

RISKS



RISKS

The Académie universitaire Louvain (AL) is a university consortium composed of the following three academic institutions: University of Namur (FUNDP), Facultés universitaires Saint-Louis, Brussels (FUSL) and Université catholique de Louvain (UCL).

In this particular case, the brochure “Risks” has been prepared by the Research Administration Departments of the FUNDP and the UCL only, with the valuable help of a peer review committee composed of:

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Foreword

There is no commonly accepted definition of “risk”. The notion of risk points out a very complex reality. It covers a wide range of heterogeneous disciplines from individual or broad societal risks (i.e., politics, engineering, finance, economy, information and communication technology...) to environmental risks (climate change, ecosystem, flooding, water and food quality...), including also direct and indirect health and psychological risks. In addition to this non-exhaustive list, there are specific risks linked to direct or indirect exposure to chemical and/or biological threats. A risk can also be considered in terms of its accidental, natural, anthropogenic or intentional origin and as per its objective or subjective dimension. In this complex context, there are three major prerequisites of an appropriate reaction to risk: to have a correct perception of it, to carry out a sound risk assessment and to properly determine the risk acceptability. On this basis and depending on the exposure time, frequency and intensity, different attitudes can be elicited: deterrence and preemptive action before any exposure, protection and pro-active response to effective risk situations, and finally the recovery phase aimed at mitigating risk exposure detrimental effects.

To grasp this complexity and help the reader find his or her way among all these items, a tentative tridimensional matrix has been drawn by the editors. Exploiting the matrix should allow the reader to find rapidly the research activity he or she is interested in, starting with major environmental, societal and health items on the X-axis, and then choosing the selected item on the Y-axis (impact, factor).

Through the range of research activities outlined in this brochure, diverse but specific aspects are highlighted, which all have to do with the notion of risk as commented above. No doubt whatsoever that more could be written about risk ! However, this brochure does not intend to cover the whole field. It is structured in 7 chapters each dealing with a particular domain (chemistry, biology, physics, psychology, social, economy and finance, and ICT). The last chapter entitled “Miscellaneous” deals with research domains that, regardless of their interest, did not find a place elsewhere: fault-tolerant electromechanical systems, *in vitro* food safety assessment at the intestinal level or risk assessment of nanomaterials.

The research activities described in this brochure are all carried out at the “Académie universitaire Louvain”, and more specifically at the Université catholique de Louvain and the University of Namur. The wide range of topics tackled does not only clearly reflect the multidisciplinary aspect of risk but also pinpoints the tight interface existing across disciplines. As such, the aim of this booklet is to provide the reader with a synoptic view of this thrilling field of expertise and its actors, in order to derive from it new transversal applications and innovative services to the society.

Jean-Luc Gala
Chairman of the Peer-review Committee

Content

A. CHEMICAL RISKS

A.1 - Evaluation of health hazards and risks of chemicals

11

P. HOET, G. VAN MAELE-FABRY

A.2 - Soil and water contamination risk

13

M. JAVAUX, M. VANCLOOSTER, S. LAMBOT, CH. BIELDERS,
PH. SONNET, J. DUFEY, P. DELMELLE, BR. DELVAUX, P. BOGAERT,
E. HANERT

A.3 - Study of atmospheric pollutants by lasers, a crucial subject for environmental and sanitary problems

15

M. LEPERE

B. BIOLOGICAL RISKS

B.1 - Assessment of the risk for functional decline in older adults: clinico-biological markers

17

CH. SWINE, P. CORNETTE, D. SCHOEVAERDTS, M. de SAINT-HUBERT,
O. TOUSSAINT

B.2 - Managing the physical, psychological and public health risks of haemophilia: an interdisciplinary approach addressing the burden of a rare genetic disease

19

S. HENRARD, C. HERMANS, N. SPEYBROECK

B.3 - Melanoma detection by optical and digital dermoscopy: epidemiology in Belgium

21

I. TROMME, N. SPEYBROECK

B.4 - Medical geography : understanding the spatial distribution of diseases in relation to the human and natural environment

23

S. VANWAMBEKE

B.5 - Bacterial foodborne pathogens and food spoilers

25

M. ABDEL MASSIH, P. MODRIE, S. TIMMERY, J. MAHILLON

B.6 - The Center for Applied Molecular Technologies: an academic-military integrated platform for biological threats assessment

27

J.-L. GALA, P.-A. FONTEYNE, L. IRENGE, J. AMBROISE

C. PHYSICAL RISKS

C.1 - Coping with floods and inundations

29

S. SOARES-FRAZAO, Y. ZECH

C.2 - Flooding and mud flow risk

31

CH. BIELDERS, M. JAVAUX, S. LAMBOT, M. VANCLOOSTER,
B. VAN WESEMAEL

C.3 - Hydrogeological characterization of aquifers and groundwater management

33

V. HALLET, I. BONNIVER, S. REKK

C.4 - Impact of climate change on health in Wallonia

35

S. HENRARD, N. SPEYBROECK

C.5 - Abiotic risks in forest ecosystems

37

M. JONARD, Q. PONETTE, C. VINCKE

C.6 - Decline of soil organic matter and soil fertility

39

B. VAN WESEMAEL

D. PSYCHOLOGICAL RISKS**D.1 - Development of emotional competence to reduce psychosocial risks**

41

M. MIKOLAJCZAK, J. GRÉGOIRE

D.2 - Addictive behaviors : risk factors, prevention and psychological intervention

43

J. BILLIEUX, PH. DE TIMARY, P. MAURAGE, ST. VAN DEN BROUCKE

D.3 - Health needs of children and adolescents growing up with a chronic condition

45

I. AUJOULAT, R. REDING, D. CHARLIER, A. MASSON, CH. VERMYLEN

D.4 - Social diversity at work

47

D. DESMETTE, G. HERMAN

E. SOCIAL RISKS**E.1 - Analysis of international crisis management, conflict transformation and resolution**

49

A. AIT CHAALAL, TH. BRASPENNING-BALZACQ, T. DE WILDE D'ESTMAEL, V. LEGRAND, M. LIEGEOIS, CL. ROOSENS, V. ROSOUX, T. STRUYE DE SWIELANDE, P. VERCAUTEREN, CH. WASINSKI

E.2 - Organizational regulations of societal risks

51

N. SCHIFFINO, L. TASKIN

E.3 - Risks and liability in healthcare and biomedicine

53

G. SCHAMPS, J.-M. MALOTEAUX

E.4 - Risk analysis and management tools in agriculture

55

M. DELPIERRE, FR. GASPART, BR. HENRY DE FRAHAN

E.5 - Risk and environment : historical, socio-anthropological, and ethical approach

