a natural conflict with socio-cultural services including a strong demand of the local communities for a local hospital in spite of the fact that many members of these communities commute to outside facilities as they believe they will get better care there. The state government of Baden-Württemberg has initiated the "Health Dialogue" as a tool to involve multiple stakeholders, including the public, in an early stage of planning process to prevent future health related risks. We have designed, \*University of Stuttgart #Ministerium für Arbeit und Sozialordnung, Familie, Frauen und Senioren Baden-Württemberg +Technical University of Ostrava 1 implemented and tested this early participation process on three levels (state, regional and local) to cope with these risks. First results are

obtained from a concrete conflict (a closedown and rebuilding of hospitals in the city of Stuttgart periphery). Patient organisations and the general public are invited to work on recommendations for the decision makers and to discuss their preferred solutions with professionals working in the health system, as well as with the authorities and even with the state health minister. The Baden-Württemberg Health Dialogue is a tool to engage and empower the concerned public in shaping prevention system and redesigning hospital structure in their region.

If this tool turns out to be effective, it could be applied to other conflicts, where sociocultural topics are directly interlinked with certain risks. It is our belief that by addressing underlying conflicts through an early empowerment of highly concerned people, a better social capacity for upcoming risks can be achieved.

Key words: Health care, hospital planning process, participation, dialogue process, mediation, health risk, preparedness

### **Logical understanding and irrational fears about radioactivity impact**

*Midori Aoyagi (NIES)*

According to the results of a series of focus group interviews carried out from October 2012 to February 2013, we discuss public understandings, attitudes; behavior against radioactive contaminations of food, a large amount of Tsunami waste generated by the East Japan Great Earthquake, and explored the reasons of fears about radioactivity.

Our focus group interviews were conducted in four groups (One male groups, three female groups) in October 2012 (first wave), and two groups (both male and female mixed groups) in February 2013 (second wave). The main theme of the first wave was about the risk-risk trade-offs among climate change and nuclear power generation, and the second wave was the risk perception of the radioactivity generated by the Fukushima power plant accident. In this paper, I will discuss the result of second wave.

Our topics were a) Images of radioactivity and nuclear power generation, b) basic understandings of radioactivity—its effects on health, general usage of radioactivity (medical, etc), exposure of radioactivity, c) treatment of waste that contains relatively higher radioactivity. Results are as follows.

i) Risk perception on radioactivity is not based on the scientific knowledge, and is very ambiguous. It is rather based on participants' past experience (class room

study of Nagasaki, Hiroshima), media exposure (TV programs for nuclear meltdown at Chernobyl, Fukushima accident, Cartoon stories such as "Barefoot Gen", "Grave of Fireflies"). Based on those images, participants' understanding of radioactivity risk is just like bacteria or virus, and participants believe that no chance of recovery from the damage by the exposure from the radioactivity, humans are unknowingly damaged as it is invisible to human in Fukushima area.

ii) As soils and waterways, sea water are contaminated with radioactivity, food such as vegetables, fruits, rice, and fished, are thought to be "contaminated," and some participants chose to buy products from the remote areas, such as Kyushu, or Shikoku (West part of Japan). They do not recognize the effort made by producers, or local governments.

iii) Participants watched short video, and some materials that explain radioactivity, producers' efforts for safer foods, and safer waste treatment by Tsunami damage. The participants who have more ambiguous knowledge tend NOT likely to accept those scientific (logical) explanations. Logical explanations cannot solve those fears.

### **Balancing risks and benefits: Perceptions of local stakeholders of the fairness of decision making process in the Barents Sea oil field development**

*Ortwin Renn, Khara D. Grieger, Knut Øien, Henning Boje Andersen*

We present a case study about local stakeholder views of the fairness, as seen retrospectively, of the decision making processes behind the siting of the oil development in the Barents Sea. The study was conducted in March 2011 in Northern Norway, about two years after the Norwegian Parliament had approved the plans for the development and operation of the Goliat Oil fields in the Barents Sea, and less than a year after the dramatic Deepwater Horizon Accident in the Gulf of Mexico.

We conducted a total of 18 interviews with 20 interviewees in the cities of Tromsø, Finnsnes, Hammerfest, Havøysund and Honningsvåg. The respondents were civil servants, academics, local and regional politicians, representatives of fisheries and other local businesses, spokespeople of NGOs and consultants.

Interviews were semi-structured, inspired by an adapted model of the International Risk Governance Council's framework (IRGC). The main objectives of the study were to provide a retrospective review of the fairness of decision making process as seen by the major stakeholders involved in this process.

Results showed that the siting process of Goliat was dominated primarily by the issue of benefit sharing. In view of potential risks to oil development, local stakeholders felt entitled to some compensation in terms of shared benefits. Moreover, stakeholders felt they had been strongly reinforced by industrial and public representatives in their high hopes for benefits to local industry and development. At the time of the interview, local stakeholders felt that their prior expectations that these benefits would materialize and provide benefits to the communities – and would then be fairly distributed among the beneficiaries - have been disappointed.

We conclude by discussing benefit perception and benefit communication and highlight in particular the need for considering the fairness of collective distribution of risks and benefits. We suggest that more research may be useful into this area as the perception of fair benefit distribution may turn out to be a decisive factor for judging technology acceptance among local stakeholders.

## M13 SYMPOSIUM: ON COMPLEXITY AND SAFETY RESEARCH

Monday: 1400-1530, R92

Chair: Karin Laumann & Britt-Marie Drottz Sjöberg (Norwegian University of Science and Technology)

In this symposium we want to present research that we currently are performing in the research group for safety and human factors at the Psychology department at the Norwegian University of Science and Technology in Trondheim. In the symposium we will present our research topics which investigate different aspects of safety in the Norwegian petroleum industry. Several of our projects are related to issues that deal with safety and complexity and how to handle complexity.

After the presentation, each of the presenters presents their view on the questions below and after we have an open discussion about these questions:

- What does complexity mean in safety research?
- Complexity and research methods? Which methods should be used to investigate complexity in safety research?

- Do we get interesting insights from qualitative data on safety and complexity and do we trust the results enough to be applicable in the field?

### **Complexity as a Performance Shaping Factor**

*Martin Rasmussen (Norwegian University of Science and Technology)*

This paper is part of a larger project that aims to adapt the nuclear intended Standardized Plant Analysis Risk-Human Reliability Analysis (SPAR-H) method for use in the petroleum sector. This paper evaluates the performance shaping factor (PSF) of complexity. Assessing complexity is a challenge in creating a solid and reliable human reliability analysis (HRA) method. Many existing HRA-methods include complexity as a PSF, but a lack of guidance and a heavy reliance on the evaluations of the analyst creates an uncertainty about the results. Through a review of HRA-methods and research on complexity this paper attempts to create a framework for assessing complexity in a reliable and practical manner.

### **Safety Management Systems as Communication**

*Thomas Wold (Norwegian University of Science and Technology)*

An IT-based Safety Management System contains procedures, safety standards and checklists and descriptions on how different tasks should be performed. Safety standards and work procedures are typically designed at an executive level in the organization, and then communicated to the lower level in the organization which applies them. How is this information perceived and understood at the receiving end? The paper presents a case study of how managers (onshore and offshore) and operators (at an offshore) installation perceive and use the management system.

Onshore executives in the organization tend to regard the Safety Management System as an important tool for all work performed on the oil and gas producing installation offshore, and they take it for granted that the operators on the installation use it. The managers perceive the system as a tool, and as a tool it does not require interpretation, it just requires handling skills. However, a Safety Management System is in fact a media text, moving from the executive level in the organization downwards to the operating level. With insight from media reception studies any mediated text must be interpreted by the receiver, e.g. the mechanics and electricians, in order to make sense, or else

they tend to avoid using the Safety Management Systems or make mistakes. The current results indicate that the operators on the investigated platform relate to the Safety Management System as an unnecessary burden, and they prefer not to use it. Research should investigate further how operators on installations (or other places) relate to a Safety Management System, work processes and safety procedures; how they understand and interpret this, and how their interpretation affects the use of management systems. The discussion provides examples of future possibilities and choices with respect to improvements.

### **Consequences of insufficient focus on human factors in a design phase of new automated technology**

*Gunhild Sætren, Sandra Hogenboom, Karin Laumann (Norwegian University of Science and Technology)*

**Purpose:** The purpose of this study was to explore how a project group included human factors in the design process of new drilling equipment.

**Design:** In this project 7 informants were interviewed. The informants were part of a project team which designed new automatic drilling technology and they represented three companies who cooperated on this specific design. Grounded theory (Strauss & Corbin, 1996) was used for analysing the data. This is part of a larger PhD project of the understanding of human factors in automated drilling technology where 43 interviews have been conducted over a period of 4 years in addition to offshore observations and a survey.

**Results:** The conclusions were that the technical aspects of the design process were thoroughly tested and seen as satisfactory by the informants. However it could be questioned if the team to a too high degree had a shared understanding of the importance of technical aspects, and had an insufficient focus on human factors. We found that the input-factors insufficient requirement specification on user friendliness, inexperience on commercial product development, lack of contextual understanding, focus on technical safety, and an understanding of that automation only leads to less human errors, lead to the two main categories insufficient information coordination and a limited focus in different phases of the design project. Our main category is thereby that insufficient human factors analyses were performed. The output result was a product that was low on user friendliness and end users who had insufficient knowledge on safe usage of the technology. This resulted in a situation where the product had to be adjusted

after it was completed and implemented in addition to extensive training for the end users retrospectively. This indicates that the costs were extensively higher than if necessary considerations had been carried out in the earlier phases.

**Implications:** We argue that this indicates the importance of a human factors focus in the design phase of a product development project. If design evaluation methods according to human factors principles such as a user analysis, task analysis, and a function analysis had been conducted the product could have been less costly, more user friendly, and end users could have had a better understanding of safe usage.

### **The effect of inter-organizational complexity on the risk of major accidents** *Vibeke Milch (Norwegian University of Science and Technology)*

Risk of major accidents has become one of the main prioritized areas of the Norwegian Petroleum Safety Authority (PTIL, 2013). Events such as the Macondo blowout in the Gulf of Mexico in April 2010 and the well control incident at Gullfaks C on the Norwegian Continental Shelf (NCS) in May 2010 have shed light on the need to acquire new knowledge and propose solutions to reduce risk in the petroleum industry.

Investigations of incidents and major accidents in the industry have identified factors related to inter-organizational complexity to be significant, where a central issue is the management of multiple organizations working alongside each other in offshore operations, particularly in drilling activities (e.g. Read, 2011; Austnes-Underhaug et al. 2011). With an expected increase of technological challenges and need for specialists due to old and depleted fields, deep-water drilling and use of automated systems, inter-organizational complexity is also likely to increase.

In spite of this, safety research in the petroleum industry has hardly been concerned with challenges relating to inter-organizational complexity, and most studies on safety and major accidents have been conducted in intra-organizational settings. Accordingly, the need for research concerning inter-organizational complexity and risk of major accidents is evident.

The main objective of the on-going project is to increase our understanding and knowledge of safety issues in drilling and well work processes that are characterized by high inter-organizational complexity. The project will analyse in what way safety issues are related to formal and informal coordination of work in inter-organizational systems, conditions for and safety effects of knowledge

sharing within and between organizations, and management and safety effects of inter-organizational industrial relations. Our aim is that the research will contribute to new knowledge and new methods that can reduce risk and increase resilience in the petroleum industry.

### **Improving Safety in Offshore drilling operations: Interpretation and communication of abnormalities in drilling data**

*Sverre Kvalheim*

During the period from 2008 to 2011, the number of well control incidents on the Norwegian Continental Shelf increased 11 to 28 incidents annually. Only ten of a total of 146 well control incidents were investigated. During a similar period, 130 hydrocarbon leaks were investigated (PSA, 2012). Some of the increase in well control incidents can be explained by the increase in the number of wells drilled, but the development is nonetheless distressing. After the Macondo blowout, several initiatives from authorities have resulted in proposed actions and potential research questions related to the management of major accident risk related to offshore drilling. Among the initiatives are suggestions for both technical and operational improvements aimed at improving safety in offshore drilling operations. The first objective of this project is to further understand the involved mechanisms in failing to identify problems in the well when indicated on the monitors used by drillers. To assess these problems, an experimental and observational study on how drillers act on, and interpret drilling data during a well control incident is to be conducted in a drilling simulator. The knowledge gained in this study is to be used to give input to how indicators of anomalies can be changed to trigger appropriate responses from the drilling crew. The second objective of this study is to develop and test an adapted CRM based training program in order to improve communication and management of errors in offshore drilling. To successfully adapt the CRM framework to the drilling context, the content of the training must be established to reflect the challenges in real life drilling situations. Like pilots, the drilling crews are exposed to complex challenges which can be classified as threats. These threats are regarded as elements outside of the crew's control which are increasing complexity and require the crews attention and management if safety margins are to be attained (Merritt, et al., 2006). Results from the second objective will assess the relevant threats and errors in offshore drilling, CRM training and auditing program for team performance in offshore drilling crews.

## **M14 SAFETY MANAGEMENT I**

Monday: 1530-1600, R3

Chair: Trine Marie Stene (NTNU Social research)

### **The procedures and working practice. The study from Danish oil and gas industry**

*Hanna Barbara Rasmussen (University of Southern Denmark, Denmark), Stian Antonsen (Norwegian University of Science and Technology, Safetec Nordic, Norway)*

**Background:** The oil and gas industry in the Danish sector of the North Sea has always focused on reducing occupational and major accidents. Over the years, accident rates have been reduced to 2.3 per million working hours in total (2010). Rules and procedures have been considered important in order to prevent accidents. This is why oil and gas companies have developed elaborate management system of work procedures. The aim of this paper is to investigate which role the procedures have on working practice on Danish oil and gas installations and if they promote safety or not.

**Theory:** The study is based on existing research on safety management rules (e.g. Hale and Borys, 2012). We also discuss procedures in light of Goffmans' (1966) theory of impression management and his concepts of front stage and back stage. **Data:** Material consists of documentary data such as procedures, reports etc. as well as interviews. Data derive from three oil and gas companies in the Danish sector of the North Sea.

**Methods:** Thematic analyses of documentary material and interviews. **Preliminary results:** The preliminary results show that all companies have a management system, which contains the large number of procedures. The procedures from the one side give guidelines to employees how to perform the work safely, but on the other side some of procedures are contradictory to each other and some of them are not updated and not living up to the current working practices.

**Key words:** Procedures, accident prevention, offshore

### **Helicopter crashes and risk factors within the domestic helicopter transportation in Norway**

*Rolf J Bye, Brita Aasprang, Stein Haugen, Stian Antonsen*

This paper is based on an analysis helicopter crashes within the domestic helicopter transportation in Norway in an attempt to identify risk influencing factors. The data used in this paper is collected during an extensive study of the Norwegian domestic helicopter industry in 2012. The domestic helicopter industry has seen several serious accidents in recent years and is generally regarded as a high-risk industry. Despite this, surprisingly little safety research has been performed in this sector.

We have analyzed all reported helicopter crashes in Norway from 2000 to 2011. The analyses have been carried out by using correspondence analysis and logistic regression (case-control study). Our results shows that (1) weather conditions (2) Inadequate planning, (3) age of pilots, (4) the pilot's total number of flight hours and (5) type of operator (organizational type) affect whether an incident may result in crash or not.

In addition, we conducted a survey that measures the safety climate within the operating companies. This survey was supplemented with 50 depth interviews. The analyses of the safety climate data indicates that the identified risk factors associated with helicopter crashes are in a limited extent addressed and handled by the helicopter operators.

### **Improving safety management of biogas in Europe**

*Olivier Salvi, Bastien Caillard (European Virtual Institute for Integrated Risk Management, Germany), Sébastien Evanno (Institut National de l'Environnement Industriel et des Risques, France)*

The investment in the production of renewable energies is experiencing a great development in the world and in particular in Europe. The main drivers are at political, economical and strategic level, and they find their expression in the Renewable Energy Directive (Directive 2009/28/EC), the European Strategic Energy Technology Plan (SET-Plan), the Energy and Climate Change policy framework and in the Energy 2020 strategy, A strategy for competitive, sustainable and secure energy. The main objective of this development is to find alternative energies to replace the fossil energy dependence which is more sustainable and reduce CO<sub>2</sub> emissions. Nevertheless, new energy produced by new technologies often generates new risks that have to be properly addressed

to guarantee that the transition to a new energy mix with more renewable energy will be performed safely and reach a wide public acceptance.

The production of biogas is positioned as energy which can not only generate a source of renewable energy but also which recycles waste. In the context of sustainable development, the place of biogas is therefore essential. Several questions about safety issues, the harmonization of the regulations and the need to develop standards are discussed in this paper, based on the results of the activities of a European Working Group on Biogas Safety and Regulation (EWGBSR) created in 2011. The risks corresponding to the biogas production and use have been framed using the method and tools resulting from the iNTeg-Risk project ([www.integ-risk.eu-vri.eu](http://www.integ-risk.eu-vri.eu)). Several deficits have been identified and a strategy to improve risk management proposed by the EWGBSR.

This paper presents the context of biogas in Europe and the strategy proposed by the European working group, covering technical aspects, regulatory and standardization aspects and organizational aspects such as learning from accidents and sharing experience.

### **Organisational conditions for professionalism and expertise: A case study of the Australian gas pipeline industry**

*Sarah Maslen*

Safe operations in high hazard industries are critically reliant on the practices and expertise of companies and their personnel, but organisations often fail to recognise this or properly support its development (Hayes, 2010). Their importance has been highlighted throughout the accident literature where warnings have been shown to go ignored (Hopkins, 2012), and the scale of what could go wrong misjudged (Hopkins, 2010). These short-comings need not be viewed as individual professional failures. Rather, expertise and professionalism can be viewed as the outcome of the organisational contexts that support or inhibit them (Lam, 2000).

Based on semi-structured interviews with 34 engineers in the Australian gas pipeline industry, this paper examines how companies in high hazard contexts can effectively build professionalism and expertise among staff with view to ensuring safe outcomes. To date, the industry has an excellent record regarding public safety, due, in part, to the safety values and expertise of its professional staff. However, the industry has an ageing workforce, and is facing the imminent retirement of many of its key experts. This presents a challenge to maintaining

engineering expertise and a safety culture as new generations take up increasing responsibility for key decisions.

This paper argues that safety understandings, practices, and expertise development are significantly influenced by organisational conditions including structural factors, resourcing, and responses to incidents. It illustrates how the necessary professionalism and expertise to avoid major accidents is more the product of experience and informal mentoring than traditional knowledge delivery formats such as courses. The findings of this study will have relevance to other industries facing similar challenges, particularly those in high hazard contexts.

## M15 INDICATORS AND METHODOLOGY

Monday: 1530-1600, R4  
Chair: Knut Øien (SINTEF)

**A new instrument to optimise human factors in the maintenance of oil and gas assets: development and validation of a resilience assessment tool**  
*Said Ameziane (The Robert Gordon University, UK, Algerian Petroleum Institute, Algeria), Mohammed Kishk, John A Steel (The Robert Gordon University, UK)*

Maintenance activities are labor intensive and maintenance staff often work under pressure to finish tasks as rapidly as possible. Poor maintenance is known as one of the major contributors to industrial accidents; human factors i.e. the interrelation between the job, the organization, and the individual has not been adequately examined in the maintenance of oil and gas assets in comparison to the aviation and nuclear industries. Systems have become more complex and socio-technique. Organisations are often working under pressure to achieve success. They must adapt their functioning and make correct adjustments, particularly the human element of the system, dealing with conditions such as lack of competence, knowledge, time and resources. These adjustments may lead to success or to increase risks. Several research works have shown that traditional accident causation models as well as risk assessment techniques often fail to address such systems. There is a need therefore to develop something different where the system as a whole is taken into account. A systemic approach based on resilience engineering that considers the

performance of the system as whole may help manage properly such a situation in order to enable the optimisation of human factors by consolidating and enhancing positive adjustments and mitigating or reducing negative ones. A resilient organisation is one which is able to respond to threats, to flexibly monitor, to anticipate any developments, and to learn from experience. A resilience assessment tool tailored to the maintenance system of the oil and gas sector, the MAintenance System Resilience Assessment Tool (MASRAT), was developed and validated. It allowed diagnose the maintenance system resilience, define a maturity level, and identify strategies to improve this level. This paper presents the tool development and validation process as well as the main results of its implementation in an oil and gas maintenance system to determine the system resilience with respect to the most significant human factors.

Key words: human factors, maintenance system, resilience engineering

## Identifying indicators for assessing the environmental impact of industrial activities

*R. Bubbico, B. Mazzarotta, C. Menale (University of Rome, Italy), R.V. Gagliardi (INAIL, Italy)*

The interaction between a given industrial installation and the surrounding territory is rather complex and difficult to be thoroughly represented. This is because of the large number of parameters to be taken into account, either associated with the installation (materials supplied or produced, operating conditions, equipment, emissions and so on) or with the territory (type of environment, weather conditions, population distribution, etc.). Furthermore, the interaction between these parameters is often not only in a single direction: for example, extreme meteorological conditions can affect, or even cause, an accident within the plant, but, at the same time, also the possible consequences of the accident, such as the release of a given chemical, are affected by the weather conditions at the moment of the release. Similarly, the population type and distribution can interact with the consequences of an accident (e.g. increasing the probability of an explosion, affecting the dispersion of a chemical due to the type and number of structures and buildings, and so on), as well as influencing the capability of evacuation of a given area. Also, the impact of the plant operation (either in "ordinary" or emergency conditions) on the surrounding territory can be quite different depending on the specific characteristics of this latter.



As a consequence, no model is currently able to represent, or even quantify, this kind of interaction. Different approaches are available in the scientific literature, but in most of the cases, they address specific issues of the problem: continuous long-term environmental impact, social or environmental consequences in emergency conditions (accidents), equipment reliability, and many others. Given the large number of parameters involved and the varying level of detail that can be adopted, there is no single solution even for addressing only one particular problem, and, as a matter of fact, for each of those aspects, different approaches have been proposed in the literature.

In the present work an attempt has been made to look at the problem from a more comprehensive point of view, and a number of representative indicators, also in relation with the specific vulnerability of the surrounding territory, have been defined and represented.

#### **Indicators To Monitor Urban Risk**

*Stig H. Jørgensen, Rundmo (Norwegian University of Science and Technology)*

The aim of the paper is to explore possibilities and limitations in developing robust risk indicators for comparing and monitoring risk and urban transport safety in Norway. Safety issues concur with environmental as well as health issues in urban planning. Shifts to public transport and active travel (biking) are encouraged by the authorities. Urban systems constitute the most complex risk environment for road users. Road transport represents a major risk in terms of injury rate. It is a main cause of death among males 15-24 years and regarding lost disability adjusted life years. The risk of insecurity could be perceived as higher than accident, due to fear of violence, harassments and unpleasant episodes amongst travelers waiting for or using public transport. Challenges in placing together risk indicators of safety and insecurity are discussed.

Road traffic accident data (2000-10) and survey data on transport risk, subjective indicators on perception of likelihood and consequences of security events in transport, are analyzed. Rates of killed and seriously injured people by type of road users are presented for the four biggest municipalities and urban regions, split by sex and age, and casualties as 'insiders' (residents in the area) and 'outsiders' (transients). The results suggest differences in urban mobility pattern and traffic risk. For private motor vehicle crashes the overall injury rates are falling, without strong associations to city size, though Stavanger experiences the lowest rates.

The risk level and road accident figures in the big cities reflect the travelers' mobility level, situational risk and composite decisions in mode of transport. The survey indicates higher subjective risk (means) assigned to security than injuries (accidents). Higher scores correspond to city size and population heterogeneity. Validity and reliability issues of the indicators are addressed with completeness and data quality.

Combined journeys (door to door transport) could indicate that walking distance to or from transport stops may enhance the risk connected to public transport. Increased proportions of walkers and cyclist may reduce the risk level for these groups through higher visibility and attention ("safety in numbers"). Urban safety policy may promote extended traffic calming and separation of types of road users as well as security measures at rallying points and desolated transport corridors.

This is a project set forth by NFR on 'Priority of safety in future urban transport systems.

Key words: Risk, Urban areas, Safety, Security, Transport

#### **Why efforts to establish early warning indicators to major accidents have failed**

*Solveig W. Pettersen, Bjørn Tore Hellesøy, Snorre Sæternes*

The Texas City refinery explosion in 2005 and the Macondo well blowout in 2010 are both reminders of the major accident potential of activities in the oil and gas industry. These events contributed to the industry's understanding of that the risk of major accidents and occupational accidents are influenced by different underlying causes.

The maturity of methods for the selection and classification of major accident indicators has however not reached the same level of understanding as for occupational accident risk. While indicators for technical, and to an increasing degree, operational elements have been defined and established performance criteria for, organizational characteristics such as communication, conflicting goals and organizational learning are often left out in the dark.

Major accidents are often the result of multiple latent deviating conditions that has developed over time. This type of failures often has an organizational nature and is rooted in the blunt-end of the organizations. Hence, these factors affect the status of the technical systems and actions of those in the sharp-end.

Monitoring organizational factors will thus increase the organizations ability to detect early warnings of a major accident.

Organizations like OGP, CCPS, API, HSE UK and OECD2 have published guidelines and recommended practices on the selection of major accident risk indicators. The implementation of these guidelines is to our knowledge limited in the upstream oil and gas and drilling industry, and is by some considered not relevant. On the Norwegian Continental Shelf, effort has been made to establish monitoring and verification activities on barriers against major accidents, with its results used as technical indicators for major accidents.

For major accident indicators to be applicable for risk-informed decision making, it is important that their effects on the major accident risk is well understood. The key is to understand how organizational factors affect the technical and operational indicators and hence, the risk of a major accident. The main purpose of this presentation is to discuss a framework for selecting technical and operational indicators that establishes a link to relevant organizational factors. The presented approach builds on reviews of existing guidelines, a literature review and interviews of industry representatives.

## M16 SYMPOSIUM: COMPLEXITY SAFARI

Monday: 1530-1600, R90

Chair: Jean-Christophe Le Coze (INERIS, France)

Throughout the years, complexity has become one of the most commonly used words in both safety and risk related studies across the boundaries of the 'hard' and 'soft' sciences. While many other concepts have been transcending these boundaries, such as for example the concepts of 'human error', 'redundancy' or 'barriers', the notion of complexity resonates with much wider implications (Le Coze, 2005, 2008, 2012, Dekker et al, 2011, Dekker, 2011, Grøtan et al., 2011, Grøtan, 2013). Complexity has slowly become a challenge to a prevalent view of science that has been very influential for the past two hundred years, resting on foundations related to reductionism, objectivity, linear causality and determinism. To these foundational pillars, complexity constitutes an alternative by employing opposite perspectives such as emergence, constructivism, circular causality and indeterminacy. But the epistemological and philosophical nature of

complexity discourse is not always clearly acknowledged. Some have made use of complexity in a rather instrumental way, using for example computer power to simulate behavior of complex systems, not always recognising the paradigmatic challenges it entails (Heylinghen, Cillier, Gershenson, 2007). The purpose of the session is to identify, share and discuss the different approaches to complexity in the field of safety and risks.

### What to do with complexity?

*Jean-Christophe Le Coze (INERIS, France)*

Complexity is everywhere. It is one of these contemporary words that has colonised both scientific and lay discourses. In the field of major accident or safety research, complexity has played a central role in structuring ideas about disasters as socio technical phenomena. The use of complexity as a key concept has been extensive in the field of safety science for the past 30 years. With early emphasis for example on technology (Perrow, 1984), on human-machine interactions (Rasmussen, Lind, 1981) or on organisations (La Porte, 1975), complexity has been shaped in relations to these different contexts of use. As a consequence, one could say that complexity is part of the genesis of the field. It helped to build a rhetoric linking together surprises, features of high risk socio-technological systems (aviation, nuclear industry, etc) and various category of operating personnel (e.g. pilots, process operators, engineers, managers, inspectorate) studied by different scientific disciplines (e.g. cognitive engineering, ergonomics, sociology, management, etc). But the use of complexity has evolved throughout the years, revealing sometimes diverging or competing meanings, some criticising for example the limits of a 'technologically' centred view of complexity in favour instead of a more 'socially' oriented one (Vaughan, 2005). Similarly, if one looks beyond the field of safety, the genesis of complexity is older than otherwise presented in recent accounts (e.g. Mitchell, 2009) and reveal many different nuances and orientations. Let us think for example of Weaver's 1948 paper on 'organised complexity' (Weaver, 1948). Thus, some authors have written about a history of complexity ideas (e.g. Le Moigne, 2003) linking its more recent developments of the twenty first century to the mid twentieth century with cybernetics, second cybernetics (self organisation), artificial intelligence, system theory. There are, therefore, several 'waves' of complexity discourses. But today, the list of writings on the topics is endless, and anyone investigating this area is impressed by the number of books,

articles and papers dealing with the subject from so many different angles. In this respect, Thrift sees complexity as 'one of the first fully mediated scientific theories' (Thrift, 1999, 61). The aim of this presentation, as part of the symposium on complexity, is to offer a historical perspective on the notion of complexity both inside and outside the field of safety and the relationship between the two.

### **Complexity Model for Sensitization of Safety and Risk Considerations**

*Tor Olav Grøtan (SINTEF Technology and Society, Norway)*

Complexity signifies a radical uncertainty or indeterminacy and is a persistent source of disturbance to most normative approaches to safety and risk assessments.

For complexity theory to be pragmatically applicable for safety and risk assessment, it is necessary to look for (metaphorical) sensitization beyond bird flocks or chaotic weather. It is necessary to consider the possibility that social dynamism, complexity and emergence (Sawyer, 2005) is radically different from "native" complexity inherent in natural/ecological or technical/industrial systems.

For risk and safety considerations, the pragmatic issue is that of making sense of uncertainties, of ambiguous and incomplete knowledge. There is thus a need for a sensemaking process that is capable of sensitizing decision makers into the possibility of complexity - but not without (non-complex) alternatives. The Cynefin sensemaking framework (Kurtz and Snowden, 2003) facilitates such a process.

It is pragmatically sound to try to identify a kind of "safe envelope" for operation. A Cynefin-based sensemaking process can accommodate such an approach, and will not only facilitate (sensitize) the consideration of ("out of the safe envelope") unsafe operation due to complexity, but also the inherent adaptive opportunities. Resilience can be framed as an organizational (engineering) effort of giving complexity a "safe(r)" direction. Risk and safety considerations (and aspirations) of complex (and resilient) systems can be transformed onto a "Complex Risk Proxy" (CRP) (Grøtan, 2013). The CRP approach also implies sensitization of the process of maintaining and revising risk assessments.

But what, and where, are the "envelopes", and who and where are the decision makers? Contemporary sociotechnical systems tend to be, global,

heterogeneous, continually rearranged and reassembled. Technical, human, organisational, social influences vary according to context, and ICT-mediated collaboration is encouraged in a way that also inflicts the essence of the human and organizational factors.

For further making sense of complexity related to safety in domains comprising a diversity of safe envelopes, it is thus necessary to facilitate a further differentiation of complexity (and resilience) in the sensemaking process. The Composite Complexity Model (CCM) (Grøtan, 2012) distinguish between the native complexity of the material world, the complexity that stems from the impact of human intent and operation, and those (complexities) that stem from concurrent and competing actor networks with stakes in the very same technological, human and organizational resources.

The current paper finally demonstrates how the CCM can shed light on safety and risk challenges for complex contemporary system.

### **Complexity: a conceptual framework**

*Inger Lise Johansen, Marvin Rausand (Norwegian University of Science and Technology)*

This presentation aims to shed light on the meaning of complexity for engineering risk assessment of sociotechnical systems. Complexity is a commonly used notion in risk assessment that carries multiple connotations and questions the value of risk-informed decision-making. Our point of departure is that complexity is inversely related to confidence in risk assessment, but that gaining a clear understanding of complexity will help to expose the strengths and limitations of risk assessment and by that lay the ground for improvement. The objective of this presentation is to present an explanatory framework that clarifies the meaning of complexity for risk assessment of sociotechnical systems and makes it of practical value for this purpose. First, the theories and ideas of complexity science are discussed in relation to uncertainty and confidence in risk assessment. This provides the basis for the proposed framework, which consists of a definition, a conceptual map, an epistemological and ontological position, and a set of complexity indicators. Complexity is defined as "Acknowledgment of limitations in the understanding of: (i) the sociotechnical system in its operational contexts and (ii) how risk can be assessed; based on the available knowledge and the assumptions about the individual system elements". A conceptual map further defines complexity in the conjunction of five elements:

an analyst, system, model, assessment context, and current state of knowledge. Complexity is not an ontological system property, but a construct that resides in the mind of the analyst. The conceptual map is made operational by a set of indicators that can be used to acknowledge, reduce, and describe complexity in the phases of pre-assessment, risk analysis, and risk evaluation. We therefore sustain a positive view on risk assessment on the grounds that there are ample opportunities for approaching complexity in risk assessment. We conclude that the proposed framework can serve to identify and facilitate deliberation on the premises and limitations of risk assessment and by that improve its legitimacy in risk-informed decision-making.

### **Complex information infrastructures**

*Eric Monteiro (Norwegian University of Science and Technology)*

Information systems (IS) underpin work practices, including safety-critical ones. IS are increasingly more interconnected, interdependent and integrated – what we dub “information infrastructures” (II) – to overcome boundaries (or “silos”) of institutional, geographical and/or professional nature.

II are accordingly complex in manners more traditional IS are not (Perrow 1984). We have conceptualisation for understanding and methods for developing IS – but hardly II.

Drawing on illustrations from the empirical domains of healthcare and energy/marine operations, my talk will identify and illustrate concepts helpful for understanding complex II.

## **M17 SYMPOSIUM: UNDERSTANDING RISK INFORMATION SEEKING IN THE ERA OF TRADITIONAL AND SOCIAL MEDIA**

Monday: 1530-1600, Rg1

Chair: Afrodita Marcu

There is a growing awareness under risk communicators that the traditional top-down communication strategy is ineffective in today's modern society. The public is exposed to numerous information sources and there is an abundance of information available through a large variety of channels. When faced with a

decision on an issue or an appropriate course of action, the individual has the difficult task of making sense of all this information.

An alternative approach to risk communication is to take an information seeking and processing perspective. The challenge is to provide the public with information that is useful to them in a way that corresponds to their information seeking strategies.

More knowledge on the public's risk information seeking strategies is needed. Drawing on work conducted within the cross-European FoodRisC consortium, this symposium will address four of the most relevant questions that need to be answered to enable risk communicators to develop effective communication strategies:

what role questions play in how consumers make sense of novel food technologies (Marcu),

which combination of traditional and new media do consumers use to find answers to their questions (Kuttschreuter)

what determines their internet search behaviour (Hilverda)

what are their information needs in times of crises (Barnett).

### **Asking questions about synthetic meat: The role of information seeking in making sense of a novel food technology**

*Afrodita Marcu, Julie Barnett (Brunel University, UK), Rui Gaspar (CIS-ISCTE, Portugal), Pieter Rutsaert, Wim Verbeke (Ghent University, Belgium), Beate Seibt (University of Oslo, Norway)*

This paper is concerned with how the public understand and weigh up the risks and benefits of a new food technology and product, taking synthetic meat as the example. Our focus is on how people ask questions and seek out information when faced with a new object of knowledge. We draw on theories of social representations and of information seeking and processing to understand the role that information seeking might play in making sense of a new food technology and its potential benefits and risks. We report an online deliberation study and focus group discussions conducted in Belgium, Portugal and UK which explored how consumers made sense of synthetic meat, what questions they had in relation to it, and how they individually and collectively anchored it to existing representations of animals, meat, and food technology, as well as to prior discourses around red meat risks and benefits. We presented the participants with a short YouTube video entitled ‘Would you eat synthetic meat?’

which described this novel food technology in an accessible language with self-explanatory animations. In the online deliberation study, 70 participants, 34 females and 36 males, age range = 18 to 60 years, left 88 questions and comments in relation to the information provided through the synthetic meat video, and indicated a wish to receive responses to 77% of these. A further 109 participants took part in 18 focus groups, 58 females and 51 males, age range = 21 to 65 years, where they did not have the option of having their questions responded to by the research team. Overall, the participants asked factual questions about taste, safety, ethics, and cost of production. They also asked rhetorical questions about the unknown long-term consequences of synthetic meat, the purpose and future of farm animals, and the societal impact of scientific progress. The participants linked synthetic meat to more familiar technologies like genetically modified foods, cloning, in-vitro fertilisation, and even to science-fiction, but anchoring was not the only way in which they made sense of synthetic meat. Processes of clarification, contextualization, elaboration and extrapolation underpinned the understanding of synthetic meat, and these processes often included question-asking. The present results suggest that it is feasible to get insight into the sense-making process through the questions that people ask. The findings will be discussed in relation to the concept of anchoring in social representations and the framework of information seeking and processing.

#### **Patterns of channel use in seeking information on food risks and benefits**

*Margôt Kuttischreuter, Femke Hilverda (University of Twente, Netherlands)*

For all communicators it is important to have a thorough understanding of the channels their audience uses. This is currently the more so, in view of the diversity in traditional and social media channels that are available for seeking information. Such knowledge is essential to reach the target audience.

According to the Risk Information Seeking and Processing Model (RISP), there are 2 basic modes of information seeking behaviour: using routine and using non-routine channels. The former is the case when people are interested in a particular piece of information that they happen to notice and they choose to pay attention to it. The latter is the case, when people want to know more about a certain topic and they may step out of their normal patterns of behaviour and continue to seek additional information until they are satisfied. It is thus very likely that individuals use a variety channels to keep themselves informed. From

the perspective of reaching the target audience efficiently and effectively, an important question is therefore whether patterns of channel use can be distinguished.

It is known that, generally speaking, particular channels attract particular audiences. How about channel use in the case of risk information? To what extent channel use is dependent on variables such as trust and risk perception is still unclear.

This presentation reports on a study on the individual's use of information channels that was conducted as part of the work done within the cross-European FoodRisC project. A cross-sectional quantitative survey was conducted among a representative sample of consumers in eight European countries (Netherlands, UK, Belgium, Ireland, Italy, Spain, Portugal and German; n=800 per country). The study focused on the risks and benefits of fresh vegetables.

Participants were questioned about their use of traditional and social media in general, and about their opinions and use of these media in case they wanted to find out more about fresh vegetables. In addition, questions were posed to tap variables distinguished in the Risk Information Seeking and Processing Model (RISP) that are presumed to affect information seeking behaviour. In particular, participants were questioned regarding their interest in food-related information, the relevance of food safety in their lives and trust in food companies and risk regulation.

Results will be presented and their implications for risk communication theories will be discussed. The implications for the information seeking and processing perspective of risk communication will be addressed.

#### **Online information seeking strategies: visited websites and duration of visit**

*Femke Hilverda, Margôt Kuttischreuter (University of Twente, Netherlands)*

Risk information seeking has been hypothesized to be related to dependent on a number of variables such as risk perception, trust, and information processing style (Griffin et al., 1999). Studies investigating these relationships have often measured information seeking by asking individuals about their information seeking behaviour or intention to search for additional information. In other studies, participants were provided with a button to be clicked in case the individual wanted to seek more information. Whether such proxies for information seeking are valid, is unclear.

This presentation will report a study investigating these relationships measuring information seeking by actually tracking the participant's behaviour online. The study, that was conducted within the cross European FoodRisC project, focused on food risks. It was hypothesized that individuals who scored higher on risk perception, lower on trust, lower on heuristic processing and higher on systematic processing would search for the answer more thoroughly, and for a longer period of time as measured by the number of sites visited and the duration of the search.

After measuring their risk perception, trust, and information processing styles, a representative sample of 200 Dutch women with children under 12 years of age were given a description of a food technology, such as genetic modification or organic production methods, and they were asked to find out which risks and benefits were mentioned on the internet. During their search their online search behaviour was recorded. Results of the study will be presented and the implications for the empirical support for models such as the Risk Information Seeking and Processing models will be discussed. Inferences for risk communication practices will be drawn.

Key words: Online information seeking, Search strategies, Risk perception, Trust, Information processing

### **Making a meal of it? What consumers wanted to know about horse DNA in beef burgers**

*Julie Barnett, Afrodita Marcu (Brunel University, UK), Aine Regan, Aine McConnon (University College Dublin, Ireland), Dave Fletcher (White October, UK)*

In January this year, it was discovered in Ireland and the UK that a number of beef products had been found to contain pig and horse DNA, and in one case, one burger product was found to contain 29% horse DNA. At times of crisis like this it is important to reassure consumers, to minimize the perceptions of risk, and to anticipate the questions the public might have in relation to such findings. Research on risk information seeking and processing (Griffin et al., 1999) often study lay information seeking in relation to familiar risks, yet little is known about how information seeking operates at times of crisis when the risk is not yet clearly contoured and everything is couched in uncertainty. We explored the information needs and the queries that Irish and UK consumers would have in relation to the findings of pig and horse DNA in beef burgers at the time when the findings had just been announced and the investigation was ongoing. We

were particularly interested in how the consumer queries might map onto the frequently asked questions (FAQs) prepared by the food agencies (e.g. the Food Safety Authority of Ireland, FSAI) in anticipation of consumer information needs. Using an online deliberation platform, we prepared a series of five information pages designed to elicit questions and comments from the participating consumers: the original FSAI press release, an update from the FSA UK, an overview of the media reports on the incident, a youtube video of the Irish Agriculture Minister explaining the incident, and the public apology from the Tesco supermarket. 22 Irish and 22 UK consumers, age range = 25 to 74, participated in our online study, which was conducted four days after the original announcement. The study consisted of two parts, completed at one week interval. The participants left 292 questions and comments – our metric of information seeking – at Part 1, to which we responded within 3-4 days. The participants' questions concerned five main areas: The routine procedure for testing meat products; How foods are traced to their sources; How cross-contamination happens; How long the situation had been going for; What would happen next and who would be held accountable. Some of these areas mapped onto the FAQs provided by the FSAI. The results of this study will be discussed in relation to information seeking and risk communication.

### **M18 SYMPOSIUM: FLOOD FATALITY RISK ASSESSMENT**

Monday: 1530-1600, R92

Chair: Karin de Bruijn (Delft Universitu of Technology, The Netherlands) & Ben Gouldby (HR Wallingford Ltd, UK)

Flood fatality risks play an increasingly important role in flood risk management. This symposium aims to discuss methods to assess flood fatality risks, results and the meaning of the outcomes to flood risk management and society.

#### **Probabilistic event based assessment of societal flood fatality risks in the Netherlands**

*K.M. de Bruijn, J. Beckers, F. Diermanse (Delft Universitu of Technology, The Netherlands)*

Flood risk management strategies for the long-term are currently being developed and discussed in the Netherlands. The discussions include a reconsideration of the flood protection standards, other protection measures, and flood impact mitigating measures. To find risky places and to evaluate different strategies not only economic risks are being considered, but also flood fatality risks are taken into account. Flood fatality risks are being studied from the perspective of individuals (how safe is my home location) and from a societal perspective. This paper focuses on the latter.

The fatality risk is defined as the probability of exceeding a number of fatalities during a single flood event. A so-called FN curve (where F is the frequency and N is the number of fatalities) provides insight in the probability of, for example, an event with more than 10, 100 or 1000 fatalities. The societal flood fatality risk proved to be relevant, but difficult to use in strategy development.

Recently, methods to assess this risk and uncertainties in this risk have been improved and clear indicators to express this risk type are being studied. The key question when studying this risk is how many breaches may occur in one event, what is the extent of the areas which may be flooded in one single event and how breaches at one place influence safety of downstream areas. To assess societal fatality risks Monte Carlo analysis is used (with importance sampling) and stochastic variables representing the load on embankments, the strength of embankments and possible responses of people have been defined. First a value is obtained for each stochastic variable and events, then inland water levels are simulated with the help of a hydrodynamic model. This model automatically includes the relations between discharges and water levels at different locations. Finally, model outcomes are translated to fatality numbers per event and the societal fatality risk is being calculated. The outcomes are then translated to meaningful indicators and compared with orientation values for the indicators.

The paper discusses the method to assess flood fatality risks, the outcomes and the use of the outcomes for the development and assessment of long-term flood risk management strategies.

#### **Incorporating life loss in a systems based flood risk analysis model**

*Ben Gouldby, Julien Lhomme (HR Wallingford Ltd, UK), Dave Hornby, Stefan Laeger (Environment Agency, UK)*

System flood risk analysis models have been used at national, regional and local scales within England and Wales for over 10 years. The models comprise a

representation of the extreme hydraulic loading levels, reliability of the flood defences, inundation simulation and flood consequences. To date, the consequence estimation has primarily focused on direct economic damages to property. More recently, there has however, been more emphasis placed on estimation of fatality risks. There are a wide range of empirical approaches for estimating life loss from flooding. Many of these methods require estimates of flood velocities as input.

The inundation model that is currently used by the Environment Agency for national and regional scale system based flood risk analysis is volume based, with no temporal component. Therefore, no estimation of velocity is provided. This paper describes the development of a computationally efficient inundation model with temporal evolution. This new model has been integrated within the system flood risk analysis model, enabling estimation of velocity. This velocity information has been combined with depth outputs to enable the application of empirical life/loss estimates. The new modelling system has been trialled on two sites where initial estimates of the spatial variability in life-loss have been provided. The results of this trial study show the system has the potential to provide this information in an operational environment. It is concluded that further improvements to the calculations of velocities may yield more robust outputs. Also approaches to synthesize inflow hydrographs for overtopped or breached defences are needed in areas where local flow and model data are not available.

#### **Practical tools for estimating loss of life from flooding: Which approach should I use?**

*Jason Needham, William Lehman, Woody Fields*

The portfolio risk management approach used by the United States Army Corps of Engineers (USACE) dam and levee safety programs incorporates various types and levels of risk assessment ranging from preliminary screening to detailed risk assessments in support of decisions. Within that risk informed framework, practical approaches for estimating the consequences due to dam or levee failure are critical to success. And, although flooding can have many types of severe consequences, the primary objective of these safety programs is to manage risk to the public who rely on those structures to keep them reasonably safe from flooding. So, whether the objective is to prioritize future studies, or



invest in remediation activities, decisions for these programs are based primarily on risk to life.

Loss of life is primarily determined by the temporal and spatial distribution of flooding due to failure, the initial distribution of people and property within the resulting flooded area, the redistribution of people and property over time as a result of warnings and evacuations, and the characteristics of the flooding and shelters where people are located when the flood water arrives. To provide life loss estimates within the context of a portfolio management process, scalable hydraulic modeling and consequence estimation procedures are needed to estimate and compare the consequences of failure and the associated risk across the entire portfolio of almost 700 dams and 2500 levee systems that fall within the authority of USACE.

The focus of this paper is on describing available options for estimating potential loss of life and providing guidance on which option is most appropriate to support varying levels of risk assessment activities.

#### **Assessment of Flood Fatality Risks by Simulation of City Evacuation Coupled to the Inundation Dynamics with Surface and Subsurface Flows**

*Valeria Krzhizhanovskaya, Natalia Melnikova, Peter Sloot (National Research University ITMO, Russia, University of Amsterdam, The Netherlands, Alexander Mordvintsev (National Research University ITMO, Russia)*

We present the computational models for assessment of flood fatality risks. The novelty of our approach is in the combination of a city evacuation model coupled to the inundation dynamics with surface and subsurface flows, which can predict inundation of low-lying inland zones far away from the edge of the flooded area, as observed in St. Petersburg city during the floods. The models constitute an important part of the modelling workflow implemented in a decision support system for flood early warning and disaster management [1,2].

The decision support system developed in the Advanced Computing Lab of the ITMO University [3] is based on the ideas of the UrbanFlood project [4,5]. It includes the models for data-driven meteorological predictions, for simulation of atmospheric pressure, wind, long sea waves and seiches; a module for optimization of flood barrier gates operation; models for stability assessment of levees and embankments, for simulation of city inundation dynamics and citizens evacuation scenarios. All the models are wrapped as software services in the CLAVIRE (CLOUD Applications VIRTUAL Environment) platform for urgent

computing, which controls the workflow and manages computational resources [6].

The overland inundation is modelled by the DRFSM code developed by HR Wallingford [7]. It uses the water flow rates discharged into the floodplain areas from breached or overtopped defences and spreads the water over the floodplain according to the city topography. The calculated water levels in the flooded areas are used as boundary conditions in the subsurface flow model, which is based on the porous medium approach. This method is computationally efficient and easy to set up, since it does not require detailed information on the underground pipe network. The model calculates the flow rate of water emerging from the low parts of the land surface.

The city evacuation is simulated by an agent-based crowd model that mimics the behaviour of pedestrians or cars escaping from dangerous regions towards safe areas. It uses the output from flood simulations to compute available evacuation paths and to track the agents trapped in the water. The model takes into account the distributions of population across the modelled area, agents speed range, awareness, and the maximal water depth that the agent can traverse. The model also includes social relationships: families stay together, and some people follow the leader who plans the evacuation path and waits for the group members. The model has been tested in a series of experiments modelling an overland inundation in St. Petersburg, Russia [8]. Further we plan to test it with a coupled surface-subsurface flood model. Later we want to evaluate the efficiency of different evacuation strategies and to experiment with distributed control through individual information devices such as smart-phones.

Key words: flood fatality risk, model, flood, evacuation, surface and subsurface flows

#### **The use of a Monte-Carlo analysis to assess the uncertainty in the estimates of loss of life from flooding using an agent based model**

*Mark Davison, Darren Lumbroso, Andy Tagg (HR Wallingford Ltd, UK)*

This paper describes a Monte-Carlo uncertainty analysis undertaken for two case study sites in England using the Life Safety Model (LSM) to assess the sources of uncertainty in loss of life estimates from floods for two cases studies. The LSM is an agent based model that simulates the dynamic interaction of people with the flood hazard.

The LSM was applied to two case study areas. The first was Canvey Island, which is located in the Thames Estuary. The island is a low-lying covering an area of 18.5 km<sup>2</sup>, with an average height of approximately 1 m below the mean high water level. Canvey Island is protected against inundation from the sea by a series of flood defences. In 1953, the island was inundated by the "Great North Sea Flood" that breached the defences and led to the deaths of 58 people and the destruction of several hundred houses. The LSM had been calibrated previously using this event.

The second case study considered the failure of a 15 m high dam that stores 2.5 million m<sup>3</sup> of water located in a steep valley directly upstream of town with a population of some 14,000 in the middle of England. A dam breach was assessed and the effectiveness of providing a warning on the risk to people was also estimated.

The research used a Monte-Carlo analysis to estimate the sensitivity of evacuation times and loss of life for the two case studies to various parameters such as the physical characteristics of people (e.g. height, weight); parameters that affects the strengths of buildings and the stability of vehicles in floodwater. The work has also investigated how vertical evacuation can be used to reduce the risk to people.

### **Spatial Modelling Approach For Tangible And Intangible Losses In Integrated Risk Analysis Of Extreme Storm Surges**

*Andreas Burzel, (Deltares, The Netherlands), Dilani R. Dassanayake, Hocine Oumeraci (Technische Universität Braunschweig, Germany)*

As part of an integrated risk analysis, the research of the 4-year joint research project XtremRisk (Extreme Storm Surges at Open Coasts and Estuarine Areas – Risk Assessment and Mitigation under Climate Change Aspects) has also been focused on developing methods and models for the assessment and spatial modelling of intangible losses. The XtremRisk project has been accomplished from 2008 to 2012, including three German Universities as well as local coastal and harbour authorities. The integrated flood risk analysis involving both tangible and intangible losses has been implemented for two pilot sites in Germany, i.e. Hamburg (Elbe Estuary) and the Island of Sylt (North Sea).

The integrated risk analysis is based on the Risk Source-Pathway-Receptor Concept. New approaches have been developed for the evaluation of tangible and intangible losses. A focus has been put on research for the investigation of

intangible losses, i.e. fatalities, injuries, cultural losses and ecological losses. As a result, suggestions for the evaluation of intangible damages have been proposed by Dassanayake et al. (2010). Following, the feasibility for the spatial modelling of these losses has been investigated. In order to allow the application of the proposed methodology on a spatial basis, a GIS-based approach for spatial modelling (Cellbased Risk Assessment, CRA) has been developed. The assessment consists of three main steps: (i) conversion of irregular shaped input data to the assigned compartmentation, (ii) application of the risk analysis for all cells within the investigation site, (iii) visualisation of the results on a spatial basis. Based on this approach, comprehensive geoprocessing tools for the modelling of (i) fatalities and injuries, (ii) cultural losses and (iii) ecological losses have been developed and successfully applied. At the conference, the spatial modelling approach and the most important results of the integrated risk analysis will be presented. A focus will be set to the results from the spatial loss of life model and the importance of spatial modelling for decision making on flood risk reduction measures.

### **M19 SYMPOSIUM: UNDERSTANDING THE SOCIETAL DYNAMICS AROUND RISKS: LEARNING FROM CITING CONTROVERSIES I**

Monday: 1530-1600, R93

Chair: Marijke Hermans (Maastricht University)

Technological infrastructures, ranging from disposal, storage and production facilities to critical components such as base stations for wireless communication technology, need to be placed. The search for such geographical sites often leads to opposition from the local community – frequently described as NIMBY-ism, even though academics have increasingly called for more critical interpretations. This panel takes up this call by acknowledging that siting controversies are not just about the local community level – which is often the most visible and adamant layer – but it stretches into other levels of social organization too: regional, national, European and increasingly global. This panel aims at bringing together academics interested in exploring the societal debates and processes around siting controversies, with a particular focus on how risks and uncertainties are conceptualized, assessed, dealt with and

challenged. What actor networks are formed and in which way(s)? And although it has become something of a truism to call for public engagement in siting practices, it remains to be seen how this is implemented and what can be learned from the experiences. Presentations will approach these interrelated questions from different theoretical backgrounds, allowing for a comparison across technological domains and various regions in Europe. More understanding of the multi-level societal dynamics around risks can thus provide insights in how to effectively deal with the potentially controversial issue of siting of technological infrastructures.

### **Roles and Viewpoints of Scientists as Policy Advisers**

*Pita Spruijt*

**Background and Aims:** Environmental health risks are often complex and uncertain, for example particulate matter and electromagnetic fields. Complexities and uncertainty can lead to local controversies on the construction of new roads and the adaptation of new mobile phone base stations. Uncertainties inherent in such problems contribute to differences in the appraisal of risks. This raises the question, among others, how experts interpret scientific uncertainty and how this affects their policy advice. We present an overview of interdisciplinary literature that discusses the roles and viewpoints of scientists as policy advisers, against a background of complex environmental health risks.

**Methods:** A structured literature search is combined with literature found through reference lists of peer-reviewed papers (snowball method). In total 270 records were analyzed using scientometrics analysis followed by a qualitative analysis and interpretation. **Results:** The scientometrics analysis yields eleven distinct groups of authors. The groups are formed based on similarities in the references authors use. Overall, research on expert roles has remained largely theoretical. There is not one dominant theoretical paradigm in the study of science-policy interactions. However, social constructionism plays a prominent role. Existing theories about science systems can be used to study real policy advice processes. Most theories are well elaborated, but empirical proof for the described changes, roles or processes is limited.

**Discussion:** The preliminary results of this overview indicate that theories on scientists who provide policy advice affirm that they hold different roles. These results should be tested empirically to be able to identify the effects of different

attitudes of scientists and policymakers on the way they, respectively, advise on and act on environmental health problems. The results of the scientometrics analysis will be discussed in the light of an earlier empirical q-sort study into roles and attitudes of experts on particulate air pollution and electromagnetic fields.

### **What uncertainties? Siting geological disposal for high-level radioactive waste in the Czech Republic**

*Karel Svačina (Masaryk University, Charles University in Prague, The Academy of Sciences of the Czech Republic)*

This paper is concerned with the role of uncertainties and their relationship with risks in the process of siting deep geological disposal for high-level radioactive waste in the Czech Republic. Siting the future repository has become a prime issue in the Czech radioactive waste management efforts, and a major societal controversy with most of the concerned municipalities strongly opposing the project. The starting point of this paper is that there are many uncertainties related to the construction of the repository – not only scientific uncertainties, but also economic, and perhaps for the Czech siting process specifically, also uncertainties about the process itself. The aim of this paper is to see how some of these uncertainties are framed, dealt with, and what happens to them in the course of negotiating the future repository. My empirical material shows that uncertainties play crucial role in the current form of the Czech geological disposal siting process. In this sense, the opposition cannot be attributed to the “NIMBY” effect only. This is in contrast with the official policy approach, which frames the siting issue in terms of risks rather than uncertainties. Following the empirical material as well as the argument of de Vries et al. that “risks may emerge out of uncertainties, not the other way around, and they will do so only after considerable efforts have been undertaken” (de Vries et al. 2011, p. 491), I would like to argue that what needs to be done in order to move forward in the siting controversy is not to pursue the risk-based policy (which is what the government is trying to do), but to put efforts into “taming uncertainties” (de Vries et al. 2011), and strive for more stable and durable grounds for the negotiation process. Theoretically and methodologically, this paper draws on contemporary ANT-informed STS work. The empirical material that this paper uses is being collected during my research work for the EC FP7-funded InSOTEC project ([www.insotec.eu](http://www.insotec.eu)), whereas the role

of uncertainties in negotiating geological disposal in the Czech Republic is a theme of my doctoral research.

**Siting controversies as a symptom of tension between levels of government: case of shale gas in Poland.**

*Agata Stasik (University of Warsaw, Poland)*

Poland has recently taken the position of the European leader in the endeavour of shale gas extraction. While other European countries and the European Commission continue to discuss about the balance of foreseen risks and benefits, the Polish government claimed the technology to be safe and framed it unambiguously as an opportunity to increase energy independence and as a way to limit coal dependence of Polish economy.

In my study I analyse how risks and opportunities are constructed and perceived on different levels of government: state, regional and local. I base on discourse and content analysis for the state level policy, and interviews and ethnography for local communities' level. The attitude of the general public towards this plan, measured both by public opinion surveys and public discourse analysis, is generally positive. However, it raises resistance in some of local communities where exploratory drillings already started. Local activists point out the sources of uncertainty which in their opinion were not adequately addressed by the respective state agencies. Nevertheless, their reservations are often framed simply as a knowledge deficit by investments' advocates from companies and state agencies.

I would like to describe this controversy as a case of political conflict between interests of local communities and central government's policy. Even if few people in Poland question that shale gas may be profitable for the state's economy, local agents believe that their own interests should not be sacrificed to meet common goals. In this perspective, conflicting visions of risk held by different agents may be explained by the fact that knowledge about the possible impact of technology is conditioned by the prior choice of values and interests worth protecting. In the opinion of local activists, their interests were not taken into account during the assessment process. Thus, the controversy on technology's impact and reliable way of technology's assessment may be interpreted as a disagreement on the fair and just relation between different levels of social and political organization (central government – local

communities), or even as a conflict between competing visions of relation between "common good" and well-being of particular groups of citizens.

## TUESDAY 18 JUNE

### T1 DECISION-MAKING IN FACE OF COMPLEXITY I

Tuesday: 1100-1230, R3  
Chair: Tor Olav Grøtan (SINTEF)

#### **Providing a structured multidimensional cost-benefit analysis to increase the transparency of security policy decision-making**

*Christian Blobner (Fraunhofer Institute for Factory Operation and Automation IFF, Germany)*

Decision-making in a security context is inherently complex, since decisions and related security measures not only affect the single dimension of "security" but influences a wide array of different dimensions, e.g. societal, environmental, technical, just to name a few. This is especially true for decisions taken by public stakeholders and security policy decision-makers. The decision-making situation and framework for public stakeholders necessarily is much wider and more complex as they have to take into account "the common good". As a result, not only the effectiveness of the security measure in decreasing the risk exposure of society is an important decision criterion but also its monetary costs and benefits. Additionally, especially public stakeholders as decision makers have to consider various qualitative criteria, the evaluation of which is less obvious. The assessment of decision alternatives, therefore, cannot be based on a strictly monetary cost-benefit basis and only from an economic profitability point of view.

To tackle this complex web of decision-making parameters, the EU-FP7 funded ValueSec research project proposes a three pillar approach, breaking down the decision-making analysis into:

1. Risk Reduction Assessment
2. (Monetary) Cost-Benefit Analysis
3. Qualitative Criteria Assessment

In effect, ValueSec follows an extended cost-benefit analysis. This approach enhances the assessment of monetary and quantifiable costs and benefits by

introducing the analysis of the risk exposure and qualitative factors into the analysis framework. The breakdown of the decision-making process into these three pillars ensures a structured analysis of decision alternatives by allowing for a separate assessment of the individual decision parameters, which affect the overall decision-making process. It increases the transparency of the decision-making process and clearly identifies decision drivers along each pillar, by assessing security measures and providing individual assessment results for these different dimensions. Through this procedure, decision-makers can better compare measure alternatives and are able to consider the trade-off between different decision alternatives.

A prototype software toolset, which combines the three pillars to a comprehensive decision support tool for public stakeholders will be implemented. Relevant stakeholders are involved in the testing and validating of the methodological approach as well as the software prototype. For this a number of realistic use cases have been planned in five different decision making contexts, which encompass the organization of a public mass event, public transportation, airport security, communal security planning and cyber security. This range of tests will ensure a broad applicability of the ValueSec toolset.

#### **Managing risk in a complex environment**

*Rainer Sachs, Markus Wadé (Munich Re, Germany)*

The growing interconnectedness and complexity of the economic, technological and social environment present a range of challenges for the insurance industry and its clients. The course of losses is becoming increasingly difficult to predict and the triggering events cannot always be clearly identified. Domino effects and loss cascades can turn local events into losses of international significance. Events like 9/11, hurricane Katrina, the financial subprime crisis or the Tohoku earthquake showed dramatically just how quickly complex reality can expose the limitations of generally accepted model assumptions and business practices.

Current discussions in risk management to this topic are often dominated by eloquent descriptions of the problems and abstract recommendations: "Prepare for the next surprise", "Think the unthinkable" or "Simplify". As fitting as these recommendations may be, implementing them in practice is very hard. For insurance companies e.g. the scope they have with regard to the decision about "keeping things simple" is limited. In an economic environment in which even

the definition of "risk - free" assets is difficult, there are scarcely any havens to be sought in simplicity. Moreover, a general approach of "keeping one's distance" from complex reality would involve becoming increasingly removed from our clients' needs.

At Munich Re, we have had intensive discussions about what conclusions to draw for risk identification and management from the growing interdependencies. If we wish to understand the complex risk environment prospectively and beyond the confines of historical evidence, we are greatly dependent on expert knowledge – from a range of different business segments and disciplines. In order to analyze complex dependencies, we are investigating new methods to improve identification, selection and modeling of the resulting accumulation risks. One focal point of this work is to develop a platform which effectively links expert knowledge from a variety of disciplines to chains of events and makes this analyzable. Given the large number of potentially relevant risks and the limited resources available, such an approach offers the opportunity to develop a joint knowledge database.

In the presentation we would like to describe the impact of an increasingly complex risks environment from the perspective of a reinsurer and to give an overview of the measures and projects we currently work on to improve our understanding and the management of these risks.

#### **Understanding coordination: Difference in perception of challenges in inter organization coordination**

*Roshni Pramanik (Lund University, Sweden)*

Modern day disasters are huge phenomena. Factors adding to their complexity are their variety, interaction between causal factors, stakeholders involved in disaster response to name a few. Extreme pressure of the situation, severe shortage of resources, mass casualties, infrastructure breakdown, large scale damage and its impact necessitate coordination among the multiple agencies involved in disaster response. Better coordination in international disaster response operations will make them more effective in terms of primary outcome which is organizing different phases of relief, rehabilitation and recovery effectively. Recent disasters like Hurricane Katrina, Indian Ocean tsunami, Haiti earthquake have seen multiple civil agencies and military working together. However civil military coordination was identified as one of the major issue. Distinct work procedures, lack of knowledge about organizational identities of

one another are likely to bring stereotyping and prejudices which are root obstacles to coordination. Perception related challenges are likely to be real in inter organization coordination. This study focuses on working difficulties as a challenge in inter organization coordination (IOC). What is exactly meant by it, its nature and its influence on working together of multiple agencies? Can we address the problem of working difficulties if we can define it? Are the challenges of working difficulties real only in case of civil military coordination? How is it perceived in other cases? Not many empirical studies so far have looked into what is meant by working difficulty in IOC. The current study aims to find an answer to these questions. An experiment is designed where different groups (10 participants in each homogeneous group) from multiple responding agencies in Sweden shall be invited to participate. Agencies in Sweden are chosen deliberately to keep the samples contained with not many differences in terms of how they work in different countries and to have better accessibility to the groups. These groups will be from MSB (Swedish Civil contingencies Agency), Fire department, Police and Swedish Armed Forces. They shall be given a common task to perform to measure working difficulties as perceived by the practitioners. The response will be then analyzed and compared based on relative magnitudes. The experiments are planned to conclude by summer, 2013. Findings shall contribute to our understanding of effective IOC and ways to do it.

#### **Fact vs. Fact: the Joint Fact-Finding (JFF) of the Risk of Radionuclides in Food Authors**

*Makiko Matsuo, Hideaki Shiroyama, Noriko Iseki, Masahiro Matsuura (University of Tokyo, Japan), Atsuo Kishimoto (National Institute of Advanced Industrial Science and Technology), Masashi Tachikawa (Ibaraki University, Japan)*

The Fukushima Daiichi Nuclear power plant accident as a consequence of the Great East Japan Earthquake resulted in the widespread of radionuclide contaminations in Japan. This posed an unprecedented issue of the contamination of food by radioactive substances.

The experts show divergent views on "scientific facts" with regard to the risk of low dose exposure to radionuclides through foods and environment. They differ in what is considered to be a "known" fact and an "uncertain or unknown" in terms of exposure below 100mSv/year. Such difference is considered to be one of the major sources of public distrust and confusion to the government

approaches for handling risks of radionuclides in food in the aftermath of the disaster.

As the radiation is used in variety of fields including medicine in our modern society for benefit, the views towards the safety and risk of radionuclides were developed in such different disciplines as radiation physics, radiological protection, epidemiology, radiation biology, radiological sciences etc. In addition, the traditional food safety community (for example, dealing with chemical risks, such as pesticide residues and food additives) has less contact with the disciplines for control of radiation risk, thus are not familiar with the philosophy of radiation risk managements developed in radiation safety community. This seems to have affected the way on how experts in different background viewed and treated risk and safety of low-dose radionuclides under uncertainty.

This study intends to reveal clear and/or potential difference of views among experts and find gaps in philosophies and disciplines on the radiation risk control by deploying the approach of Joint Fact-Finding (JFF). JFF is a collaborative approach or process. It provides a forum for (a) co-framing what problem needs to be addressed and (b) co-producing "jointly found fact" including the areas of agreement and disagreement. Through the JFF process, the study tries to classify "facts" in several categories. It also considers what other facts than science should be considered and discuss how such issues can be integrated in elaborating radiation counter measures. Finally it explores implications for the elements needed for a more transparent and evidence-based decision making.

## T2 RISK PERCEPTION I

Tuesday: 1100-1230, R4

Chair: Nick Pidgeon (Cardiff University)

### **Perceptions Of Socio-Economic Drought As Causes Of Hydrological Drought Mismanagement**

*Ioannis Daskalakis, Kalliopi Sapountzaki (Harokopio University, Greece)*

In Greece, the future of the Acheloos river catchment basin, its mountain hinterland and estuary in Aetoloakarnania are jeopardized because of the planned river diversion owing to the risk of socio-economic drought as perceived

by the agricultural communities of the Region of Thessaly. Considering that water management should be undertaken within each river basin and that only entire catchment areas should be the basis for water management decisions, the diversion of Acheloos seems to represent a clear case of hydrological and ecological drought mismanagement. The diversion is a huge intervention and has been decided for the sake of the politically powerful farming communities of Thessaly demanding mitigation of the major agricultural (and socioeconomic) drought and desertification risk they are faced with. However this risk stems from their malign cultivation and drilling practices.

A similar case of drought mismanagement can be found in the Dodecanese islands. Various social and institutional agents perceiving only their own water necessities and economic interests exert political pressures for rapid mitigation of socio-economic drought. However, lack of confidence in official/public water policies leads many consumer agents to support illegal networks of water procurement (involving illegal drillers, water carriers etc) which in turn become an essential part of a false but socially trusted management solution. Another example comes from the north-eastern part of the island of Crete where rapid development beyond the environmental limits has put excessive pressure on the relatively few available water resources. The misleading perceptions of water abundance resulting in overabstraction of groundwater resources have caused the area to suffer from extensive salination of the underground aquifer. The Aposelemis dam, while being perceived as an effective response to this manmade hydrological drought, could prove to be an unwise management solution in the long run.

The basic conclusion and simultaneously assumption of this paper is that using perceptions of socio-economic drought as drivers of water resource (and drought risk) management is a recipe of hydrological and ecological drought mismanagement. The reasons are related to: (a) lack of reliable water cycle data and insufficient drought risk communication; (b) unilateral and partial drought risk "knowledges" of individual actors; (c) changing water from a common environmental good to a marketable good and privatization of water supply, and (d) disregarding drought risk transference in time and space owing to human interventions into the system of water resources.



### **Understanding farmers' drought risk adaptation motivation: empirical evidence from survey data**

*Rianne van Duinen, Tatiana Filatova, Peter Geurts, Anne van der Veen*

Climate change projections show that the frequency and severity of droughts in the Netherlands are likely to increase during summertime. Freshwater is a vital factor for agricultural production. Temporary precipitation shortages cause decreased soil moisture levels and increased salt concentrations, causing damage to crop production and consequently to a loss of farm income. Adaptation, which can be directed at both decreasing drought exposure and sensitivity, is the key to decrease a farmer's drought risk. In order to design effective public climate adaptation strategies, it is important to understand a farmer's individual adaptive behaviour since many individual farmers' choices cumulatively determine the performance of the agricultural sector as a whole, and its vulnerability to climate change.

The goal of this study is twofold. Firstly, we investigate the factors that determine a farmer's decision-making on drought adaptation measures. We apply Protection Motivation Theory (PMT) to assess the socioeconomic and psychological factors explaining an individual's decision-making concerning protective measures in a risk context. According to PMT, risk perception, perceived effectiveness, perceived costs and self-efficacy are the key variables to explain individual adaptation motivation. Besides these factors literature shows that subjective knowledge, trust in the government, and a person's position within the social network are important determinants. All these variables change with time, and consequently with the increasing frequency of climate-induced drought hazards, as well as with social interactions among farmers.

Secondly, we explore the possibility to distinguish between groups of farmers based on their stage of adaptation preparedness. Protection Motivation Theory – Trans Theoretical Model (PMT-TTM) is an extension of PMT-theory suggesting that people at different adaptation decision-making stages are differentially affected by perceived probability, severity, self-efficacy and response efficacy. The basic premise is that different groups can be distinguished based on those who have not yet decided to adapt (pre-contemplators), those who have decided to adapt (contemplators) and those already performing adaptation behaviour (action).

To study these research questions, we run a survey amongst a population of 2000 farm households in the southwest Netherlands. This area is characterized

by its spatial diversity of water supply and salinity issues, and will be highly affected by climate change. From data on farm type, farm size and farm technology it appears that the population is mostly heterogeneous. In this presentation we will discuss the design of the questionnaire and demonstrate the preliminary results.

### **A typology of farmer's risk perceptions and coping strategies**

*F. van Winsen, Y. de Mey, L. Lauwers, S. Van Passel, M. Vancauteren, E. Wauters*

Farming is a risky business. The ways in which farmers perceive risks, inherit to agricultural production, and chose to manage these risks is object of this study. We aim to elucidate different risk perceptions, attitudes, coping strategies and general attitudes towards farming and their interactions. More specifically the objectives of this study are; (i) to learn about the relationships between farmers' worldviews, attitudes towards farming, risk perceptions, risk attitudes, stated risk behaviours and revealed risk behaviours, and (ii) to distinguish between farmers' risk coping strategies.

We will take a mixed methods approach, combining qualitative and quantitative methods. First we will explore farmers' risk coping strategies in extensive open interviews. Next we will test the findings in a survey on a sample of approximately 750 farmers, representative for the Flanders region in Belgium. This survey will test; farmers' worldviews, personalities, attitudes towards farming, risk attitudes, risk perceptions and risk behaviours. Items will be tested on a 5 point Likert scale. In order to compare stated to revealed risk behaviour, the results will be complemented with the individual business results from the regional bookkeeping data network.

Confirmatory factor analyses will be used to group items in factors representing farmers' attitude, perception, perceived behaviour, and personality traits. Pearson's correlation will be used to test the relationship between these different factors. Finally pathway analysis will be used to test the presumed causal relationships between the factors, assumed in the conceptual framework of transactional modelling (Willock et al., 1999). Furthermore, using non-hierarchical clustering method a typology for distinct clusters of the different factors over the farmers will be established (Thomson, 2001 in McCarthy & Thompson, 2007).

With this research we will be able to draw conclusions about risk coping strategies of Flemish farmers and to distinguish between different types of strategies.

**Experience of crisis and its' relation to risk perception and risk behaviour**  
*Susanna Öhman and Anna Olofsson (Risk and Crisis Research Centre (RCR) Mid Sweden University)*

This paper investigates previous experience as a way to understand risk perception and risk behavior. The aim is to investigate how experiences of crisis such as accidents, fires, illnesses, violence and natural catastrophes influence risk perception and risk behaviour. The analyses use data from three Swedish national surveys from 2005, 2008 and 2011. The dataset used each year is composed of two representative samples of the Swedish population between the ages of 16 and 75: One national random sample (n=2000), and a random sample of people living in areas with a relatively large population of people with foreign background (n=750). The results show that previous experience is the single strongest predictor even after controlling for gender, ethnicity, income, education and values.

### T3 RISK COMMUNICATION II

Tuesday: 1100-1230, R90

Chair: Margot Kuttschreuter (University of Twente)

**Communicating emerging food risks: the impact of 1- or 2-sidedness, vividly presented information and spatial distance on message credibility**

*De Vocht Melanie, Cauberghe Verolien, Uyttendaele Mieke, Sas Benedikt (Ghent University, Belgium)*

Emerging food safety risks on fresh produce, due to climate change and globalization, represent a new challenge within risk communication. The goal of this study is to investigate how a risk message should be designed to increase message credibility. Defined as 'the perception of the message being credible, clear, understandable and likely', message credibility is an essential variable in risk communication as it is an important prerequisite to message acceptance (Mackenzie & Lutz, 1989; Renn et al., 1991). According to the Extended Parallel

Processing Model (Witte 1992), a risk message should evoke a perceived threat and perceived efficacy in order to achieve message acceptance, leading to increased awareness about the risks. Research showed that vividly presented information can increase the perceived threat (e.g., Cauberghe et al., 2009). Furthermore, research indicated that the spatial distance of where the risk could occur, can influence people's reactions to the message (Lieberman & Trope, 2008). Moreover, when communicating risks related to food, both the benefits and the risks of eating fresh produce can be presented (2-sided), or only the risks (1-sided). Both strategies can impact message acceptance (Eisend, 2006).

Using a 2 (Picture of grapes and bacteria vs. Picture of grapes) X 2 (Occurrence in Flanders vs. Occurrence worldwide) X 2 (1-sided vs. 2-sided) between subjects factorial design, this study investigated the impact of these manipulations on message credibility. A leaflet was designed for every condition and 390 respondents (Mage=38.54 years (SD=14.47), 46,1% male) were randomly shown one of the eight leaflets, followed by a paper-and-pencil survey. Every leaflet contained the same information about recommended measures that consumers may take and measures that the government is taking.

A significant third-order interaction effect was found using the manipulations as independent variables on message credibility ( $F(1,372)=9.501, p=.002$ ). Simple effects showed that when the risk could occur in Flanders and the risk is very vividly presented, the message credibility is significantly higher when the information is presented 1-sided ( $M=6.09, SD=.76$ ) instead of 2-sided ( $M=5.45, SD=1.50$ ). However, when the risk could occur worldwide and the risk is very vividly presented, then the message credibility is significantly higher when 2-sided information is given ( $M=5.92, SD=.76$ ), than when 1-sided information is presented ( $M=5.50, SD=1.17$ ). These results have important managerial implications for international risk communication, which will be discussed together with more results.

**Decision-making to uptake screening for inherited cardiac conditions among adolescents: The role of risk perceptions, risk as affect and social context**

*Y. Hirst, L. Timotijevic, J. Barnett, S. Cox*

Health screening is a process of identifying apparently healthy people who may be at increased risk of a disease or condition (UK National Screening Committee). For a health screening to be effective, a clear communication of risk is required including the options for treatment or how to reduce possible risks.

Despite increased efforts to communicate risks clearly, the ways to increase participation in health screenings remain debatable (Broadstock & Michie, 2000; Breen et al, 2001; Shiloh & Ilan, 2005). Research in the area of non-participation in general is scarce and provides limited understanding of why offers of screening are declined.

The current study aims to explore the role of affect in the decisions whether or not to uptake a health screening, and in particular, what role it plays in the interpretation of risk and benefits communicated through an invitation to attend a health screening. The focus of the study is upon invitation for cardiac screening of adolescents for an underlying inherited cardiac condition, chosen for its low profile and its relevance to younger people (age<35) who are rarely a target of screening procedures. Six in-depth interviews were conducted with parents of adolescents (aged 14-17) who reported no previous engagement with cardiac risk in the young and their screening. A think aloud method is utilised to elicit a concurrent decision-making process for cardiac screening and a concurrent follow-up interview for the reasoning of the decision. The parents' accounts for the factors influencing whether or not to have screening were analysed using Thematic analysis (Braun & Clarke, 2006). Weinstein's (1988) Precaution Adoption Process Model (PAPM), with a particular emphasis upon the role of affect, was adapted to identify the stages of engagement and differentiation in the characteristics of the decisions. The results suggest that processing of risk information is inseparably linked with the respondents' understandings of the role of organisation offering screening and the screening procedure, whilst the "feelings of risk" provide a first step in engagement with health risk. The decision not to participate in screening is characterised by low feelings of risk, low perceived credibility of the organisation offering screenings, and low perceived benefits of the screening behaviour.

### **Evaluating municipal risk- and vulnerability analyses: how risk is communicated between the municipal and regional level in Sweden**

*Lexin Lin, Anders Nilsson, Johan Sjölin, Marcus Abrahamsson, Henrik Tehler (Lund University, Sweden)*

Risk- and vulnerability analyses (RVAs) are performed in many countries on different levels of society. They form one of the most important basis for assessing society's crisis preparedness, and serve as a means for strengthening society's capacity to deal with extreme events. In Sweden, most authorities

(local municipalities, county administrative boards, etc.) on all administrative levels (local, regional and national) are obligated to conduct such analyses (SFS 2006:942, SFS 2006:544). The general idea of the multi-level Swedish RVA system is that an analysis conducted at a lower administrative level should serve as a basis for the level above. For example, the analyses produced by local municipalities should serve as a basis for the region's county administrative analysis. The Swedish system is thus highly dependent on the ability of various authorities to communicate risks by using the RVAs. In the present paper, we explore the question of what constitute a good, or useful, risk- and vulnerability analysis.