57

FR. BARTIAUX, N. FROGNEUX, I. PARMENTIER, O. SERVAIS

E.6 - Epidemiology of natural disasters and civil conflicts

59

D. GUHA-SAPIR, B. DUBUS

F. ECONOMIC AND FINANCIAL RISKS**F.1 - Stochastic modelling of dependence in quantitative risk management**

61

M. DENUIT, CH. HAFNER, J. JOHANNES, R. VON SACHS, J. SEGERS

F.2 - Audit, control and governance

63

G. SARENS

F.3 - Pension funding and solvency

65

P. DEVOLDER, H. TASSA

F.4 - Financial risks in insurance and energy markets

67

P. DEVOLDER

F.5 - Financial liquidity risk

69

R. DE WINNE, C. D'HONDT, M. PETITJEAN, I. PLATTEN

F.6 - Investment risk in actively-managed strategies and structured products

71

P. GIOT, M. PETITJEAN

G. ICT RISKS**G.1 - Goal-oriented risk analysis for software requirements engineering**

73

A. VAN LAMSWEERDE

G.2 - Cryptography

75

O. PEREIRA, FR.-X. STANDAERT

G.3 - Secure implementation of cryptographic tokens

77

FR.-X. STANDAERT

G.4 - Secure protocols

79

O. PEREIRA

H. MICELLANEOUS RISKS**H.1 - Fault tolerant electromechanical actuators and generators for high reliability energy conversion systems**

81

BR. DEHEZ, E. MATAGNE, P. SENTE, FR. LABRIQUE

H.2 - *In vitro* food safety assessment at the intestinal level

83

Y.-J. SCHNEIDER

H.3 - The Namur Nanosafety Centre: an integrated platform for the risk assessment of nanomaterials

85

O. TOUSSAINT, ST. LUCAS, J.-M. DOGNÉ

Reading notes pivot table

The pivot table below categorizes the reading notes per impact (3 columns) and per risk factor (8 rows). Some reading notes were classified in more than one cell, according to the risk impact on environment, health or society and/or the moment when the notion of risk is considered (before / prevention, during / management, after / recovery).

Risk factor	Environment			Health			Society Economy / Business Geopolitics Humanitarian context Legal context		
	Before (prevention)	During (management)	After (recovery)	Before (prevention)	During (management)	After (recovery)	Before (prevention)	During (management)	After (recovery)
Chemical (chemicals and pollutants)	A1, A2, A3	A1, A2, A3	A1, A2, A3	A1	A1	A1			
Biological (diseases and microorganisms)				B1, B2, B3, B4, B5, B6	B1, B2, B4, B6	B1, B2, B4, B6			
Physical (natural or anthropogenic)	C1, C2, C3, C5, C6	C1, C2, C5, C6	C1, C2, C5	C4	C4	C4			
Psychological				D1, D2, D3	D1, D2, D3	D1, D2, D3	D4	D4	D4
Social	E5	E5	E5	E6	E6	E6	E1, E2, E4	E1, E2, E3, E4	E1, E2, E3, E4
Economic and Financial							F1, F2, F3, F5, F6	F2, F3, F5, F6	F2, F3, F4, F5, F6
ICT							G1, G2, G3, G4		
Miscellaneous				H2, H3	H3		H1	H1	H1

Evaluation of health hazards and risks of chemicals

SENIOR SCIENTISTS

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- ▶ Geneviève VAN MAELE-FABRY

Research Field and Subjects

- ▶ Assessing the health hazards and risks of chemicals for industry, national or international organisms.
- ▶ Development of exposure and health monitoring programmes for the assessment of health risks associated with industrial and environmental pollution by chemicals.
- ▶ Primary studies:
 - i) epidemiological occupational studies on workers exposed to industrial pollutants;
 - ii) biological monitoring of exposure: development and validation of biological methods to evaluate the intensity of exposure and establish exposure threshold levels.
- ▶ Evaluation of existing data:
 - i) systematic reviews and meta-analyses, critical reviews;
 - ii) evaluation of potential effects on human health associated with exposure to chemical agents;
 - iii) establishment of guidelines for the surveillance of workers exposed to chemical substances.

Representative References

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- ▶ HOET P., HAUFROID V., DEUMER G., DUMONT X., LISON D., HANTSON P. Acute kidney injury following acute liver failure: potential role of systemic cadmium mobilization? *Intensive Care Medicine* 38(3): 467-473. **2012**.
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- ▶ HOET P., DE SMEDT E., FERRARI M., IMBRIANI M., MAESTRI L., NEGRI S., DE WILDE P., LISON D., HAUFROID V. Evaluation of urinary biomarkers of exposure to benzene: correlation with blood benzene and influence of confounding factors. *International Archives of Occupational and Environmental Health* 82(8): 985-995. **2009**.
- ▶ HOET P., LISON D. Ototoxicity of toluene and styrene: state of current knowledge. *Critical Reviews in Toxicology* 38(2): 127-170. **2008**.

Funding

- ▶ Service Public Fédéral Santé Publique
- ▶ Agence Française de Sécurité Sanitaire de l'Environnement et du Travail (AFSSET)

Partnership

- ▶ Institut National de Recherche et de Sécurité pour la prévention des accidents du travail et des maladies professionnelles (INRS), France
- ▶ Institut National de la Santé et de la Recherche Médicale (INSERM), France
- ▶ Institut de Recherche Robert-Sauvé en Santé et en Sécurité du Travail (IRSST), Montreal, Canada
- ▶ Institut universitaire romand de Santé au Travail (IST), Lausanne, Switzerland

Products and Services

- ▶ Evaluation of potential human health effects associated with exposure to chemical agents, based on
 - literature data : critical review, systematic review, meta-analysis
 - field studies

- ▶ Development of biological markers of exposure to evaluate the intensity of exposure to chemical substances and to establish exposure threshold levels.

Keywords

Health Risk Assessment
Occupational Exposure
Environmental Exposure
Chemical Agents
Biological Monitoring
Critical Review
Meta-analysis

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Soil and water contamination risk

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- ▶ Bruno DELVAUX
- ▶ Patrick BOGAERT
- ▶ Emmanuel HANERT

Research Field and Subjects

- ▶ Study of the fate and transport of chemicals of natural and anthropogenic origin, particular agricultural origin, in soil and water.
- ▶ Study of pollution pressure on soil and water resources.
- ▶ Development of analytical techniques to assess soil and water contamination risks.
- ▶ Development of geophysical, in particular hydrogeophysical prospecting techniques for contamination risk assessment.
- ▶ Development of mathematical models (deterministic and stochastic) to simulate water and chemical transport in soil and water systems on different spatial scales.
- ▶ Study of the relationships between widely available land attributes (soil map, land use map,...) and the functioning of soil and water systems in terms of contamination and pollution attenuation.
- ▶ Development of advanced stochastic techniques for contamination risk mapping.

Representative References

- ▶ MINET J., WAHYUDI A., BOGAERT P., VANCLOOSTER M., LAMBOT S. Mapping shallow soil moisture profiles at the field scale using full-waveform inversion of ground penetrating radar data. *Geoderma* 161: 225-237. **2011**.
- ▶ DELEERSNIJDER E., CORNATON F., HAINE T., VANCLOOSTER M., WAUGH D.W. Tracer and timescale methods for understanding complex geophysical and environmental fluid flows. *Environmental Fluid Mechanics* 10: 1-5. **2010**.
- ▶ MATTERN S., FASBENDER D., VANCLOOSTER M. Discriminating sources of nitrate pollution in a sandy aquifer. *Journal of hydrology* 376: 275-284. **2009**.