The focus is on the communication of risk between the local and regional level. There are 290 local municipalities in Sweden that annually send information on risk and vulnerabilities to their regional county administrative boards. Each of the totally 21 county administrative boards in Sweden is responsible for one geographic region. Our study involves 3 of them: Örebro län, Skåne län and Stockholms län. In the three regions, there are 71 local municipalities, covering approximately 38% of the total Swedish population.

Each of the 71 RVAs that the local municipalities submitted to their corresponding county administrative boards in 2012 was analyzed in terms of 29 variables. The variables focused on various aspects of the documents hypothesized to be important for the usefulness of an analysis. Examples of the analyzed variables are how the likelihood of potential scenarios was described, how consequences of scenarios were presented and how (if) the local municipal's capacity to manage various events were included. The variables were described by using 9 ordinal scales and 20 nominal scales.

Each county administrative board was then asked to rank the municipal RVAs, according to how useful these documents were perceived to be. A statistical analysis was then conducted to check the correlations between the overall rankings of municipal RVAs, and each of the variables used to analyze the RVAs. We conclude that some of the variables, such as description of probability and consequences, correlate strongly with the perceived usefulness of the documents.

Key words: Risk- and vulnerability analysis (RVA), risk communication, correlational analysis, municipal and regional level, Sweden

### **Coping with 'complex' and 'simple' risks in risk assessments**

*Malin Mobjörk, Hannes Sonnsjö, Misse Wester (FOI – Swedish Defence Research Agency, Sweden)*

Traditional risk assessments focus on simple risks, i.e. risks with a linear relation between cause and effect and where quantitative assessments are possible regarding both probabilities and consequences. However many risks we face today are of a different character and an accurate probability assessment is not possible to make. These risks have a multitude of characteristics, but are centred on complexity in terms that they are loaded with indirect and/or compounding effects. Other common features are delayed effects as well as intricate feed-backs loops which make them difficult to analyse. Examples of risks having these characteristics are financial crises, social unrest, cyber threats and climate change.

To a certain degree many of these risks are included in risk assessments, but traditional risk assessment cannot address differences between simple and more complex risks. This is not least evident when the assessments are synthesised into a risk matrix. Even though the uncertainties behind the assessments many times are recognised during the analysis, the risk matrix still presents the findings in a two-dimensional way reducing the fundamental differences that build up the assessments. This implies that the risks in the risk matrix are presented in a comparable way, but it is an illusionary comparison. Hence, based on a flawed representation of risks by the traditional risk matrix, decisions on priorities are similarly flawed since they do not reflect a fair portrayal.

Since organisations that work with risk assessments, such as civil contingency agencies, have a need to make comparisons in order to prioritise as well as including risks of different characters they are facing a dilemma. If they apply a strict, rationalistic, approach to risk assessment they fulfil requirements of comparability, but exclude many types of risks. If they include a multitude of risks in the risk assessment but stick to the traditional way of presenting the findings, they do not fulfil adequate requirements of comparability. To solve this dilemma the methodological approach needs to be developed so it both can cope with different types of risks and fulfil the organisation's need of comparability. The aim with this paper is to discuss the challenges raised in a risk assessment that includes a diverse area of risks, which is the case for many organisations, and discuss possible ways to manage these challenges.

### **T4 SAFETY MANAGEMENT II**

Tuesday: 1100-1230, R90

Chair: Trygve Steiro (Safetec Nordic AS)

#### **What safety researchers want to learn from accidents: Proposing an accident reporting system for the fishing fleet?**

*Edgar McGuinness, Ingrid B. Utne (Norwegian University of Science and Technology)*

Fishers cast their lot upon the water on relatively small, isolated vessels, often under harsh and unforgiving weather conditions. Hazardous work is conducted on a moving, oscillating and inherently unstable working platform, in cramped workspaces, on uneven, slippery and cluttered decks, with operations involving heavy fishing gears and mobile rotational machinery. In fisheries, fatalities and injuries generally happen, in isolation in time and space; therefore even if the numbers have been relatively high over a long period, they have not given rise to a wider public debate about safety of fishers at sea. Sadly this is a recurrent theme in the scientific literature related to fisher's accidents, with the same patterns of events, the same type of accidents and almost familiar tragedies.

The individual regulatory, legislative and reporting formats of any state conducting an investigation or receiving accident reports varies. Unfortunately, investigative resources are not often applicable; hence, the majority of current statistics are derived from self completed accident reporting forms. Therefore, the content and format of these standardized report forms often determines the depth to which fisheries accidents may be probed in the interest of determining root causes, so as to learn from accidents. The problems faced by researchers, is the paucity of information on the circumstances of the recorded accidents, making it a matter of gleaning every possible detail from relatively blank canvases.

The aim of this paper is an investigation of the most important constituent elements and most suitable format for the introduction of a standardized accident reporting system for the fishing fleet. The proposed system is adapted to incorporate fields of information, not currently recorded in most national accident reporting systems. These additional fields are of great interest and benefit to those institutional researchers, governmental authorities and private organizations working in the area of fisheries safety. It is believed that the use of

this new reporting system that incorporates novel and much desired supporting information about the vessel, injured party and circumstances of the accident will facilitate the design of preventative strategies for the continued improvement of safety conditions in the fleet.

Key words: Accident reporting system; Fishing

### **Unexpected exercises and training in high risk organizations**

*Glenn Egil Torgersen (Norwegian Defence University College, Norway), Trygve J. Steiro (Safetec Nordic AS, Norway)*

The last years' terror events and crisis situations provide new challenges for training for unexpected situations. Therefore, unexpected exercises and training for the unexpected can be means to meet these new challenges. Unexpected exercises can briefly be defined as: "without announced preparations before starting the exercise".

The paper will stress the need for unexpected exercises, discuss the educational framework for ensuring its success and point to limitations that can be met. We will also discuss ethical considerations regarding such type of training. It is our belief that such a framework is urgent to consider for many high risk organizations.

Training for the unexpected and learning from such exercises calls for more perspectives to be included and more esthetic methods and concepts must be drawn upon in order to articulate and awaken the actual training content. These types of exercises will demand a clear mission plan and consciousness development throughout the organization. It will demand involvement from the unions and other relevant stakeholders. All stakeholders must be involved in the development of an exercise plan. The plan demands clear roles, exercise structure and working conditions (compensation etc.). Such exercise cannot be absolute acute and members need to step out of the daily operational context. This means that unexpected exercises will demand more resources and planning than traditionally exercises. Typically a pre- brief will be necessary both for practical reasons but also from an ethical point of view.

What is most evident is an educational plan giving clear direction on focus on learning rather than finding scapegoats, management creating room and involvement in debrief processes and exploiting the learning into improvement and in updated preparedness analysis. The plan must be based on didactic training factors. In the field of education, is there an apprehension that it is

important to train for the unexpected and the immediate. It is necessary to reveal what functions well and what is missing in such situations in order to raise competence both on individual level, management and organizational level. This can be followed up by prepared exercises and simulator training in order to retrain.

Unexpected exercises and training for the unexpected opens up for more indirect educational principles (Torgersen and Sæverot, 2012a, b). These principles we argue are important both with regards to training content and methods for training for the unexpected since the solutions will not reveal themselves immediately. The paper will focus on the following topics that will be elaborated:

- 1) Development of a training program included methods
- 2) Preparing (i.e. lead astray regarding the training scenario to create a surprising situation)
- 3) Implementing
- 4) Pre-brief
- 5) Fundamentals for learning (awareness raising and systemizing experiences and learning) aligned to training demands and updated preparedness analysis.

### **From Fossil Fuels to Biofuels - The Impact of Risk on Compliance**

*Tonje Jenssen Espeland (Institute for Environment and Human Security, Germany), Frederic Boudier (Department of Technology and Society Studies, The Netherlands)*

The study analyzes compliance with EU legislation in a context of environmental risk. The case study selected is the European Union's 10% target of renewable fuels in the transport sectors of all Member States by 2020. The target has been criticized because of slow technological development on renewable fuel alternatives and the contested environmental benefit of biofuels. The study combines insights from risk governance literature and compliance literature from European Studies, and makes a case for a combined theoretical framework of the two approaches. The analytical framework of risk regulation regimes is applied to a comparative analysis of the adaptation processes in Germany and the United Kingdom to the 10% target. The analysis draws on empirical material collected for the study, including critical discourse analysis of newspaper articles and 15 expert interviews.

The study tests the assumption that some countries are more risk-averse than others. In terms of regulatory style, Germany is often cited as 'risk-averse' whereas the UK is seen as 'risk-neutral'. These categories form the study's initial hypotheses. Between 2007 and 2012, both countries experienced strong public debates on biofuels. The biofuels debate triggered a regulatory dilemma over how to ensure that the risks of biofuel production do not exceed its benefits. This dilemma is recognized both at the EU level and at the national level. Germany and the UK adopted risk-averse regulatory responses, but with different implications for their likelihood of compliance. The study finds Germany to have faith in achieving the target in a sustainable manner. In the UK, possible environmental risks are seen as a reason for retrenchment. The study concludes that the categories 'risk-averse' and 'risk-neutral' are insufficient to explain the regulatory responses. However, the responses correspond to the two countries' traditional EU integration patterns. Their stand-points furthermore reflect the level of their national biofuel industries, highlighting the link between industry strength and policy outcomes. The study concludes that it is the nature of the risk debate that makes this case important, because it foreshadows the risk regulatory future of Europe. Energy crises and climate change are likely to pose many more risk tradeoff dilemmas, and the question of how such risk tradeoffs are judged in the decision-making process will become ever more important. The study shows that combining insights from the compliance strand of research and risk research is a fruitful and promising approach for understanding the complexity of risk regulation in Europe.

Keywords: Compliance, Risk Regulation, Renewable Energy, Biofuels

### **Evaluation of comprehensive security systems for public transport - a methodological framework**

*Janne Merete Hagen (University of Stavanger/Norwegian Defence Research Establishment), Anne-Kari Valdal (University of Stavanger/Proactima AS), Kenneth Pettersen (University of Stavanger), Brita Gjerstad (University of Stavanger/IRIS, Norway)*

Since the 11th of September 2001 attacks in New York, innovation and development of security technologies in public transport has boosted. Different kind of sensors, scanners and surveillance technologies are being developed and implemented in transportation facilities worldwide in order to detect and deter any suspicious activities or persons. New security regimes have evolved, and

they are in particular visible in the airline industry, in city metro systems and in shipping. As the security industry is still evolving, and security guards are protecting more properties and the safety of people on travel, cost-effectiveness of such technologies and regimes is not transparent to the public or well documented. Still security measures are believed to have effect. In some instances the security solutions may even have negative effects, and for instance interfere with privacy issues and ethics. These dilemmas are sometimes hardly debated among stakeholders.

We have developed a risk based framework for debating and evaluating in a broad perspective the benefit and cost of security capacities, taking into account the non-quantifiable decision variables and dilemmas, and uncertainty related to data. The framework consists of a process description and a range of evaluation criteria, covering the classes: economics, security capacity suitability, passengers' security perception and legal and ethical aspects. In addition to prioritize and evaluate the different criteria, the framework guides on follow up management strategies based on the outcome of the evaluation. In short, it guides on how to follow up the output of security risk assessment and the identified security gaps by involving stakeholders and offering a transparent process for prioritizing and selecting security capacities. Evaluation itself may be difficult and in particular challenging with the related high uncertainty in data. This is also taken into account, as uncertainty in data is debated. In its simplest form, evaluation can be conducted by a group meeting where the focus is on a selection of criteria. A more advanced use would rely on quantitative studies, and surveys. Finally, the use of and the strengths and weaknesses of the framework is demonstrated in a constructed case; in which a personal transport operation has to choose among two security capacities.

### **T5 SYMPOSIUM: VISUALIZING AND UNDERSTANDING SAFETY BARRIER STATUS FOR RISK-INFORMED DECISION-MAKING**

Tuesday: 1100-1230, R92

Chair: Nicola Paltrinieri (SINTEF Technology and Society, Norway, Università di Bologna, Italy)

Several lessons learned from recent industry events show that accident root causes are related to inadequate monitoring and/or lack of understanding of safety system information. Examples of degrading behavior of the system due to increasing maintenance backlogs are relatively common and often occur without the potential effect on the risk picture being properly assessed. There is an emerging need of specific methods to support critical decisions by providing key information on barrier and safety function status in an intuitive and visual form. Increased awareness of the barrier conditions and the overall related risk will represent not only a more robust framework for preventing undesirable events, but also a cost-effective result for industry. This symposium represents an attempt to answer these needs. For this purpose, experts from the Center for Integrated Operations in the Petroleum Industry (Norway) and world-wide renown universities, such as the Norwegian University of Science and Technology (NTNU - Norway), the Memorial University of Newfoundland (Canada) and the University of Bologna (Italy), will be gathered to share different approaches and perspectives and open a stimulating discussion in an international context.

#### **Coupling of advanced techniques for dynamic risk management**

*Nicola Paltrinieri (SINTEF Technology and Society, Norway, Università di Bologna, Italy), Faisal Khan (Memorial University of Newfoundland, Canada), Valerio Cozzani (Università di Bologna, Italy)*

Complete and effective activities of identification and assessment of hazards and risks in the process industry are of paramount importance for the prevention of major accidents. Although several techniques of HAZard IDentification (HAZID) and Quantified Risk Analysis have often proven effective in the industry, they generally lack of the dynamic dimension of risk management. In other words, they lack the ability to learn from the experience and to account for early warnings. There is the need to know how to deal with atypical accident scenarios as soon as their emergence is demonstrated. The related risk has to be addressed in an ever-changing environment. In fact, what is not identified or assessed cannot be prevented or mitigated and a latent risk is more dangerous than a recognized one due to the relative lack of preparedness. This study addresses the need of dynamic approach to risk by coupling two advanced techniques for hazard identification and risk assessment: the Dynamic Procedure for Atypical Scenarios Identification (DyPASI) and the Dynamic Risk Assessment

(DRA) methods. DyPASI was developed in the EC project iNTEg-Risk. This technique aims to produce a complete and updated HAZID process. Atypical accident scenarios, which by definition are deviating from normal expectations of unwanted events or worst case reference scenarios, are identified through a systematic screening of related emerging risk notions. The DRA method aims to estimate updated expected frequency of accident scenarios by means of Bayesian inference. Real time abnormal situations or incident data are used as new information to update the failure probabilities of the system safety barriers, which necessarily affect the overall scenario frequencies and the related risk picture. The BP Texas City refinery accident occurred on March 23rd 2005 was considered as a case study. The results obtained from the application of the dynamic risk approach firstly show that the accident was predictable and may have been prevented through this approach. Secondly, the demonstration of the effectiveness of the approach highlights the need of an association of safety culture and decision making processes capable to dynamically deal with emerging and increasing risk issues.

#### **Dynamic Risk Assessment: A Tool For Process Safety Management**

*Faisal Khan, Nima Khakzad (Faculty of Engineering & Applied Science Memorial University, The Netherlands), Paul Amyotte (Department of Process Engineering & Applied Science Dalhousie University Halifax, Canada)*

Dynamic failure assessment is a new approach in process safety management, which enables the real time failure analysis of a process. Dynamic failure assessment has been used in the past by nuclear industries for accident likelihood estimation using accident precursors. Recently it has been successfully applied to process units to revise failure probabilities using incident and near miss data. In dynamic risk assessment, an extension of dynamic failure assessment, Bayesian and joint probability theories are used to develop a predictive failure model for a given process. As the process operates and generates incidents and near misses, the accident occurrence probability is predicted using accident precursors and later multiplied with consequences to quantify real time risk. The concept of developing a dynamic risk profile for a process system, which encompasses likelihood and consequences of a given abnormal event, is presented here. Dynamic risk estimation uses Bayesian theory to update the likelihood of an event occurrence and a generalized consequence algorithm to obtain the relative consequences of the given event.



This approach results in a risk function, which has predictive capabilities and the ability to be updated with time; it is ideal for accident prevention and dynamic decision-making. Application of dynamic risk assessment to a process system is also presented.

Key words: dynamic risk assessment, safety management, risk-based design, accident precursors, accident modeling

### **Visualization of simultaneous activities on an offshore installation**

*Sizarta Sarshar (Norwegian University of Science and Technology)*

Installations require preventive and corrective maintenance due to degradation to the installation and due to events occurring during operation. During normal operation it is important to have an overview of the planned activities that are to be carried out in the facility. It is equally important to be aware of the potential risk they have individually and together as they are performed simultaneously. Some activities will influence others in the way that they e.g. either depend on each other due to shared resources or they cannot be performed simultaneously due to safety issues.

In this work, our focus is on modelling and visualizing such risk influences and dependencies between the activities that are planned to be carried out over a given period of time. The objective is to evaluate different data presentation techniques in the context of communicating and visualizing planned activities and their potential risk. The first step is to model the risk influence between planned activities and develop concepts for how to visualize these. The second step is to perform usability studies of the developed concepts with offshore personnel. This paper reports on the first step of this study.

### **Dynamic assessment of the risk picture using indicators**

*Stein Hauge, Eivind Okstad, Nicola Paltrinieri (SINTEF Technology and Society, Norway)*

Lessons learned from recent industry events show that accident root causes can be identified in a general drift towards inadequate risk management or explicit changes in risk-relevant processes. Degrading behavior of the system due to increasing maintenance backlogs or temporary impairment of safety functions related to installation modifications often occur without the potential effect on the risk picture being properly assessed. As a result, it has been

proposed to develop suitable risk indicators that have the ability to monitor such dynamic changes to the risk picture.

In this paper we present the work from a case study conducted for a Norwegian offshore installation where indicators for on-line monitoring of the process related risk were developed. The case study is part of a larger project where the main objective is to develop and apply integrated operation (IO) concepts to prevent major accidents. Based on the installation specific quantitative risk analyses (QRA) and additional sensitivity analyses, a list of risk-prioritised parameters were identified. The selected parameters included "containment / leak frequency", "control of ignition sources", "gas detection" and "emergency shutdown". The parameters were chosen based on their relatively high contribution towards the fatal accident rate (FAR) as well as the frequency for loss of main safety functions. When developing indicators for each of the mentioned parameters it became clear that the technically based QRA was no longer sufficient, especially due to its lack of focus on causal factors. Additional information sources such as the installation specific barrier analyses, studies of hydrocarbon leaks and meetings with the operator were therefore also used. This combination of information resulted in a set of 10 indicators for which a weighing and scoring system was suggested in order to enable an overall "process risk indicator". The selected indicators should facilitate an improved recognition, assessment and visualization of operational risk factors, as well as reflecting the status of important safety barriers during operation.

### **Risk visualization – What is meant by risk picture operators?**

*Jørn Vatn (Norwegian University of Science and Technology)*

In order to support decisions regarding risk it is important to present an appropriate risk picture to the decision makers. With a risk picture is meant a set of undesired events, the causes and factors that may contribute to the event, the possible consequences of the event with corresponding influencing factors, and uncertainties related to all these issues. Although we may easily define the risk picture as prosed above, it is not always obvious how to present the risk picture in a way that in the best way support the decision process. So-called risk picture operators are means to visualize the risk picture. In this paper the following operators on the risk picture are discussed: With filtering we mean to filter out several aspects of the risk picture. Primarily filtering means to focus on only one hazardous event and/or a limited set of end consequences, e.g., only number of

fatalities. With aggregation we mean the process of summing more than one event, more than one cause etc to give a sum of various events, causes and so on. With merging we mean the process of grouping several similar outcomes into one category representing several outcomes. With zooming we mean to view part of the risk picture for a specific location (in space and/or time). With hiding we mean to hide important information when presenting the complete risk picture. Typically we hide causes behind the hazardous event, factors that influence whether causes could lead to the hazardous event or not, and factors that influence the severity of the hazardous event. A case study is presented where these operators are discussed in relation to monitoring of safety barriers. Further we discuss what should be the “core elements” of a risk picture enabling visualization. We define a risk picture rich if it is possible to apply operators on the risk picture. Examples of what is a rich risk picture are discussed, and challenges related to gathering the information required to obtain a rich risk picture. For example to zoom the risk picture in time, it is required to embed dynamic information related to execution of critical tasks, both with respect to the underlying risk model, but also with respect to the actual situation. A critical aspect here is to link so-called strategic risk analyses with operative risk analyses.

## T6 SYMPOSIUM: ROBUST SAFETY REGULATION I

Tuesday: 1100-1230, R93

Chair: Petter Almklov (NTNU Social Research)

In this symposium researchers provide papers that can be used in developing and support robust regulation and inclusive risk governance in high risk industries and sectors. The symposium addresses:

- Conceptualization and understanding of the robustness of the risk regulation regimes in hazardous industries.
- Examination of the interface between a regulatory regime and industrial safety management systems.
- Comparison of leading regimes in an international context.
- How insights from safety research on holistic concepts like safety culture, resilience etc can be applied by regulators and authorities.

- The transnational dimension of regulation: The dynamics between international markets, international rules and standards and national regulation.

Major accidents such as the Macondo blowout and oil spill in the Gulf of Mexico, demonstrate that simultaneously ensuring productivity and safety is a major challenge in the petroleum industry. To meet such challenges leading countries have developed regulatory regimes which differ in several respects, particularly with regard to supervising and fostering self-regulation by industry, and all are engaged in a continuing quest for increasingly robust regulation.

Papers will particularly focus on the petroleum industry, other hazardous industries and transportation sectors, but we aim also to discuss more generic topics pertaining to robust regulation.

### **Regulating Hse-Culture. A Literature And Document Study Of The Translation Of Hse-Regulation Into Corporate Sms-Systems**

*Jens Røyrvik*

The framework regulations for health, safety and the environment (HSE) in petroleum activities demands ‘a sound HSE culture’ (§ 15) in the involved organizations (PSA, 2011). The concept of HSE culture is also emphasized in government white papers on safety in the petroleum sector (e.g. White Paper no. 7: 2001-2002). HSE culture is intuitively an important phenomenon, but is at the same time a vague and elusive concept, interpreted in different ways within companies (Høivik et al., 2009). As a possible result, the practical consequence of this regulation are likely to be highly diverse in the different petroleum companies, depending on how a ‘sound HSE culture’ has been understood, translated, negotiated and made actionable in practice.

In the NRC project “TRACULT”, researchers from NTNU Social Research and Safetec investigates the translations of the concept and how they are both understood and treated differently by the authorities and the different companies that participate on the Norwegian Continental Shelf. The first part of this investigation has been to undergo literature that discusses HSE Culture, and documents from both authorities and the industry, relating to the §15.

We have applied a quantitative technique labeled content analysis and emergent coding in order to select our corpus of texts, and to define categories that we code articles and documents by. The articles and documents are

categorized by a set that includes both string variables (such as abstracts and definition of culture) background variables (such as type of article, date/year and academic affiliation) and finally we encoded the articles with variables relating to understanding of culture, HSE and HSE-Culture. The dataset are used to create a database, which will be made publicly available, in order to compile documents and articles and thus track translations and trends in how HSE culture is understood, and how the industry reacts to §15 in different ways. In this initial stage of our research project we will conduct a systematic analysis of how it manifests itself in official documents. Our presentation will be grounded in a discourse analysis, including correspondence analysis, and we will focus both on the method used to construct the database – and trends of translations found by our analysis.

### **Inspections and Intelligence A comparative analysis of offshore regulations in Norway and U.S.**

*Helge Ryggvik*

The aim of paper will be to present a comparative analysis of offshore regulatory regimes in Norway and in the U.S. Both immediately after the Deepwater Horizon accident and when different commissions made their reports, the Norwegian regulatory regime together with the British Safety case often was held up as a positive alternative. U.S. regulations are often described as detailed descriptive, while Norwegian regulations is performance based. However, if one take very concrete regulations, for example the regulations for drilling that was relevant for the actual operation in the run up to the accident when BP lost control over the Macondo well, one would find that the actual content is very similar to what one would find in Norwegian regulations. The main difference can be found in the underlying philosophy. Therefore, a better way to describe the essence in the two regimes and the differences is to describe how inspections, audits and several enforcement measures are conducted. The qualitatively, broad approach to audits, inspections and enforcement measures in the Norwegian oil sector is mirrored by the very different way inspections was conducted in the Gulf of Mexico up till April 2010. The presentation will support the claim that the broad, qualitatively audits one can find in the Norwegian system is a better way to uncover safety breaches than the narrower, technical oriented approach one could find in the Gulf of Mexico. However, both systems have to be understood in its historical context. Since there can go years before

an installation is visited by regulators in the Norwegian system, it is essential to in time uncover potential dangers. There is no guarantee that regulators always will have the necessary experience, independence and complacent free attitude that are essential for the system to work. The Norwegian system will not work without a constant developing, self-reflecting and intelligent approach from its regulators.

### **Risk regulatory regimes in promoting resilience preventing major industrial hazard. Case study of offshore oil - and gas industry**

*Preben H. Lindøe (University of Stavanger, Norway)*

In many industrialized countries there has been a paradigm shift from an old reactive regime based on prescriptive and technical requirements towards a risk based, proactive regime with functional legal requirements. Part of this development is the search for improvement in the design of robust and resilient technological systems.

The new regimes differ in several respects, particularly with regard to partnership between public regulators and industry, supervising and fostering self - regulation by industry, the involvement of labor force and other stakeholders and the issue of mutual trust among the parties. The paper address the following question: "What characterize risk regulatory regimes in promoting (1) occupational health and safety, (2) resilient technical system preventing major industrial hazard and (3) environmental pollution? The means by which the issue is analyzed and discussed is by comparing contrasting modes of regulatory approaches in the offshore oil and gas industry.

The paper has three main sections. Firstly a theoretical framework is presented, analyzing state/public and private/industrial partnership by combining safety management system (self - regulation) with public/state regulation with legal binding laws and regulation. Secondly the empirical context of the offshore regimes is introduced with emphasis on the relationship between major accidents and regulatory responses and a historical perspective on the development. Finally the resilience and robustness of the different risk regimes is analyzed and discussed regarding occupational health and safety, technical safety/integrity and pollution to the sea.

### **Boxing and dancing: Tripartite collaboration as an integral part of a regulatory regime in Norway**

*Ragnar Rosness (SINTEF, Norway), Ulla Forseth (Norwegian University of Science and Technology)*

Researchers from non-Scandinavian countries are often perplexed by "the Norwegian model" when they study the regulatory regime in the Norwegian petroleum industry. The regulations seem too open-ended, the inspections too few, and the reactions to non-compliance too soft to produce acceptable HSE (health, safety and environment) performance. Tripartite collaboration between trade unions, employers' federations and the political and regulatory authorities is often emphasised as a key to understanding the Norwegian model, but it may be challenging for outsiders to understand how this collaboration works in practice.

We shall use the metaphors "boxing" and "dancing" as a point of departure for exploring the robustness of the regulatory regime in the Norwegian petroleum industry and its relationship to the tripartite collaboration on HSE. We analyse collaboration and conflict between trade unions, employers' federations and the political and regulatory authorities in a period around year 2000. This period was characterised by a fierce controversy about the risk level in the industry, followed by a period of revitalisation of tripartite collaboration on HSE. We conceptualise the regulatory regime as an actor-network, and use a discourse analysis approach to pinpoint the enrolment of new actors in the controversy.

The controversy concerning the risk level and the subsequent efforts to revitalise tripartite collaboration led to a rapid expansion of actor-network dealing with safety in the petroleum sector, e.g. through enrolment of the political authorities, the media and the research community. The actors used a variety of rhetoric devices to promote their positions during the controversy. We identified different discourses that embedded contrasting epistemological and ethical premises.

The durability of the revitalised tripartite collaboration was achieved mainly through mechanisms that facilitate, stimulate or provoke certain action patterns. The authorities promoted a process where converging sense-making and the development of organisational structures for collaboration mutually reinforced each other.

The question "who regulates" does not have a simple answer when we conceptualise a regulatory regime as an actor-network. The parliament, the

ministry and the NPD regulate, but the tripartite collaboration, with its episodes of conflicts, negotiations and joint action also regulates HSE.

The capacity for self-correction demonstrated in this case is an important contribution to the robustness of the regulatory regime for HSE in the Norwegian petroleum industry. The ability to engage in a conflict when HSE was under pressure and the capacity to subsequently join forces and revitalise collaboration were equally important aspects of this robustness.

### **T7 SYMPOSIUM: NATURAL HAZARDS: RISK INTERPRETATION AND ACTION**

Tuesday: 1330-1500, R3

Chair: J. Richard Eiser (Univ. of Sheffield, UK)

The risk of disaster associated with so-called "natural" hazards typically depends not simply on the hazard event itself but on the actions and decisions of individuals and groups at many levels from ordinary citizens to scientific experts and government officials, as well as on how scientific evidence of risk is (co-)produced and communicated by more and less trusted sources. These themes are central to a recently established international programme on Integrated Research on Disaster Risk ([www.irdrinternational.org](http://www.irdrinternational.org)) within which one working group focuses on Risk Interpretation and Action. This symposium introduces aspects of this approach in the contexts of empirical and conceptual papers considering, seismic, volcanic and flooding risk in particular. Among the main issues addressed are how citizens' personal experience of hazard events shapes their interpretation of risk and how effective and trusted communication can mitigate disaster risk.

#### **Trust, precaution and interpreting volcanic risk**

*J. Richard Eiser (Univ. of Sheffield, UK), Amy Donovan (Univ. of Cambridge, UK), Stephen Sparks (Univ. of Bristol, UK)*

Interpreting uncertain risks and providing appropriate advice to the public is a challenge to scientists and risk managers. Based on typically uncertain forecasts, a balance has to be struck between an overly cautious approach, which may result in 'false alarms' with associated costs and inconvenience, and an overly

risky approach, which may result in a hazard turning into a disaster, with associated fatalities and/or damage. Key questions are how advice is interpreted by the public as a function of their own experience and interests, and the relationship between such interpretation and their trust in different communicators. We report the findings of two parallel surveys in Iceland and the UK in which participants described their reactions to the Icelandic volcanic ash-cloud events of 2010 and 2011. For the Icelanders, these events appeared to fit into a more familiar history of experience with volcanic activity, including direct risk to persons, property and livelihood. Endorsement of a more precautionary approach to risk management was associated with higher trust in scientists and the Icelandic Civil Protection. Friends and family were also highly trusted. For the British, the 2010 eruption at Eyjafjalljokull and its impact on air travel around N. Europe was a new experience. Those who were more accepting of a precautionary approach to risk management were less likely to say that "nothing bad would have happened" if air traffic restrictions had not been imposed and tended to trust scientists and government sources more, whereas those who flew more often tended to show higher trust in the airline companies and questioned the necessity of the length of the restrictions in 2010 and 2011. These findings illustrate some of the interrelationships between trust, risk interpretation and estimation of personal cost and benefits.

### **Seismic Risk Mitigation in Port Systems**

*Ann Bostrom, Tim Scharke, Lori Reimann-Garretson, Glenn Rix*

Earthquakes pose a significant threat to many seaports. The global rise of shipping and evolution of public-private partnerships in seaports pose potential challenges for seismic risk management. To examine stakeholders' risk interpretation and decision making in port systems, we conducted qualitative mental models interviews (N=42) in two ports at high seismic risk. The interviews demonstrate that engineers and other decision makers in port systems are well aware of the vulnerability of port infrastructure, cranes, and operations to earthquake damage; they also volunteer information about past and predicted earthquake magnitudes as well as wider economic impacts of seismic events at ports. Nevertheless, the findings paint a picture of increasingly complex risk governance, divergent ideas about how to measure risk performance, and lack of attention to seismic risk management.

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### **Social role and causal structure as determinants of environmental risk perception and behavior**

*Gisela Böhm (University of Bergen, Norway)*

A dual-process model of risk perception is presented that complements cognitive and consequentialist evaluations with deontological and emotional ones by distinguishing two modes of evaluative processing: (a) a consequentialist evaluation that focuses on potential consequences, and (b) a deontological evaluation that focuses on moral values. Each of these two modes is assumed to trigger specific cognitive evaluations, specific emotions, and specific behavioral impulses. An experiment is presented that tested whether the relative dominance of the two evaluative modes depends on the causal structure of the environmental risk that is evaluated and upon the social role of the evaluator. Three types of causal structure were varied by providing scenario information: (a) anthropogenic risks that endanger only nature, (b) naturally caused risks with potential harmful consequences for humans, and (c) anthropogenic risks that may harm humans. Participants evaluated each scenario from the perspective of one of three social roles: environmental activist, expecting parent, mayor. For each scenario, subjects evaluated the event's morality, perceived risk, the intensity of specific emotions, and their preference for prospective actions. Results show that deontological evaluation is stronger for anthropogenic than for natural causation and stronger for environmental activists than for the other roles. The implications for environmental decision making are discussed.

### **Personal experience of flooding heightens climate change risk perception and mitigation intentions**

*Stuart Capstick (presented by Nick Pidgeon)*

Climate change has long been considered a 'hidden hazard', due to its tendency to be seen as a temporally and spatially remote risk, and because of the difficulty of attributing discrete occurrences to climate change.

Nevertheless, a number of recent studies have examined whether direct experience of extreme weather events may stimulate public recognition of and response to climate change. This work is particularly pertinent in light of phenomena which have lately been experienced around the world such as hurricane Sandy in the USA, bushfires in Australia, and widespread flooding in Europe. Results from studies examining the links between personal experience and perceptions in the context of climate change have tended to be equivocal, although recent analysis by Spence et al. (2011) has suggested this may be because experience effects are complex and indirect, mediated by a series of psychological processes.

We present new analysis based on survey findings obtained during a period of nationwide flooding in Wales in late 2012. This is designed to replicate and extend previous research through enhancement of the way in which flooding 'experience' is gauged – including through oversampling in a region which had been acutely affected, and through measures which distinguish between different types of impacts encountered by respondents (e.g. property damage, travel disruption). In addition, we address a shortcoming of previous work through appraising the extent to which climate change is spontaneously associated with flooding, and whether this varies according to flooding experience. Finally, we examine in greater detail the mechanisms connecting flooding experience with climate change risk perception and behavioural response.

Our analysis indicates that flooding experience affects behavioural intentions indirectly through its influence upon climate change concern, attitudinal strength, perceived vulnerability, and efficacy beliefs. We also find for the first time that spontaneous association between flooding and climate change varies in line with extent of flooding experience. This finding suggests that particularly for many people affected by flooding, climate change constitutes a risk which is now manifesting in everyday life. We discuss how the links between personal experience and perceptions may best be conceptualised in the context of climate change, as well as implications for communication.

#### **Communication and Action based on Risk Interpretation**

*Britt-Marie Drottz-Sjöberg (Norwegian University of Science and Technology)*

Communication is the means to establish and sustain all kinds of social organization and collaboration. Communication is essential in efficient everyday

decision-making and risk prevention work and it is crucial in reducing detrimental effects in disasters. This paper highlights communication aspects especially related to environmental or physical hazards based on the RIA workgroup's suggestions of developing a conceptual framework to guide future research in the area. This involves the themes of risk interpretation, decision making under uncertainty and subsequent action and learning. The framework underlines the need to better understand how decision-making under uncertainty is influenced by people's interpretations of risk which in turn are based on own experience, beliefs, values and feelings as well as cultural and social dynamics. The role of trust in others is highlighted from the individual as well as the collective perspectives. The discussion addresses the impact of social context and underlying societal values on disaster outcome.

#### **T8 SYMPOSIUM: RISK AND VULNERABILITY ASSESSMENT OF BUILDINGS AND CRITICAL INFRASTRUCTURES AGAINST NATURAL HAZARDS AND RESILIENT STRATEGIES**

Tuesday: 1330-1500, R4

Chair: Linmei Nie (SINTEF)

Recent natural disasters (e.g. Xynthia storm in France in 2010 and the Great East Japan Earthquake and Tsunami in 2011) highlights that Low frequency high consequence (LFHC) natural hazardous events induced by climate change may bring about catastrophic impacts on critical infrastructures and trigger cascading effects. Research should capitalise on knowledge acquired from risk and vulnerability assessment and strengthen the resilience of our community and the critical infrastructures to the emerging changes and increasing risks of natural hazards in Europe.

This symposium aims to bring the synergy of scientists and managers from multidisciplinary areas who are working on climate change, risk and vulnerability analysis and different critical infrastructure systems in respect to natural hazards, provide state-of-the-art of risk and vulnerability assessment methodology for critical infrastructures and present new concepts and methodology for stress testing. It is divided into two sessions: Session 1 focuses on the drivers for change, critical infrastructure and interdependency and

assessment methodology: Session 2 turns on application of various risk and vulnerability assessment methods on buildings and infrastructure, risk management and resilience.

This symposium presents the most recent outcomes from EU FP7 project-FloodProBE and other national and international projects.

### **A storyline approach and application for flood vulnerability analysis of critical infrastructure**

*Karin de Bruijn, Berry Gersonius*

Past experiences showed that the resilience of flood-prone areas strongly depends on the vulnerability of critical infrastructure towards flooding. Critical infrastructure includes electricity networks, communication networks, roads and water and sewerage networks. During flooding critical infrastructure is needed to be able to organize emergency management, to inform the public and thus to limit flood impacts. After the floodwater has gone, critical infrastructure needs to be repaired before further recovery will occur. Besides, damage to critical infrastructure may lead to a spread of flood impacts beyond the flooded area.

In common flood risk analyses critical infrastructure and the effects outfall are not considered. In the EU Floodprobe project, therefore, methods were developed to study the vulnerability of critical infrastructure and its relation with flood risk assessments at various levels of detail. This paper gives an overview of the methods, describes the storyline method in detail and illustrates its application to the Island of Dordrecht. A storyline is a realistic sequence of incidents and human responses that may happen during a flood event. Storylines should at least exist of 4 actors (water, critical infrastructure, authorities, and civilians) and 3 phases (before, during and after the flood). Both advantages and drawbacks are discussed.

### **A global approach to risk assessment of critical infrastructures**

*Vittorio Rosato (ENEA, Italy)*

We consider a global approach to risk analysis of complex Critical Infrastructures (CI) through a new generation of Decision Support System for the prediction of Crisis Scenarios induced by natural hazards. The system starts from accurate, high resolution LAM (Local Area Model) providing weather forecast and precipitation abundances. These results, used in conjunction to GIS databases containing thematic information at the regional scale, are used to

evaluate impacts on population, buildings, infrastructures. Generated crisis scenarios are then used in combination with CIs simulators, to gain estimates of the reduction (or loss) in the functionality of CIs, also considering interdependency effects. Implementation of such DSS is going to be accomplished in the frame of a large paneuropean network, CIPRNET (Critical Infrastructures Preparedness and Resilience Network) recently started.