Main Equipment

- ▶ Analytical laboratory: basic and advanced equipment for chemical analysis of complex environment matrices (atomic emission spectrometers (ICP-AES), carbon analyser; atomic adsorption spectrometer; high pressure liquid chromatograph; X-ray diffractometer; NC elemental analyser).
- ▶ Hydrogeophysical laboratory: advanced hydro geophysical equipment for assessing proxies of soil and water contamination. Mobile GPR platform (quad vehicle, high precision GPS, multiple antenna ground penetrating device, electromagnetic induction device). Geo-electrical device (electrical resistivity tomography).
- ▶ Soil physical laboratory: equipment for measuring of the density of soil (pycnometer) and soil porosity (mercury porosimetry). Equipment for the measurement of the moisture retention curve (sand box apparatus, pressure plate apparatus) and the unsaturated hydraulic conductivity curve (suction and pressure infiltrometers, multi-step outflow devices). Equipment for the determination of the hydrodynamic dispersivity.

Products and Services

- ▶ Inorganic and mineral analysis of complex environmental matrices (soil, water)
- ▶ (Hydro)geophysical prospection for fast assessment of soil and water contamination
- ▶ Deterministic modelling for assessing soil and water contamination risk at the local (HYDRUS2D/SLIM/WAVE) and the regional scale
- ▶ Stochastic and geostatistic modelling tools for assessing soil and water contamination risk at the regional scale (BMELib)

Keywords

Soil contamination
Water contamination
Groundwater
Diffuse pollution
Risk mapping

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Study of atmospheric pollutants by lasers, a crucial subject for environmental and sanitary problems

SENIOR SCIENTIST

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Research Field and Subjects

Atmospheric pollutants, both in gas phase and aggregates, participate in the global warming of our atmosphere inducing climate change. These pollutants probably also generate important sanitary problems, such as chronic diseases (asthma ...) and cancers (skin, lungs...). The study of these atmospheric pollutants by laser, especially gases (hydrocarbons such as methane, carbon dioxide ...) between atmospheric temperatures and high temperatures of residual combustion gases (several hundreds of degrees) is required to determine their concentrations accurately. In this context, the study of atmospheric clusters (based on carbon and hydrocarbons) and the interactions between clusters and gases are also required for remote sensing of our atmosphere. A better understanding of these atmospheric pollutants will enable their concentrations to be determined accurately with a view to monitoring and/or reducing these pollutants.

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- DHYNE M., JOUBERT P., POPULAIRE J.C., LEPÈRE M. Self-collisional broadening and shift coefficients of lines in the $\nu_4+\nu_5$ band of $^{12}\text{C}_2\text{H}_2$ from 173.2 to 298.2 K by diode-laser spectroscopy. *Journal of Quantitative Spectroscopy & Radiative Transfer* 112: 969–979. **2011**.
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Funding

- FUNDP
- Fonds National de la Recherche Scientifique (F.R.S. - FNRS)
- PNCA du CNES (CNRS, France)

Partnership

- Institut UTINAM, Université de Franche-Comté, Besançon, France.
- Service de Chimie Quantique et de Photophysique, Université Libre de Bruxelles, Belgique
- LPMAA, Université P. et M. Curie, Paris, France
- Department of Physics, Astronomy and Geophysics, Connecticut College, New London, USA
- Centre for Microsystems and Photonics, Department of Electrical and Electronic Engineering, University of Strathclyde, Glasgow, UK
- Member of NARILIS (<http://www.narilis.be/>) - since 2011

Main Equipment

- Diode-laser spectrometers and different absorption cells allowing measurements at low (100 K to room temperature) and high (room temperature to 1000 K) temperatures, with different optical pathlengths.

Products and Services

- Precise measurement of quantity of gases in low concentration in gas mixtures

Keywords

Atmospheric pollutants
Lasers
Atmospheric clusters
Concentration determination
Gases at low and high temperatures

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Assessment of the risk for functional decline in older adults: clinico-biological markers

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- ▶ Marie de SAINT-HUBERT
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Research Field and Subjects

The decline in daily life functioning in older adults is a paramount public health challenge with both quality of life and economical outcomes. Indeed, demographic ageing, particularly the intensity of ageing, is associated with an increasing number of old and very old people at risk for functional decline, since disability is appearing later in life. Identification of elderly subjects at risk of functional decline is thus a major concern since targeted interventions may prevent or limit functional loss in both community-dwelling subjects and hospitalized patients. In a hospital setting, several screening tools for predicting functional decline after hospitalization have been proposed. On the other hand, inflammation, immunosenescence and neuroendocrine dysregulation have been proposed as impaired physiological mechanisms involved in the process of functional decline and biomarkers. This interdisciplinary project is structured into two themes:

- ▶ A study of clinical screening tools: identify and compare instruments which can be used on admission of older hospitalized patients to detect the risk of functional decline at and after discharge.
- ▶ A study of the potential interest of selected biomarkers in the identification of patients at risk of functional decline
 - i) Inflammation markers (IL-6, IGF-1, CRP)
 - ii) Immunological markers: cytokine profile, thymopoeisis, cell subpopulation phenotypes and telomere length in peripheral mononuclear cells
 - iii) Transcriptomic markers: abundance of a preselection of transcripts involved in inflammation, immunosenescence and stress response

The interdisciplinary character of this research is unique in so far as it combines two bio-gerontological sciences labs with a clinical platform. The university hospital (CHU Mont-Godinne/UCL) clinicians recruit and assess the study subjects concerning frailty and functional status, and the labs analyse the blood samples using advanced technologies. The immunological studies center (CIL ULg) analyses immunological markers including telomere length. The molecular biology lab (URBC - FUNDP) analyses transcriptomic markers.

The industrial outcome is a multimarker tool (real-time PCR using specific probes and development of a mathematical predictive model) combined with clinical tools to measure the risk of decline in function in the months following an index health event in a frail older adult.

Representative References

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- ▶ de SAINT-HUBERT M., JAMART J., MORRHAYE G., MARTENS H., GEENEN V., VO T.K.D., TOUSSAINT O. Serum IL-6 and IGF-1 improve the clinical prediction of functional decline after hospitalization in older patients. *Aging Clinical and Experimental Research* 23(2): 106-111. **2010**.
- ▶ de SAINT-HUBERT M., JAMART J., BOLAND B., SWINE C., CORNETTE P. Comparison of three screening tools predicting functional decline in hospitalized older patients. *Journal of the American Geriatrics Society* 58 (5): 1003-1005. **2010**.
- ▶ VO T.K.D., GODARD P., de SAINT-HUBERT M., MORRHAYE G., DEBACQ-CHAINIAUX F., SWINE C., GEENEN V., MARTENS H.J., TOUSSAINT O. Differentially abundant transcripts in PBMC of hospitalized geriatric patients with hip fracture compared to healthy aged controls. *Experimental Gerontology* 46(4): 257-64. **2010**.

Patents

A patent application on the biomarkers was filed by the Technology Transfer Office of the University of Namur in the name of all the partners of the SENEGENE project. (PCT/EP2011/050472)

Awards

► Price for the best oral communication at the 9th autumn meeting of the Belgian Society for Geriatric and Gerontology (Liège, 10/2001): IL-6, TNF- α , IGF-1 in relatively healthy older people. de Saint-Hubert M. *et al.*

Funding

► Wallonie, Réseaux II, étude SENEGENE

Partnership

- Unité de Recherche en Biologie Cellulaire (URBC), FUNDP Namur
- Centre d'Immunologie de Liège (CIL), ULg Liège
- Centre d'Analyse de Résidus en Trace (CART), ULg Liège
- Institut de Recherche Santé & Société (IRRS)
- Namur Research Institute for Life Sciences (NARILIS)

Keywords

Functional decline
Hospitalized older patients
Biomarkers
Immunosenescence
Transcriptomic biomarkers
Inflammation

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Managing the physical, psychological and public health risks of haemophilia: an interdisciplinary approach addressing the burden of a rare genetic disease

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- ▶ Cedric HERMANS
- ▶ Niko SPEYBROECK

Research Field and Subjects

Haemophilia is a hereditary X-linked haemorrhagic disease characterised by partial or complete deficiency of circulating factor, namely factor VIII in haemophilia A and factor IX in haemophilia B. Haemophilia is a rare disease, with a prevalence of 1 in 5000 male live births for haemophilia A and 1 in 25 000 for haemophilia B.

This disease is transmitted from mothers (called carriers of haemophilia) to sons. Patients are divided into three groups according to their circulating blood coagulation factor: severe, moderate and mild haemophilia. Treatment requires prophylactic or on demand intravenous injections of coagulation factor concentrates.

The Haemostasis and Thrombosis Unit of the Cliniques universitaires Saint-Luc, in collaboration with the UCL and Research Institutes, is actively involved in the genetic characterization and evaluation of the multiple consequences of haemophilia, such as:

- ▶ The burden of haemophilia, due to direct mortality and morbidity (high truancy level, usual activity impairment, psychological consequences, pain,...). Costs of haemophilia related to replacement therapy are studied.
- ▶ Validation of an original evaluation by 3D gait analysis of haemophilic arthropathy, a major complication of haemophilia that results in severe impairments and activity limitation.
- ▶ Evaluation of the appropriate dosing of coagulation factor concentrates
- ▶ Psychosocial and clinical implications for haemophilia carriers
- ▶ Identification of the causal genetic mutation using innovative techniques

Prof. Hermans and his team take part in several national and international expert groups and take an active part in clinical research. The advanced multidisciplinary research team includes medical doctors, a geneticist, a physiotherapist and statisticians from several research institutes (IREC, IRSS and IoNS).

More than 215 patients with haemophilia and several hundred haemophilia carriers are currently followed by the Haemophilia Centre.

Representative References

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Awards

- ▶ Henri Horoszowski Memorial Award 2009
- ▶ Heroes in Haemophilia Award 2010

Funding

- ▶ Financial support from Bayer, Baxter, Pfizer, CSL Behring, Octapharma
- ▶ Saint-Luc Foundation
- ▶ Belgian Society on Thrombosis and Haemostasis (BSTH)
- ▶ Salus Sanguinis Foundation

Partnership

- ▶ Association belge de l'hémophilie (AHVH)
- ▶ European Haemophilia Therapy Standardisation Board with Baxter (EHTSB)
- ▶ European Haemophilia Consortium (EHC)
- ▶ Inter Disciplinary Working Group (IDWG) with Baxter
- ▶ European Coagulation Disorders Advisory Council (ECDAC) with CLS Behring
- ▶ European Haemophilia Centres and Organisations in Europe (EUHASS)
- ▶ C. HERMANS is member of the executive committee of European Association for Haemophilia and Allied Disorders (EAHAD)

Products and Services

- ▶ Statistical analyses adapted to rare diseases
- ▶ Preceptorships for foreign doctors on haemophilia
- ▶ Communication on haemophilia (web-site, information brochures, 3D-movie) (visit our movie on <http://www.hemophilie-ucl.be>, Section "L'Hémophilie en 3D")
- ▶ Identification of candidate patients to be enrolled in clinical trials
- ▶ Expertise on clinical management of haemophilia
- ▶ Data base of patients with haemophilia and haemophilia carriers followed at the Cliniques universitaires Saint-Luc
- ▶ Lectures on haemophilia and its complications

Keywords

Haemophilia
Coagulation factor
Burden of disease
Cost of disease
Musculoskeletal
Clinical trials
Applied statistics

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Melanoma detection by optical and digital dermoscopy: epidemiology in Belgium

SENIOR SCIENTISTS

- ▶ Isabelle TROMME
- ▶ Niko SPEYBROECK

Research Field and Subjects

Melanoma is one of the leading causes of death by cancer in the young Caucasian adult population. Only surgical treatment has proven to be effective in reducing mortality and its efficiency is positively influenced by early detection. Optical dermoscopy is a technique that uses a handheld instrument to examine superficial skin structures that are not seen with the naked eye. A large number of studies have demonstrated the efficiency of dermoscopy for the diagnosis of melanoma. Furthermore, the recent emergence of digital dermoscopy has allowed the collection and electronic storage of images, resulting in comparative analysis over time, leading to earlier melanoma detection.

The melanoma group (Centre du Cancer, Cliniques Universitaires St Luc) was the first Belgian unit promoting optical and digital dermoscopy. Dr Tromme has taught dermoscopy to dermatologists in Belgium and France.

A study conducted in 2009/2010 resulted in a one-year data collection of all the melanocytic lesions excised by 46 Belgian dermatologists. The objectives were: (1) to compare, in daily practice, the efficiency of three dermoscopy methods: optical dermoscopy alone with little or adequate training, optical dermoscopy with access to digital dermoscopy; (2) to confirm the safety of the latter approach.

A second on-going study assesses the burden and costs of melanoma in Belgium. The disability adjusted life years (DALY) metric is used to measure the burden of melanoma in Belgium.

The societal costs of diagnosis and treatment of melanoma is studied in order to analyse the possible burden and/or cost reduction by using optical and digital dermoscopy. This information may be useful for the social security authorities in Belgium.

Representative References

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Funding

Nuovo-Soldati Foundation for Cancer Research

Partnership

- ▶ Isabelle Tromme is a member of the International Dermoscopy Society and has the active support of Professor Luc Thomas (Lyon1 University, Centre Hospitalier Lyon Sud)
- ▶ Further cooperation with Brecht Devleeschauwer (Université catholique de Louvain, Brussels, and Ghent University, Ghent) and Nicolas Praet (Institute of Tropical Medicine, Antwerp).

Products and Services

- ▶ Melanoma Group (200 to 300 melanomas/year)
- ▶ Pigmented Lesion Clinic (Digital dermoscopy for melanoma high risk patients)
- ▶ Annual basic and advanced dermoscopy course for dermatologists

Keywords

Melanoma
Dermoscopy
Digital dermoscopy
Early diagnosis
Burden of disease
Cost of disease
Clinical trials
Applied statistics

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<http://www.centreducancer.be/assets/files/Brochure%20mélanome%20stlucok.p>

Medical geography : understanding the spatial distribution of diseases in relation to the human and natural environment

SENIOR SCIENTIST

► Sophie VANWAMBEKE

Research Field and Subjects

The research unit is developing expertise in the study of the etiology, distribution and risk of vector-borne and zoonotic diseases in relation to the environment. More specifically, interactions between human and/or animal populations, the landscape, and vectors, hosts and pathogens are studied. Human, animal, and zoonotic pathogens are investigated. All are considered, to varying degrees, to be public or animal health issues, causing significant mortality and/or morbidity. The analysis of remote sensing data in order to map land cover and land use is a prominent tool, and the department has long experience in the field. Spatial analysis and Geographic Information Systems are an important complement to the use of remote sensing data and constitute an important facet of the expertise developed. Statistical analysis and modelling complete the set of tools routinely used to document the interactions introduced above. Besides methodological and technical expertise in these domains, communicating and working with scientists from various backgrounds is a cornerstone competence of the unit. It is absolutely necessary, in a research context that addresses biological, medical, epidemiological and geographical issues. The experience so far includes mosquito- and tick-borne diseases as well as zoonotic diseases, in a range of environments, including tropical ecosystems and western and eastern European settings. Research carried out so far has indicated that considering that the local environment is relevant to both vector presence and human exposure, disease risk should be considered during land use planning and policy making.