### **Risk and Vulnerability Analysis in a Subsea Road Tunnel Project**

*Per Hokstad, Bodil A. Mostue (SINTEF, Norway), Christian Boye (COWI, Norway)*

Rogfast is a subsea road tunnel planned to be built on the western coast of Norway. If carried out, it will become the longest and deepest sub-sea tunnel in the world. Main characteristics of the tunnel will be presented, and the authorities' requirements for a risk analysis will be discussed. Then we give the main steps of a risk and vulnerability analysis that has been carried out; in this presentation in particular looking at the threats caused by natural hazards. Consequences both with respect to the loss of service (tunnel closed) and the number of injuries/fatalities are considered, resulting in various risk matrices. Also some risk reducing measures are considered and evaluated. Further, a more detailed risk analysis is carried out in order to evaluate e.g. emergency preparedness. Risk acceptance is here somewhat complicated, as the length of the tunnel is outside the normal size of tunnels described in standards. This is here solved by introducing a "reference tunnel" with similar "traffic work" as expected in Rogfast, and for which a more specific risk acceptance criteria exist.

### **Integrated and validated participatory vulnerability assessment**

*Jan Ketil Rød, Tomasz Opach (Norwegian University of Science and Technology), Tina S. Neset (Linköping University, Sweden)*

Norway may become more exposed to weather extremes in the future, but the effects will vary geographically. It is therefore important for local governments to know where the most exposed areas are. To implement the most adequate adaptation measures, it is also important to know why places become vulnerable.

We identify the most exposed places by counting the relative number of buildings where people either live or work that is situated inside a hazard zone for an unwanted extreme event (flood, landslide, and storm). A reliable assessment of exposure could be used to support decision making as to where,

and what kind of, necessary adaptive and preventive measures to climate change-related hazards should be carried out. However, to be scientifically robust and credible for relevant stakeholders, the assessment needs to be validated both empirically and through participatory approaches. We validate the assessment using historical insurance compensations for damages on building caused by flood, landslide and storm.

The impact extreme events may have on humans depend not only on hazard exposure, but also on the vulnerability of people's surroundings and how capable people are to anticipate, cope with, resist, and recover from an impact. This capability is often referred to the concept of '(social) vulnerability' and refers to various groups having different preconditions to respond to exposure due to socio-economical and/or demographic inequalities. The approach 'integrated vulnerability assessment' combines information on exposure to physical threats with information on demographic and socio-economic characteristics. It is a top-down approach, which we combine with a bottom-up vulnerability assessment. The bottom-up assessment is arranged through dialog meetings as well as via web-based visualization tools designed for participatory vulnerability assessments.

## T9 EMERGENCY PREPAREDNESS & RISK ANALYSIS

Tuesday: 1330-1500, R90

Chair: Knut Øien (SINTEF)

### **Benefit of the introduction of standard ISO 22320 in Incident Response Organizations.**

*Giedo van Pellicom (Arbeidsveiligheid & Expertise Van pellicom B.V.B.A, Belgium)*

In recent years there have been many disasters, terrorist attacks and other major incidents which have shown the importance of effective incident response in order to save lives, mitigate harm and damage, and to ensure a base level of continuity of essential societal functions. Such functions include health and rescue services, water and food supply, and electricity and fuel delivery. While in the past the focus of incident response has been national, regional or within single organizations, today and for the future there is a need for a multinational

and multi-organizational approach. This is a result of worldwide governmental, non-governmental, commercial and industrial relationships and dependencies.

The new introduced International Standard, ISO 22320; enables public and private incident response organizations to improve their capabilities in handling all types of emergencies (for example, crisis, disruptions and disasters). The multiple functions of incident response are shared between organizations and agencies, with the private sector and the government having different levels of responsibility. Thus there is a need to guide and coordinate all involved parties in how to prepare and implement effective incident responses. The ISO 22320 will, based on minimum requirements, enable organizations involved to operate with joint optimum efficiency.

Effective incident response needs structured command and control, coordination and cooperation, in order to establish coordination and cooperation carry out command processes and facilitate information flow amongst the involved organizations, agencies and other parties.

Cross-organization, -region or -border assistance during incident response is expected to be appropriate to the needs of the affected population and also to be culturally acceptable. Therefore community participation in the development and implementation of incident response measures is essential. Involved organizations require the ability to share a common approach across geographical and organizational boundaries.

Information requirements, as well as requirements pertaining to the information management process and structure, may enable industry to develop technical solutions which will provide maximal interoperability according to information and communication exchange needs during incident response.

An effective incident preparedness and operational continuity management programmer can be implemented using ISO/PAS 22399, and by conducting regular multi-organizational exercises.

Key words: ISO 22320; ISO 22399; Incident Response; Cross Organisation; Disaster Response

### **Optimization of external emergency planning zones in the Czech Republic**

*Jakub Rehacek, Jakub Dlabka, Pavel Danihelka, Barbora Baudisova (VSB-Technical university of Ostrava), Jan Skrinsky (VSB-Technical university of Ostrava, Occupational Safety Research Institute, Czech Republic), Vilem Sluka (Occupational Safety Research Institute, Czech Republic)*



As a part of continual improvement of crisis management, the procedure of major accidents external emergency zones set-up has been evaluated in the Czech Republic. The existing principles of zones setting are based on approach resulting from IAEA TEC-DOC 727 method, which was used despite the fact that authors of IAEA method discourage to use it for direct risk mapping. Moreover, the distances derived from this method are multiplied by factor 2 in all cases, even if the effects of accidents of diverse types vary by different functions of distance from source. Other problems are, that only 10 step-wise external emergency planning zones distances could be defined and it is rather complicated to recognize type of the accident for which the zone is planned; existing method also does not allow use of direct outputs from risk analysis in Safety Report. This is why the process of external emergency zones setting enhancement was started with the support of the Ministry of the Interior.

Newly developed method fulfills following principles:

- Six various accident types (explosion of condensed matter, VCE, BLEVE, Boil-over, airborne toxic release and large fire) are evaluated and transparently attributed to hazard
- Classification of chemicals follows directive 2012/18/EU of the European Parliament and of the Council and Regulation (EC) No 1272/2008 of the European parliament and of the Council
- Multi-step procedure may be applied; first obligatory generic step is based on quantity only and it is very conservative
- Facultative controlled use of Safety Report and/or more sophisticated distance calculation, which may diminish the distance, is enabled
- Simplified equations and diagrams are used for emergency zone distance assessment
- Refinement of zones based on local conditions is applicable

After testing and discussion with external experts, the developed method is intended to be transformed to the Ordinance of the Ministry of the Interior in the Czech Republic.

Key words: Emergency preparedness, emergency planning, major accident prevention, risk zoning, crisis management

### **Risk Analysis: Beyond Technical Factors**

*Y. Dien, C. Duval (EDF - R&D, France)*

Major role of Risk analysis is to prevent process event. In that sense, risk analysis is a pillar of industrial safety. The conventional risk analysis methods are focused on technical factors (risks and associated barriers) and began to take account human issues. Nevertheless real accidents analyses show that direct and/or immediate causes of their occurrence are linked to technical factors and human factors (human error). They also show that root causes are to be found in the organization (e.g. failure of operational feedback process, weakness of control bodies, production pressures...).

In order to be more efficient regarding prevention, Risk Analysis methods had to be reappraised. A new method was developed, assessed: this method can be labelled as integrated Risk Analysis approach since it covers the organisation and the contextual aspects, beyond technical and human aspects.

The main innovations of this method consist of:

- taking account of organisational factors and linking them with other factors;
- taking account of contextual factors (environmental, regulation...) in the assessment;
- integrating quantitative approach and qualitative approach.

Our paper will explain the concept of Pathogenic Organisational Factor (POF) which is based on knowledge of several tens of industrial events. We will also explain how POFs help to characterise the safety level of an organisation and the way it could cope with risks. This characterisation is added to the conventional risk analysis methods in order to tackle every type of risks: technical, human, organisational and contextual. Furthermore we will address a way to mix qualitative data related to the human and organisational aspects and quantitative ones related to technical and contextual ones. Application of this new Integrated Risk Analysis method on some real cases shows that it seems more appropriate to tackle the socio-technical systems rather than technical factors and human factors one after the others (i.e. the common "split" approach). In conclusion of the paper, we will propose some trends for improving the integrated Risk Analysis method.

## T10 COPING WITH MAJOR RISK

Tuesday: 1330-1500, R91

Chair: Jan Hovden (Norwegian University of Science and Technology)

### **Multi-organizational co-operation during emergencies at local authority level**

*Erna Danielsson, Jörgen Sparf, (Mid Sweden University, Sweden), Joseph Trainor (University of Delaware, USA) (WITHDRAWN FROM THE CONFERENCE)*

This study focuses on multi-organizational co-operation in the management of emergencies at local authority level, especially our understanding of co-operation in a broader perspective, wherever organizations other than rescue organizations are involved and there is no well defined incident scene. The purpose is to develop practical and, in this paper, theoretical knowledge of how co-operation and decision-making in multi-organizational emergency management is affected by (i) the different cultures and working methods (logics) of the organizations involved, (ii) the characteristics of the given organizational emergency management field, (iii) the organizations' familiarity with emergency management, and (iv) the organizations' members sense making of emergencies. To understand how multi-agency cooperation is affected by this, we use theory of enacted sense making and on improvisation, and Quarantelli & Dynes model on organizations in disaster. Our assumptions are that members of different organizations construe emergency management in different ways, and this affects their priorities and decision-making, which in turn affect their co-operation.

### **The importance of a shared vision to achieve coordinated and consistent risk management: a case study of a central government department**

*Craig Mauelshagen, Fiona Lickorish, Sophie Rocks, Simon Pollard, David Denyer (Cranfield University, UK)*

Achieving robust, consistent and coordinated risk management is problematic for many organisations. This case study of a Central Government Department constitutes an important contribution to understanding the social and organisational aspects of enterprise risk management. We investigated factors affecting risk management practice through 22 semi-structured interviews with individuals responsible a number of major and highly uncertain risks. The findings revealed risk practices were varied and often primarily influenced by

existing routines and individual's perceptions of risk management despite official guidance being available. We propose an explanation for our findings drawing on theories of coordination through mutual adjustment and shared mental models. Drawing on our findings we argue that establishing an explicit conceptualisation of what risk management 'should be' (what we call a 'shared vision') acts as an important bridging concept facilitating communication and coordination of risk management practice. Further, our results highlight the importance of regular training, in addition to strong governance structures and a supportive institutional culture, to achieve risk management that is coordinated and consistent across an organisation.

### **Reframing Of Nuclear Communities - Nuclear industry reinterpreting nuclear communities heightened willingness to consider final repository**

*Mika Kari (University of Jyväskylä, Finland)*

Up to the 1970s disposal of nuclear waste was regarded as non-urgent low-tech task and not a problem of priority. However, what had been considered fairly easily achievable technological task turned out to be very hard socio-technical problem. Increased concern regarding nuclear installations and radioactivity, combined with distrust towards the nuclear industry (and experts) fuelled by accidents and the rise of the environmental movements in 1970s, made sure that siting and constructing a repository for spent nuclear fuel would not be an easy undertaking.

In turn of the 1990s it was assessed that radioactive waste had changed from non-issue to an 'Achilles heel' for nuclear industry as civil high-level nuclear waste repositories had been systematically rejected. It was suggested that places that already host waste or nuclear related facilities remained the only places where repositories could possibly be welcomed; dependency on the industry making these 'nuclear oases' susceptible for siting.

The cause of these problems has been characterised as a change in framing from promising new technology to technological risk; from enthusiasm to rejection. Established 'nuclear oases'-type approach, in turn, framed nuclear communities as exceptions from the rule because of dependent workforce and economical leverage nuclear industry has over these communities.

On the industry's side, as response for the frame change, shift has been documented from traditional 'decide, announce and defend' approach to 'engage, interact and co-operate' increasingly focusing on partnership and long-

term relationships. In 2007 Forum on Stakeholder Confidence (FSC, working under OECD's Nuclear Energy Agency) brought up the idea of communities with 'industry awareness', stating that willingness to consider repository should not be seen primarily as a sign of dependency but instead building on to existing cultural basis, thus attempting to reframe nuclear communities as exceptions because of their cultural disposition.

The aim of the paper is to form a comprehensive picture of these two framings of nuclear communities, 'nuclear oases' and 'industry awareness', and analyse similarities and differences in their premises. Furthermore, paper will look at feasibility of these frames and FSC claim that 'industry awareness' should replace 'nuclear oasis' as the main frame. Survey data used in the paper is from Eurajoki, Finland, the first municipality in the world to approve of spent nuclear fuel repository within its boundaries.

#### **Nuclear Safety, responsibility and human agency**

*Marja Ylönen (University of Jyväskylä, Finland), Luigi Pellizzoni (University of Trieste, Italy)*

Nuclear safety was brought again to the forefront after the Fukushima nuclear accident. The disaster set in motion an international learning process, such as the stress tests carried out in Europe to reassess the robustness of nuclear power plants. Stress tests focused on threats deriving from the biophysical world, whilst threats coming from human and organizational failures were postponed for future treatment. Recently these latter aspects have been addressed by international nuclear safety organizations, such as the International Atomic Energy Agency and the OECD Nuclear Energy Agency.

In this paper we analyze the shifts in responsibility between biophysical world and internal inefficiencies of nuclear safety regulation and organizational systems. We will deploy the concepts of responsibility, principal-agent dilemma and ethics of care as analytical tools for exploring the way agency (or lack of it) is accounted for in making sense of systemic failure. Our analytical frame will be applied to the IAEA's general safety requirements' reports and the OECD Nuclear Energy Agency's safety reports as well as the Stress tests report of the UK and Finland.

## **T11 SYMPOSIUM: RISK ANALYSIS IN MARITIME TRANSPORT AND OPERATIONS I**

Tuesday: 1330-1500, R92

Chair: Ingrid Utne (NTNU)

The symposium will be a joint session with the conference ICCGS (International conference on collision and grounding of ships and offshore structures) arranged at Marinteknisk Senter on June 17-19<sup>th</sup> 2013 (<http://www.ntnu.no/iccgs>). In this way the participants at both conferences will be able to attend a session of common interest, which will create new and expanded opportunities for networking and exchange of knowledge. It is suggested that the session will be arranged for up to half a day (depending on the amount of abstracts accepted) so that those people attending and having to travel in between the conference sites spend some time together.

#### **A Revision Of The Industry Standard Risk Model For Ship Collisions And Groundings**

*Martin Hassel (Safetec Nordic AS, Norway), Svein Kristiansen*

The last decade has seen the implementation of numerous navigation aids, safety barriers and various tools to ensure the safe navigation and operation of ships. Still, a significant amount of ship collisions and groundings occur every year. Safetec Nordic has performed collision risk assessments since its inception almost 30 years ago, and made the risk model that has been the industry standard since then, when it comes to calculating the risk of ship collisions. It is currently being revised, to better account for the new technology that has entered the arena. The technology has changed a lot during the last decade, and navigators have had to learn new skills and adapt to a new work environment. But how has this affected safety?

The focus of most research on anti-collision and anti-grounding seem to be on technical aids and the development of new tools and technologies, adding to an already complex work environment for navigation officers and crewmembers. Human factors, including underlying management and organizational factors have significant impact on complex systems such as ship operations, and should be given equal and appropriate attention when risk is being investigated. Too many risk models are using research of questionable quality, and parameter

values that may no longer be valid. Why isn't more research being done to investigate the actual situation onboard our offshore vessels and merchant shipping vessels?

The risk model currently being used by Safetec for ship collisions are two pronged. The first part consists of mapping and assessing the mechanics and physics of the area and traffic to be evaluated, while the second part is the core of the risk model, where new parameters and methodology may be introduced, if available. Safetec will present a brief overview of a typical collision risk assessment, and highlight some relevant issues regarding the need for further research in this area.

#### **Verification of risk and functional requirements of complex marine systems** *Stian Ruud, Ingrid Bouwer Utne (Norwegian University of Science and Technology)*

Ships and rigs operate in challenging environments and perform critical operations. Thus, they are dependent on reliable navigation, propulsion, steering, and dynamic positioning systems. Complex operations with divers, heavy lifting crane operations, and operations in arctic areas may increase the risk of loss of position and collisions between ships and platforms. Risk analyses are necessary in order to identify possible hazardous events and consequences of system failures under the assumed operating conditions. Verification is performed to ensure that the system performance complies with a set of specific requirements.

Requirements to maritime systems may be related to redundancy, maximum restoration time, single failure criteria, or a minimum operational termination time. In the offshore oil and gas industry requirements may be expressed in terms of risk or reliability performance requirements to the operation and the systems. The overall objective of this article is to discuss how technical requirements to safety critical systems are subject to audits, verifications, certification, as means to provide evidence of the operational risk.

The applicability of the verification results is dependent of the limited information available in the early system development and installation phases. System properties during the life cycle may be static, slowly degradable, or dynamic, where the system properties may have variable predictability. Some of the required properties, such as the existence of redundant components can directly be verified by a surveyor. However, complex systems and their operations require advanced verification analysis and methods challenging the

efficiency of the current verification scheme. Many verification methods are available, but a key challenge is to manage and schedule the different verification methods and verification activities in an optimal manner to deliver reasonable verification results for complex systems with a wide range of system properties. This is further addressed in this article.

This article is prepared as part of the D2V research project with participating partners Kongsberg Maritime, DNV, and NTNU.

#### **Quantitative Risk Analysis for New IMO Rule - Safe Return to Port** *Hyungju Kim, Stein Haugen, Ingrid Bouwer Utne (Norwegian University of Science and Technology)*

Safe Return to Port (SRtP) is a new IMO regulation for passenger ships. It requires physically separated redundancy in order to ensure the safe return by the ship's own propulsion after a casualty. However, complying with this regulation causes significant amounts of design modification and additional ship building cost.

The main objective of this study is to compare the quantitative effectiveness of this new regulation with existing regulations in terms of risk reduction. In order to accomplish this objective, this study investigates the SRtP regulation and finds the specific characteristics of it. With these specific characteristics this study suggests a suitable analysis principle and performs a case study with two fuel oil systems. One fuel system complies with the new regulation and the other does not.

## **T12 SYMPOSIUM: ROBUST SAFETY REGULATION II**

Tuesday: 1330-1500, R93

Chair: Preben Lindøe (University of Stavanger)

In this symposium researchers provide papers that can be used in developing and support robust regulation and inclusive risk governance in high risk industries and sectors. The symposium addresses:

- Conceptualization and understanding of the robustness of the risk regulation regimes in hazardous industries.

- Examination of the interface between a regulatory regime and industrial safety management systems.
- Comparison of leading regimes in an international context.
- How insights from safety research on holistic concepts like safety culture, resilience etc can be applied by regulators and authorities.
- The transnational dimension of regulation: The dynamics between international markets, international rules and standards and national regulation.

Major accidents such as the Macondo blowout and oil spill in the Gulf of Mexico, demonstrate that simultaneously ensuring productivity and safety is a major challenge in the petroleum industry. To meet such challenges leading countries have developed regulatory regimes which differ in several respects, particularly with regard to supervising and fostering self-regulation by industry, and all are engaged in a continuing quest for increasingly robust regulation.

Papers will particularly focus on the petroleum industry, other hazardous industries and transportation sectors, but we aim also to discuss more generic topics pertaining to robust regulation.

### **Regulating infrastructures in the face of coupling and fragmentation**

*Petter Almklov*

Understanding the interconnections between critical infrastructures is demanding. This is even more the case when one includes the organizational and institutional context. In this presentation we discuss some of the challenges that have to be addressed by public and private actors when analyzing and governing risks that involve several infrastructure sectors. Increased technical coupling between infrastructure-sectors occurs in parallel with a development where the same sectors experience organizational fragmentation. The infrastructures of today are often run by networks of private and public entities, rather than single utility companies. The number of actors that need to be involved to map, analyze and manage risks that cross sectors is increasing. The institutional changes also imply that work is managed and coordinated in ways that imply a stricter focus on efficiency and accountability with regards to core tasks and responsibilities. We suggest that cross sectorial safety management may require some other organizational qualities as well. We outline a landscape of increased technical interconnectedness and organizational fragmentation, and some of

the challenges this leads to when working with risks that cross sectorial boundaries. We suggest that risk identification and management requires increased transparency between companies that may not have incentives to share information or cooperate, and that both operational personnel and systems personnel are involved in cooperative efforts between infrastructures. We present a set of recommendations and suggestions with relevance for public agencies and for infrastructure owners on how to address the organizational and institutional challenges borne out of these processes. The presentation is based on our chapter in "Risk and Interdependencies in Critical Infrastructures" (ed Hokstad, Utne, Vatn 2012)

### **Implementing vague rules. Transformations, translations and controversies**

*Jacob Kringen*

This presentation reviews and analyses recent developments in the regulatory regime in the Norwegian petroleum sector, focussing on accountability and legitimacy challenges arising from regulatory content as well as from institutional context. The regulations have over a period of years established purpose-oriented self-regulatory system, embedded within a largely trust-based tripartite institutional framework. This involves a delicate balance between the parties involved: notably the authorities, the industrial actors, and the unions. Legal provisions seldom provide clear-cut thresholds for acceptable risk and regulatory compliance. Due to reputational concerns and a 'compliance-friendly' regulatory incentive structure, enforcement policies are largely accommodative and few cases involve sharp confrontations over legal standards, which are virtually unexposed to judicial review in court. Still, the regulatory system is continuously challenged through negotiations over vague and floating legal standards, as well as contested risk indicators, and may erupt into open conflict when tradeoffs between safety and profitability are perceived as disproportionate. On the other hand, purpose and/or principles based regulation may also evaporate, dissolve, or become irrelevant, if they are not properly attached to industrial realities, management practices, and regulatory expectations.

The presentation addresses how these two risks of risk regulation are encountered and coped with by comparing two cases where specific system features interact in the 'normal state' as well as in cases of internal and external disturbance. First, it examines a controversy related to rest and working hours

where system thresholds were severely tested through regulatory enforcement practices, and shows how industrial and union interests are mobilized in negotiations over economic costs, levels of protection, acceptable risk, and welfare considerations. Second, it examines a regulatory invention requiring the industry to develop a sound HSE-culture and the substantial and interpretive burdens that was put on both the regulators and the industry. The two cases raise several distinctive and yet similar problems of accountability and legitimacy well known to modern regulatory systems and policies. Such problems may well be phrased in terms of regulatory robustness, given that such robustness will depend heavily on precisely the degree of acceptance the regime enjoys from key stakeholders within the relevant institutional context.

### **Increasing foreign actors in road and sea transport of goods in Norway: safety challenges and regulatory measures**

*Tor-Olav Nævestad*

Global and European market pressures have led to an ongoing increase in the shares of foreign actors in the Norwegian transport sector. Data from the National Public Roads Administration and the police indicate that foreign actors, especially from Eastern Europe, are overrepresented in accidents. Today, the number of foreign actors involved in domestic road transport of goods in Norway (cabotage) is profoundly limited by Norwegian regulations, such that it accounted for only 0.1 % of total domestic freight transport in 2010. However, from January 2014 Norwegian rules on cabotage will be adapted to those of the European Economic Area (EEA) and the EU. The intention of the EU is to gradually reduce restrictions on cabotage among member states. Thus, when Norway adapts to these rules, it seems likely that the market for domestic road transport of goods in Norway gradually will be opened for actors from EU-countries.

Since the 1970s the transport of goods by ship has been increasingly internationalised. The domestic transport of goods at sea in Norway is open to foreign actors, and port statistics show an increase in internationally registered ships in domestic and international traffic in Norway (Statistics Norway 2012a). Additionally, the number of groundings with foreign ships has increased substantially in recent years. As in the road sector, there are good reasons why increasing international participation would alter the accident risk profile in Norwegian shipping. Safety attitudes and safety experience have been found to

be poorer for non-Norwegian crew and managers working for a large Norwegian shipping company (Håvold 2005). Furthermore ships registered in other lands are often able to operate under that country's wage and working conditions, which are often poorer than Norwegian equivalents, with clear implications for safety.

The main aims are to assess the effect on accident risk of the increasing shares of foreign actors in road and sea transport of goods in Norway; and to provide a scientific knowledge base that Norwegian authorities can use to develop measures to reduce any increased risk identified.

In order to fulfil these aims, the project seeks to fulfil the following goals: survey the prevalence of and the routes chosen by foreign actors in road and sea transport of goods in Norway, use the findings along with accident database analyses to estimate the accident risk of these actors, examine the risk factors and safety challenges related to the growing internationalization of the road and sea sectors, and discuss possible measures that could be implemented to meet these safety challenges. A further aim is to assess the impact of legislation planned for 2014, which probably will open the domestic road transport market to international actors, on driver/carrier profile and associated accident risk.

### **The relationship between regulation, safety management systems and safety culture**

*Trond Kongsvik, Kristine Vedal Størkersen (NTNU Social Research), Stian Antonsen (Safetec)*

In the maritime industry, the introduction of self - regulation and functional requirements is a key strategy for the improvement of safety. The International Safety Management (ISM) Code requires the ship-owners to develop their own Safety Management Systems (SMS), involving formalization of e.g. reporting, audits and operation of ships. The flag states are required to oversee the implementation of the code on the ships. In other words, there is a strong link between the overall safety regulation and the more specific safety management systems. However, there is some research suggesting that there might be a weaker link between the ship - owners formal safety management systems, and the seafarers informal ideals of work (Knudsen, 2009; Antonsen, 2009, Kongsvik et al., 2013).

The informal ideals of "good seamanship" entails 'a blend of professional knowledge, professional pride, and experienced - based common sense'

(Knudsen, 2009). In this paper, we wish to explore how the self - regulatory regime is imposed and enacted in the industry, and its possible relation to safety culture. This will be illustrated by the results from a study of the Norwegian maritime industry. The study combines quantitative (survey) and qualitative (interviews) methods. The data contain information from regulators, ship-owners offices and seamen. It includes both passenger and freight cargo transport.

Our findings indicate that the structural measures relating from the ISM code have actually had influences on cultural aspects among seafarers. Cultural change, however, cannot be expected to happen overnight and rules and procedures need to be successfully implemented and communicated to have any effect. This makes the ship-owners office a key element in the industry's safety management chain. In addition, our data indicates that there are several additional factors influencing safety culture in the maritime industry, such as market conditions, customer demands and national politics.

### T13 DECISION-MAKING IN FACE OF COMPLEXITY II

Tuesday: 1530-1700, R3

Chair: Matthew White (European Centre for Environment & Human Health)

#### **Multiple hazards, impossible choices, difficult decisions - perceptions of risk and safety in the NHS**

*Chris Bennett (Kings College London, UK)*

The importance of ensuring patient safety has always featured in the work and training of healthcare staff. However the issue did not become institutionalised at a policy level until early this century, with the publication of two influential reports on patient safety by the Department of Health (DoH 2000, 2006). Meanwhile, the acute awareness of patient safety issues which characterises today's NHS has been fuelled by the publicity surrounding a series of failures to meet safety standards, most recently the report on the Mid Staffordshire NHS Foundation Trust Public Inquiry. This paper draws on the literature relating to adverse events in healthcare and recent qualitative empirical data from

observation of and interviews with hospital staff to explore the evolution of perceptions of risk in relation to patient safety in the NHS. It offers evidence that behavioural responses to risks to patients compete for priority with many other different sorts of hazards which may have consequences for individuals or groups, or indeed for organisations or society as a whole. The empirical data, which are drawn from a study of hospital staff who have recorded an adverse event affecting patient safety on the hospital database, indicate that individuals are aware of the complexity of the choices they have to make, though the weight they give to different types of hazard tends to vary according to their occupation, seniority and status. It appears that staff may feel that although patient care represents a core value for them, indeed for many it appears to be their *raison d'être* as healthcare workers, they are sometimes unable to prioritise the immediate needs of patients. For many this appears to represent an ethical dilemma that they are unable to resolve and which in some cases causes them immense stress. Staff may seek to relieve this stress in a number of ways, one of which involves recording a perceived risk to patients because of having to respond to other priorities as an adverse event, thus ensuring that their concerns will at least be noted. It is argued that the findings from this research suggest that insufficient attention is given to ethical factors in understanding and predicting behaviour in response to perceived risk.

Key words: risk perception, decision making, patient safety, choice stress, ethics

#### **Perceived Unfair Randomness in Gambling; the Tilt Reaction and Effects of a Negative, Unexpected Outcome**

*Andreas Kiste (Norwegian National Rail Administration)*

The paper is a theoretical review of the effects of negative, unexpected outcomes in gambling that may occur in spite of prior decisions supported by normative rules or probability estimates such as expected value. The tilt reaction has been studied in this context and the degree of reaction is considered related to the significance of investment (e.g. monetary value, utility), and the amount of prior experience with the game (e.g. professionals, novices). The main research question focuses on whether the decision maker becomes risk averse or risk taking following (the reaction to) an unexpected, negative outcome of a prior decision. The hypothesis, influenced by Prospect theory, is that a person in such a situation would be inclined to take risks rather than avoid risks. The

selected literature to investigate the hypothesis involves theories of emotions, moods, feelings or affects as well as aspects of cognitive processing. It is assumed that the interaction between emotional experience and logical thinking is the key to understand the effects on decision making after experiencing an unexpected negative outcome. It is suggested that violations of an expected outcome create a degree of arousal and negative mental states, e.g. anger, surprise and disappointment, basically because the outcome violates expectations of fairness. It is discussed to what extent the involved stakes (losing money, "losing face") and prior experience (novices, professional players) influence the next move towards risk taking or risk aversion.

Key words: tilt, gambling, fairness, decision-making, emotion, logic

### **The process of decision-making in a burning crisis situation: A multiple sequence approach of decisiveness**

*Bert Bruggemans, Hugo Marynissen*

Many fire fighters are confronted with decision-making under extreme time pressure in harsh conditions. Earlier research on decision-making indicates that prior experience and training help them to assess the dynamic risks in a split second while making a professional judgement under extreme stress. However, the question could be raised how fire fighters make the right decisions under the same extreme conditions without the ability to rely on prior experience driven or thought responses. This research paper examines the decision-making process of a Belgian fire fighter crew before and during a building collapse. The results indicate that contrary to existing views on decision-making in burning crisis situations, multiple subsequently processes are at play. Fire fighters act on multiple sequences, and in each of these a different form of decision-making is in use. The rationale for switching between particular decision-making processes is anchored to the type of interaction, the fire fighter's perception and conception of the situation, and the type of knowledge used to tackle the problem. Based on these findings, recommendations for practical implementations, such as training and development, and directions for further research in the domain of decision-making in burning crisis situations are offered.

### **Combining risk perception and risk attitude: A comprehensive individual risk behaviour model**

*F. van Winsen, Y. de Mey, L. Lauwers, S. Van Passel, M. Vancauteren, E. Wauters*

Risk considerations are becoming increasingly important in agriculture. For example, volatility of both output and input prices is expected to increase due to globalization, liberalisation and increased trade levels. Surprisingly, despite the unanimous agreement on the growing importance of risk and despite a huge body of literature, the practical application in the agricultural domain of this literature is little. Further, even when it is applied, risk management often fails to meet expectations, as businesses fail and opportunities are left untaken. Clearly the mere existence of principles, processes and knowledge is not sufficient to guarantee success.

The focus of this study relates to the difference between theoretical conceptions of risk and risk behaviour on the one hand, and the conceptions of risk and risk behaviour of individual decision makers on the other. Put simply, individual risk behaviour is, despite a huge body of literature not well understood and unless we are able to improve our understanding of what decision makers would do, risk management tools advising decision what they ought to do will fail. This observation is not new in itself. However, while we do not think that any expert in agricultural risk management will falsify this idea, it is virtually never considered in the research literature. We want to direct the reader to the seminal paper by Sitkin and Pablo (1992), who, inspired by the very same conclusion, developed a risk behaviour model for company managers. Our research builds on this work and modifies it by focusing on agricultural decision makers and by involving the decision makers in building the model.

Traditionally, methods in risk management practice, such as the subjective expected utility approach, regard risk management as the process of maximizing risk preferences, given the objectively measured or estimated risk. Risk perception is not considered explicitly, but implicitly it is assumed that whenever risk management strategies are inadequate, this has to do with either the inability of calculate the objective risk, or a biased perception of the objective risk. Risk management tools then function as a way to inform the decision maker on the objective risk, such that risk perception equals the objective risk.

In this study, we try to bridge the gap between literature and practise by reviewing the determinants of risk and risk behaviour from the literature. Furthermore we present a basic model reconciling these determinants.



## T14 RISK GOVERNANCE

Tuesday: 1530-1700, R4

Chair: Lars Bodsberg (SINTEF)

### **Risk communication and food safety policies: the case of the case of risk governance with a grain of NaCl**

*Stéphanie Vanhaeren (University of Liège, Belgium)*

In this paper, we will analyze a case about food policies, in the lens of the “risk governance model” as it was theorized by Renn (Dreyer and Renn, 2009). This model completes the “transparent model” (Millstone, 2004) by adding a new emphasis on risk evaluation and risk communication between the actors.

Within this model, communication becomes the central element at every stage of the risk analysis process. This process provides a mutual and iterative learning between actors, marking the difference between simple information, unilateral in nature and communication, which allows enrichment loops, opening the possibility for stakeholders to create a common repository shared by all actors in the process.

A specific category of risk, and peculiarly in health-related risk is what is called “emerging risk”. For these risks, uncertainties are noticeably high for the multiple unanswered questions it leaves, particularly about the magnitude of risks for human beings and their long-term combined effects.

Emerging risks call for a precaution-based management. A decision-making system based on precautionary principles must rely on two learning processes: first, authorities must take into account multiple socio-economical actors as shown in the transparent model in order to implement political trade-offs of risk governance. Secondly, citizens must have the resources not only to understand but also to adopt the decision and its possible consequences and to conform themselves to its implementation.

Communication is a central concept in public policies evaluation (Muller, 2005), which considers policy as the result of interactions between many players facing their worldviews and their approaches to action, to define modes of action and the representation of reality that will guide the choices and actions to solve common known problems. This referential, once applied to the risk governance, lays the foundation for a security referential (Brunet, 2007) resulting in the structuration of the individual and social perception of risk.

For this system to function, one fundamental aspect is to develop specific communication tools in order to implement successfully those two aspects of precautionary approach of risk governance while carrying out this bilateral learning process. As an illustration, we will focus on the conflicting claims between the EFSA and the European Commission through the case of bisphenol A.

### **Can a pre-assessment help us to properly manage controversial risks of chemicals? A discussion on the potential improvement of the REACH restriction process**

*Jeroen Devilee, Julia Verhoeven, Martijn Beekman, Anne B Knol (Dutch National Institute for Public Health and the Environment, The Netherlands)*

In Europe the REACH regulation was adopted to regulate the safe use of chemicals. One of the instruments of this regulation is the restriction of chemicals that cause unacceptable risk. A Member State can prepare a dossier proposing to restrict the admission on the market or use of a substance. This dossier is evaluated by a Risk Analysis Committee (RAC) and a Socio Economic Analysis Committee (SEAC). Characteristic is that both the dossier as the evaluations by the Committees are based on the best scientific information available and that the socio-economic analysis of the restriction proposal is only very limited. The dossier together with the two evaluations provide the basis for a decision by the European Commission.

Up to now, four restriction proposals have been evaluated. Recent experience with a restriction dossier on phthalates has learned that deciding on risk management based on the best scientific information available might not always be the most suited approach. Around some dossiers there is a lot of uncertainty or there can be different views that make the risk ambiguous. Deciding based on the best scientific information available in these dossiers may result in prolonged concern and societal debate among European citizens and scientists, regret if concerns prove to be right and improperly informed decision making.

For risks like phthalates, a more precautionary approach using a more extensive SEA might be more suited to decide on risk management. We argue that the REACH restriction process will benefit from a pre-assessment in order to identify the type of risk to be managed and to design the subsequent evaluation process accordingly. Currently, there are no arrangements for pre-assessment in

the approach and there is still a lot of convincing and persuasion of Member States needed.

### **Risk regulation regimes in action: Analyzing Finnish and Swedish spent nuclear fuel repository licensing processes**

*Tapio Litmanen, Mika Kari (University of Jyväskylä, Finland), Barry Solomon (Michigan Technology University, USA)*

This study focuses on the highly technical and safety critical risk regulation processes of nuclear waste management. The cases to be studied are Finnish and Swedish plans to dispose of spent nuclear fuel in geological repositories for thousands of years. These two countries are the most advanced in their plans. In Finland, the nuclear waste company Posiva submitted its construction license application at the end of 2012. For the Swedish case, the Swedish Nuclear Fuel and Waste Management Company (SKB) submitted its construction permit applications to the Swedish Radiation Safety Authority (SSM) and to the Environmental Court to build the Spent Fuel Repository in March 2011. In both cases the handling of the application and review of the safety case is expected to take several years. The companies in both countries have assured the public that their plans can hold up to critical assessment and that disposal of spent fuel will not harm the environment and the health of future generations. However, critics doubt that safety can be guaranteed.

Our aim is to analyze: 1) institutional waste management frameworks in both countries, paying special attention to the role of civil society actors and transnational risk regulation; 2) how lay-people and civil society organizations (CSOs) have been able to participate and contribute to recent nuclear waste decision-making; and 3) the nature of nuclear waste risk debates in both countries. In particular, we are interested in determining how one safety critical issue, namely corrosion of copper canisters, is discussed. Research data consists of official documents of the nuclear waste companies and nuclear safety authorities, but also reviews from CSOs and statements of laypeople. Theoretically we will apply a risk regulation regime approach, which is oriented towards institutional issues. However, we will argue that civil society regulation has to be better integrated into these regimes. We assume that CSOs can press corporations to deliver improvements in their research, development, and technical design and similarly they can follow the work of regulators and give potentially superior ideas for improving waste management.

Key words: Nuclear waste, licensing, risk regulation, regime, civil society organizations

### **Assessing the Environmental Risks of Shale Gas Development: A UK Story** *George Prpich, Simon Pollard (Cranfield University, UK)*

The recent International Energy Agency's report on gas<sup>1</sup> suggests that the world is about to enter a period of increased natural gas use driven primarily by the development of unconventional gas resources. The UK holds a vast quantity of unconventional gas locked deep underground in shale deposits and previous attempts to hydraulically fracture and release this gas resulted in two seismic events to which the UK Government responded by promptly establishing a moratorium on further hydraulic fracturing. An independent review of hydraulic fracturing by the Royal Academy of Engineers and The Royal Society<sup>2</sup> recommended that environmental risk assessment, covering the full life cycle of shale gas operations, should be mandatory. The UK Government have since developed high-level guidance for operators on environmental risk assessment (ERA) as part of a wider response. In December 2012, the UK lifted the moratorium on shale gas exploration.

This presentation will discuss the case of shale gas exploration in the UK by way of presenting the key elements of the ERA guidance. We critically analyse the motivation and intent of the document, the major environmental and safety risks, the unique regulatory challenges posed by shale gas operations (e.g. seismicity) and finally, provide insight about the implementation of ERA's in new and emerging sectors.

For activities that are new or contentious, it is important that environmental risks are assessed, managed and communicated properly. Guidance may be developed to help organisations consider the risks to and from their operations as well provide regulators with confidence that risks are being managed properly. Guidance may also assist operators in understanding the regulatory implications of their activities, thus providing direction for efficient application of permissions and permits. This document builds upon ERA 'best practice'<sup>3</sup> and draws upon previous example from the nuclear waste disposal sector. It is intended to promote safe operation and provide a mechanism for communication between operator, regulator and the public.

## T15 SYMPOSIUM: RISK AND VULNERABILITY ASSESSMENT FOR BUILDING CRITICAL INFRASTRUCTURE AGAINST NATURAL HAZARDS AND RESILIENT STRATEGIES I

Tuesday: 1530-1700, R90  
Chair: Vittorio Rosato (ENEA, Italy)

Recent natural disasters (e.g. Xynthia storm in France in 2010 and the Great East Japan Earthquake and Tsunami in 2011) highlights that Low frequency high consequence (LFHC) natural hazardous events induced by climate change may bring about catastrophic impacts on critical infrastructures and trigger cascading effects. Research should capitalise on knowledge acquired from risk and vulnerability assessment and strengthen the resilience of our community and the critical infrastructures to the emerging changes and increasing risks of natural hazards in Europe.