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Funding

- Belspo
- European Commission: 7th Framework Programme
- Fonds National de la Recherche Scientifique (FNRS)

Partnership

- ▶ Institute of Tropical Medicine, Antwerp
- ▶ University of Zaragoza
- ▶ University of Oxford
- ▶ Swedish Agricultural University
- ▶ Université Libre de Bruxelles
- ▶ Utrecht University
- ▶ Natural History Museum, London
- ▶ University of Hawaii
- ▶ Member of the EDENext Network, a consortium of 47 European institutions

Keywords

Spatial epidemiology
Medical geography
Vector-borne diseases
Zoonotic diseases
Land use
Land cover

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Bacterial foodborne pathogens and food spoilers

SENIOR SCIENTISTS

- ▶ Marleen ABDEL MASSIH
- ▶ Pauline MODRIE
- ▶ Sophie TIMMERY
- ▶ Jacques MAHILLON

Research Field and Subjects

The main research topics currently under investigation in the laboratory involve the identification, monitoring and typing of opportunistic and pathogenic prokaryotes from food and environmental matrices, as well as the molecular characterization of their genetic and genomic plasticity, in relation to their differential virulence or spoilage potentials.

The first model bacterial group studied by the team is *Bacillus cereus sensu lato*. This cluster of genetically closely related bacteria is particularly interesting because of the wide virulence spectrum displayed by its members, from the biopesticide *B. thuringiensis* to the food pathogen *B. cereus* and the causative agent of anthrax *B. anthracis*. Of particular importance is the study of genetic transfers and exchanges (transposition and conjugation) occurring between and among *B. cereus* and *B. thuringiensis* strains, under both laboratory and environmental conditions. The team also contributes to characterization of the ecological aspects of the *B. cereus* group, both in environmental niches and food matrices: natural habitats, population distribution and diversity and horizontal gene flux.

A second model bacterium is *Staphylococcus epidermidis* and its capacity to form biofilms (e.g. in human catheters) used by other pathogens such as *Staphylococcus aureus*.

A more recent and more exploratory topic is the potential roles of archaea in the long-term conservation of foods, especially under high salt concentrations.

The techniques and strategies used are those of food microbiology, molecular biology, genetic engineering and bioinformatics. Depending on the virulence of the bacteria (*S. epidermidis*, *Escherichia coli* O157:H7, *Listeria monocytogenes* or *B. cereus*), experimental research is performed in L1, L2 or L2+ containment facilities. The research group is also a reference laboratory in *Requasud*, a network of analytical laboratories providing advice and technical support to agrifood SMEs.

Representative References

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- ▶ IRENGE L.M., DURANT J.-F., TOMASO H., PILO P., OLSEN J.S., RAMISSE V., MAHILLON J., GALA J.-L. Development and validation of a Real-time quantitative PCR assay for Rapid Identification of *Bacillus anthracis* in environmental samples. *Applied Microbiology and Biotechnology* 88: 1179-1192. **2010**.
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Patents

- ▶ New strain of *Bacillus thuringiensis*. European patent - International application # PCT/EP 89/01539 (1989)

Awards

- ▶ BioMérieux Award: *Excellence in pathogen research* for the best Poster "Debast et al. - Development and validation of a reference material for food microbiology using *Bacillus cereus*

spores" presented at the Thirteenth Conference on Food Microbiology, Gent, Belgium, September 2008.

▶ The "Richard C. Knudsen Publication Award" given by the American Biological Safety Association for the paper Verheust *et al.* (2010) Applied Biosafety 15: 32-44.

Funding

- ▶ Fonds National pour la Recherche Scientifique (FNRS)
- ▶ Fonds Spécial de Recherche UCL (FSR)
- ▶ Wallonie : Direction Générale Opérationnelle de l'Agriculture, des Ressources Naturelles et de l'Environnement (DG03 - D GARNE)
- ▶ Wallonie: Direction Générale Opérationnelle de l'Économie, de l'Emploi et de la Recherche (DG06) - WagrAlim
- ▶ Service Public Fédéral Santé Publique, Sécurité de la Chaîne alimentaire et Environnement
- ▶ European Space Agency (ESA)

Partnership

- ▶ Reference laboratory in Food Microbiology for the *Requasud* network.
- ▶ BACEREUS: research project on *B. cereus* and its toxins (consortium of 5 institutions).
- ▶ CONSALIM: research project on foodstuff modification mechanisms (consortium of 12 private companies and 5 scientific institutions).

Main Equipment

- ▶ Air and surface samplers
- ▶ Home-made biofilm flow cells
- ▶ Pulse-Field Gel Electrophoresis (PFGE)
- ▶ Denaturing Gradient Gel Electrophoresis (DGGE)
- ▶ Basic equipment for Molecular Biology and Food Microbiology (PCR, electrophoresis, gel reader, spectrophotometers, electroporator, incubators, laminar flows, light-microscopes)
- ▶ L2 and L2+ biosecurity laboratories

Products and Services

- ▶ Detection, isolation, enumeration and screening of microorganisms in food and environmental matrices and production lines
- ▶ Identification and molecular typing of bacterial food contaminants and pathogens using advanced biochemical and molecular methods.
- ▶ Food quality consulting for SME: decontamination techniques, hygiene and authorized disinfectants.
- ▶ Advices on legal issues: criteria, norms, regulation and HACCP.
- ▶ Organization of *Requasud* international food microbiology proficiency testing (twice a year).

Keywords

Bacillus spp.
Bacterial identification and typing
Bacterial toxins
Foodborne pathogens
Food quality and biosafety
Food spoilers
Phages
Proficiency testing

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The Center for Applied Molecular Technologies: an academic-military integrated platform for biological threats assessment

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- ▶ Pierre-Alain FONTEYNE
- ▶ Leonid IRENGE
- ▶ Jérôme AMBROISE

Research Field and Subjects

The CTMA/DLD-Bio is a mixed academic-military biotechnological platform pooling resources from the Université catholique de Louvain (Center for Applied Molecular Technologies-CTMA) and the Chemical, Biological, Radiological and Nuclear (CBRN) Defense Laboratories Department from Belgian Defense (DLD-Bio).

One of the tasks of CTMA/DLD-Bio is to develop routine and emerging molecular genetic technologies for rapid, specific, sensitive Detection, Identification and Monitoring (DIM) of biological agents in clinical and environmental samples. This includes also DNA-based identification of virulence and antibiotic resistance determinants and clonal analysis. Technologies and applications are dual-use and validated on a wide range of biological and environmental samples. New emerging technologies, such as nanotechnologies, are designed and validated within internal and external consortia to produce innovative operational tools enabling better detection and protection against known and unknown threatening infectious agents.

A second task is to assess the mechanisms of Belgium (BE) and EU responses and preparedness to biological threats in a Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) context. Accordingly, CTMA/DLD-Bio is very active in the field of security through its participation in the Integrated Mission Group for Security (IMG-S group) and its CBRN-Technical Area (TA6) branch. Senior members are BE representatives in the European Defense Agency Capacity Technology Group, in the European Commission Advisory group, and in the NATO Sampling and Identification of Biological Agents Group. Senior members are also BE-qualified experts to carry out investigations of allegations regarding a possible use of biological, chemical or toxins weapons on request of the United Nations.

A light fieldable analytical capacity for rapid DNA-based identification of biological threats in the field has been developed by the team, deployed in 2009 in Kasai (Democratic Republic of Congo) and used several times in live demo's afterwards. This capacity has also prompted :

▶ the participation of CTMA/DLD-Bio to the European Defense Agency projects BFREE (Biological Free mixed CBRN samples for safe handling and analysis) and to several EU-FP7-Security programs (ARCHIMEDES, PRACTICE, EDEN)

▶ the coordination of the EU-FP7-Security project MIRACLE (Mobile laboratory for the Rapid Assessment of CBRN threats Located within and outside the EU) and the coordination of the EU Space Agency research project B-LiFe, (Biological Light Fieldable Laboratory for Emergencies).

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- ▶ IRENGE L.M., WALRAVENS K., GOVAERTS M., GODFROID J., ROSSEELS V., HUYGEN K., GALA J.L. Development and validation of a triplex real-time PCR for rapid detection and specific identification of *M. avium* sub sp. *paratuberculosis* in faecal samples. Veterinary Microbiology 136 (1-2): 166-172. **2009**.

Patents

- ▶ Assay for detecting and identifying microorganism: International patent EP 1725681 – 2006-11-29 (US patent N° 7.785.780 delivered on the 31/08/2010)
- ▶ Method for normalization of quantitative PCR and microarrays: filed under No. 61/556.655 (U.S. provisional filed on 07/11/2011).

Funding

- ▶ European Defense Agency
- ▶ European Space Agency
- ▶ European Commission (7th Framework program)
- ▶ Wallonie: Direction Générale Opérationnelle de l'Economie, de l'Emploi et de la Recherche (DGO6)
- ▶ Région Bruxelles Capitale
- ▶ BE-Ministry of Defense (Royal High Institute of Defense)

Partnership

- ▶ Multinational consortia (see FP7 programs)
- ▶ Belgian academic partners: VUB, Institute Tropisch Geneeskunde
- ▶ Industrial partners : SES-TechCom Luxembourg, Zentech

Main Equipment

- ▶ Molecular Genetics tools (sequencing and pyrosequencing, real-time PCR, synchronous fluorimeter; nucleic acid extraction robots, spectrophotometer)
- ▶ High and low density array: hybridization station, scanner and piezzo spotters Probe station
- ▶ Luminex
- ▶ HPLC
- ▶ ELISPOT reader
- ▶ Luminex, HPLC

Products and Services

- ▶ Diagnostic applications
- ▶ Genome characterization
- ▶ Resequencing
- ▶ Low/high density gene expression profiling
- ▶ Biostatistical analysis

Keywords

Security
Biological threats
CBRN threat assessment
Detection
Identification
Biosensors
Training
Genetics

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Coping with floods and inundations

SENIOR SCIENTISTS

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- ▶ Yves ZECH

Research Field and Subjects

One of the probable consequences of global climate change is the worsening of hydrological extremes, especially flood events. Most of the protective structures (dams and dykes) will undergo threats probably greater than expected at the time of their design.

Dams and levees are indeed constructed throughout the world for water supply, irrigation, navigation, flood protection, electrical power, and water-based recreation. These hydraulic structures are of great benefit to society; however, inundation caused by dam failure and levee breach has disastrous consequences. The failure of a large dam has the potential to cause more death and destruction than the failure of any other man-made structure. Large flood waves resulting from these failures commonly cause loss of life, human suffering, and destruction of properties and ecosystems for hundreds of miles in the inundated valley. Depending on the terrain, flood waves can cause extensive scour and erosion, and large-scale movement of sediment and debris. The potential failure of tailing dams can cause significant damage to the environment through rapid dispersion of hazardous materials and contaminants, including heavy metals.

Failure of such structures and the consequences of these failures must be considered in a context of sustainable development. This is achieved through leading research in the fields of:

- ▶ Physical and digital modelling of flood waves due to dam- or dyke-break and consecutive inundations, including the consequences of sediment transport and morphological evolution.
- ▶ Study and design of preventing and protecting works against inundation: storage reservoir, flood plains, etc.

Representative References

- ▶ VAN EMELÉN S., SOARES-FRAZÃO S., RIAHI-NEZHAD C.K., CHAUDHRY M.H., IMRAN J., ZECH Y. Simulations of the New Orleans 17th Street Canal breach flood. *Journal of Hydraulic Research* 50(1): 70-81. **2012**.
- ▶ SOARES-FRAZÃO S., ZECH Y. HLLC scheme with novel wave-speed estimators appropriate for two-dimensional shallow-water flow on erodible bed. *International Journal for Numerical Methods in Fluids* 66(8): 1019–1036. **2011**.
- ▶ ALEIXO R., SOARES-FRAZÃO S., ZECH Y. Velocity-field measurements in a dam-break flow using a PTV Voronoi imaging technique. *Experiments in Fluids* 50(6): 1633-1649. **2011**.
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Funding

- ▶ National Science Foundation (PIRE projects), US
- ▶ European Union
- ▶ Belgian National Science Foundation (Fonds de la Recherche Scientifique)

Partnership

- ▶ National Taiwan University
- ▶ University of South Carolina (USA)
- ▶ Ecole Polytechnique Fédérale de Lausanne (EPFL)
- ▶ Eidgenössische Technische Hochschule Zürich (Ecole Polytechnique Fédérale de Zurich ETHZ)
- ▶ Université Montpellier 2
- ▶ Università degli Studi di Pavia
- ▶ CEMAGREF Lyon
- ▶ Università degli Studi di Napoli Federico II
- ▶ University of Mississippi, Oxford
- ▶ Rijksuniversiteit Gent

Main Equipment

- ▶ Test flume 36 m length, 3.60 m width and 0.50 m depth; discharge up to 250 l/s
- ▶ Sedimentological test flume, 7.5 m length, 0.50 m width and 0.45 m depth; discharge up to 40 l/s; slope from 0 to 5 %
- ▶ Compound channel test flume, 10 m length, 1.20 m width and 0.30 m depth; discharge up to 40 l/s; slope from 0 to 3 %
- ▶ Test flume for dam-break over mobile sediments, 6 m length with jack-controlled downwards moving gate, 0.25 m width adjustable up to 0.50 m over half of the length

Products and Services

- ▶ Prediction of water level evolution in rivers by one- and two dimensional modelling;
- ▶ Real-time flood forecasting;
- ▶ Sediment transport in rivers and navigation canals: prediction and management
- ▶ Design and optimisation of lock-filling systems
- ▶ Critical analysis of river models and procedures for inundation mapping

Keywords

Fluvial hydraulics
Floods
Dams
Breaching
Inundations
Rivers
Flood plains
Compound channels

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Flooding and mud flow risk

SENIOR SCIENTISTS

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- ▶ Mathieu JAVAUX
- ▶ Sebastien LAMBOT
- ▶ Marnik VANCLOOSTER
- ▶ Bas VAN WESEMAEL

Research Field and Subjects

- ▶ Study of the processes controlling flooding and mud flow risk, in particular:
 - i) rainfall-runoff and surface sediment transport;
 - ii) the connectivity of surface flow in terms of soil surface properties (roughness, infiltration capacity, etc...);
 - iii) the space-time distribution of moisture content;
 - iv) hydraulic properties and other physical properties of the soil surface by means of geophysical and nearby remote sensing techniques.
- ▶ Development and improvement of flood risk and mud flow models on different spatial scales.
- ▶ Development of model parameterisation schemes in terms of soil structure on different scales.
- ▶ Development of techniques for identifying the physical properties of soil, in particular inversion techniques.
- ▶ Design and evaluation of flood and sediment control technologies and strategies and techniques for sustainable soil and water management.