This symposium aims to bring the synergy of scientists and managers from multidisciplinary areas who are working on climate change, risk and vulnerability analysis and different critical infrastructure systems in respect to natural hazards, provide state-of-the-art of risk and vulnerability assessment methodology for critical infrastructures and present new concepts and methodology for stress testing. It is divided into two sessions: Session 1 focuses on the drivers for change, critical infrastructure and interdependency and assessment methodology: Session 2 turns on application of various risk and vulnerability assessment methods on buildings and infrastructure, risk management and resilience.

This symposium presents the most recent outcomes from EU FP7 project-FloodProBE and other national and international projects.

### **Advanced methodology for risk and vulnerability assessment of interdependency of critical infrastructure in respect to urban floods**

*Damien Serre, Serge Lhomme (Université Paris-Est, France)*

The behavior of the urban network infrastructures, and their interactions during flood events, will have direct and indirect consequences on the flood risk level in the built environment. By urban network infrastructures we include all the urban technical networks like transportation, energy, water supply, waste

water, telecommunication... able to spread the flood risk in cities, qualified as critical infrastructures due to their major roles for modern living standards.

From history, most of cities in the world have been built close to coast lines or to river to beneficiate this means of communication and trade. Step by step, to avoid being flooded, defenses like levees have been built. The capacity of the levees to retain the floods depends on their conditions, their performance level and the capacity of the authorities to well maintain these infrastructures. But recent history shows the limits of a flood risk management strategy focused on protection, leading to levee breaks these last decades.

Then, in case of levee break, cities will be flooded. The urban technical networks, due to the way they have been designed, their conditions and their locations in the city, will play a major role in the diffusion of the flood extent. Also, the flood risk will have consequences in some not flooded neighborhoods due to networks collapses and complex interdependencies.

Firstly we will describe the methods we are using to determine the level or resilience of the urban networks with three specific capacities (resistance, absorption and recover). Secondly an integrated spatial decision support system will be presented through one application in a European city.

### **Risk and vulnerability assessment and resilient strategies for urban flood risk management**

*Linmei Nie, Elise Balmand (SINTEF, Norway)*

Traditional flood risk management approach is based on structural and non-structural measures that were designed according to probability analysis of historical flood events. The weakness of this approach is that it does not take into account of the dynamic changes in natural and in the built environment, such as climate change, changes in topographic and urban landscape during urbanization and the coping capacities of the existing buildings and infrastructure networks, and social and economic conditions.

This paper presents a comprehensive framework of risk and vulnerability assessment and resilient strategies in respect to urban flood risk management. A multi-criterion index system is developed in order to assess the overall risk and vulnerability in natural, in building and infrastructure systems, taking into account of social and economic aspects and institutional and legislation and the built environment. Urban flood resilient strategies are developed based on

overall risk and vulnerability assessment. The developed index system for risk and vulnerability assessment and resilient strategies were tested in case studies.

### **One step forward in flood risk assessment also results in one step forward for policy development. Or not?**

*Karin Stone, Mark Morris*

Knowledge on flood risk management and protection of the built environment has taken big steps forward, driven by the strategic goals of the Floods Directive and support from FP7 initiatives. This knowledge is being developed to improve the implementation of the EU Floods Directive. Effective implementation however is dependent upon effective interaction with stakeholders, including policymakers but most often the developed knowledge does not reach the policy maker. The science-policy-interface (SPI) is when science meets policy and vice versa policy meets science. Although these two parties are interlinked and dependant, this interaction is not always obvious or natural due to for instance culture and scope differences.

Through an analysis of on-going projects tackling similar SPI issues within the context of the Water Framework Directive, barriers have been identified which could stand in the way of an effective utilization of the developed knowledge for implementation of the Floods Directive. The barriers were prioritised through stakeholder workshops held at the FLOODRisk 2012 conference. These insights feed back to the FLOODProBE program where the involved scientists not only focus on developing improved flood risk assessment methods, but also take a critical look at their role as a knowledge broker and identify the steps required to transfer the developed knowledge into a usable aid for policy development.

## **T16 SYMPOSIUM: THE PERCEPTION OF ENERGY RESOURCES IN THE UK AND SWITZERLAND AFTER FUKUSHIMA**

Tuesday: 1530-1700, R91

Chair: Vivianne Visschers (ETH Zurich, Switzerland)

Many European countries have been gradually expanding their renewable energy resources in their total energy production to mitigate climate change. The nuclear accident in Fukushima, Japan, nevertheless changed the future

energy policy rather drastically in some European countries. While the Swiss government decided to phase out nuclear power, the UK government did not change its energy policy. To ensure the public's acceptance of the future energy portfolio in a country, the perception of diverse energy technologies should be taken into account. In this symposium, we therefore discuss the public's opinion on various energy technologies in two

European countries with different perspectives on nuclear power since Fukushima, namely the UK and Switzerland. The aim of the symposium is to reveal the future chances and risks of various energy resources from the public's point of view. First, people's spontaneous associations with nuclear power and with solar power are depicted and compared before and after the Fukushima accident. The next speaker discusses whether the attitudes and preferences for nuclear power have changed since the accident. The determinants of the acceptance of various energy technologies are compared in the following talk. The last speaker exemplifies the importance of letting publics evaluate "whole energy systems".

### **A comparison of spontaneous associations with nuclear power before and after the Fukushima disaster, and of associations with nuclear and solar energy resources**

*Carmen Keller, Bernadette Sütterlin, Michael Siegrist (ETH Zürich, Switzerland)*

It is theorized that associations with a stimuli that spontaneously come to people's mind when confronted with that stimuli, and the affective evaluations of these associations, guide people's judgments and decisions. Accordingly, past research has examined spontaneous associations with a given technology to better understand its public acceptance. A study conducted among Swiss residents in 2009, before the Fukushima disaster, examined the relationship between respondents' associations with nuclear power plants, and how willing they subsequently were to accept the replacement of long-serving nuclear power plants with a new generation of nuclear power plants. This study revealed that over 40% of the people spontaneously associated nuclear power plants with energy, and descriptions of the appearance of nuclear power plants, or their locations. Participants in favor of nuclear power primarily mentioned the benefits of an energy supply, whereas participants who were opposed to replacing nuclear power plants had diverse negative associations, including: risk, negative feelings, accidents, radioactivity, waste disposal, and health and

environmental issues. In addition, participants who were undecided often had similar associations to participants who were in favor of nuclear power.

To examine the changes in the affective representations underlying the acceptance of nuclear power, the very same people were asked again to indicate their spontaneous associations with nuclear power plants, but this time in 2012, after the Fukushima disaster, and the subsequent change in Swiss energy policy. Moreover, a larger representative sample was also used to assess spontaneous associations with solar energy resources. A total of N=1211 persons participated, whereas slightly fewer than half of the sample (n=561) had already participated in the 2009 study. The present study identifies changes to the spontaneous associations with nuclear power plants between 2009 and 2012, and examines its relationship with the acceptance of nuclear power. In addition, the spontaneous associations with nuclear energy are compared with associations with solar energy, and the acceptance of solar energy resources. Practical implications will be discussed.

### **Reconciling Risk: How did supporters and opponents of nuclear power in the UK respond to the Fukushima nuclear accident?**

*Christopher R. Jones, Herman Elgueta, J. Richard Eiser & Richard Crisp*

The results of opinion polls conducted since the Fukushima nuclear accident paint a mixed and country-specific picture of the impact on support for nuclear power. These polls show that while opposition in some countries has increased, changes in support for the technology within other countries – and notably the UK – have been less profound and more short-lived (e.g., Foratom, 2012).

The apparently muted impact of the Fukushima accident on UK attitudes tends to mirror findings from studies conducted in the immediate aftermath of the 1986 Chernobyl nuclear accident. Eiser, van der Plicht and Spears (1995) argued that a tendency for people to process information relating to the Chernobyl accident in accordance with their pre-existing general attitudes, tended to dampen the absolute impact of this event on their attitudes.

For instance, while opponents of the technology may have cited Chernobyl as 'proof' that nuclear power is dangerous; supporters may have used the apparently superior safety record of the UK nuclear industry as a justification for their continued support of the technology. Thus, while the accident would have added to people's knowledge about nuclear power, in both instances general attitudes would have been relatively unchanged.

Within the present study (conducted via an online survey distributed one month after the Fukushima accident, April 2011) we sought to investigate how supporters and opponents of nuclear power in a UK sample had reconciled news of the accident. More specifically, using an updated version of the 'electricity calculator' task (Jones, Eiser and Gamble, 2012) we investigated how the Fukushima accident differentially: (a) impacted upon participants' attitudes and beliefs about nuclear power; (b) influenced participants comparative preferences for nuclear power as an electricity generating option; and (c) how key variables (e.g., trust in government, concern with climate change, etc.) may have interacted with attitudes, beliefs and preferences.

During the 'electricity calculator' task, participants are asked to create an electricity generating mix for the UK using five energy sources (i.e., coal, gas, nuclear, renewables, and electricity import). Decisions to limit the inclusion of one option within the task need to be necessarily met with comparable net increases in reliance on one or more of the other available options. Thus, this paradigm is useful for investigating the trade-offs that people will accept (or tolerate) in a situation where perceived electricity demand must be met from a limited number of options and where nil reliance on all options is not feasible.

### **Explaining the public's acceptance of five energy technologies: Differing effects of perceived benefits, perceived risks and protected values**

*Vivianne Visschers (Institute for Environmental Decisions, Switzerland)*

Due to the Swiss government's decision to phase out nuclear power, alternative energy resources should be expanded in order to secure the energy production in the future. All energy technologies are related to some risks and benefits, and people differ on the perception of these risks and benefits. It is therefore worthwhile to know to what extent perceived risks and benefits, as well as other determinants, influence people's acceptance of an energy technology. The impact of so-called protected values on the acceptance of an energy resource has not yet been investigated. Protected values refer to values that are of utmost importance to a person and therefore cannot be traded off. Protected values can thus detain or even stop the realisation of a new power plant or site. In a recent mail survey, we investigated the Swiss public's acceptance regarding the expansion or construction of five energy resources: solar, nuclear, hydro, gas and wind power. The aim of the study was to examine to what extent the acceptance of each energy technology would be influenced

by perceived risks and benefits, trust in stakeholders, protected values, and environmental and energy-security values. A postal mail survey was sent to a sample of the German-speaking population in Switzerland (N = 863). Respondents reported their acceptance to expand or construct a power plant, perceived costs, perceived benefits, trust in stakeholders, and protected values for each of the five energy resources. The questionnaire also included items to assess respondents' environmental values and energysecurity values. Results showed that for all energy resources, perceived benefits was the strongest predictor of acceptance to expand or construct a power plant. Perceived costs only had a moderate impact on the acceptance to expand or construct a solar, hydro and wind power plant, whereas its influence on the acceptance of nuclear and gas power expansion or construction was negligible. Protected values were negatively related with the acceptance of all energy resources. Remarkably, this relation was just as strong for hydro power as it was for energy sources that are perceived as hazardous, i.e. nuclear and gas power. In sum, the most important determinant of the acceptance of various energy technologies is perceived benefits. A comparison of the other determinants on their influence on acceptance however indicated that we should not use one and the same model to explain the public's acceptance of different energy resources.

### **Evaluating energy technologies in context of whole systems: Public preferences for future energy pathways and their underlying values and risk perceptions**

*Christina C. Demski (Cardiff University, UK)*

Many European countries are planning and currently undergoing highly complex energy transitions. In the UK, a number of energy policy targets are directed toward securing a diverse and affordable energy supply and reducing carbon dioxide emissions to mitigate climate change. To deliver on these targets the UK must focus on changing to low-carbon sources of energy and moving to more sustainable lifestyles. The public are seen as key intermediaries who will either resist or assist in the transition to a low carbon society. Currently, much of the research on public perceptions of energy has focussed on individual components of the energy system in relation to the supply side (e.g. nuclear power or wind energy) or aspects of the demand side (e.g. how energy is consumed or used); there has been very little attention paid to examining public perceptions of whole energy system change. Although there are conceptual and

methodological challenges for engaging publics with multiple aspects of energy transitions, evidence from behavioural decision research shows that people do not come to unfamiliar or complex technological issues with fully formed views but can be supported in the construction of their preferences through systematic elicitation (Lichtenstein and Slovic, 2006). As such, we present findings from an innovative national survey (August 2012, N=2441) in which members of the UK public created their own energy futures using a scenario building tool. The survey facilitated the expression of preferences within the context of other choices as well as overarching aims of energy transitions (carbon reduction, security). Rather than presenting one public pathway we use this data to show that multiple public pathways exist. Similarities between different energy futures are highlighted (high reduction in fossil fuels and inclusion of offshore wind energy) as well as key differences or decisive components are explored; specifically the extent of inclusion or exclusion of more controversial supply technologies such as nuclear power, CCS and biofuels. Although the paper will focus on supply technologies and their envisioned role in energy transitions, demand-side change linked to energy resource preferences is also discussed. Fundamentally, the analysis examines key values, risk perceptions, and conditions underlying different public energy futures (e.g. environmental values, technological optimism, technology-specific risk). This will illustrate where public pathways meet and diverge with existing scenarios, indicating where major obstacles or opportunities for change might exist.

### **T17 SYMPOSIUM: RISK ANALYSIS IN MARITIME TRANSPORT AND OPERATIONS II**

Tuesday: 1530-1700, R92

Chair: Ingrid Utne (NTNU)

The symposium will be a joint session with the conference ICCGS (International conference on collision and grounding of ships and offshore structures) arranged at Marinteknisk Senter on June 17-19<sup>th</sup> 2013 (<http://www.ntnu.no/iccgs>). In this way the participants at both conferences will be able to attend a session of common interest, which will create new and expanded opportunities for

networking and exchange of knowledge. It is suggested that the session will be arranged for up to half a day (depending on the amount of abstracts accepted) so that those people attending and having to travel in between the conference sites spend some time together.

### **Feasibility of collision and grounding accident data for probabilistic accident modeling**

*M. Hänninen, M. Sladojevic, S. Tirunagari and P. Kujala (Aalto University, Department of Applied Mechanics, Espoo, Finland)*

There exist various sources of data related to marine traffic safety, and the amount of data seems to be further growing in the future. However, the data sets have different formats, scopes, and initial purposes. The paper discusses the feasibility of maritime traffic accident and incident data to probabilistic modeling of collision and grounding accidents, especially their causal factors. In addition, a case study is conducted for examining the data feasibility. First, categorical Finnish accident causal data is utilized in learning a Bayesian network model from the data. The data feasibility is then evaluated based on the how well the model matches to unseen accident cases and how it performs in classification of the accidents. The results indicate that the dataset does not contain enough information for the applied of modeling approach. Finally, recommendations to improving the data or ways to cope with the uncertainty are given.

### **Bridge crossings at Sognefjorden - Ship collision risk studies**

*M. Gamborg Hansen, S. Randrup-Thomsen, T. Askeland & M. Ask (Rambøll, Denmark), L. Skorpa, S. Jorunn Hillestad & J. Veie (The Norwegian Public Roads Administration, Statens Vegvesen, Norway)*

The Norwegian Public Roads Administration, Statens Vegvesen (SVV), intends to improve the existing E39 road connection between Kristiansand and Trondheim by replacing eight existing fjord ferry crossings along E39 by fixed crossings – either replaced by tunnels or by bridges. Some of the crossings are highly complicated due to large water depths and the width of the fjords. For this reason Rambøll has for SVV carried out ship collision risk studies for different bridge designs for the Sognefjorden crossing – 3,7 km wide and up to 1,3 km deep - in order to demonstrate that the solution is technical feasible and safe. The present paper describes the applied methods for transforming the available

information - bathymetry, geography, bridge geometry and the very detailed ship traffic recordings (AIS data) - into a risk model that is able to estimate ship collision probabilities and also forms the basis for delivering design loading requirements to the bridge designers.

### **VTS a Risk Reducer, A Quantitative Study of the Effect of VTS Great Belt**

*T. Lehn-Schiøler, M. G. Hansen, K. Melchild, T. K. Jensen, S. Randrup-Thomsen, K. A. K. Glibbery & F. M. Rasmussen (Rambøll, Denmark), F. Ennemark (Femern A/S, Denmark)*

In the Danish water of Great Belt a Vessel Traffic Service (VTS) offers navigational assistance and information about conditions important to shipping and safety at sea. In this paper a general method for evaluating the effect of a VTS in terms of how much VTS increases the navigational safety is presented. The method is developed based on incident reports from Great Belt VTS. Results from the Great Belt VTS leads to a conservative estimate that VTS is able to reduce the number of collision and grounding with between 60% and 90%.

## **T18 SYMPOSIUM: UNDERSTANDING THE SOCIETAL DYNAMICS AROUND RISK: LEARNING FROM CITING CONTROVERSIES II**

Tuesday: 1530-1700, R93

Chair: Marijke Hermans (Maastricht University)

Technological infrastructures, ranging from disposal, storage and production facilities to critical components such as base stations for wireless communication technology, need to be placed. The search for such geographical sites often leads to opposition from the local community – frequently described as NIMBY-ism, even though academics have increasingly called for more critical interpretations. This panel takes up this call by acknowledging that siting controversies are not just about the local community level – which is often the most visible and adamant layer – but it stretches into other levels of social organization too: regional, national, European and increasingly global. This panel aims at bringing together academics interested in exploring the societal debates and processes around siting controversies, with a particular focus on

how risks and uncertainties are conceptualized, assessed, dealt with and challenged. What actor networks are formed and in which way(s)? And although it has become something of a truism to call for public engagement in siting practices, it remains to be seen how this is implemented and what can be learned from the experiences. Presentations will approach these interrelated questions from different theoretical backgrounds, allowing for a comparison across technological domains and various regions in Europe. More understanding of the multi-level societal dynamics around risks can thus provide insights in how to effectively deal with the potentially controversial issue of siting of technological infrastructures.

### **A Comparative Socio-Cultural Analysis of Risk Perception of Carbon Capture and Storage in Finland, Netherlands, UK and Poland**

*Faridoddin Karimi, Arho Toikka (Environmental Policy Research Group, Finland)*

The transition to a sustainable energy regime is not just an engineering question, but a social and political issue as well. In this paper, we consider one contested technology still in development, Carbon Capture and Storage (CCS), from a socio-cultural perspective. CCS is deemed a necessary bridging technology to a lowcarbon economy by many, but the hurdles the technology needs to pass before widespread use are considerable. While technological issues are being solved, social issues need attention too. Current analyses focus on public acceptance largely as a function of information. We draw upon cultural theory in order to understand the issues in more detail.

We use survey data from a Eurobarometer on Public Awareness and Acceptance of CO<sub>2</sub> capture and storage together with qualitative case study data and prior cultural analyses in the four countries to argue that public acceptance of novel technologies is not a simple case of information transit and knowledge dissemination. Rather, we argue it is a more complex process, incorporating cultural factors such as the degree of separation between groups, strength of institutions over space, time and social roles, and society's tolerance for uncertainty and ambiguity.

On the basis of this analysis, we can provide a richer frame for analysts wishing to understand why and how societies and societal actors challenge and contest technologies and energy regimes.

### **'Should I be worried?' - citizens perceptions of mobile phone technology health risks over time**

*Bert de Graaff (University of Amsterdam, the Netherlands)*

In this paper we examine how citizen's perceptions of a specific health risk change over time in relation to changes in risk governance practices. We compare two waves of longitudinal interview and survey data on two panels of citizens in the Netherlands. These citizens are confronted with the siting of a base-station for mobile phone technology in their neighborhood.

This is part of a larger project on the effects of risk communication on citizens' perceptions of the possible health risks of electromagnetic fields (EMF) associated with mobile phone technology. Earlier, we reported that scientific uncertainty is predominantly depoliticized in Dutch governance of the EMF and health issue. Debates on the 'roll-out' of the mobile phone network are reduced to a biomedical, epistemic debate and citizens' political practices are rarely opened-up.

Here we focus diachronically on the relation between, on the one hand, conceptualizations of risks and uncertainties in risk governance and specific siting practices, and, on the other hand, the conceptualizations of risk and uncertainties regarding mobile phone technology citizens express. In particular, we test the finding that issue-specific governance practices discipline citizens' problem definitions (Bröer, 2008; Bröer & Duyvendak, 2012, Bröer et al, 2013). To do so, we work with an interpretive, relational sociological perspective on the 'techno-social' practices of base-station siting.

Risk governance practices do not fully make up citizens' 'interpretive resources' as the confrontation with the siting procedure leads to a situated learning process. Nevertheless, we find that citizens' conceptualizations of the technology appear dominated by the health-issue put to the fore in risk governance, but also differ when citizens argue for their willingness to 'take the risk' or take the siting-process itself as symptomatic for wider political issues. Finally, we discuss methodological considerations when combining interpretive and survey-design in longitudinal research into risk perception.

### **The struggle for knowledge - The dynamics of citizen engagement in mobile phone mast siting controversies**

*Marijke Hermans, Marjolein van Asselt, Wim Passchier (Maastricht University, The Netherlands)*



When a technological infrastructure needs to be sited, the local community is often quick to respond with the organisation of meetings, pamphlets, marches, etc. It seems to take little effort for a community to unite in a citizen group that has one univocal message: 'We don't want this infrastructure here'. One can easily conjure up images of angry, disappointed, and fearful citizens that question the industry's or government's plans for siting. If one looks more carefully though, one can also see well-versed, intelligent, and opinionated citizens. The aim of this paper is to critically analyse the role of 'the citizen' or 'the public' involved in siting controversies.

The general image of citizens is often one of unreasonable, irrational and risk-averse individuals mobilising and protesting against the system. Risk research has a long history in analysing public reactions to siting practices, focusing on the risk perception of individuals, their NIMBY behaviour or (lack of) understanding about the sited technology. In these perspectives, citizen-behaviour can very easily be interpreted as 'resistance' or 'protests'. These attributes are however value-laden with negativity by suggesting that citizens are against and thus outside the system, making their concerns illegitimate. To allow a more productive, open and symmetrical analysis, I instead suggest using the term 'engagement' when it comes to describing the behaviour of citizens in siting controversies.

On the basis of case study research of six mast siting controversies in the Netherlands and Flanders (Belgium), including around 60 interviews with local citizens, policymakers, politicians, lawyers and journalists as well as document analysis and observations of meetings, I analyse citizen behaviour as forms of contemporary engagement that involve diffuse, multi-layered forms of networking and alliance-building. I claim that knowledge and struggles over information are central to contemporary engagement in public controversies. Citizens can gather a remarkable amount of technical, legal and scientific knowledge with which they contest the government's perspectives. Also, citizens form networks that move beyond the local setting, either establishing their own (inter)national group or becoming part of an established organisation (e.g. environmental group). This opens up an immense array of expertise and knowledge that is used as resources in the siting controversy. Analysing the involvement of citizens in siting practices as forms of engagement can be a step forward to better understanding and facilitating the participation of citizens in

government decision – an aim which is widely considered as opportune to produce socially robust policymaking.

## WEDNESDAY 19 JUNE

### W<sub>1</sub> SYMPOSIUM: RISK GOVERNANCE AND SAFETY PERFORMANCE IN NO FAILURE CONDITIONS

Wednesday: 1100-1230, R3

Chair: Atle William Heskestad (NTNU Social Research)

The term no failure conditions refers to activities where very high effort are made to avoid critical failures with respect of the success of the activities. At the same time these activities might be risky to conduct. Such activities might be expensive to conduct, using critical resources and having complexity with respect of success as well as safety issues. Examples of such activities are space experiments which are expensive to conduct, where the resources are limited and which is conducted by several entities in a complex organization. During such experiments both safety and avoiding "loss of science" have to be maintained, and there are several equalities with respect of methods used for these to purposes. The symposium intends to highlight risk governance and safety performance issues for activities where there might be synergies between efforts to ensure success of activities and efforts to avoid the risks of the activities.

#### **Loss of science as a benchmark of hazard for conduction of human spaceflight experiments**

*Mona Schiefloe, Tore Havan, Atle William Heskestad (NTNU Social Research)*

Human spaceflight experiments are conducted on the international space station (ISS) through a complex hierarchical network of collaborating entities. The Norwegian user support and operations center (N-USOC) is managing biological experiments using a highly advanced incubator, the European modular cultivation system (EMCS) for all users worldwide. These experiences have been the starting point to research on communication and collaboration with respect

of safety issues as well as crucial business issues denoted as "loss of science", the latter meaning failures that can result in unsuccessful conduction of experiments.

Space experiments are prepared through extensive planning, documentation, testing, reporting and training of involved personnel in advance of the launching and conduction of microgravity research experiments. The purpose of the preparations is to identify and explore critical issues for successful and safe experiments. The principal entities of the experiment are the ISS mission control center (MCC-H) and the payload operations integrations center (POIC) of NASA, the Columbus Control Center (Col-CC) of ESA, the scientific team and several technical teams consisting of payload developers, the EMCS engineering team and USOCs communicating with each other. Being the integrator and operator of all EMCS activities, the N-USOC has a central coordinating role in the preparations of an experiment and has the function of being a link between the scientists and the space organizations ESA and NASA.

The experiments have the loss of science as a benchmark of hazard for all entities and all levels. Minimizing the potential loss of science is a corner stone of all pre-launch activities and real time operations. The paper elaborate how procedures, testing, communication and collaboration issues might be or have been crucial factors to prevent loss of science. In addition links between loss of science and safety issues are described. The safety of the ISS crew members is always of highest priority, and all payload operations must be kept within the limitations given by crew safety restrictions.

The paper is based on the experiences from plant experiments integrated by N-USOC and conducted in EMCS in the time period 2006-2013.

#### **Risk governance and safety in complex high reliability organizations: balancing formal structures versus needs for flexibility during operations of human space flight missions**

*Abdul Basit Mohammad, Jens Petter Johansen, Petter Grytten Almklov (Norwegian University of Science and Technology)*

The subjects of our paper are two dimensions that influence the results delivered by complex organized high reliability organizations; Structure and Flexibility (Anticipation and improvisation). Hierarchical organizations may aim to make risk manageable, safe and operability friendly by trying to find the "sweet spot" of optimal balance within these dimensions. We explore this

balancing act through the frame of ISS (International space station) operations. ISS operations are executed in a hierarchical, distributed manner in a technologically and organizationally complex environment. Here, preparation work including planning and training for conducting activities on ISS are emphasized. These are important aspects of governing risk and for installing vital barriers for safe operations. These practices provide structures that introduce some rigidity in the organization in order to guide the organization's work towards reliable conduct of critical activities, and they encourage anticipatory behavior. However, capabilities for improvisation or flexibility are also important attributes of the organization that seeks to ensure high reliability and resilience. For ISS operations, flexibility becomes an increasingly important factor for reliability as the organization moves closer to the operational phase of activities and during the operations phase. We argue that several implicit attributes that allow for adaptation have significant impacts on the performance of organizations in specific phases, complementing the structural attributes that formally guide performance. From this vantage point, we try to generalize how organizations may strike a balance between (and understand the interconnected nature of) formal structures and flexibility for optimal risk governance. The competence required to enable flexibility and adaptive distributed cognition is briefly discussed.

#### **Human space flight - Training to ensure successful operations and safe performance in control rooms**

*Liz Helena Froes Coelho, Brit-Eli Danielsen, Trine Marie Stene (Norwegian University of Science and Technology)*

The International Space Station (ISS) is a habitable multinational laboratory orbiting the Earth. It serves as a unique microgravity and space environment research laboratory in which crew members conduct experiments in biology, human biology, physics, astronomy, meteorology and other fields. The station has been continuously occupied by humans since October 2000. Columbus is ESA's own module and Europe's laboratory on the ISS. The Norwegian User Support and Operation Centre (N-USOC) is one out of nine USOCs that under ESA management form a network involved in conducting decentralized payload operations for the European elements and Columbus laboratory onboard the ISS.

During operations N-USOC personnel is on console to monitor and control their payload and associated crew operations 24/7. The operations require close cooperation with other control centres, as well as engineering support and science teams. The training objective covers subjects like: payload technology, human operations and scientific goals. The training plan use methods like simulations, lessons learned and "what-if" scenarios.

The purpose of this paper is to discuss how the N-USOC training aims at ensuring safety and success, which at the same time implies reducing risks for failure and loss of science.

#### **Fire safety management and sosio-technical relationships: Exploring theories of safety constraints and coherence principles**

*Henrik Bjelland, Ove Njå (University of Stavanger, Norway), Geir Sverre Braut (Stord Haugesund University College, Norway, Norwegian Board of Health Supervision, Norway), Atle William Heskestad (presenter) (NTNU Social Research)*

Modern safety management in complex socio-technical systems is largely associated with risk management. Although risk management is promoted in the regulation of a wide range of safety problems, empirical studies show that (fire) safety engineers are rather uncomfortable dealing with uncertainties, for instance in the form of probabilities, and risk. Moreover, the safety consultants' clients often lose touch with their own safety issues when consultants transform these issues into abstract measures of risk. Focus on quantifying risk also tends to lead to a reductionist approach to safety, where system decomposition is the answer to complexity. There is a search for initiating events, causal connections and barrier failures. Data on barrier reliability and effectiveness is crucial to the calculations. However, and this is nothing new, safety is poorly described through reductionism. On the contrary, safety is better viewed as a property of the complex socio-technical system as a whole in an interaction with its environment. The systems are continuously adapting to changes within itself and in its environment. Accidents are allowed to occur when there is a failure to control system adaptation, and the safety margins for safe operation are crossed. In this paper we provide an alternative to risk-based management of safety. Our focus is directed towards what we want to achieve, i.e. safety, through identification of safety objectives, accidents/losses and hazards that threatens the safety objectives, and safety constraints that needs to be enforced to control hazards. This encourages a multi-disciplinary approach where one does not need

to speak the language of probability to participate. Safety engineers focus on what they know best: systems and phenomena, by analyzing the connection between accident scenarios and the safety constraints. Instead of searching for non-existing objective decision criteria, the quality of a design process and resulting documentation may be judged in multi-disciplinary process on the basis of a set of coherence principles. The paper elaborate the use of such principles with respect of sosio-technical issues concerning decisions processes on safety matters.

## W2 RISK PERCEPTION II

Wednesday: 1100-1230, R4

Chair: Matthew White (European Centre for Environment & Human Health)

### **Perception and attitude changes toward Science and Technology in Japan after the Earthquake**

*Motoko Kosugi*

This study aims at revealing risk perception and attitudes toward science and technology of the public and experts after the Great East Japan Earthquake and the accident at the Fukushima Daiichi nuclear power plant in March 2011, in contrast to those prior to the events. Questionnaire surveys were conducted in August 2012 for the general public in metropolitan areas and academic professionals in biotechnology, nuclear energy technology and nanotechnology. As the results, comparison with the equivalent questionnaire survey (survey of the public in November 2009, survey of experts in February 2010) showed that risk perception of nuclear power generation has arisen not only in the public but in the nuclear experts. The publics image of nuclear power generation significantly shifted to widespread damage and the technology should be regulated by the government from local damage and self-management by the company, respectively. Moreover, the public turns to place higher priorities than before on the perspectives of necessity for the society and possibility to prevent negative environmental impact when they evaluate nuclear power generation in the society, instead of the governments capability for risk management and prevention of misuse and the electric power companies capability for risk

management. As regards genetically modified food, the publics risk perception has also arisen and image rather changed to regulation by the government from self-management by the company. These publics perception changes are similar to the shift in the case of nuclear power generation, thus it might be affected by the nuclear accident. On the other hand, risk perception of application of nanotechnology to medical treatment became slightly lower than before. The image of nanotechnology was new as same as previous survey and shifted to local damage from widespread damage. These results suggest that the public is still less familiar with nanotechnology. The publics belief in positive aspects of science and technology at large slightly decreased, while anxiety in negative aspects somewhat eased. In contrast, there is little change in attitudes of the experts.

### **Stability of energy imageries and affects following shocks to the global energy system: The case of Fukushima**

*Roh Pin Lee (Technische Universität Bergakademie Freiberg, Germany)*

Unexpected shocks to the global energy system through catastrophic events such as Three Mile Island, Chernobyl, Deep Water Horizon and more recently Fukushima generally arouse considerable public concern worldwide. Such events often put policy and managerial decision-makers under significant pressure to respond in the form of contingency plans or changes to existing regulations and development plans. This is evident for example in countries such as Germany, Switzerland and Italy where emotional and affect-loaded protests following the 2011 Fukushima accident has led to a radical change in their energy strategies.

To support the timely development of regulatory and legislative frameworks and facilitate strategic and preemptive (rather than reactive) measures, there is a need to gain insights into the origins and nature of energy perceptions, and understand how perception changes in the face of catastrophic events. To that end, researchers have emphasized the value of a qualitative analysis of energy imageries in addition to a quantitative examination of energy affects. However, earlier studies either exhibited a predominant focus on one energy source (i.e. nuclear), or the timing of their investigations did not enable an examination of changes in perception toward multiple energy sources after a catastrophic event. Moreover, previous research often focused on quantifying affective perception, thereby neglecting the rich qualitative imageries which could provide valuable insights into the origin of people's concerns.

To address these gaps, this study carries out an in-depth qualitative and quantitative analysis of imageries associated with seven key energy sources. This research has three main objectives: (1) identify imageries commonly associated with each energy source, (2) examine imagery-associated affects, and (3) analyze changes in imageries and associated affects after a catastrophic event. Participants are German young adults undergoing tertiary education. 275 participants took part in the study in January 2011 (before Fukushima) and 452 in May 2011 (after Fukushima).

Results show that the top five imageries associated with each energy source accounted for over 50% of the imageries participants associated with it. Participants furthermore differentiated between various imageries affectively (i.e. different imageries elicited different affects). After Fukushima, significant stability in imageries as well as imagery-associated affects is observed for all seven energy sources. This is suggestive of the tenacity of imageries associated with an energy source and the resilience of energy affects. The observed stability of energy perception thus caution against implementing reactive measures in response to emotional public reactions in the aftermath of catastrophic energy events.

### **Public Perceptions of Climate Change and Energy Futures Before and After the Fukushima Accident: A Comparison between Britain and Japan**

*Wouter Poortinga (Cardiff University, UK)*

The threats posed by climate change call for strong action from the international community to limit carbon emissions. Before the Fukushima accident that followed the Great East Japan earthquake and tsunami on 11 March 2011, both Britain and Japan were considering an ambitious expansion of nuclear power as part of their strategy to reduce carbon emissions. However, the accident may have thrown nuclear power as a publicly acceptable energy technology into doubt. This study uses several nationally representative surveys from before and after the Fukushima accident to examine how it may have changed public perceptions of climate change and energy futures in Britain and Japan. The study found that already before the accident the Japanese public were less supportive of nuclear power than the British. Whereas British attitudes have remained remarkably stable over time, the Japanese public appear to have completely lost trust in nuclear safety and regulation, and have become less accepting of nuclear power, even if it would contribute to climate change

mitigation or energy security. In Japan the public are now less likely to think that any specific energy source will contribute to a reliable and secure supply of energy. The implications for energy policy are discussed.

### **Risk Perception Studies on Istanbul**

*Seda Kundak (Istanbul Technical University, Turkey)*

Risk perception on natural hazards in Turkey has been an emerging topic afterwards of 1999 Kocaeli and Duzce earthquakes. The motivation lies behind the fact that it was the first time in the Turkish history, disaster mitigation had been considered as the responsibility of all stake holders, not only the government. Therefore, awareness campaigns, public participation, volunteering and increasing individual capacity against earthquakes have become hot topics to have a fresh start in building resilient communities. The most obvious constraint in dissemination of risk reduction activities among people had arisen in the scope of their willingness which is bred by their trust to others, liability on information's given and their risk perception. Few but comprehensive case studies have been accomplished in this period focusing to investigate risk perception of Istanbul's inhabitants. This paper aims to provide an overall evaluation of these studies regarding their findings to produce strategies in risk reduction at the community scale. The findings show that socio-economic indicators are influential in risk perception and taking structural precautions, however, none of the cultural and personal attributes have emphasis on neither changing behavior nor generating collective actions. Furthermore, people indicate poor linkage with the authorities and lack of available platforms that might enable them in participation of decision process concerning their living environment. On the other hand, in some case studies, the relation between risk perception and spatial features of the settlement has been noted. For instance, people living in the settlements with high population density complain about the lack of information from authorities. People living at the risky zones reflect their worries in a sharp way. In the areas where the land values are high, people endeavor to reduce their risks in their households. Consequently, all aspects which affect risk perception and taking action underline the need of innovative approaches and strategies applicable to the special characteristics of the communities.

Key words: Risk perception, Istanbul, earthquake

### W3 RISK COMMUNICATION III

Wednesday: 1100-1230, R90

Chair: Michael Siegrist (ETH Zurich)

#### **Communicating risks to young consumers. The raw milk experience in Italy**

*Giulia Mascarello, Crovato Stefania, Pinto Anna, Ravarotto Licia (Istituto Zooprofilattico Sperimentale delle Venezie, Italy)*

Since 2004 raw, or unpasteurized, cow's milk has been sold in Italy from dedicated vending machines and is now becoming increasingly popular with consumers, who recognize it as a natural product with strong ties to local communities. Sales have significantly increased in the past few years and are now estimated to exceed 100,000 litres a day. Over 1,400 vending machines are installed in about 90 cities across the country, most of them in the north. The sale of raw milk, however, was found to be responsible for a number of health issues. Several outbreaks of verocytotoxin-producing *Escherichia coli* (VTEC), associated with raw milk consumption, have been reported since 2004, as have serious cases of Haemolytic-uraemic syndrome (HUS), especially among at-risk individuals and children, including one fatal case in 2010. The health emergency caused by increased raw milk consumption prompted Italian authorities to introduce ad hoc regulations and require that information for consumers be displayed on the vending machines, including the recommendation to boil milk before consumption. In 2012, the Italian Ministry of Health emphasized that consuming raw milk without boiling it first still posed a health emergency that required risk communication initiatives aimed at raising consumers' awareness. In light of the above, and with a view to informing young consumers on this issue, an intervention study was designed involving 807 students aged 16 to 17 years from across the country. The project investigated adolescents' food habits, behaviours and attitudes towards milk through focus groups and structured questionnaires. An online videogame was used to communicate microbiological risks to the students. By following the adventures of its main character, players were taken on a journey throughout the milk supply chain, learned to identify the critical moments when contamination can occur and familiarized themselves with good domestic handling practices. The tool was evaluated through structured questionnaires administered to the students. Data collected revealed

the need to urgently implement the communication activities aimed at ensuring consumer protection. Indeed, widespread consumption of milk among young people and their families is not accompanied by proper knowledge about healthy milk storage and handling practices at home and the perception of risks associated with milk consumption was found to be low. Moreover, the analysis of the weaknesses highlighted by the evaluation of the online videogame provided useful information which could help design and implement risk and emergency management strategies capable of reaching the target group rapidly and effectively.

#### **On Common Terms with Shared Risks - studying the communication of risk between the local and regional level in Sweden**

*Peter Månsson, Henrik Tehler, Marcus Abrahamsson & Henrik Hassel (Lund University, Sweden)*

In Sweden, municipalities, county administrative boards and national authorities are obliged by regulations to identify and analyze the risks and vulnerabilities within their geographic areas or sectors of responsibility. The results of these assessments are described in documents called risk and vulnerability analyses (RVA). The quality of the analyses hinges upon that various actors succeed in sharing information across sectorial and administrative borders (e.g. county administrative boards at regional level are supposed to use local municipalities' RVA:s as an input to their assessments). However, even if the legislation is clear with respect to the ambition of achieving a high degree of information sharing, it is far from easy to transform that ambition into practice. One aspect that can inhibit the usefulness of the documents being shared is if the actors producing the documents use different ways of describing the risk and vulnerability information. This problem has previously been termed uncommon categorization, and in the present paper we investigate the extent of that problem with respect to the communication between the local and regional level in Sweden.

In 2010, the Swedish Civil Contingencies Agency (MSB) issued a new regulation which sought to standardize the ways municipalities assess their risks and report on the outcomes of their RVA:s. Our study focuses on two regions in Sweden, Örebro and Skåne (there are 21 in total) containing a total of 45 local municipalities (out of 290 in Sweden). We investigate the RVA:s from the local municipalities that were available to the county administrative boards in 2010

and 2011 with the aim of describing the extent of the problem of uncommon categorization and how it developed during the time period in question. Specifically, we study documents with respect to (1) if they use scenarios, (2) how they describe likelihood, (3) how they describe consequences, and (4) which consequence dimensions they use. In addition, we also study how the documents are structured in general.

We conclude that the problem of uncommon categorization is significant in the studied material. There is a great variety in the ways the local municipalities describe risks and vulnerabilities and it does not appear as if there has been any significant change from 2010 to 2011. We argue that this might pose a serious problem for the Swedish crisis management system since it will inhibit the county administrative boards' ability to use the information from the local municipalities' RVA:s in their assessments.

### **Psychological distance and risky decisions: How risk communication needs to highlight hidden influences**

*Martina Raue, Bernhard Streicher, Eva Lermer, Dieter Frey*

Research on Construal Level Theory has shown that the psychological distance (e.g. time, space, social distance, probability) influences individuals' mental representations of events or objects. The greater the psychological distance, the more abstract the mental representation becomes (high level construal). The smaller the psychological distance, the more detailed the mental representation (low level construal). The effect of the level of construal directly influences people's judgment and decision making, therefore it has been of high interest in recent psychological research. When decision makers are confronted with complex situations where intuitions play a role, such influences are certainly relevant. In recent studies we showed that people make riskier decisions under high than under low construal level. In subsequent studies we investigated the meaning of our findings in the field. We manipulated psychological distance in a relatively safe situation and examined how subjective risk estimates of runners for running specific risks change with the point in time of asking. Therefore we asked 117 participants of a run to estimate the probability of certain risks of running. One group was asked two days before the run, one group shortly before the run and one group after the run. Risk estimates for injuries increased with the run coming closer and were highest after the run. These results demonstrate how psychological distance can affect subjective risk estimates. Interestingly,

the risk assessments are highest shortly after the run, therefore we believe that experiencing a potentially risky event leads to a even concreter representation of that event and therefore to higher risk estimates. In further studies we are investigating these influences in economic decision making. When Managers make risky decision it makes a difference how psychological distance is inherent in the decision problem. Whether they make a decision with long-- - term or short-- - term consequences now or later; if people are involved that are perceived as close or rather distant; if the decision affects their immediate surrounding or is perceived as spatially farther away. The influence of psychological distance on risk perception is of high importance for decision makers and needs to be highlighted in risk communication.

### **'Risk as analysis and risk as feelings' in practice: Presenting a segmentation based on the reconciliation of objective RF-EMF exposure measurements and subjective risk perception profiles**

*Dr. Isabelle Stevens, Sam Aerts, Tom Evens, prof.dr. Lieven De Marez, prof.dr. Wout Joseph, prof.dr. Luc Martens iMinds-MICT-UGent, Belgium iMinds-INTEC-UGent, Belgium*

Exposure assessment plays an important role in informing people about wireless technologies using radiofrequency (RF) electromagnetic radiation (EMF) and their potential health effects. Exposure certainly is an issue on the citizen's as well as the policy maker's agenda, but confusion often reigns from both sides. Users' anxiety is too often focused on only a limited number of possible effects, and not seldom based on wrong assumptions (e.g. the closer to an antenna the more exposure). Moreover, policy makers' efforts to inform citizens are never complete, while the exposure debate can only be tackled in its totality. This study attempts to integrate the 'risk as analyses and risk as feelings' approach as proclaimed by Slovic et al. (2004) in an empirically based segmentation study, allowing us to tackle the information needs that relate to the biased risk assumptions concerning RF-EMF risks. Combining perceived (subjective) and actual exposure (objective exposure), people can be segmented into 'risk groups'. The identification and profiling of these risk groups in a city community are vital in the construction and implementation of accurate, complete and segment-tailored information and risk communication strategies regarding RF-EMF radiation exposure.

The core methodology of the study included a mixed method approach. In the study, quantitative and qualitative research designs were integrated. Firstly, a quantitative survey study (n=559) was performed in the city of Ghent, Belgium, to map the subjective risk perceptions, affective responses, and behaviour. A parallel track of RF-EMF measurements provided input for a tangible exposure map of a delineated area in the city and allowed us to provide respondent specific exposure information. The combination of both the objective exposure and the subjective perception profiles allowed us to construct and validate the segmentation and profiling of the 'risk groups'. Secondly, a qualitative track was performed. In total, 50 in-depth interviews with selected respondents were performed. This allowed us to perform more in-depth analyses on the core concepts and to detect changes in awareness levels, attitudes, risk information seeking and preventive behaviour intentions after confrontation of the respondents with their concrete RF-EMF exposure rates (using exposimeters). As a result, we could confirm or reject assumptions concerning risk perceptions and (change in) preventive behaviour in the context of EMF risks.

#### W4 REGULATION OF MAJOR RISK I

Wednesday: 1100-1230, R91  
Chair: Ragnar Rosness (SINTEF)

##### **How may dialogue based authority supervision improve safety standards? - A case study on HSE regulation in the Norwegian petroleum sector**

*Rune Schwebs (Petroleum Safety Authority, Norway), Preben H. Lindøe (University of Stavanger, Norway)*

The paper first addresses issues related to the regulative regime, the tripartite regulative development process, regulative dilemmas, and then mainly focuses on the effect of Petroleum Safety Authority, Norway (PSA) dialogue based supervision. The paper presents two case studies (2010, 2012) with informants representing the tripartite "Regulatory Forum". An additional survey (2012) among offshore crews in three rig companies evaluates PSA audit methodology and influencing impact.

In Norway the HSE regulation regime is built on trust, cooperation and open communication between authorities and duty holders. Regulations are enhanced through a formal tripartite governance process between worker unions, employer associations and authorities. Over the years these basic principles have led to a set of goal - or performance based - regulations. Building on the above regime and development principles, PSA has taken on a self-declared role as an influential promoter of safety culture and safety standards amongst duty holders. While many supervisory agencies have asymmetrical power bases and carry out strict "control" and "sanction" strategies, PSA has added "dialogue" as the third dimension of state supervision.

This strategy allows a more symmetric authority supervision approach characterized by open communication and dialogue. A top-down "command and control" strategy, as seen in the US, tends to be rule-bending and antagonistic, while a bottom up "enforced self-regulation" motivates industry actors towards improved safety standards (Baram/Lindøe 2011). The paper describes how PSA uses both statutory law and informal strategies when enforcing, influencing and "steering" industry actors towards higher safety standards and safer operations.

##### **The Role of the State in Transnational Nanomaterials Risk Regulation: Analyzing the Expansion of State-Centric Rulemaking in the EU and the US** *Ronit Justo-Hanani (Tel-Aviv University, Israel)*

This paper explores the growing power of states in transnational nanotechnology risk regulation and thereby their impact on research and technology trajectories. Decentralization of governance structure has been reported by scholars, yet the role of the state is evolving and still underexplored. We draw on a case study of nanomaterials and chemicals regulatory policies, by analyzing recent regulatory developments in the EU and US. Using data-reporting and market-entry regulations as examples, the evidence demonstrates the expansion of state-centric marketoversight rulemaking, and 'stronger' patterns of centralization in the EU. We argue for significant increase in regulatory power exertion, countering predominant views on decentralization as the prevailing governance response. These findings suggest the adaptation and strengthening of state-based regulatory systems in the context of scientific uncertainty and complexity of global nanotechnology settings: despite these challenges for policy making, the EU and the US increase government role in technology regulatory policy.



### **Enterprise Risk Management: Internal Accountability?**

*J. Sithipolvanichgul, J. Ansell, R. Agarwal (University of Edinburgh Business School, UK)*

Enterprise Risk Management (ERM) has been advocated as solution to the problems of Traditional Risk Management (TRM). It is supposed to deal with the silo-based approach to management of risk within an organisation by taking a holistic strategic. The aim is to centralise the management of risk within the organisation and ensure that the board deals with the risk. Hence strategic, external, internal, operational, compliance and reputational risk will be dealt with jointly. In doing so it is expected that there will be advantages to be gained by the organisation with the ability to merge risk and gain consistency. The difficult is that there are many alternative definitions and standards associated with ERM. It has also been found that firms employing ERM can be adjudged not to perform as well as firms using TRM. Many reasons can be advanced for this result. It may be that the difference arises from reporting regimes under the two approaches. It could also be attributed to the culture that is established within the organisation under these approaches. In TRM often risk responsibility is passed down to the departmental heads that manage their individuals risk and take action on such more rapidly. Whilst in ERM the board of the organisation and its member with designated responsibility take control of the risk. Hence in TRM accountability for specific risk is taken by managers involved with those risks, against a central accountability for the organisation's risk within the ERM model. Obviously within the rhetoric of ERM all involved should be seen as responsible, but again this can become a vague concept. This paper will explore the different definitions to ERM and highlight the strengths of them with the aim to suggest the best method for dealing with accountability. It will explore this through stakeholder theories and social exchange.

Key words: Enterprise Risk Management, Accountability, holistic strategic, Contingency theory

### **Better by design: Rethinking interventions for better environmental regulation - a case study of environmental policy making in the UK**

*C.M. Taylor, S.J.T. Pollard, S.A. Rocks (Cranfield University, UK), A.J. Angus (Cranfield School of Management, UK)*

Better regulation seeks to extend existing policy and regulatory outcomes at less burden for the actors involved. No single intervention will deliver all environmental outcomes. There is a paucity of evidence on what works why, when and with whom. We examine how a sample (n=33) of policy makers select policy and regulatory instruments, through a case study of the Department for Environment, Food and Rural Affairs (Defra), UK. Policy makers have a wide range of instruments at their disposal and are seeking ways to harness the influence of non-governmental resources to encourage good environmental behaviour. The relevance of each influence varies as risk and industry characteristics vary between policy areas. A recent typology of policy and regulatory instruments has been refined. Direct regulation is considered necessary in many areas, to reduce environmental risks with confidence and to tackle poor environmental performance. Co-regulatory approaches may provide important advantages to help accommodate uncertainty for emerging policy problems, providing a mechanism to develop trusted evidence and to refine objectives as problems are better understood.

## **W5 SYSTEMIC RISK AND VULNERABILITY ASSESSMENT**

Wednesday: 1100-1230, R92

Chair: Terje Aven (University of Stavanger)

### **Analyzing the governance of disaster risk from a system perspective: A case study in Nicaragua**

*Claudia Rivera (Lund University, Sweden, National Autonomous University of Nicaragua, Nicaragua)*

Describing and understanding how risk is managed in complex systems where multiple actors can influence the situations is not an easy task. Previous attempts to describe the management of risk in such contexts include examples from traditional risk management literature and from risk governance, but also examples that have employed broader perspectives such as resilience engineering and societal resilience. Despite the great variety, both in terms of the area under study and the methods employed, it is argued that a key aspect of any attempt to describe the management of risk in a complex system is to

focus on the functions that the system performs. For example, in traditional risk management literature and also in recent standards the functions of Identify, Analyze and Evaluate are often employed. In other areas, such as resilience engineering the function of Anticipate, Monitor, Respond and Learn are more common. Although the names of the functions employed are different there are significant similarities in terms of their output in the systems of interest. In the present paper a functional perspective is employed in the analysis of disaster risk reduction in Nicaragua. More precisely, four functions are used to analyze the Nicaraguan system for disaster risk reduction; Data acquisition (how does the system get information about the current situation?), Orientation (How does the system determine if actions needs to be taken and in that case what should be done?), Planning (How does the system transform what is to be done into a concrete plan that can be implemented?), Adaptation (How does the system transform the plan into practical action?). The four functions are used as a basis for a combined interview and document study focusing on what the actors within the Nicaraguan disaster risk reduction system contributes with in terms of the four functions and also how they interact with each other. The result is an overview of what is done in Nicaragua with respect to disaster risk reduction, both in terms of what the different actors in the system produce, how they do it, and how they communicate information with each other. Based on the results from the study it is concluded that the system clearly allocate responsibilities to all the parts that forms the system. However, the various level of administration has weak mechanisms to shear information concerning risk management.

Key words: Risk governance, risk management, resilience engineering, system-based approach.

### **Network reliability benchmark study with application to gas transmission system**

*Vytis Kopustinskas, Sergio Contini, Pavel Praks (European Commission, Italy)*

Recent concerns about security of the main energy infrastructures (gas, electricity, oil) in Europe highlighted the need to model complex systems that are connected in networks and usually are continent-wide. Modeling of complex networked systems is a challenging task due to usually large number of network nodes and complex interdependencies among the nodes. The paper investigates Monte-Carlo and fault tree based methods to analyze security and reliability

aspects of network systems that are transmitting resources between the nodes and are vulnerable due to component failures or external supply cuts.

This paper presents a benchmark study by using Monte Carlo simulation approach and fault tree analysis method to model reliability of a networked system. Although applicability of the methods could be possible for many flow networks, the study in particular concerns gas transmission network. The methods are extended to a real EU country gas network reliability study.

### **Qualitative analysis and typing intersystem accidents**

*Valery Lesnykh, Alexander Bochkov (Science Research Institute of Economics and Management in Gas Industry, Russia), Tatiana Timofeeva (State University of Management, Russia)*

In recent years, the studies related to the risk analysis system of interacting components systems (System of Systems) have become very important. Of particular relevance are studies that have examined risk critical infrastructure life-support systems (LSS). In this case, first of all discusses the risks of illegal actions (terrorist action), but no less interesting is the problem of inter - system accidents related to the triggering event of natural, technological, organizational, etc.

Large studies performed on a system (cascading) accidents in electric power systems, including analysis of the effects in conjugated systems. However, poorly enough, the problem of inter-system accidents when the triggering event related to other LSS, such as the gas supply system or telecommunications system, was investigated.

Qualitative analysis of a number of inter-system failures that are different triggering event, the composition and scale effects are performed. Approach to inter-system accidents typing in key LSS (electricity, heat, gas, oil supply, water supply, telecommunications, transport) is offered. Typing is done with the triggering event, the composition of the systems involved, the duration of the accident, the social and physical consequences, territorial distribution of impacts and other factors.

Key words: Infrastructure life-support systems, cross-system failure, qualitative analysis, typing intersystem accidents

## W6 RISK IN TRANSPORTATION

Wednesday: 1100-1230, R93

Chair: Bjørn Egil Asbjørnslett (Norwegian University of Science and Technology)

### **What if the emergency system fails? Focusing on complex transportation system in London.**

*Funda Atun (Politecnico di Milano, Italy)*

Cities have been considered as one of the most complex systems which consist of highly interconnected, economical, structural, social systems linked by multiple interactions, which can be interrupted in case of a hazardous event. However, even though cities' complexity amplifies effects of an event, it also provides opportunities to increase city systems' resilience. This study considers complexity both as the source of the problem and as a feature that could be part of the solution, and focuses on the transportation system as an important potential contributor to city's resilience.

The background of the study is constructed within a theoretical framework that blends the contribution of three research areas: transportation system, disaster risk management and complexity theory, which enables the researcher to adopt a methodology to tackle the complexity of the transportation system against natural disasters. The empirical part of the research has been elaborated in six London Boroughs to understand regulations, emergency management system and public awareness related to the flood risk which threatens London. Besides document analysis, an in depth survey has been conducted with stakeholders from organizational (decision makers), tactical (key personnel of the transportation network) and public (local people living hazard prone area) levels.

The main problem that emerged is the gap between the emergency management as planned and the actual situation in the field after an event. Significant gaps between what is planned and what may occur in the field have been highlighted in this study. Such gaps mainly derive from the failure in considering "interdependency of components in a system", "secondary effects in hazard maps" and "strongly embedded social structure within the physical structure". The study started by considering these three issues as the main reasons of the mismatching between plans and actual situations and sought to

know the interaction pattern among structural, organizational, tactical, and public layers, and how the outcome coming from this interaction affects and may be affected by the transportation system.

As final products conceptual frameworks and maps, which consider induced hazards and human failures as well as the hazard itself, have been prepared for understanding how the actual situation may differ from the scenarios according to which plans have been prepared. The adopted "what if" scenarios method was chosen to address the complexity of systems that are changing dynamically when stressed. Results of the application of the what if scenarios showed that a much more flexible system is required to tackle complex emergencies.

Key words: Systemic Vulnerability, Resilience, Complex Transportation System, Flood Risk, London

### **Estimating Resilience in Maritime Transport Systems**

*Bjørn Egil Asbjørnslett, Jørgen G. Rakke (Norwegian University of Science and Technology), Inge Norstad (The Norwegian Marine Technology Research Institute, MARINTEK, Norway)*

This presentation address issues related to quantitative estimation of resilience in maritime transport systems. The focus is set on understanding resilience in maritime transport systems, how resilience may be quantitatively assessed and measures for this, as well as how the inherent system resilience can be utilised when needed.

In resilience engineering, the flexibility in use of the infrastructure resources of a transport system will be important. Increasing the robustness of a transport system could be achieved by adding more resources to the infrastructure configuration. An alternative to robustness is to better understand and use the resilient capabilities and capacities of the present transport system infrastructure elements. In a maritime transport system, the vessel resources are a flexible part of the transport system infrastructure, where the flexibility stems from the fact that a vessel can sail (almost) any fairway, and call (almost) any port, as long as we consider a given type of shipping.

An approach to measuring the resilient capability and capacity of a maritime transport system, start with a throughput optimised annual delivery plan. Routing of vessels and scheduling of cargo loads on specific vessels are prepared as part of this. A simulation is then performed within the optimization model, based on three scenarios with different degrees of active mitigation. In the first

scenario, whenever a disruption event matures the optimization model will re-plan the annual delivery program to optimize the remaining throughput capacity. The second scenario will whenever a disruption event mature re-schedule individual shipment if such can be made without influencing other parts of the shipping network. The last scenario will not do any active mitigation. The resilient capacity of the maritime transport system can then be measured as the difference in throughput capacity between the three scenarios.

The difference in throughput capacity between the first and second scenario show the value of active mitigation through the use of computerized optimization tools that find new, re-optimal solutions for the remaining period of a plan, versus short-term adaptation of the plan to utilise available resources in lieu of a disruption in another part of the transport system. This capacity difference could be seen as the true resilient capacity of the transport system, thus showing the value of finding all recourse actions available both short term and longer term within the planning horizon.

### **Helicopter pilots and perceived risk**

*Rolf J Bye, Stian Antonsen, Jorunn Seljelid (Safetec Nordic)*

This paper discusses the relationship between the statistically estimated risk and risk perception. It is based on a comparison of estimated risk in the Norwegian domestic helicopter industry, and measured risk perception among the pilots and other crewmembers. The domestic helicopter industry has seen several serious accidents in recent years and is generally regarded as a high-risk industry.

Despite this, surprisingly little safety research has been performed in this sector. The data used in this paper is collected during an extensive study of the Norwegian domestic helicopter industry in 2012. This project included an analysis of accident reports, estimation of the risk level, interviews of pilots/crewmembers, and a survey.

Based on existing theory on risk perception, we present a comparison between the risk level that has been estimated on the basis of accident statistics, and the crews' perception of risk.

The findings show that there is a mismatch between estimated risk levels and the pilots' beliefs about the likelihood of accidents in connection with various helicopter operations. Several of the helicopter operations with highest probability of an accident, was considered the least risky ones by the pilots.

Further, the measurement of risk perception shows that there is a difference in risk perception between pilots. Analysis of accident data shows that pilots with less than 1,000 flight hours and pilots with more than 5,000 flight hours are more accident prone than pilots with between 1,000 and 5,000 flight hours. However, the accident prone pilots consider it less probable that they will be exposed to an accident compared with the pilots with between 1,000 and 5,000 flight hours.

The findings have implications for existing theoretical assumptions regarding subjective risk perception. These theoretical implications will be discussed in this paper, in an attempt to modify existing theoretical views regarding risk perception.

### **Examination of a cultural theory of transport risk**

*Torbjørn Rundmo, Hroar Klempe, Stig H. Jørgensen (Norwegian University of Science and Technology), Juliana Granskaya (St. Petersburg State University, Russia), Trond Nordfjærn (Gediz University, Turkey).*

Studies out previously have applied several cultural theory approaches to explain risk judgement without success. Obviously, one a possible reasons for the failure may be that the theories have been inadequate. The main objective of this research is to present and examine the psychometric qualities of a new measurement instrument aimed to examine culture as symbol exchange, i.e. as communication, based on Sausserian semiology. The results are based on a self-completion questionnaire survey about transport risk perception and behaviour carried out in Norway, Russia, India, Ghana, Tanzania, and Uganda (n=1951). The reliability of the new measurement instrument was found to be satisfactory. In accordance with studies carried out previously, the results showed that general culture as well as traffic safety culture in transport was not significantly associated with risk judgements. However, culture predicted drivers' transport risk behaviour. In addition, culture seemed to be a more significant predictor in collectivistic cultures while attitudes were more important in individualistic cultures. It may be that research carried out previously on the role of culture has not focused the relevant criterion variable and also drawn conclusions in general that is culturally biased.

## W7 RISK AND EXPOSURE MODELING

Wednesday: 1330-1500, R3

Chair: Paul Amyotte (Dalhousie University)

### **Demonstration and exploitation of the 2-FUN human exposure model identified as a promising tool derived from European research activities; A case study on Pb in the environment**

*Johan Bierkens, T. Fierens, M. Van Holderbeke, C. Cornelis, A. Standaert, L. Int Panis (Flemish Institute for Technological Research, Belgium)*

Human health risk assessment and management of chemicals is a major concern for policy and industry and ultimately benefits all citizens. Exposure assessment is generally considered to be the weakest point, because current tools: (a) lack an integrated approach for assessing combined stressors, (b) often use 'worst-case' scenarios leading to over-conservative results, (c) lack uncertainty/sensitivity tools allowing the identification of risk drivers. To overcome these drawbacks, the FP6 project 2-FUN developed a prototype software package containing a library of models for exposure assessment, coupling environmental multi-media and PBPK models. The FP7 funded 4-FUN project aims at the demonstration and exploitation of the 2-FUN prototype software. Transfer to stakeholders will guarantee its long term viability. Case studies on actual datasets for both organic and inorganic pollutants will be performed to validate the 2-FUN tool. We report on a case study focusing on lead pollution mainly due to past emissions by non-ferrous smelters in Belgium (Northern Campine Area). The following datasets are available for validating the 2-FUN tool: (i) biomonitoring data on Pb in blood from children; (ii) data on population behaviour (diet, activity patterns, etc.); (iii) Pb contamination levels in air, dust, soil, well water and locally produced food in homes and public places. The biomonitoring campaign enrolled 338 toddlers aged 2 to 6 years, recruited in the study area and in a reference area. Based on these measurements, an exposure scenario will be developed to estimate the external Pb exposure and also calculate the Pb body burden (based on PBPK modelling). Model simulations will be compared with past evaluations (e.g., Standaert A. et al. 2009 *Epidemiology* 20;6: S53-S54). The final objective of the current research is to improve the reliability of the 2-FUN model calculations through a systematic comparison with actual measurements and to demonstrate how uncertainty

margins can improve risk governance for realistic exposure scenarios satisfying the needs of stakeholders.

### **A qualitative approach to risk management of hazardous materials in the Netherlands: lessons learned from 7 sluice cases**

*Vincent van der Vlies (ARCADIS Netherlands, The Netherlands)*

It is no secret that the Netherlands is prone to risks of flooding due to the fact that the country is largely located below sea level. Throughout history however, the Dutch have made the location to their strategic advantage by using rivers and the North Sea for water transport. Also, the Dutch have created a vast network of waterways such as canals with sluices and floodgates to ensure safety, as well as means of transportation by water of (among others) large quantities of hazardous materials.

The debate on risks concerning hazardous materials has intensified in the Netherlands since the 1980s. Following the Bijlmer airplane disaster in Amsterdam in 1992 and the SE Fireworks disaster in the city of Enschede in 2000, for example, society has become more aware of the risks involved in the production, storage and transport of hazardous materials. In order to prevent disasters and improve the safety of people in areas adjacent to risky activities the Dutch implemented external safety policy (*externe veiligheidsbeleid*). External safety policy aims to control the risks related to the production, storage and use of hazardous materials as well as the transport by road, rail or water and through pipelines.

The Dutch government has specified generic external safety norms to give direction to decision making. Risks are calculated however with models that not only use transport of hazardous materials as their input, but also population numbers in the adjacent area. Due to the fact that not many people live directly adjacent to dams and sluices, it would seem as if an incident would not lead to many problems due to a low population density. However, if sluices and floodgates were destroyed by an incident of hazardous materials, the primary function would be diminished resulting in new risks. The normally used quantitative approach therefore does not seem to be a sufficient way to control risks.

In collaboration with Rijkswaterstaat, the collaborative arm of the Dutch Ministry of Infrastructure and the Environment, we executed seven case studies in order to test a qualitative approach and by using, among others, risk

inventories and evaluations, questionnaires and interviews. This paper studies the effectiveness of a qualitative approach to external safety risks in relation to water transport and particularly reflects on its effectiveness with regard to controlling risks at sluices and dams.

### **The approach for cyber common cause failures risk assessment of smartgrid substation with a critical load**

*Eugene Brezhnev, Vyacheslav Kharchenko, Artem Boyarchuk*

Electricity industries are being widely transformed, driven by the need for more energy, urbanization, scarcity of natural resources and global warming. One of the most promising technologies is the smart grid technology which combines a traditional electric power grid (PG) with an "intelligent" information and communications technologies to produce a smarter power system. Nuclear Power Plants (NPP) is an intrinsic part of future smart grid.

The substations which provide links between NPP and PG are extremely strategic to NPP safety. Compared to other systems in an electric utility network, the substation has the highest density of valuable information needed to operate and manage a smart grid. Unreliable substation equipments and insufficient cyber security introduce new risks to NPP safety.

Nowadays there are no differences among substations in respect to cyber security. But substations with critical loads, such as NPPs, should be given the highest level of importance. Substation security issues are important in the respect to NPP safety. Smart substations main assets are not only physical facilities, but also cyber information, databases and software applications, different intelligent digital devices.

Substation state of operability might be compromised by common cause failures (CCFs) which could occur at any substation levels and introduce new risks to NPP operation. CCFs are the failures (or unavailable states) of more than one cyber assets due to a shared cause during its operation. CCFs include the hardware common cause failures (HCCFs) and cyber common cause failures (CCCFs). HCCFs are known issues in safety critical industries but cyber CCFs might be determined as events when cyber assets' availability, confidentiality and integrity are compromised within a specified (short) time interval. The reasons are the common vulnerabilities, coupling within networks between equipments which might lead to security violation due to human errors, shared input data equipment, environmental events (flooding, storm and cyber attacks).

Diversity is suggested as one of the general principles of fault- and intrusiontolerant smart substations designing and increasing its reliability. The approach for smart substation CCFs risk assessment and mitigation techniques is suggested including diversity and defense in depth. The new metrics of smart substations diversity evaluations are introduced which allow estimate the diversity required to decrease risks of CCCFs. Smart substation's attributes of diversity (design, signal, functional, equipment and others) are considered in the paper.

### **The role of maintenance management in managing major accident barriers**

*Elisabeth Hansson Blix, Robert Ekle (Safetec, Norway)*

Barriers against major accidents are in focus by the petroleum industry and the Petroleum Authorities (Ref. Principles for barrier management). Barriers shall be established to protect the facilities against major accidents. The barriers shall be technical, operational and organizational and shall either "reduce the probability of failures and hazard and accident situations developing" or "limit possible harm and disadvantages of such". The barrier strategies being developed by the industry today can in many ways be described as a way to do design specific risk analysis to living documents in the operational phase as the barriers shall prevent against the major accidents described in the risk analysis. All installations are undertaking maintenance and inspection activities, traditionally the work tasks and the frequency for planned maintenance was based on industrial practice and vendors proposals. Reliability centered maintenance (RCM) are a structured analysis to established a maintenance programme with maintenance activities being optimal for safety, cost and operational availability. RCM analysis has become commonly used both on drilling facilities and production facilities.

This article discusses the interface between the new barrier management regimes and the maintenance management regimes. These regimes have many interfaces and there are a lot to gain on letting these systems "play together". This interface has been outlined in the NORSOK standard Z-008 (Risk based maintenance and consequence classification) but the standard gives no details for how to actually integrate the barrier management and the maintenance management system. Many of the activities taking place to follow-up and verify the established barriers, especially the technical barriers, will be activities described and reported in the maintenance management system. Additional

reporting may be required to give the overview of the barrier status as requested by the barrier strategy. This paper will present and discuss case studies, mainly from drilling rigs on the Norwegian continental shelf.

## W8 RISK PERCEPTION III

Wednesday: 1330-1500, R4  
Chair: Michael Siegrist (ETH Zurich)

### **The use of the symbolic significance heuristic as a source of biased decisions**

*Michael Siegrist, Bernadette Sütterlin*

In assessing the outcomes of decisions, people may rely on the symbolic significance heuristic. This heuristic describes people's tendency to use symbolic significant attributes while neglecting other crucial information. People may be especially prone to use this heuristic in decisions on topics that are subject to social norms, such as environmentally friendly behavior, environmental risks or risks for humans. In Experiment 1, participants were presented with two energy consumer descriptions. One contained a positive symbolic significant attribute (e.g., driving a Toyota Prius) and a negative symbolic neutral attribute (e.g., covering 28,700 km); for the other one, the reverse was true (e.g., driving an SUV and covering 11,400 km). As expected, the energy use of the consumer with the positive symbolic significant attribute was rated lower than the one of the consumer with the negative symbolic significant attribute. In Experiment 2, participants had to assess the environmental impact of sulfur dioxide emissions. In one description the emission was man-made, in the other description the emission was caused by a volcano. Even though the negative outcome (i.e. the number of fatalities) was described in the same way in both conditions, participants assessed the outcome to be more severe in the man-made disaster compared with the natural disaster. In Experiment 3, participants received either the information that three workers died during the construction of a nuclear power plant or the information that three workers died during the production of solar panels. Participants were asked to assess the tragedy of the incident. Even though the outcome was the same, participants perceived the incident as more tragic in the solar panel scenario compared with the nuclear power plant

scenario. The three studies demonstrate that the use of the symbolic significance heuristic may result in biased and more risky decisions.

### **PRIC: Introducing an augmented model of Perceived Risk Information Control in the context of electromagnetic field risks**

*Isabelle Stevens, Lieven De Marez, Tom Evens (iMinds-MICT-UGent, Belgium)*

Over the last decades, various models were developed as tools to assist the design and implementation of effective risk communication strategies. Especially in contexts where opaque risks are socially amplified because of the lack of unanimous scientific evidence of potential hazards on short or long terms, effectively communicating about these risks and about effective preventive behaviour is very hard. Also in the context of electromagnetic field (EMF) risks, increasing emphasis has been put on the public's risk perception (Nielsen et al, 2010; Hom et al. 2011, Wiedemann, 2006), its predictors and relationship to information seeking. Interdisciplinary research tracks have been established, involving both engineers to scrutinize specific EMF exposure levels and pathological risks, and social scientists to assess the subjective risk perception processes. In general, we can state that people are increasingly confronted with EMF radiation technologies and moreover, besides the lack of consensus on scientifically proven effects, there is also a large amount of biased information on this topic. One of the core objectives was the validation of an integrated risk information behaviour model in the context of EMF risks (PRIC). The proposed model integrates building blocks of four fundamental (risk) information seeking behaviour models (PRISM, RISP, TPB & EPPM). Hypothetically, risk information seeking is triggered by affective responses on increased risk perception levels. However, this study also focuses on the empirical relationships between information seeking, information seeking control (self-efficacy in information gathering) and the final perceived level of risk information control. A cross-sectional survey (n=559), scrutinizing risk perceptions and related concepts in the context of EMF risks was performed among citizens in the city of Ghent, Belgium. Using latent variable structure modelling (SEM), we can confirm that our new, integrating model accounted for 50% of the variance in the perceived risk information control. Concluding, the validated PRIC model states that risk information seeking is triggered by affective responses as a result of increased risk perception levels. The combination of concrete information seeking behaviour with the perceived level of self-efficacy in the seeking process affect

the level of perceived risk information control. The perceptions of controlling the information about the risk is stated to be a substitute for the inability to control the opaque risks of EMF radiation.

### **The gender gap in risk perception is the result of a task - dependent high-level cognitive process**

*Matthias Dhum, Corinne Moser, Pius Kruetli, Michael Stauffacher (ETH Zurich Institute for Environmental Decisions (IED) Natural and Social Science Interface (NSSI), Switzerland)*

A large body of research shows that women perceive (or at least: report) more or higher risk than men across a broad range of risk domains. However, evidence to explain the origin of this gender gap is still lacking. The scientific debate often refers to the "nature vs. nurture" concept, implying biologically hard-wired vs. socialized differences. In a series of studies, we utilized different methodological approaches from emotion psychology and neuroscience and different experimental tasks to further shed light on the emergence of the gender differences. In a normative rating of affective pictures, we were able to reproduce the common gender gap in risk perception. However, in a subsequent study investigating the neuronal underpinnings of these perceptual processes using functional magnetic resonance imaging (fMRI), we could not find any differences in brain activity between men and women. These results suggest that the gender gap is the consequence of a high-level cognitive process. This process is also task-dependent, which means that the mere visual perception of risk objects is not sufficient to elicit gender differences. The implications of these findings regarding the "nature vs. nurture" debate are discussed. Moreover, suggestions for new methodological approaches for the investigation of gender differences are presented by linking classical questionnaire studies on risk perception to methods from emotion psychology.

### **Towards an integrated model of risk perception: The case of Solar Radiation Management**

*Christine Merk, Gert Pönitzsch, Carolaa Kniebes (Kiel Institute for the World Economy, Germany) Katrin Rehdanz, Ulrich Schmidt (Kiel Institute for the World Economy, Kiel University, Germany)*

The implementation of new technologies crucially depends on their public acceptance. It is thus important to assess the public perception of technologies'

risks and its determinants. Previous research has mostly looked at factors individually; an integrated framework of risk perception is yet to be empirically established. This paper uses at the case of Solar Radiation Management (SRM) in Germany. Its implementation is currently discussed as a remedy for climate change but it implies large uncertainties and ambiguities about the long-term effects on the climate system. Our analysis uses Structural Equation Modelling. We look at the weighing of cognitive and affective components of acceptance and identify linkages between them. Preliminary results indicate an especially strong impact of trust in institutions, negative and positive affect, as well as the perception of risks and benefits on the acceptance of SRM. These factors mediate other determinants, like values, as well as the perceived seriousness of climate change. We do not find an impact of prior knowledge on acceptance

Key words: risk perception; acceptance; affective evaluation; trust; values; climate engineering; Solar Radiation Management

## **W9 RISK, ACCEPTABILITY, AND TRUST II**

Wednesday: 1330-1500, R90

Chair: Britt-Marie Drottz Sjöberg (Norwegian University of Science and Technology)

### **Public acceptance under low trust: A case study of Zenibako Wind Power Plant in Japan**

*Kosuke Sato, Susumu Ohnuma (Hokkaido University, Japan)*

Objectives: It is no doubt that trust is essential for unravel the tangles in a public decision making. The question is how to design the decision process when trusts in all stakeholders are low. We would have grave difficulty to renovate trust once lost. Transparent process should be designed in such a situation. Moreover, involvement of stakeholder, the third party and citizens is also required. However, the evaluation of the fair procedure would differ between those who approve/ disapprove the plan. This study attempts to find out an answer in such a controversial issue with a case study. First, effects of trust on approval and acceptance are confirmed with clarifying the difference between interests (or value similarity) and reliability consisted of expectation of intention



and ability. Then, we explore the relevant factors related to public acceptance. Finally, we discuss what the fair decision process is.

**Case:** Zenibako coast seemed to be a good candidate for siting the wind power plant. However, opposition movement arose claiming scarcity of coast vegetation, concerns for health hazards of low frequency wave and bird strike. The environmental assessment was carried out and inspected by the third party committee, which concluded that there is little concern for the claims. Even after this process, the movement did not settle down. This study investigates peoples attitudes towards the Zenibako case: the importance of relevant values, their estimation of each stakeholders behaviors, approval of siting Zenibako Wind Power Plant, and desirable decision process.

**Method:** To examine how people think about the Zenibako case, a mail-out survey was conducted in February 2012 to 900 random samples of residents living in 4-8 km distance from the site. Among these samples, 430 valid responses were obtained (47.9% collection rate).

**Results:** While many people approved for siting the wind power plant, their estimations of stakeholders trustworthiness, honesty, and fairness were low. Trust in stakeholders affected the degree of approval and acceptance even after the influence of evaluation of the plan was partial out. Procedural fairness of the local government and evaluation of the plan influences the degree of acceptance. This indicates the possibility that even those who disapprove would accept the plan if they evaluate the plan as good and the local government as taking fair procedure. However, desirable decision process was different by attitude toward the plan. The implication for public acceptance will be discussed.

### **Effect of risk perception and environmental concern on monetary valuation of health effects from road traffic-related air pollution and noise in five European countries**

*Erik Lebrecht (Utrecht University, the Netherlands, National Institute for Public Health and the Environment (RIVM), The Netherlands), Tiffany Istamto (Utrecht University, The Netherlands), Danny Houthuijs (National Institute for Public Health and the Environment (RIVM), The Netherlands)*

**Background and aim:** Evaluation of societal cost and benefits gain importance in management of environmental health problems. Willingness-to-pay (WTP) to avoid and willingness-to-accept (WTA) to accept health and wellbeing effects are central concepts. WTP/WTA can be derived from market prices e.g. health

care costs, value-of-a-statistical-life or the depreciation of property value. They can also be assessed by surveys directly inquiring about people's WTP/WTA. Either way, risk perception and acceptability issues are typically not incorporated in WTP/WTA studies. Our aim was to study how people financially value environmental quality and to assess how risk perception and environmental concern affect WTP/WTA of health effects of traffic-related air pollution and noise.

**Method:** A web-based survey was carried out in England (UK), Finland (SF), Germany (GE), the Netherlands (NL) and Spain (SP) in the context of the EU-funded project INTARESE. Two versions of the questionnaire were made to limit size; one focusing on air pollution and the other on noise. We aimed at 2000 respondents per country and respondents randomly received one of the two versions of the survey with a random sequence of the WTP and WTA questions to prevent biases. Translation was performed by the survey bureau and checked by native speakers.