Representative References

- ▶ MINET J., LALOY E., LAMBOT S., VANCLOOSTER M. Effect of high-resolution spatial soil moisture variability on simulated runoff response using a distributed hydrologic model. *Hydrology and Earth System Sciences* 15: 1323-1338. **2011**.
- ▶ EVRARD O., VANDAELE K., BIELDERS C., VAN WESEMAEL B. A grassed waterway and earthen dams to control muddy floods from a cultivated catchment of the Belgian loess belt. *Geomorphology* 100(3-4): 419-428. **2008**.
- ▶ LALOY E., BIELDERS C. Plot scale continuous modelling of runoff in a maize cropping system with dynamic soil surface properties. *Journal of Hydrology* 349(3-4): 455-469. **2008**.

Main Equipment

- ▶ Hydraulic equipment. Equipment for river discharge logging: weirs, parshall flumes, hydraulic gauges, gauging station, tipping buckets with different capacity. Hydraulic canal for the calibration of hydraulic instruments.
- ▶ Surface flow simulator for the study of surface run-off processes under controlled conditions. Rainfall simulator.
- ▶ Soil physical equipment. Equipment for the determination of the density of soil (pycnometer), soil porosity (mercury porosimetry), soil moisture retention pF- curve (multi-step, pressure chamber), soil hydraulic conductivity curve (infiltrimeters).
- ▶ Advanced surface hydrological and soil hydro-ecological models: The Meshed Hydrological Model (MHM), i.e. a spatially distributed hydrological model for the prediction of flow in hydrological catchments

Products and Services

- ▶ Hydrological risk assessment studies of small hydrological catchments, using advanced hydrological modelling tools, in particular ARCGIS (geographical data analysis, spatial modelling), MHM-TFM (hydrological modelling), HEC-RAS (hydraulic modelling), STREAM (mud flow)
- ▶ Provider of hydrological data, in particular from the hydrological monitoring network of the site of Louvain-la-Neuve (meteorological data, rainfall network, parshall flume at the outlet of the artificial lake, survey well) and from microcatchments

Keywords

Flooding
Mudflow
Runoff
Soil erosion
River flow
Rainfall
Flood control
Storm basin
Hydrological model

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Hydrogeological characterization of aquifers and groundwater management

SENIOR SCIENTISTS

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- ▶ Isabelle BONNIVER
- ▶ Samantha REKK

Research Field and Subjects

Apart from the ice caps, the groundwater stored in aquifers is the main fresh water reservoir located on continents. It is a renewable natural resource which is increasingly threatened due to intense anthropic activities especially close to densely inhabited areas. The threat can be subdivided into the quantitative domain (over-pumping vs. aquifer recharge) and the qualitative domain (punctual or diffuse pollution). To ensure sustainable development, aquifers and groundwater resources must be well characterized, monitored and managed.

The department of geology at the University of Namur specialises in the construction of hydrogeological maps using a Geographic Information System (such as Arcmap) associated with databanks (such as Access, Oracle...) in which information such as geological environment, borehole description, hydrochemistry ... is compiled.

Detailed investigations could be conducted by the hydrogeological team. These would include:

- ▶ field investigations to describe the regional lithology and structural geology; water balance calculation of river basins (meteorological data collection and interpretation, river gauging, ...)
- ▶ aquifer characterization (aquifer delimitation, geophysical investigation, pumping tests, piezometric records, hydrochemistry, ...)
- ▶ parameterization and modelling of flow and contaminant transport processes (tracer tests, groundwater flow and transport mathematical models, ...).

At present, scientific research is mainly oriented towards karstic hydrogeology, carrier dewatering processes and diagnosis of water catchment contamination due to pesticides.

The department has also wide experience in various countries in Africa (Ethiopia, RDC, ...) and Asia (Philippines, Indonesia) that means it can conduct investigations in different hydrogeological environments (volcanic areas and hydrothermal hydrogeology, coastal areas and sea water intrusion environments, ...).

Representative References

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- ▶ HALLET V. Modélisation mathématique de l'évolution, à long terme, des teneurs en nitrates dans la nappe aquifère des craies du Crétacé de Hesbaye (Belgique). *Revue des Sciences de l'Eau* 17(1): 5-24. **2004**.

Funding

- ▶ Wallonie: Direction Générale de l'Agriculture, des Ressources Naturelles et de l'Environnement
- ▶ Société Publique de Gestion des Eaux
- ▶ Coopération Universitaire au Développement
- ▶ Banque Nationale de Belgique
- ▶ Private companies

Partnership

- ▶ ArGEnCo: Architecture, Géologie, Environnement et Constructions (ULg)
- ▶ Service de Géologie Fondamentale et Appliquée (UMons)
- ▶ Département des Systèmes de Référence et Géodynamique (Observatoire Royal de Belgique)
- ▶ Gocad research group. Nancy School of Geology.
- ▶ Département de géographie (UCL)
- ▶ Lhoist Group
- ▶ Société Wallonne de Distribution d'Eau
- ▶ Centre de Recherche Agronomique Wallon
- ▶ University of Mekele – Ethiopia
- ▶ Ateneo de Manila University – Philippines
- ▶ Volcanological Survey in Indonesia.

Main Equipment

- ▶ Seismic tomography
- ▶ Electrical tomography
- ▶ Multiparameter water probes
- ▶ Automatic water samplers
- ▶ Field fluorimeters
- ▶ ArcGIS software
- ▶ Modflow software

Products and Services

- ▶ Geological mapping
- ▶ Hydrogeological mapping
- ▶ Geophysical prospecting
- ▶ Aquifer characterization
- ▶ Aquifer modelling
- ▶ Tracers test and interpretation
- ▶ Karst investigation

Keywords

Hydrogeology
Geophysics
Tracer tests
Groundwater models
Carrier dewatering
Hydrogeological map
Karst

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Impact of climate change on health in Wallonia

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- ▶ Niko SPEYBROECK

Research Field and Subjects

Climate change (CC) is a global concern and decisions are taken to limit anthropogenic greenhouse gas emissions through attenuation efforts. On the other hand, certain impacts of CC are inevitable and will require human adaptation. Since 2006, the European Commission has encouraged European countries to evaluate CC impacts at national and regional levels in order to implement several adaptation strategies starting in 2012. In this context, the Belgian government has asked Wallonia, Flanders and the Brussels-Capital Region to study their CC impacts in order to develop a comprehensive and inclusive federal plan. In Wallonia, this research was led by the Agence wallonne de l'Air et du Climat (AWAC). The work was undertaken by EcoRes and TEC (Tourisme Transports Territoires Environnement Conseil) and assisted by scientists from the Université libre de Bruxelles (ULB), the Université de Liège (Ulg) and the Université catholique de Louvain (UCL). The UCL team, from the Institute of Health and Society (IRSS), was in charge of the evaluation of present and future health-related vulnerabilities due to CC.