**Results:** Overall, we obtained 10,494 questionnaires; 5243 for air pollution and 5251 for noise. The yearly WTP mean for air pollution in UK, SF, GE, NL and SP were respectively €146, €187, €180, €128 and €121. For noise, these were respectively: €85, €123, €123, €63 and €83. Values for WTA were a factor of about 35 higher than WTP values, in line with the literature. Multiple regression analysis indicated significant between country differences. In addition to known determinants from socio-demographics and economics (e.g. household income), risk perception and environment concerns also significantly added to the model. The differences between countries in WTP/WTA changed after adding information about risk perception and environment concerns.

**Discussion:** Earlier studies documented socio-demographic and economic factors as determinants of WTP/WTA. Our studies is the first to show the role and importance of risk perception and environmental concern for WTP/WTA for air pollution and noise in an international setting. It is also the first in assessing the WTP/WTA for both traffic-related air pollution and noise simultaneously using the same instrument. The role of risk perception and environment concerns and their effects on differences between countries show the importance of sociocultural differences between countries in WTP/WTA.

**Key words:** willingness-to-pay, willingness-to-accept, risk perception, environmental concern, air pollution, noise, monetization

### **The impacts of Fukushima nuclear accident on public acceptance of geological disposal of high level radioactive waste**

*Shoji Ohtomo, Hideaki Osawa, Yukio Hirose, Susumu Ohnuma (Konan Women's University, Japan Atomic Energy Agency, Kansai University, Hokkaido University)*

Objectives: The public acceptance of siting of radioactive waste disposal facilities is very difficult. The Fukushima nuclear power plant accident destroyed the trust in Japanese nuclear politics, and it has further increased the difficulty. This study explored the impacts of the accident on the public acceptance of siting a disposal facility of high level radioactive waste (HLW). We applied the technology acceptance model to predict public acceptance of investigation for siting of geological disposal facility of HLW. The model was determined by affective reaction, trust, risk perception, social stigma, social benefit, personal benefit, intergenerational subjective norm, and procedural fairness pertaining to geological disposal. People became sensitive about the radioactive contamination due to the Fukushima nuclear power plant accident. We presumed that social stigma (i.e. negative image associated with radioactive waste) and the intergenerational subjective norm (i.e. expected sanctions from family and future generations) were salient after the accident. Method: Longitudinal data were collected from Internet surveys that were measured before the Fukushima nuclear power plant accident (in February, 2011) and after the accident (in February, 2012). People who were recruited from around Japan based on Japanese demographic rate participated in the surveys. A total of 1930 people completed the pre and post - accident surveys. Results: The level of public acceptance of investigation for siting of geological disposal facility was decreased after the accident. Affective reaction, risk perception and trust of geological disposal became more negative. Moreover, the accident reinforced concerns about social stigma and intergenerational subjective norm. The perceptions of social benefit and procedural fairness were harmed after the accident. Furthermore, multi-modeling analysis before and after the accident showed the effect of trust was weakened and the effect of affective reaction was strengthened. Although people responded the same questions, previous variable assessing acceptance of siting investigation of geological disposal facility had correlated poorly with the post-accident variable. This means that general perceptions of siting facility of HLW were changed after the accident. Conclusion: Our results showed the Fukushima nuclear power plant accident altered Japanese people's acceptance of siting a disposal facility of HLW.

Therefore, people became less accepting the investigation for siting of geological disposal facility. This study discusses that the strategy for public acceptance of siting of radioactive waste disposal facilities should be changed in consideration of the accident.

## **W10 REGULATION OF MAJOR RISK II**

Wednesday: 1330-1500, R91

Chair: Lars Bodsberg (SINTEF)

### **Internal control regulations – a challenge for the management of ICT safety and security in Norwegian electric power supply network companies?**

*Ruth Østgaard Skotnes, Ole Andreas Engen (University of Stavanger, Norway)*

The aim of this article is to study managers' and employees' attitudes towards the current internal control (IC) regulations for ICT safety and security in network companies within the Norwegian electric power supply sector, and how IC regulations can be a challenge for the safety management of ICT systems in network companies. IC was introduced as the main principle for controlling safety and security in the Norwegian electric power supply sector in 2002. Instead of designing detailed rules and control systems, the authorities prescribe safety goals and permit the companies to develop and enforce their own detailed rules. These function-based regulations are meant to contribute to a heightening of the companies' sense of responsibility for their own safety.

However, according to results from observation studies, some companies find it difficult to comply with the IC regulations, and want more detailed norms and guidance from the authorities. IC regulations regarding ICT safety and security can pose a specific challenge for the safety managers in the network companies because of the complexity of the ICT systems. The results of a survey among managers and employees in Norwegian network companies suggest that a majority of the respondents have a positive attitude towards functional regulations. On the other hand, a majority of respondents also want more detailed safety and security guidelines for the current implementation of a new technology named advanced metering infrastructure.

The IC system can be a demanding and comprehensive system to keep up to date by the authorities; it demands a lot of knowledge and expertise to monitor that the companies comply with the regulations. However, the Norwegian electric power supply sector consists of companies with different organizational forms, functions, tasks, size, and goals, and it can be difficult to issue detailed regulations that would apply to all companies. Defining how the roles in safety management should be distributed between the state and industry has been said to be one of the most complex questions regarding safety regulation. According to interviews with representatives from the authorities, the introduction of self-regulation has resulted in reduced focus on contingency planning in many companies. To raise the safety level, more competence and knowledge about ICT risk, safety and contingency planning is needed in the companies, combined with more supervision and inspections from the authorities.

#### **Co-operation of authorities to prevent major risk – Finnish case study**

*Riitta Molarius (VTT Technical Research Centre of Finland)*

Risks associated with new technologies, as well as risks due to new configurations of old technologies, have been linked with recurring major accidents in societies. For example, in Finland, a change in the configuration of the wastewater purification plant in 2004 resulted in around 8000 people succumbing to illness (Heikkilä et al. 2011) and during the year 2010 the new building construction procedures caused risk of collapse and even the collapses of over ten ceilings or roofs in public sport centre buildings (Safety Investigation Authority 2011). And also at the end of 2010, the new access control system in railways was deemed to have created a dangerous situation when the change of one control section prevented communications between a train and the control system (Safety Investigation Authority 2009). These situations highlight the importance of comprehensive risk management. For example, in the water pollution case, the impacts of the new configuration were analysed with the sole focus on the waste water system, and no consideration was given to the interface with the tap-water network. However, these situations should have been relatively easy to handle, as there are only a few owners of those entire systems.

The situation differs when the question concerns the whole of society and the interaction of several unconnected actors, such as process sites in industrial areas, for example. As enterprises are generally reluctant to reveal their process

information to others, often due to the nature of competition, the authorities are the only ones who are in a position to compose any comprehensive picture of the actions over a whole region. However, the individual authorities also are limited to their own sectorial knowledge areas and, hence, there is a need for more extensive co-operation also between them, in order to obtain an all-encompassing depiction of the risk for the region. In Finland this co-operation is typically poor and it is based on reported opinions gleaned from other authorities on the basis of regulations. In order to improve the situation and to form a more comprehensive overview of the risks, I present an Integrated Assessment - based method which aims to enable smoother interaction with and between the authorities in their aim to identify emerging risks and the subsequent associated mitigation and preparedness actions. The method has been developed from the "Future Wheel" and the main focus is on workshops which strongly exploit also the tacit knowledge of different authorities.

#### **The role of environmental civil liability: an empirical analysis of the French legal system**

*Pierre Bentata*

In France, environmental harm is a domain largely regulated by administrative standards. Though, both at the EU level and at the French State level, the use of environmental liability has been greatly extended over the last decade. The aim of this article is to analyze the precise role of environmental civil liability in France. We do so by focusing on data from France, and claim that judges in fact seize hold of the possibility of combining regulation and civil liability. In other words, civil liability and regulation are complementary because they promote a duty of care in different ways. Moreover, judges and regulators interact; they provide each other with relevant information that is mutually beneficial for the maintenance of standards. Based on a unique database – that gathers all the litigations concerning environmental accidents judged by the French Supreme Court (Cour de Cassation) from 1956 to 2010 – we conclude that judges heavily rely on prior regulation, especially in cases of causal uncertainty. We argue that particularly in those cases where liability would traditionally be weak courts tend to rely on breaches of regulation as evidence of increased risk of an activity by the perpetrator. On the other hand, judges can hold regulators liable when regulators did not monitor a regulated plant and this threat provides regulators with incentives to design and to apply stringent standards over risky activities.

For these reasons, we conclude that regulation and civil liability should be jointly used to promote smart interdependencies that mitigate civil liability and regulatory failures.

### **Planning for Future Crises: Governance Principles for Slow-Developing Risks That May Have Potentially Catastrophic Consequences**

*Len Fisher (University of Bristol, UK), Marie-Valentine Florin (International Research Governance Council, Switzerland)*

Many of the serious problems that we face today follow a similar pattern, where the effects of slow, imperceptible change go unheeded until they bring us to a point of rapid, usually irreversible, and often catastrophic, change. This underlying pattern of slow-developing catastrophic risk (SDCR) leading to dramatic critical transitions in our socio-economic-ecological systems, may be seen retrospectively in recent bank and financial system crashes, in revolutionary social changes such as the “Arab Spring”, and in ecosystem collapses such as the desertification of the Aral Sea and large areas of China. Future instances are likely to include the social, economic and ecological effects of biodiversity loss and the dramatic consequences of slow, now probably irreversible, global warming.

Following a meeting between scientists, politicians and senior policy-makers at an IRGC-sponsored workshop at the Instituto Veneto di Scienze, Lettere ed Arti in Venice on 24–26 August 2011, a concept note was prepared based on those discussions, with further input from several of the participants. There was considerable cross-fertilisation of ideas across the various scientific, economic and social disciplines, with recognition of the essential commonality of the problem. Even more important was the recognition of how the potential governance of these serious long-term problems could be informed by science in new and effective ways, and how the emerging underlying principles might be used to develop practical policy guidelines.

Here we summarize the contents of that note (published in February 2013) and invite discussion of its key points, which include:

- The recognition that the potential for SDCRs is built in to all complex economic, ecological and social systems (in technical terms, such risks are endogenous). The risk arises from interactions and consequent changes within the system itself, rather than as a result of external factors.

- A framework for decision-making that recognizes the inevitability of SDCRs, and which includes 1) awareness of and flexible responsiveness to warning signs and 2) planning for resilience within our socio-economic-ecological systems, so that when SDCRs culminate in critical transitions (as some inevitably must), the effects both prior to and after the transition are mitigated, and adaptation to any new state is swift and effective.

- A framework for improved communication between scientists, policy-makers and other stakeholders.

### **Safety in the Petrochemical Industry: Review of Libyan Safety Regulations to Major Risks**

*Mustafa Elmontsri, Ibrahim Hadud (Higher Institute of Occupational Safety and Health, Libya)*

According to the Libyan Investment Board (LIB, 2011), the petrochemical industry is an essential component of Libya's manufacturing sector. Libya's economy is mainly dependent on the oil and gas industry, the petrochemical industry is specialised in the production of organic chemicals which are commonly used as raw materials for other products. Certainly, the petrochemical industry has provided numerous advantages to the public. However, petrochemical industry is one of the major risks that require strict safety regulations to avoid accidents and protect those working in the field. The industry involves chemical reaction, hazardous material, flammable explosion and any other risk that are can occur to the staff or the contractor for the company while doing their job.

This study focuses on the current status of safety and risk management activities conducted by the petrochemical plants in Libya, and on the trends in the global market.

This study is aimed at showing the risks associated with the petrochemical industry in Libya, it also aims at reviewing and assessing the Libyan safety regulations related to the petrochemical industry. The study will be based on actual assessment of the safety management systems in two large petrochemical plants in Libya. The review will include an assessment of the safety rules and procedures followed by these plants in order to critically analyse the current situation. The study will also provide actionable recommendations in order to help the Libyan authorities in issuing new safety regulations related to the Petrochemical industry in accordance with the international requirements.

Key words: Petrochemical Industry; Safety Management; Safety Regulations; Libya Major Hazards

## W11 SYMPOSIUM: BARRIER MANAGEMENT IN THE PETROLEUM INDUSTRY

Wednesday: 1330-1500, R92

Chair and introduction: Ole Magnus Nyheim (Safetec)

Safetec is currently working on several projects on barrier management in the petroleum industry, and will propose to arrange a symposium on this topic. To get a broader perspective on the experience with the development and implementation of various systems of barrier management, representatives from the petroleum companies Statoil and Teekay Petrojarl have been invited to participate and share their views.

Barrier management is a crucial part of the risk management process in terms of reducing the probability and potential consequences of major accidents, such as the Macondo blowout. However, there is a multitude of possible ways to deal with this topic in the design and operation of petroleum facilities.

Barrier management is highlighted in the guideline "Principles for barrier management in the petroleum industry" published in 2013 by the Petroleum Safety Authority (PSA) in Norway, as a method to ensure implementation of barriers that are relevant, effective and robust. The main purpose of barrier management is to either prevent an unwanted accident or reduce the consequences if an accident does occur. The systems, solutions and measures needed to secure the necessary amount of risk reduction are controlled through implementation and monitoring of barriers.

Several operators and drilling companies on the Norwegian Continental Shelf currently work with developing or updating their barrier management system based on the PSA guideline. Still, it is uncovered significant variation among these companies in terms of barrier management by means of inspections, investigations and mapping of risk level. The guideline is meant as a response to this, formulating and collecting the most important guidelines for barrier management. It is therefore an important issue to focus on clarifying the

requirements related to barrier management in the regulations in order to clarify and specify PSAs expectations.

### **Development of a barrier management system – both on an overall and installation specific level (Teekay Petrojarl)**

*Morten Søndrol (Teekay Petrojarl, Norway)*

Teekay Petrojarl (TKPJ) is currently working to update the overall system for barrier management, including a barrier management philosophy and administrative procedures built on this philosophy. The work also includes implementation on an existing FPSO and a new FPSO currently in detailed engineering.

The presentation will focus on how TKPJ have implemented barrier management in the company and our experience with the implementation process. This includes challenges related to developing a new barrier monitoring system in an organization already used to a certain way of operating, as well as a new barrier strategy for an FPSO that has been in operation for more than 10 years. The presentation will focus on both the system chosen for barrier monitoring in operation, and the development of installation specific barrier strategy and performance standards for the identified barrier elements. The latter has required a continuous inclusion of staff from the relevant FPSO when defining relevant DSHAs, necessary barrier functions and available barrier elements.

### **Operation Condition Safety – a method for verification of operational and organisational barriers**

*Snorre Sklet*

Operational Condition Safety (OTS) is a method for verification of operational and organisational barriers. The purpose of the method is to map and monitor organisational conditions influencing the risk for major accidents. The method is based on a set of performance standards developed for seven operational and organizational barriers; 1. Work practice, 2. Competence, 3. Procedures and documentation, 4. Communication and teamwork, 5. Workload and physical working environment, 6. Management, and 7. Management of change.

The presentation will give an introduction to the background for development of the method, how the method is developed, and finally, present some of the experiences gained through use of the method in practice.

## **Integrated barrier management**

*Stian Antonsen (Safetec, Norway)*

Integrated barrier management is a system that includes technical, operational and organisational barrier elements in one integrated barrier management system. The main ideas incorporated in integrated barrier management are that 1) there should be a clear link between the risk picture at a given installation and the barrier functions established to mitigate this risk, 2) technical and operational barrier elements are to be treated at the same level in the sense that they actively can stop an undesired sequence of events, or directly reduce the consequences of an undesired event, 3) the barriers should be treated as area specific in accordance to the actual risk identified in each area of the installation.

In addition, organisational barrier elements have to be integrated in the barrier management system. These will not necessarily stop an undesired sequence of events, but will rather influence the probability of an undesired event to occur or escalate, as these elements are directly and indirectly influencing the performance of the technical and operational barrier elements.

The presentation will provide an introduction to the principles on which integrated barrier management is built, to central challenges and to possible ways to move further. The latter refers to ways to verify the performance of different barriers, challenges to integration with maintenance systems, and challenges related to implementation and communication of the principles in the organisation.

## **W12 COMPLEX SYSTEMS- APPLICATIONS AND CHALLENGES**

Wednesday: 1330-1500, R93

Chair: Per Hokstad (SINTEF)

### **Visible Risk And High Sensivity In Urban Planning And Real Estate Development \_ Judicial Action And Social Acceptance 2013**

*Jean-François DAVID (Expert près la Cour d'Appel de Versailles, Expert agréé par la Cour de cassation, France)*

Scope and approach: Combination of large real estate programs and traditional land use – detached or semi detached houses - leads to itching and fears among inhabitants. The hereafter issue occurred around a large real estate and urban development site upon a former “Fort” of the XIXth century belt defending Paris. In that suburb with independent dwellings, that project was undoubtedly a tremendous change, leading to high sensitivity to environmental factors.

Legal response: When a real estate developer is about to start an important program with likely technical relations with its neighborhood, it is legally possible, in order to prevent or limit further litigation, to ask the court to have a judicial expertise ordered (“referee préventif”) to: - Assess as is situation, - Gather relevant information and evidence for further indemnification or mitigation, if any.

Question and technical answer related to environmental fears: Front to a political and collective fear of the possible impact of those building works–atmospheric fall out, dust, - associations of pupils’ parents wanted a strong environmental response. City council, in charge of school management and urban planning was both eager to give a positive answer to its constituency, and to have also an appropriate response to real estate building. The link with legal provisions of “référé préventif” gave way to an additional mission for an environmental expert (different of building and architecture expert already assigned in that project).

Results in public ownership and shared understanding of environmental situation: Air pollution measurement results were sent with a commentary from the judicial expert, which finally gave credit to a “no hazard situation”. The presentation will tackle : - The process to set up a technical monitoring system with stake holders, - The links between communication upon coarse technical results, public understanding and ownership of the environmental situation description under judicial process and supervision.

### **Animal husbandry in The Netherlands. An explorative study**

*Ric van Poll, Marleen Kraaij, Erik Lebret (RIVM, The Netherlands)*

Intensive Animal Production Systems/Animal Husbandry (IAPS) is becoming more and more a matter of debate and concern in society and policy making in The Netherlands. Those who are in favor point out the benefits like economic growth, efficient use of resources, ensuring affordable groceries or better

opportunities for control of animal and public health. Those against this development point out increased (public) health risks, compromised animal welfare, and the use of resources elsewhere (negative ecological footprint). The stakeholders involved are plenty and diverse, ranging from political parties to trade associations and from policy bodies to non-governmental organizations (NGO's). In the process it appears that the concept of IAPS is not very well defined. Various definitions may be found. Key elements in defining IAPS are 'soil-extensive' and 'large-scale' farms. On the question what is a 'large scale farm' also various answers may be found. It appears that IAPS is a multi-dimensional concept, that is: it is a hierarchical concept that is characterized by many different underlying aspects (or dimensions/ attributes), like economics, animal welfare, ethics, spatial planning, environment and health. These aspects all contribute to the concept in their own specific way. In turn, specific aspects of their own may represent these specific underlying aspects. The observed controversies, the ill-defined concepts, the diversity in aspects involved and the large diversity in stakeholders may easily lead to a societal dispute with Babel-like properties on the topic of IAPS. This requires stringent governance. We assume that further assessment of societal concern and stakeholder's perception of the concept of IAPS will positively contribute to the governance of the many aspects related to IAPS in the Netherlands. In the paper we will present some preliminary results on the concern assessment. We will also discuss key elements, uncertainties and ambiguities in the debate and present a research and activity agenda for risk governance of IAPS in The Netherlands.

### **Health, safety and environmental challenges in exposed aquaculture production – an investigation of fish farmers' experiences**

*Siri Holen, Ingrid Bouwer Utne (Norwegian University of Science and Technology)  
Ingunn Marie Holmen, Trine Thorvaldsen, Andreas Myskja Lien (SINTEF Fisheries and Aquaculture, Norway)*

Currently, there is an increased focus on aquaculture production in more exposed and remote waters. Such locations often have higher significant wave heights and stronger sea currents than the more sheltered fjords. However, moving fish farms further offshore is assumed to have several advantages, such as less environmental impact, fewer community conflicts regarding the use of coastal waters, and higher value creation. Several challenges have to be addressed and solved before fish farming offshore can be realized. The research

project SustainFarmEx (Towards Sustainable Fish Farming at Exposed Marine Sites) works with these issues involving several aquaculture companies, SINTEF, and NTNU.

The objective of this paper is to present the results of interviews and observations at several fish farms regarding operation during the winter storms of 2011 - 2012. The purpose of the investigation is to collect information about the working hazards and consequences of the storms, personnel work performance, how operation was impacted and the type of damages and incidents that occurred due to the bad weather. This information can be used to develop overall design, operation, and management strategies to improve safety, reliability, and productivity of exposed aquaculture production.

In total, eight interviews with personnel at five different locations were carried out. Four of the locations are in Norway, and one on the Faroe Islands. In addition, field observations of specific work operations at a relatively exposed fish farm in a fjord were included. Typical experiences of relevance for exposed aquaculture production are that often during the winter season, and sometimes several days in a row, it is not possible for the personnel to move around on the cages. At times seawater flows across the gangways and may reach the handrails. This means that the risk of accidents, such as crushing, falling, and drowning, increases, along with wear and tear on ropes and nets. Rough conditions also involve operational challenges, with for instance feeding and removing dead fish, leading to less optimal living conditions for the fish in the cages.





# POSTER ABSTRACTS

## POSTER OVERVIEW

Poster session Monday 1700-1900:

**B. Ádám & G. Gulis**

The relation of risk assessment and health impact assessment

**C. Aschan**

Coordination of European Research on Industrial Safety

**M. Ashrafi & H. Davoudpour**

An Analysis of an Offshore Accident: a Chaos Approach in Risk Assessment

**C.-H. Chan & K.-Y. Wu**

Risk Assessment of Exposure to Bis(2-ethylhexyl) Phthalate (DEHP)

**S.-Y. Chiang, C. Dalajamts, H.-L. Yu, M.-T. Wey & K.-Y. Wu**

The Development of A Physiologically Based Pharmacokinetic (PBPK) Model for Aristolochic acids (AAs) and Their Metabolites in Rats

**F. Guerra-Diaz & M.R. Rovira**

Contextualising the origin of environmental, social and corporate governance risks: A conceptual model

**J. Hegde**

Interpretations of Surprise Dimensions Applicable to Safety Studies

**S.-M. Hong, J. Kim & S. Kim**

Before/After Fukushima: Analyzing the Change of Different Acceptances of Nuclear Power with Cross-sectional Data in Korea

**Hope, Jones, Webb & Watson**

Understanding Rebound Effects: The role of Compensatory Green Beliefs

**C. Houcine**

A probabilistic approach of flood risks applied to the Dutch lakes and rivers

**H-T Hsu, Y-C Chang & Y-W Shiau**

A study of airborne particulate metals in the surroundings of an electric arc furnace factory and its effect on the pulmonary function of school children in central Taiwan

**J.Jung, G. Kim, Y. Choi & S. Kim**

The Impact of Value on Japanese's Trust, Perceived Risk and Acceptance of Nuclear Power after Earthquake and Tsunami, 2011

**G. Kim, Y. Choi & S. Kim**

Does the Fukushima Accident Matter!: Macro-Level Analysis of Change in the Public Acceptancetoward Nuclear Energyacross 49 Countries

**H. Kim, S. Kim & S-M Hong**

The Role of Affective Image in Stability and Change of Attitude after Fukushima Nuclear Accidents

**J. Kim, J-B Joo & S. Kim**

The Comparative Study of Public Attitude toward Nuclear Power Energy in 10 HNPDCs (Highly - Nuclear - Power - Dependent Countries)

**S. Kim, J. Park & J. Jung**

Searching for Principles of Attitude Change in Risk Judgment after Fukushima Nuclear Power Accidents

**G. Kjølle, M. Hofmann & O.Gjerde,**

Monitoring vulnerability in electric power systems

**I.J. Knai**

Styring av sikkerhet i lys av diskurs

**P-C Lia, & H-W Maa**

Spatial and temporal variation of human health risk of dioxin in Kaohsiung City, Taiwan

**C. Park & S. Kim**

Analyzing the Variation in Social Acceptance of Nuclear Power across 27 European Countries

**J. Park, S. Kim & Y-S Ham**

Exploring the Anchoring Effect of Value on the Acceptance of Nuclear Power Energy

**S. Park, J-B Joo & S. Kim**

Experience vs. Perception: The Role of Real Experience on Acceptance of Nuclear Power

**C. Petrovitsch & C. Klöckner**

Factors for Concern about Crime and Trust in the Police after Experiencing Violent Crime

**M. Rasmussen**

Development of a Petroleum Human Reliability Analysis Method

**Y. Ryu, S. Kim & S. Park**

The interactive impacts of distal and proximal factors on intention to purchase Japanese food products after Fukushima Nuclear accidents

**K. Y. Ryu, J. Wang & S. Kim**

Testing the Heuristic-systematic Information-processing Model (HSM) in Risk Perception about Nuclear Power Accidents from Fukushima, Japan

**Sano & M. Kikuchi**

How did weekly magazines in Japan report the risk caused by the nuclear power-plant accident

**K. V. Størkersen**

Railway and maritime transporters' view of supervising authorities

**G. Sætren**

Human factors and safety in an implementation process of automated drilling technology on an offshore oil and gas installation

**L.Tang, T. Yokoyama, H. Kubota, & A. Shimota**

Life Cycle Assessment of electricity generation from coal-fired power plants with carbon dioxide capture and storage in Japan

**L. Vederhus, J.I. Håvold, S. Nistad, M. Aarset, & A. Ødegård)**

Perceived Demands in Integrated Offshore Operations

**J. Wang & S Kim**

Does Trust Matters? : Impact of Trust on the Public Acceptance of Nuclear Power Energy

**M.White, W-S Timmins & C. Redshaw**

The Pharma Transport Town: Understanding the Routes to Sustainable Pharmaceutical Use

**C. Whittle, C.R. Jones, C.R. & A. While.**

Are Citizens Prepared for a Sustainable Future?

**T. Wold**

Challenges with using Safety Management Systems in a petroleum producing company

**C.-H. Yang, S-Y Liu & K-Y Wu**

Probabilistic Assessment of Health Risk for Dioxin in Taiwan

**H. Yeonji, S. Kim & G.Kim**

The analysis of determinants for risk judgement about Fukushima nuclear accident

### **The relation of risk assessment and health impact assessment**

*Balázs Ádám (Center of Maritime Health and Society, Denmark), Gabriel Gulis (University of Southern Denmark)*

The level and distribution of health risks in a society is substantially influenced by measures of various policies, programmes or projects. Risk assessment can evaluate the nature, likelihood and severity of an adverse effect. Health impact assessment (HIA) provides similar function when used as a powerful tool for the evaluation of potential health consequences of planned measures. It is often discussed whether HIA is not just another term or form of risk assessment and what is their relation. Our aim is to discuss similarities and differences between the two methods so as to clarify their relationship. The experiences accumulated during the preparation of several case studies in a large scale international project (RAPID) are used for argumentation and formulation of recommendations on how risk assessment can be systematically integrated into the HIA process. Risk assessment uses well standardised scientific methods to characterise the probability and magnitude of harm caused by a hazard, preferably in a quantitative manner. In turn, HIA is a process to assess future impacts of recent proposals and is dominated by qualitative evaluation. It makes a projection for a future scenario rather than assessing a present situation. As part of this process, however, methods applied in risk assessment are used. Risk assessment typically characterises relation of a well-defined risk factor to a welldefined health outcome. Within HIA usually several individual risk assessments are needed in the risk appraisal phase to describe effects of various factors on different health outcomes. Consequently, HIA is typically led by a large, preferably intersectoral steering group with representatives of communities at risk. Risk assessment, in contrary, is mainly a licensed scientific process completed by licensed experts and lacks participatory approach. According to our findings, to be able to manage the analysis of the complex impact structure of various planned measures in HIA, the comprehensive assessment of health effects requires the analysis of the full impact scheme and must follow each level of the causal chain from the proposal through related health determinants and risk factors to health outcomes. The stepwise analysis, systematic prioritization and consideration of horizontal interactions between the causal pathways make it feasible to use widely recognized risk assessment methods in the HIA process, even in the most demanding cases of policy HIAs.

### **Coordination of European Research on Industrial Safety**

*Carita Aschan (Finnish Institute of Occupational Health, Finland)*

ERA - NET scheme is the principal means launched under the EU Framework Programme 6 to support the cooperation and coordination of national and regional research programmes in the EU member states and associated countries, and hence an important element in the drive towards the creation of the European Research Area (ERA). Its objective is to develop and strengthen the cooperation and coordination of national or regional research activities through networking of programmes, including their mutual opening and the development and implementation of joint activities.

SAF€RA is an ERA-NET project entitled 'Coordination of European Research on Industrial Safety towards Smart and Sustainable Growth' funded for three years by the European Commission in the 7th Framework Programme. It responds to the fact that industrial safety is an enabling and important success - factor in the pursuit of beneficial business activities, and hence a vital and important prerequisite for sustainable growth and competitiveness of the EU. The problems related to industrial safety are common to all and cannot be tackled adequately at the national level. Therefore, there is an urgent need to refocus the resources of national research programmes in EU Member States on industrial safety. SAF€RA will bring dynamism into European research on industrial safety by fostering collaboration of national research programmes, by encouraging lateral thinking and by promoting innovations related to implementation of industrial safety.

SAF€RA is a consortium of 19 public agencies, ministries and research organizations representing 10 European countries which fund or manage research in industrial safety. The consortium has started its work by identifying the thematic research landscape and funding mechanisms within their national funding programmes and by examining complementarities, gaps and new opportunities in safety research, which has enabled the consortium to elaborate a common vision and a joint research strategy addressing the main problems encountered in industrial safety in partner countries. This includes identification of thematic priorities for future joint research programmes prior to the launch of joint calls for proposals concerning industrial safety. In the presentation first tangible results of SAF€RA will be reported.

### **An Analysis of an Offshore Accident: a Chaos Approach in Risk Assessment**

*Maryam Ashrafi, Hamid Davoudpour (Amirkabir University of Technology, Iran)*

Risk and safety management theories and methods such as other scientific disciplines are fundamentally influenced by thinking paradigms under which theories and methods are developed. The reductionism (Newtonian) and chaos (Post-Newtonian) paradigms are different paradigms which can result in different risk and accident analysis methods. Taking into account Newton's rules of movement, reductionism assumes the entire world as a machine controlled by robust and predictable rules. Based on this paradigm, system identification is limited to its components identification and inter-components cause and effect relationships are ignored or assumed simple and linear.

Technology increasing growth, enhancement of the modern world's communications and interactions and the development of complex technological systems lead to the emergence of complexities that methods based on traditional Newtonian paradigm are not capable of comprehensive risk analysis and management in complex technological systems. Almost all traditional hazard or risk analysis techniques, such as FMEA, HAZOP, FTA, and PRA rely on a chain of linear cause and effect analysis. Specifically, they are not suited to handle complex systems with nonlinear cause and effect relationship, and emergent characteristic.

Considering traditional paradigm limitations, the scientific flow of risk and safety management should shift to a new paradigm. Chaos theory as the basis of this modern paradigm can provide us with a more accurate analysis of complex technological systems accidents. Based on chaos paradigm, systems' trajectories constantly fluctuate among various attractors and sometimes a micro change in a part of system can result in deep and macro changes in the whole system.

We propose a novel conceptual approach of risk assessment in complex technological systems based on the concept of chaos theory, evolution over time and taking into account nonlinear nature of cause and effect relationships. The main premise of the proposed approach claims that employing a non-classical thinking approach of risk assessment in will result in a higher and more accurate awareness of the overall system.

We analyze an offshore accident based on the chaos-based approach and its features consisting of sensitiveness to initial condition, nonlinearity, and

dynamic adaptation. Finally, the challenges with which we may encounter in chaos-based accident analysis are discussed and its advantages and disadvantages are concluded.

### **Risk Assessment of Exposure to Bis(2 - ethylhexyl)Phthalate (DEHP)**

*Chi-Hsuan Chan, Kuen-Yuh Wu (National Taiwan University, Taiwan)*

Bis(2-ethylhexyl)phthalate(DEHP) is a widely used plasticizer in polymer products and considered as an endocrine disruption and is associated with reproductive toxicity. Industrial release and migration of DEHP from plastic containers could lead to human exposures. In the past more than 10 years, environmental monitoring on DEHP has been conducted by Taiwan Environmental Protection Agency. These data was not systematically evaluated for environmental policy. Therefore, aggregate assessment of health risk for residents exposed to DEHP through multiple media and routes was conducted by using the CalTOX multimedia model. Local landscape properties and exposure factors were used with a continuous emission of DEHP to simulate environmental concentrations and compared with available DEHP data for validation. Two-dimensional Monte-Carlo simulation was operated by using the Crystal Ball software to calculate concentration, dose, hazard index (HI) and risk distributions. Preliminary results reveal that predicted concentrations of air, surface water and sediments from CalTOX are within the range of those in the collected environmental data. The estimated 95th percentile of the aggregate dose for the general population in Taiwan was 3.02  $\mu\text{g}/\text{kg}/\text{day}$  and the corresponding hazard index (HI) is 0.17. These results should be considered as DEHP environmental exposure for the general Taiwanese residents under a continuous input rate and be taken into account for further assessments of specific exposure pathways.

### **The Development of A Physiologically Based Pharmacokinetic (PBPK) Model for Aristolochic acids (AAs) and Their Metabolites in Rats**

*Su-Yin Chiang (China Medical University, China), Chimeddulam Dalajamts (National Taiwan University, Taiwan, Health Sciences University of Mongolia, Mongolia), Hwa-Lung Yu, Ming-Tsai Wey, Kuen-Yuh Wu (National Taiwan University, Taiwan)*

Consumption of Chinese herb (*Aristolochia fangchi*) containing aristolochic acids (AAs), a mixture of nitrophenanthrene carboxylic acid derivatives found primarily in the genus *Aristolochia*, is associated with a progressive renal interstitial fibrosis known as aristolochic acid nephropathy. The objective of this work was to develop a physiologically based pharmacokinetic (PBPK) model to predict levels of AAs and their active metabolite aristolactams (ALs) in target organs of rats treated with a single dose of AAs at 0.5 and 5 mg/kg and to investigate the influence of dose-dependent metabolism on the predicted blood levels of AAs. The model will help to reduce the uncertainties associated with dose, route, and species extrapolations in the assessments of cancer risk of human exposure to AAs. The model structure for AAs and their metabolites was time-dependent and flow-limited and consisted of five essential compartments: liver as a specific tissue for the metabolism, richly perfused tissues, poorly perfused tissues, adipose, and kidney as a target tissue and for the excretion. Model development and simulation were performed by using software packages of MATLAB and Simulink graphical user interface (GUI). The model equations included the ordinary differential equations to explain the change in amount of AAs and ALs over time and algebraic equations. Some chemical specific model parameters, such as partition coefficients were predicted based on the method of unified algorithm developed by Peyret and his coworkers in 2010. In the model, Michaelis-Menten kinetic parameters were estimated by fitting the model and used to describe the saturable metabolism and renal excretion and reabsorption for both parent AAs and metabolite ALs. The performance of the model was evaluated by comparison of the predicted blood levels of AAs and ALs to the levels measured in rats after i.p injection of AAs mixture. Sensitivity analyses were implemented to indicate dose dependent influence of metabolic activities on model output.

Key words: Aristolochic acids, Aristolactams, PBPK model, metabolites, partition coefficients

### **Contextualising the origin of environmental, social and corporate governance risks: A conceptual model**

*F. Guerra-Diaz, M.R. Rovira (University of Barcelona, Spain)*

The complex nature of challenges, such as environmental conflicts and economic crises, compel companies to adopt measures, which include

environmental, social and corporate governance (ESG) issues as risks. Although, companies are becoming increasingly more concerned with managing these risks, they are having problems doing so.

To find a possible cause of why companies are having problems in managing these kinds of risks, it is necessary to know the origin and in which they are used. For this, we conducted a literature review of the concept of risk, their elements and characteristics in the natural, social and economic systems using the ecological economics points of view. With this, we designed a conceptual model that shows the differences that have the concept of risk in the three systems studied, allowing contextualize the origin of ESG risks and their relationships with the different sciences involved in the study and management.

The results show that there are two main schools of thought that define the risk. A social line in which the risk is understood in terms of the individual's intrinsic state of mental perception, direct consequence of modernity and of our own decisions. The other line corresponds to a point of view mainly dominated by economists in that risk is conceived in terms of an attribute, which is external to the individual and exists when it can be measured and calculated.

The ESG risks originate in finance field that belongs to the economic system. The interest on these risks stems from the importance and the necessity to incorporate these non-financial risks in their analysis, with financial tools. However, the ESG risks include issues related to both the social system and the natural system making it difficult to manage with traditional financial tools.

Our approach, summarized in the conceptual model, could help to generate a new type of ESG risk management for organizations. This vision would leave a partial point of view, limited only to the financial field that tries unsuccessfully to manage these risks. For this type of ESG risks, a systemic vision, would understand the interdependencies between them, providing a possible solution to the difficulty in managing such risks.

Key words: ESG Risk, Risk Management, Ecological Economics.

### **Interpretations of Surprise Dimensions Applicable to Safety Studies**

*Jeevith Hegde (Norwegian University of Science and Technology)*

As research in safety studies continually evolves, new theories and terminologies are used to describe, identify, and avoid surprising outcomes from critical accidents. While some studies refer to previously researched

terminologies, the contexts used to capture the reasons leading to surprises vary from study to study, resulting in varied perceptions on the same topic. To sustain continuous learning among research communities, it is essential to evaluate these theories amongst each other by exploring the possibility of arriving at a common ground between various terminologies. This paper employs a literature review methodology to identify key terminologies used by safety researchers to define surprises and investigates their inter-relationships. The theories reviewed in this paper are sensible and meaningful, but are dependent on the contexts used by researchers to demonstrate them. Since applications of such terminologies transcend into a wide area of real life scenarios, it is vital for the end-user to grasp them contextually. Holistic understanding of similar terminologies ensures that the end-users can make sense of such theories and apply them appropriately. By utilizing theories in tandem, the research community can also bridge the gap between existing terminologies. This paper discusses the ability of reviewed terminologies to probe the perennial question; "Are surprises really surprising?". It also provides examples that demonstrate the inter-relationships among research theories and terminologies used to study surprises.

#### **Before/After Fukushima: Analyzing the Change of Different Acceptances of Nuclear Power with Cross-sectional Data in Korea**

*Sung - Man Hong (Anyang University, South Korea) Jungyul Kim (Daegu University, South Korea), Seoyong Kim (Ajou University, South Korea)*

The accidents from Fukushima nuclear power plants seemed to give the swift of public attitude toward acceptance of nuclear energy. However, there are very few studies to examine the state and structure of such attitude changes. Therefore, by comparing the cross - sectional data after and before Fukushima, we highlight the structure of change in acceptance of nuclear power.

For this end, we reviewed the existing studies which mainly focused on aftermath after nuclear accidents of the Chernobyl and Three Mile Island. Those studies paid the attention to the topics such as change of relation and determinant structure, stability, reactance, convergence/polarization, multidimensionality and ambivalence.

For data analysis, first, we divide the acceptance of nuclear power into five sub - categories such as acceptance of nuclear power generation, acceptance of

nuclear power plant, local acceptance of nuclear power station, acceptance of nuclear energy, comparative acceptance. We expected that there are before - after variations of attitude changes across seven acceptances. Next, we will examine how much each perceived risk, perceived benefits, trust, knowledge and negative affect has impact on those attitude changes

#### **Understanding Rebound Effects: The role of Compensatory Green Beliefs**

*Hope, Jones, Webb and Watson (University of Sheffield, UK)*

To mitigate the risk of negative impacts from anthropogenic climate change and to promote more resilient and energy-secure societies, the UK government has set ambitious carbon reduction targets requiring a reduction in energy consumption in all areas, including the domestic sector. While it is anticipated that specially designed schemes like the 'Green Deal' will encourage the public to make the transition to more sustainable lifestyles by improving household energy efficiency, there is a risk that these efficiencies (and associated carbon savings) will be undermined, or negated, by "rebound" and "backfire" effects. For example, money saved on home insulation may be spent on long-haul flights that might otherwise not have been taken; or the installation of more affordable heating systems might lead people to maintain their homes at temperatures exceeding recommended levels. A novel approach to understanding this issue is through the application of the "compensatory beliefs" concept developed in Health Psychology (i.e. the belief that the negative effects of one behaviour like smoking, can be compensated for by engaging in a positive behaviour like exercise) to environmentally significant behaviours (e.g. electricity use, recycling, etc.). The results of a mixed methods study exploring the concept of compensatory beliefs in the domain of energy use and misuse (i.e. compensatory 'green' beliefs) will be presented with insights from interview, Think-Aloud and questionnaire data.

#### **A probabilistic approach of flood risks applied to the Dutch lakes and rivers**

*Chbab Houcine*

Large parts of the Netherlands lie below mean sea level or below local water levels of the large lakes and rivers. Therefore, the country has to be protected against flooding, using dikes, dunes and flood barriers. The design of these flood

defences is based on safety standards expressed as return periods. They vary from 1000 to 10,000 years. According to the Dutch water law, all main flood defences must be tested every 6 years.

The hydraulic load acting on flood defences can have many causes which usually fluctuate in time and space, and have random intensities. Probabilistic models are needed to combine these different threats. These models allow the estimation of the probability of flooding and evaluation of the actual dike heights and the need for reinforcements.

Basically, probabilistic modelling consists of a whole chain of activities that must be gone through. An important step in the probabilistic modelling is the calculation of water levels and wave parameters for a set of representative locations. Different combinations of boundary conditions result in a spectrum of situations in which the dikes are under threat. Under the authority of the Ministry of Infrastructure and Environment, more advanced models have recently been set up. For the computation of water levels a 2D WAQUA model was developed. This model replaces the existing 1D SOBEM model. 2D modelling allows for more accurate calculation of the water levels in complex areas. Furthermore, it generates water levels not only in the middle of the river but also on the banks. In deep and wide water branches a 2D SWAN model was developed to generate wave parameters. SWAN takes into account all physical processes that affect the waves as they propagate from deep water to the toe of a dike, including the propagation across varying bottom topography.

This paper shows the chain of activities included in the probabilistic modelling based on the example from the Rhine and Meuse estuary. Basically, in the Netherlands this model is made suitable for application in all inland water systems. This probabilistic approach of the Dutch water systems now forms a basis towards policy preparation and decision with regard to finding efficient investment in managing flood risks now and in future adapting to climate change and land subsidence

**A study of airborne particulate metals in the surroundings of an electric arc furnace factory and its effect on the pulmonary function of school children in central Taiwan**

*Hui-Tsung Hsu, Ya-Chi Chang, Ya-Wen Shiau (China Medical University, Taiwan)*

Electric arc furnaces (EAF) are used in the steel industry to convert pig iron, scrap and other iron units to steel. It is widely used in Taiwan to produce carbon and steel alloys. However, it is estimated that approximately 10 - 25 kg of dust is generated per ton of steel produced when scrap is remelted by EAF. In Taiwan, EAFs discharge approximately 170,000 tons of dust annually. Moreover, chemical analysis showed that concentrations of Cr, Cu, Mn, Mo, Ni, Se, Ag, Sn, V, and Zn in EAF dust were significantly greater than background soil concentrations. The mass of respirable particles as well as the chemical composition of the particles has been identified to be potentially responsible for various deleterious effects on human health. The present study combined air sampling with pulmonary function tests (PFTs) to determine both the extent of air pollution proximal to an electric arc furnace and its impact on human health. The mass concentrations of PM<sub>10</sub> and PM<sub>2.5</sub> in exposure areas were not significantly higher than the samples taken at a control area. However, the concentrations of five metal elements, Cd, Cr, Cu, Ni, and Zn in PM<sub>2.5</sub> were increased with decreasing distance from the emission source. PFTs showed that the average forced vital capacity (FVC) of boys was decreased with decreasing distance from the EAF factory. With normalization of pulmonary function by age, height and weight, we found that the  $\Delta$  FVC became more negative with a decrease in distance from the EAF. Lastly, regression analysis was performed to analyze the impact of the concentrations of the five metals in PM<sub>2.5</sub> on the performance of pulmonary function. The results showed that the metals can be ranked from the highest to the lowest in terms of impact on the variation of  $\Delta$  FVC of boys as follows: Cr, Cd, Ni, Cu, and Zn. This finding is consistent with the ranking of metal toxicity reported in the literature for a rat lung epithelial cell line.

**The Impact of Value on Japanese's Trust, Perceived Risk and Acceptance of Nuclear Power after Earthquake and Tsunami, 2011**

*Jaejin Jung (Gyeonggi Research Institute, South Korea), Seoyong Kim, Hyeongjong Kim (Department of Public Administration, South Korea)*

The Earthquake and Tsunami, March 2011 brought out the tragic results in Japan society. After they had struck the nuclear power stations in Fukushima, following catastrophic accidents have been changing Japanese's attitude and public policies toward nuclear energy.



Our study will analyze the impact of values on trust, perceived risk and acceptance of nuclear power among Japanese. As a lot of researches in risk analysis have focused the trust, perceived risk and perceived benefit as determinants for acceptance of nuclear power, very few studies had paid the attention to more deep fundamental factors to influence those three factors. We assumed the different values—Ideology, Fatalism, Religiosity, Post-materialism in our case—have consistent and significant impact on them.

Our analysis will test the role of value, based on survey data (N=700). First, we analyze the relationships between three variables—i.e. trust, perceived risk and acceptance of nuclear power. Second, analyze the impact of values on those three predicted variables after controlling demographic variables. Third, do how the interactions 'between values themselves' or 'between values and other independent variables', influence the predicted variables.

We believed that our study highlights the deep value structure and its impact on the attitude of trust, perceived risk and acceptance in nuclear power.

#### **Does the Fukushima Accident Matter!:**

##### **Macro-Level Analysis of Change in the Public Acceptance toward Nuclear Energy across 49 Countries**

*Geunsik Kim, Yongseon Choi (Institute of Governmental Studies, South Korea), Seoyong Kim (Department of Public Administration, South Korea)*

The accident of nuclear power stations in Fukushima caused by Tsunami, March 2011 has generally been assumed to change the public attitude toward nuclear power around world. However, there are no systemic studies to investigate the specific content and structure of attitude and its change. Our study aims to examine the public attitudes and its' change at the macro-level at the country level after the accidents by analyzing cross-national data (n=49 countries).

For this end, first, we describe the attitude, attitude change, no-change-rate and cleavage according to the basic demographic variables after the Fukushima accident. Second, after set up those variables as dependent variables, we test how the independent factors—*e.g., Historical, Economic, Cultural, Political, Risky Factors and etc.*—influence those attitudes. Based parsimonious model, we find out the relative explanation power of those factors in explaining the variance

of attitude change. Finally, we examine not only the interactions between independent variables but also their impact on attitudes toward nuclear energy.

##### **The Role of Affective Image in Stability and Change of Attitude after Fukushima Nuclear Accidents**

*Hyeonjong Kim, Seoyong Kim (Ajou University, South Korea), Sung-Man Hong (Anyang University, South Korea)*

Recently, a lot of researchers have found that the stigma as emotional or affective image does the critical role in risk perception. As the affective images have outweighed the rational calculative thinking, it seemed to play a role in the attitude formation or changes. Hence, our study will focus on the role of affective image in stability and change of attitude after Fukushima nuclear accidents. Like the Chernobyl accidents, the accident of Fukushima nuclear power station has been believed to change the attitude which people generally have in their mind. Also, the affective image will influence such attitude change. Hence, it is questionable how much or which way it influence the attitude stability and changes. We suggested that affective image has different impact on positive/negative thinking toward acceptance of nuclear power.

##### **The Comparative Study of Public Attitude toward Nuclear Power Energy in 10 HNPDCs (Highly - Nuclear - Power - Dependent Countries)**

*Jungyul Kim (Daegu University, South Korea), Jae-bok Joo (Korea Research Institute for Local Administration, South Korea), Seoyong Kim (Ajou University, South Korea)*

This study will comparatively analyze the public attitude toward nuclear power energy in 10 Highly Nuclear Power Dependent Countries, i.e., HNPDCs. For the comparison, we choose the ten countries as HNPDC - including Belgium, Bulgaria, Czech Republic, Finland, France, Hungary, Korea, Slovakia, Slovenia, Sweden - in which nuclear power shared above 30 percent of electricity production.

We assumed that, even if HNPDCs depend on the nuclear power, each public across countries shows different attitude toward it. Hence, it is questionable what makes such differences. This study will answer the question by analyzing the survey data collected at the individual levels.

Before analyzing the micro-level data, we describe the history and present state of nuclear energy in each country. Next, analyze the present state of social acceptance according to demographic variables. Finally, test the causal relationships between the acceptance of nuclear energy and its determinants.

### **Searching for Principles of Attitude Change in Risk Judgment after Fukushima Nuclear Power Accidents**

*Seoyong Kim, Jaeung Park (Ajou University, South Korea), Juyong Jung (Korea National University of Transportation, South Korea)*

The catastrophic accidents from Fukushima power plant, 2011, have changed people's attitude toward nuclear power or energy. To explain the process and degree of attitude change, it need utilize the comprehensive theories and test those in term of realistic situation. Our study will examine the structure and mechanism of such attitude change in case of Fukushima accident by mobilizing the survey method. To examine the attitude change, first, we set three variables — i.e., negative /positive attitude, degree of risk, risk-benefit ratio, all of which are related with risk judgment toward nuclear power - as dependent variables. Second, we will analyze the effect of proximal determinants for the attitude change, which include motivation, ability and amount of negative information. Finally, we test the role of distal causal factors in attitude change, which concern with the perceived risk, perceived benefit, stigma, trust and knowledge about nuclear power energy.

### **Monitoring vulnerability in electric power systems**

*Gerd Kjølle, Matthias Hofmann, Oddbjørn Gjerde, (SINTEF Energy Research, Norway)*

Modern society is increasingly dependent on a secure electricity supply to cover basic needs such as food and water supply, heating, safety, financial services, etc. At the same time, the power system is under change for a number of reasons, due to e.g., increased utilization of the power grids, integration of intermittent renewable generation, smart grids, and climate change. These factors may affect the vulnerability of the ageing power system. Vulnerability is here defined as an internal attribute of the power system regarding susceptibility or coping capacity towards a certain hazard or threat.

The control of these vulnerabilities is an essential part of power system asset management. Dedicated vulnerability analyses as well as suitable indicators are necessary to measure how vulnerable the power system is. However, presently there are only few, if any, available indicators. In particular, indicators and data on an aggregate level will help to monitor and predict the vulnerabilities in quantitative terms, and identify underlying mechanisms e.g., change in the power grid's technical condition. A research project in collaboration with grid operators and regulators has reduced this gap by developing methods and indicators to identify and analyse vulnerabilities. The project has emphasized extraordinary events, i.e., failures and disturbances in the power grids leading to wide-area interruptions or long-lasting interruptions with severe impact on society.

Research results are obtained in three different areas. First of all, a framework is developed of definitions, indicators and methods that can be used to monitor and classify vulnerabilities in electric power grids. Different types of indicators that cover all dimensions of vulnerability are specified and example indicators calculated. Secondly, methods and tools for enhanced power system risk and vulnerability analysis, with particular emphasis on extraordinary events are developed and tested. The methods take the conceptual bow tie model as a starting point and different methods of risk and vulnerability analysis are utilised. Thirdly, case studies are performed to illustrate the development and use of vulnerability indicators and methods. Several indicators are tested through case studies in co-operation with grid operators. In addition, historical blackouts and extraordinary events in power systems are analysed to learn from past events and understand the course of action that led to these events.

### **Styring av sikkerhet i lys av diskurs (in Norwegian)**

*Ivar Johannes Knai*

Etter terrorhandlingene i 22. juli 2011 er viktige sider ved norsk samfunnssikkerhet og beredskap satt under lupen. 22. juli-kommisjonens rapport påpekte alvorlige feil og mangler når det gjelder myndighetenes evne til å identifisere og erkjenne risiko, forebygge og håndtere alvorlig hendelser og kriser.

Norge står utvilsomt foran viktige veivalg. Kan vi være sikre på at dette blir gode valg som faktisk gir bedre sikkerhet? Har vi kort tid etter 22. juli 2011

tilstrekkelig gangsyn til å gjøre kloke valg om bl.a. den viktige balansen mellom sikkerhet og frihet? Er vi bevisst de diskurser og tilhørende kunnskapskonstruksjoner som over langt tid har formet det norske samfunnet og påvirket våre veivalg fram til nå? I hvilken grad kan bestemte problem- og løsningsforståelser ha resultert i nettopp slike feil som hendelsene 22. juli 2011 avdekket?

Dominerende diskurser og de kunnskapskonstruksjoner (virkelighetsoppfatninger) som produseres gjennom disse, kan eksempelvis omfatte en overdreven tro på detaljert styring og kontroll og det man kan kalle en instrumentell (mekanisk eller maskinmessig) tilnærming til årsak-virkning sammenhenger. Og hva er i så fall grunnen til at vi har slik tiltro til instrumentelle løsninger på organisasjons- og styringsproblemer?

Tilsvarende kan det finnes godt innarbeidede diskurser og kunnskapskonstruksjoner med en overdreven tro på bruk av nye teknologier og avanserte sikkerhetsstyringsystemer. EU har hatt en ganske ensidig teknologi- og systemfokus for sikkerhetsforskningen i sitt 7. rammeprogram. Nå advarer EU selv mot farene ved dette. I forarbeider til sikkerhetsforskningen i det kommende rammeprogrammet (Horizon2020) anbefales det å sette fokus på læring, involvering, demokrati, etikk og tillit, med andre ord på sosiale kvaliteter som er avgjørende for sikkerheten i et samfunn.

Manger ser på debatten i forkant av de veivalg vi skal gjøre med stor uro. Den «risikostyringskulturen» som allerede på mange måter preger vår tids samfunn, synes å bli befestet og få ytterligere kraft. I forlengelsen av de tolkninger og argumentene som brukes om risiko, sårbarhet og sikkerhet i samfunnet, kan det være betimelig å spørre: Er utfallet gitt? Går vi uvegerlig mot et samfunn hvor sikkerhet blir altoverskyggende og hvor vi må leve med omfattende sikkerhetssystemer på de fleste av livets områder?

Og, på et mer overordnet nivå, må vi spørre; Hvorfor får visse kunnskapskonstruksjoner og diskurser en nær sagt udiskutabel posisjon? Svaret på dette bør være interessant for alle som er involvert i styringen av sikkerhet i samfunnet.

Hensikten med essayet er først og fremst å stille to spørsmål:

Kan diskursanalyse identifisere, beskrive og forklare diskurser som preger debatten om framtidens samfunnsikkerhetsarbeid i Norge?

På hvilken måte kan bevisstgjøring om de aktuelle diskursene være viktig for styringen av samfunnsikkerhet og beredskap?

## **Spatial and temporal variation of human health risk of dioxin in Kaohsiung City, Taiwan**

*Pei-Chiun Lia, Hwong-wen Maa (National Taiwan University, Taiwan)*

Human health risk is mainly related to the pollutants of source emissions. These pollutants release chemicals of concern into environmental media, causing the hazardous effects to a human body. In order to estimate the effects of these exposures, it is required to use a human health risk assessment procedure, a useful tool to estimate health impact associated with various emission sources. Moreover, the risk is not only related to the sources but also depended on the geographical attributes and the temporal variation. In this study, the main goals are going to assess the health risk of receptors in the studied area, identify the spatial distribution of risk, and distinguish the annual variation.

Kaohsiung City, the second largest metropolis of Taiwan, is a significant industrial region. There are several stationary emission sources, including power stations, municipal solid waste incinerators, medical waste incinerators, sinter plants, electric arc furnaces, etc. The residential areas or agricultural regions are near these high-density industries. Despite all the sources are satisfied the emission standard, the health risk is possibly going to be considerable for receptors.

For the purpose of assessing the total health risk due to all types of emission sources, AERMOD, an atmosphere dispersion model, was used to estimate the concentration of contaminants in the environment. The target compound was the dioxin which is usually produced from combustion. The properties of dioxin emissions were determined by directly collecting and analyzing samples from the local stack flue gases. Then geographic information system (GIS) was used to calculate the cumulative concentration and to present the spatial distribution. The concentrations of dioxins were detected annually from emission sources in Kaohsiung City. In this study, the variation of health risks will be evaluated with annual data and spatial distribution.

To integrate the spatial distribution and temporal variation of risks is a way to identify the high risk region and period, which provides another perspective to modify the emission policy and to reduce the health risk.

### **Analyzing the Variation in Social Acceptance of Nuclear Power across 27 European Countries**

*Cheonhee Park, Seoyong Kim (Ajou University, South Korea)*

Since the nuclear energy provides not only benefit but also risk, the public felt the dilemma to accept it. Hence, it is natural that there exists the variation of social acceptance about nuclear energy across countries. However, few studies examined such variation and its cause across countries. Therefore, it need investigate the different attitudes and their cause across countries.

Based on survey data, our study will empirically analyze the variation and its determinants of social acceptance across 27 European countries. For this end, first, we describe the difference attitude across countries in social acceptance of nuclear energy, which defines as a support for the reduction, maintenance and increase of nuclear energy in production of electricity. Second, analyze how determinants such as perceived risk, perceived benefit, knowledge or information, trust, image and experience related with nuclear energy influence such acceptance after controlling the demographic variables. Third, based on qualitative data, we will provide the explanations and implication about the different acceptance across countries.

### **Exploring the Anchoring Effect of Value on the Acceptance of Nuclear Power Energy**

*Jaeung Park, Seoyong Kim (Ajou University, South Korea), Yo-Sang Ham (Daegu University, South Korea)*

What factors affect the acceptance of nuclear power energy? Usually a lot of researches have focused on the proximal independent variables — such as perceived benefit/risk, trust, affective image and knowledge — to influence the acceptance of nuclear energy. However, these factors cannot explain all the variance of acceptance because they are circumscribed by more fundamental factors, for example, value or culture. In this vein, this research will focused on roles of value in acceptance of nuclear power. For this works, we will highlight the value such as environmentalism, cultural bias, science - technology optimism about science technology, political ideology, and religion and so on. In particular, we assumed that the value plays a role as not only directive independent variable

but also moderating ones between psychometric antecedents and acceptance of nuclear power.

### **Experience vs. Perception: The Role of Real Experience on Acceptance of Nuclear Power**

*Sungjin Park (Ajou University, South Korea), Jae-bok Joo (Korea Research Institute for Local Administration, South Korea), Seoyong Kim (Ajou University, South Korea)*

After catastrophe of the Fukushima nuclear power plant, general public have been shocked and instilled fear. There was the plenty of anxiety in which most people were concerned about the exposure or contamination of radiation. On the other hand, it made people pay the attention to anywhere close to nuclear power plant which potentially has the possible risk like Fukushima case.

Even if such stories highlight the power of experience, a lot of studies in psychometric paradigm have given a little attention to the role of such experience. Hence, it need study the role of experience in acceptance of nuclear power or related causal process. We argued that the experienced can explain the variance of acceptance, which did not fully, covered by frequently used variables such as perceived risk/benefit, trust and knowledge.

We will focus on the specific role of experience: In which way does it have relationships with acceptance and its causal factors, how does it moderate the relationships between acceptance and its antecedents?

### **Factors for Concern about Crime and Trust in the Police after Experiencing Violent Crime**

*Cara Petrovitsch, Christian Klöckner (Norwegian University of Science and Technology)*

Concern about crime is linked with negative psychological outcomes, decreased health and wellbeing, whereas low trust in the police leads to underreporting crimes, lack of cooperation with the police as well as resenting restrictions. Due to those profound consequences the finding that being the victim of a violent crime both increases concern about crime as well as decreases trust in the police led to this study. Ten victims of violent crime will be interviewed in order to measure their concern about crime, trust in the police

and change in those after the experience as well as possible fortifying factors such as personality, attitudes and circumstances. Five of the participants are selected for experiencing the crime during their day to day lives whereas the other five are selected for dealing with violent crime as part of their vocation, e.g. body guards. Due to the qualitative analysis of the interview material it is not yet possible to know all measured variables but this abstract will be updated alongside the ongoing study which starts in January 2012.

### **Development of a Petroleum Human Reliability Analysis Method**

*Martin Rasmussen (Norwegian University of Science and Technology)*

Major accidents in the petroleum industry can have severe consequences for people and the environment, and the prevention of such accidents have been made a thematic priority area by the Research Council of Norway in the PETROMAKS Preliminary work program 2013-2022 (The Research Council of Norway, 2012). Today, operational risk and the requirements of safety barriers are assessed through the use of Quantitative Risk Analyses (QRAs). The QRA process is well established within the offshore industry where it has been used for more than three decades. QRA has traditionally had a focus on technical systems and capabilities, with little focus on human and organizational factors (HOFs) (Skogdalen & Vinnem, 2011). Several reports and analyses of incidents and accidents in the petroleum industry have suggested that HOFs should be paid more attention to in future risk and barrier assessments (McAndrews, 2011). The most recent and prominent example being the President's Report on the Deepwater Horizon accident (Report to the President, National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011), where it is suggested that the petroleum industry should learn from the nuclear industry in terms of several risk aspects. In this project we follow that recommendation and we will try to learn from the nuclear industry; an industry that has integrated human factors, and human reliability analysis (HRA) in particular into major accident risk analyses. The Standardized Plant Analysis Risk-Human Reliability Analysis (SPAR-H) was developed for and is currently used in the nuclear industry. Our goal with this project is to adapt the SPAR-H to the petroleum industry and thereby creating a Petroleum Human Reliability Analysis (Petro-HRA), and hopefully contributing to filling the gap of HOFs in today's QRA.

### **Testing the Heuristic-systematic Information-processing Model (HSM) in Risk Perception about Nuclear Power Accidents from Fukushima, Japan**

*Yeongjae Ryu, Jaesun Wang, Seoyong Kim (Ajou University, South Korea)*

The accidents of Fukushima nuclear power stations produce too much of information about risk from nuclear power accidents. It generally assumed that after the people try to interpret the information by utilizing the specific mode of information process, they judge the risk. Our study will test the heuristic-systematic information-processing model (HSM) suggested by Shelly Chaiken. HSM suggested two information process modes in heuristic or systematic ways; the heuristic mode used the least amount of cognitive processing governed by availability, accessibility, and applicability whereas the system mode did the effortful processing, depending on comprehension, analysis and reliability of information.

To test the workings and roles of those two modes in judging the risk information related with Fukushima nuclear power accident, we will collect the data with survey method. The main topics in analysis will include as follow; first, examine the tendency of using two modes according to the demographic variables and relationships between those two modes; Second, analyze the impact of determinants of two modes on risk judgment about Fukushima accident after controlling the related variables; Third, investigate the moderating effect of two modes between independent variable and dependent variable.

### **The interactive impacts of distal and proximal factors on intention to purchase Japanese food products after Fukushima accidents**

*Yeongjae Ryu, Seoyong Kim, Sungjin Park (Ajou University, South Korea)*

After Fukushima accidents, Japanese food producers had faced the decrease in food sale and export because of consumers' fear about the possibility of radioactive contamination. Korea is one of countries which have imported the Japanese agricultural or fishery product. Hence, it is meaningful researches about what are factors to influence the purchase behavior.

This study empirically examines the impact of distal, and proximal factors on intention to purchase Japanese food products by analyzing the survey data. First, we hypothesized that the purchase decision will be influenced by not only proximal factors—e.g., evaluation about risk, affective image, quality of food

products but also distal factors—e.g. perceived risk/benefit, knowledge, trust and stigma, related with nuclear power. Moreover, we hypothesized that there are interactive relationships between proximal and distal factors. Those relationships influence the purchase behaviors. The test about two hypotheses will provide the purchase behavior in risky food products.

### **How did weekly magazines in Japan reported the risk caused by the nuclear power-plant accidenth**

*Kazumi Sano (National Institute for Environmental Studies, Japan), Macoto Kikuchi (Osaka University, Japan)*

The Fukushima Dai-ichi nuclear power plant of Tokyo Electric Company (TEPCO) is located at the sea shore of Futaba-gun in Fukushima prefecture. At 11th, Mar. 2011, it was heavily damaged by the Great East Japan Earthquake and the massive tsunami generated by the earthquake. In this accident, a large quantity of radioactive materials was released in the atmosphere on March 15 and March 21 after the nuclear fuel meltdown. The large area was polluted by the radioactive fallout. The news media reported the accident intensively. Just after the accident, however, information offered by the media was confusing, partly because the official information from the government and from TEPCO was limited and partly because the news media lack scientific knowledge on the structure of the nuclear reactor and the physics and health issues of the radioactivity. In this study, we consider how the weekly magazines reported this critical accident. The risk process consists of the following steps: (1) risk resource, (2) risk perception, (3) risk communication, (4) risk assessment, and (5) risk management. Among these steps, the risk perception by the public is considered to be affected strongly by the news media. The weekly magazines, however, are not regarded as a neutral news media. Rather, their articles in general strongly reflect the editorial opinions and sensationalism is favored over objectivity. In this sense, the weekly magazines are "biased media". So, there are many points to discuss from the viewpoint of the risk communication. We analyze the articles appeared in the seven major weekly magazines published during the first half year after the earthquake. We found that the difference in the scientific literacy among the magazines are reflected, for example, in selection of the experts who made comments in articles. We focus on how the sensational information provided by the weekly magazines at the early stage of

the nuclear accident could have affected the risk perception of the public after two years from the earthquake.

### **Railway and maritime transporters' view of supervising authorities**

*Kristine Vedal Størkersen (Norwegian University of Science and Technology)*

Regulators are seen as important for preventing risks and accidents in organisations. But how are the supervising authorities in two industries – maritime and rail – perceived by the transport companies' sharp and blunt ends? The risk regulation framework is useful guide for data gathering and analysis of risk and risk prevention. I do a qualitative pre-assessment about the transporters' views on problems, and an appraisal based on literature, information about the industries and qualitative data.

The transporters see the purpose of regulations and regulators as long as they concentrate on safety. Some do not know the regulators, others are fond of their dialogue meetings – all are in favor of dialogue. They believe that through even more dialogue the regulators will learn the practicalities and understand the industry's views, and thus not be strict and narrow where there is no need to be to prevent accidents (and even more where it is need). The industry representatives from all levels of the organisations mostly have shared opinions, but there are some disagreements between the sharp and the blunt end transporters, especially about what the operating personnel see as the authorities' silk gloves on the companies.

Discussion of the data show that there is risk for the regulations not being adapted or adopted in the companies, due to the transporters' opinion that the regulators lack competence and are not worthy of trust. Practical competence among the regulators and more contact with the industry might be measures to reduce the gap between the regulating level and the companies, and make useful regulations.

Keywords: Safety; regulation; maritime industry; rail industry; regulators; decision-making

### **Human factors and safety in an implementation process of automated drilling technology on an offshore oil and gas installation**

*Gunhild Sætren (Norwegian University of Science and Technology)*

The purpose of this project was to explore factors that could make a safest possible change process. The change process followed was an implementation of automated drilling technology on an offshore oil and gas installation. From November 2008 till July 2012, 42 interviews were conducted with personnel ranging from the designers to the end users, and observations were done offshore. Grounded theory was used for analysis (Strauss & Corbin, 1990).

Article 1: This article (Sætren & Laumann, 2012) treated how trust affected the outcome of the change process (see Figure 1). It was found that according to the change theory of Armenakis and Harris (2002) it was a successful change process. However it was also found that the end users had too much trust and a non-questioning attitude to safety during the implementation process. These results were compared to the theory of high reliability organizations (Weick & Sutcliffe, 2007) and it was concluded that too much trust and a non-questioning attitude could reduce safety.

Article 2: The purpose of this article was to explore how a project group included human factors in the design process of new drilling equipment. The results were that if design evaluation methods according to human factors principles such as a user analysis, task analysis, and function analysis had been conducted the product could have been less costly, more user friendly, and end users could have had a better understanding of safe usage.

Article 3: This article will concern how the informants perceived the safety of the technology prior to and after a serious unwanted incident that occurred whilst using the new technology.

### **Life Cycle Assessment of electricity generation from coal-fired power plants with carbon dioxide capture and storage in Japan**

*Longlong TANG, Takahisa Yokoyama, Hiromi Kubota, Akiro Shimota (Central Research Institute of Electric Power Industry, Japan)*

The method of life cycle assessment (LCA) is used to assess and compare the environmental impacts of a pulverized coal-fired power plant (PC) system with and without carbon capture and storage (CCS). The PC system without CCS, as reference scenario, represents the state-of-the-art of ultra-supercritical PC in Japan. The system with CCS comprises post-combustion CO<sub>2</sub> capture with monoethanolamine (MEA) solvent, compression, and transport by pipeline and storage in a geological reservoir. LIME<sub>2</sub> an endpoint-type LCIA (life cycle impact

assessment) method of Japan was used to quantify the environmental impact on both midpoint (11 impact categories) and endpoint (4 safeguard subjects: human health, social asset, biodiversity and primary productivity) level. Results of the system with CCS shows that compare to the reference scenario the GHG emissions per kWh are reduced substantially to 241 g/kWh from 892 g/kWh and that the impact category of air pollution is expected to decrease by 37% as an environmental co-benefit caused by the deeper reduction of PM (particulate matter) and SO<sub>2</sub> emissions. Most notable environmental trade-offs are the increase in human toxicity, acidification and eutrophication due to lower power generation efficiency and an additional emission of MEA, NH<sub>3</sub> from CO<sub>2</sub> capture process compared with the reference scenario. The normalized impact scores based on damage assessment results on four safeguard subjects show that, due to CCS, damages of "biodiversity" and "primary productivity" become increased slightly while and a large decrease on that of "human health" is significantly caused. Furthermore a sensitivity analysis was conducted to confirm the magnitude of the LCA result by changing the CCS scenario which fitted to Japanese condition of CO<sub>2</sub> transport and storage more.

### **Perceived Demands in Integrated Offshore Operations**

*L. Vederhus, J.I. Håvold, S. Nistad, M. Aarset, (Aalesund University College, Norway), A. Ødegård (Molde University College, Norway)*

The aim of our research is to explore the challenges of integrated operations in order to establish a management- and training framework for risk prevention and intervention. Simulator training has already gained ground, and with increasing offshore activity into deeper waters and harsher environments, many ship owner companies invest correspondingly in training facilities and course participations. There are currently few reports of the actual effects of this activity, possibly due to the lack of instruments for measurement. Crew Resource Management (CRM) training, however, has proven successful in other high-reliability industries, like aviation and medicine. The scenarios in offshore simulator training has further the advantage of being based on instructors' intuitive understanding of real-life challenges, thus potentially being able to adapt quickly to the continuous innovations in this industry. Also, despite a lot of research focusing on safety and risk management both for offshore activity and at sea, meaning that much knowledge is already present, we have not found any studies designed to reveal what factors the crew on board anchor handling- and

subsea vessels themselves perceive as demanding during an operation. Understanding their perceptions can have implications both for management and for training to handle these issues, states, situations and conditions. In this paper, we explore the structure of demands, based on a 42-items questionnaire answered by experienced anchor handling crew (n=220) attending simulator training in Aalesund at the Offshore Simulator Center (OSC) between 2005 and 2009.

### **The Pharma Transport Town: Understanding the Routes to Sustainable Pharmaceutical Use**

*Mathew White, Will-Stahl Timmins, Clare Redshaw (University of Exeter and Plymouth, UK)*

Approximately 5 million tonnes of human pharmaceuticals are sold in Europe each year. Many of the active compounds in these products are subsequently found in the environment with well documented impacts on ecosystems (e.g. fish feminisation and vulture population decline) and human health (e.g. development of antibiotic resistance). Given an increasingly older population, who are the chief consumers of these products, the amount of compounds in the environment and associated risks to wildlife and human health will increase dramatically in the coming years. The aim of this poster is to explain the key pathways from original production and promotion of these products to their environmental destination. Some compounds are not metabolised by the body and excreted into waste-water, others are never consumed in the first place and discarded in refuse or flushed down the toilet. The poster documents these pathways. In addition it examines the pathways of influence. That is, it shows how and by whom the products are promoted and the influence these processes have on consumer preferences and medical staff's willingness to prescribe certain drugs. The aim of the poster is to start discussion about our current and future use of pharmaceuticals and identify areas where individuals and policy makers could intervene to reduce the pressure on the environment. The poster recently won an award in the National Science Foundation's "International Science & Engineering Visualization Challenge" and an outline (but not the full poster) was published in the journal *Science* in February 2013.

### **Are Citizens Prepared for a Sustainable Future?**

*Whittle, C., Jones, C.R. and While, A.*

Visions for future cities, such as sustainable or smart cities, are increasingly permeating UK and global development initiatives. Many of the future city concepts involve the utilisation of more efficient technologies as well as technologies which should enable citizens to make more efficient (less wasteful) choices. The focus of the research is on the interface between efficient technology within cities and the user citizens. It is investigating how future, sustainable and smart city developments consider citizens and what expectations are being placed on these future citizens. The poster presentation will give an introduction to the research area and present findings from a current study, which is investigating city stakeholders' views on current city developments; the inclusion of the citizens, the expectations on future citizens and some of the assumptions being made within future city concepts about citizens' acceptance and abilities. It is argued that failing to take into account citizens' abilities and beliefs will lead to many future city developments falling short of their potential to make the city a more sustainable and liveable, urban environment.

### **Challenges with using Safety Management Systems in a petroleum producing company**

*Thomas Wold (Norwegian University of Science and Technology)*

Research Question: Safety procedures are usually constructed at an executive level in the company. They are so communicated to the operative levels in the organization, using an IT-based management system. How is this information perceived and understood in the receiving end? The concept of interpretation has usually been neglected in the safety research.

Any media text must be interpreted in order to make sense to the receiver. This notion applies also when the text is standardized procedures in an industrial company. There is a distance between the sender of the message (management) and the receiver (the operators) with respect to time, space and knowledge background. This opens for interpretation of the text among the operator that might differ from the management's intention.

Method: Qualitative interviews with onshore management and offshore management and operators.



Preliminary results: Operators are less enthusiastic about the management system than middle management. The latter group acknowledges there are weaknesses in the system, but state they are optimistic about improving the management system and the processes. The main weaknesses they mention are related to difficult language and poor user friendliness.

Also operators complained about the language used in the management system. They found it to be unnecessary complicated English, and that it sometimes took some time before they understood the meaning. With processes they use often, this is not a problem as they know these processes well. Problem arises when they have to use a process which is outside of their routine activities.

The informants related the poor user friendliness to difficulties in finding their place in the management system; to navigate through the system and finding the necessary processes. Again this arises as a problem mainly when they have to do something that is not routine. Several operators found their own ways to deal with the management system. Some had memorized which paths they needed to take to find the processes and checklists they needed most often, disregarding the rest of the management system. Others had printed out a bunch of checklists for later use, while others had created their own database with the documents they needed. With such strategies, they will not be advised about changes or updates in the procedures.

Although they acknowledge that the management system is regarded as important, most operators prefer not to use it. They regard the management system as time consuming, and prefer “just to get the job done”.

### **Probabilistic Assessment of Health Risk for Dioxin in Taiwan**

*Chiang-Hsing Yang (National University of Nurse and Health Sciences, Taiwan),  
Shu-Yuh Liu, Kuen-Yuh Wu (National Taiwan University, Taiwan)*

Dioxin is classified as a human carcinogen and an environmental endocrine disrupter and is ubiquitous in environments. Daily exposures to dioxin from various media and routes have been of great concern. In the past more than 10 years, environmental and biological monitoring of dioxin were conducted annually by the Taiwan Environmental Protection Administration (TEPA). These data have not been fully utilized to associate health risk with daily dioxin exposures. In order to assess aggregate health risk due to exposures to dioxin through multiple media

and routes by integrating the currently accumulated environmental dioxin data in Taiwan, the CalTox model was adopted by replacing some model parameters with Taiwan local data. Particularly, the local parameters such as local landscape data, chemical properties and exposure factors were used for modeling under the continuous input mode. The annual environmental dioxin data and dioxin emission data at 2002 and 2007 were collected. The CalTox was run for 5000 trials with two-dimensional Monte Carlo simulation under Excel environment. The outputs were compared with the environmental monitoring data in different media to validate the model. Our results show that an estimated upper limit of 95% confidence interval of aggregate exposures for the general population (19-64 years old) in 2002 and 2007 was 0.776 pg/kg-day and 0.402 pg/kg-day, respectively. Hazard index (HI) was  $1.3 \times 10^{-4}$  in 2002 and  $6.5 \times 10^{-5}$  in 2007, also decreasing gradually. Sensitivity analysis shows that food intake rates (e.g. fish intake and meat intake) are critical parameters. The assessment on human exposure to Dioxin can be further improved by more integrity and systematical collected data.

### **The analysis of determinants for risk judgement about Fukushima nuclear accident**

*Hong Yeonji, Seoyong Kim (Ajou University, South Korea),  
Geunsik Kim (Institute of Governmental Studies, South Korea)*

Our study aims to specify which determinants relatively influence the risk judgement about the nuclear accidents related to Fukushima accidents. For this end, first, we suggested the more integrated research model including variables at the individual level in two contrasting theories, psychometric paradigm and risk communication model. The former stressed the internal perception and cognition in judging the risk objects whereas the latter did the role of information in social amplification of risk. We argued that two theories should be considered at once because they have each advantage in explaining the variance of risk perception.

In the analysis section, we examine to what extent each *psychometric paradigm*—i.e., perceived risk, benefit, trust, and stigma—and of *risk communication*—i.e., source credibility, message attribute (negative or vivid contents), characteristics of receiver (motivation and ability)—influence the risk judgment.

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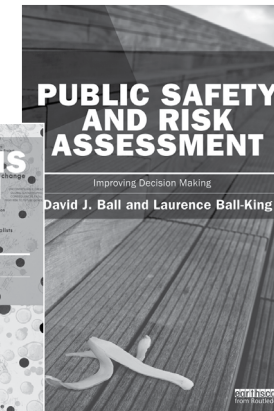
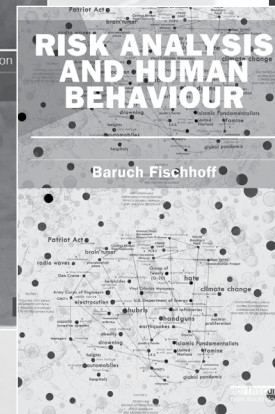
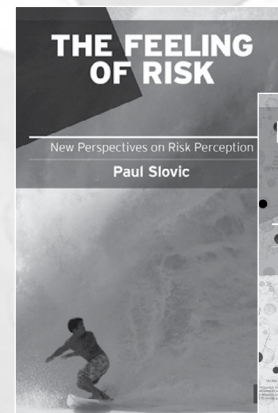
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