An initial assessment indicated that future, and sometimes current effects of CC on health in Wallonia may result in direct mortality and morbidity from heat waves, especially for the elderly and other vulnerable populations. Furthermore, there are links between poor health and climate-mitigated environmental factors such as water and air quality, which can result in allergies, respiratory diseases, and food-borne diseases, amongst others. That being said, much of the future impact and risks of CC on health in Wallonia remains uncertain. For example, the future emergence of numerous serious and less serious vector-borne diseases is difficult to predict.

Research and prioritised allocation of resources should be focused on continued studies and monitoring initiatives that could play an important role in the evaluation of current and potential health impacts of CC.

Representative Reference

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Funding

- ▶ Wallonie : Agence wallonne de l'Air et du Climat (AWAC)

Partnership

- ▶ Wallonie: Agence wallonne de l'Air et du Climat (AWAC)
- ▶ Other Universities (ULB, Ulg)
- ▶ EcoRes (www.ecores.eu)
- ▶ Tourisme Transports Territoires Environnement Conseil (TEC)

Products and Services

- ▶ Scientific consulting on health issues
- ▶ Statistical analysis
- ▶ Data analysis of epidemiological patterns

Keywords

Climate change
Health

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<http://www.uclouvain.be/irss.html>
http://airclimat.wallonie.be/spip/IMG/pdf_Note_d_orientation_strategique_cplte.pdf

Abiotic risks in forest ecosystems

SENIOR SCIENTISTS

- ▶ Mathieu JONARD
- ▶ Quentin PONETTE
- ▶ Caroline VINCKE

Research Field and Subjects

Global changes (including climate variability, extreme events and atmospheric pollution) may promote important modifications of forest dynamics, health and productivity. Some abiotic risk occurrence and intensity may be amplified.

The research team seeks to evaluate abiotic risks and their consequences upon forest ecosystems and to suggest adapted management responses.

On the first hand, positive factors for tree growth, such as the augmentation of photosynthetic activity resulting from increased atmospheric CO₂ concentrations and sustained nitrogen input from atmospheric deposition, will likely lead to enhanced forest production, at least in the short term, and at sites without major nutrient deficiencies.

But climate change could, either directly or indirectly, induce shortages in soil resources. In temperate zones, spring and summer droughts may become more intense, in some cases inducing nutritional disorders; winter water logging would be enhanced as well as soil acidification through atmospheric deposition.

From a forestry perspective, adaptive forest management, site sanitation and effective crisis plans should prove very valuable when fighting these threats.

To study causal factors and their effects on forests, use is being made of various approaches: *in situ* monitoring and manipulation of ecosystems, studies under controlled conditions, ecosystem characterization, process identification, modelling. The main disciplines are related to forest ecophysiology and ecology.

From an applied perspective, diagnostic or decision support tools such as stand or site typologies, vulnerability maps and hot spot identification are developed. Special emphasis is also given to devise silvicultural prescriptions integrating ecological, technical and economical aspects.

Representative References

▶ CAMPIOLI M., VINCKE C., JONARD M., KINT V., DEMAREE G., PONETTE Q. Current status and predicted impact of climate change on forest production and biogeochemistry in the temperate oceanic European zone. Review and prospective for Belgium as a case study. *Journal of Forest Research* 17(1): 1-18. **2012**.

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▶ JONARD F., ANDRE F., PONETTE Q., VINCKE C., JONARD M. Sap flux density and canopy conductance of European beech and common oak trees in pure and mixed stands during the summer drought of 2003. *Journal of Hydrology* 409(1-2): 371-381. **2011**.

▶ JONARD M., ANDRÉ F., GIOT P., WEISSEN F., VAN DER PERRE R., PONETTE Q. Thirteen-year monitoring of liming and fertilization (K and P) effects on tree vitality in Norway spruce and European beech stands. *European Journal of Forest Research* 129(6): 1203-1211. **2010**.

▶ VINCKE C., DIEDHIOU I., GROUZIS M. Long term dynamics and structure of woody vegetation in the Ferlo (Senegal). *Journal of Arid Environments* 74 (2): 268-276. **2010**.

▶ JONARD M., ANDRÉ F., DAMBRINE E., PONETTE Q., ULRICH E. Temporal trends in the foliar nutritional status of the French, Walloon and Luxembourg broad-leaved plots of forest monitoring. *Annals of Forest Science* 66(4): 412. **2009**.

▶ VINCKE C., THIRY Y. Water table is a relevant source for water uptake by a Scots pine (*Pinus sylvestris* L.) stand: evidences from continuous evapotranspiration and water table monitoring. *Agricultural and Forest Meteorology* 148(10): 1419-1432. **2008**.

Funding

- ▶ Wallonie : Direction générale opérationnelle de l'Agriculture, des Ressources naturelles et de l'Environnement – Département de la Nature et des Forêts (DG03 – DGARNE – DNF)
- ▶ Institut Bruxellois pour la Gestion de l'Environnement (IBGE)
- ▶ European Union (Interreg)
- ▶ Belgian Science Policy

Partnership

- ▶ Département de la Nature et des Forêts (DNF)
- ▶ Département d'étude du milieu naturel et agricole (DEMNA)
- ▶ ULg-GxABT, Unité de Physique des bio-systèmes
- ▶ INRA-Nancy: Biogéochimie des écosystèmes forestiers; Bioclimatologie et écophysiole; Croissance et production; Phytoécologie forestière
- ▶ INRA-Bordeaux: unité Ecologie fonctionnelle et physique de l'environnement; Unité Mixte de Recherches 'Transfert sol-plante et cycle des éléments minéraux dans les écosystèmes cultivés'
- ▶ KUL, Afdeling Bos, Natuur en Landschap
- ▶ RUG, Department of Forest and Water Management; Laboratory of Forestry
- ▶ SCK-CEN, Biosphere Impact Studies
- ▶ ULB, Laboratoire de Lutte Biologique et Ecologie Spatiale
- ▶ ULg, Dpt of Environmental Sciences and Management, Laboratory of Plant and Microbial Ecology, Institute of Botany

Main Equipment

- ▶ Environmental monitoring: automated meteorological station; soil temperature and soil water content probes; rainfall, stem flow and through fall automated collectors; lysimeters; sap flow sensors; dendrometers; portable infrared gas monitor and soil respiration chamber; LAI 2000; hemispherical photography
- ▶ Mineral analyses of plant, water, and soil samples: microwave digestion, HPLC, ICP, C&N analyzer

Products and Services

- ▶ Environmental monitoring: instrumented permanent plots, data mining and reporting
- ▶ Mineral analyses: plant (including woody tissues), water, and soil samples
- ▶ Image analyses of plant samples
- ▶ Modelling

Keywords

Environmental monitoring
Modelling
Silviculture
Water and nutrient constraints
Water and nutrient cycling
Ecophysiology
Global changes

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Decline of soil organic matter and soil fertility

SENIOR SCIENTIST

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Research Field and Subjects

The decline of soil organic matter is recognized in the European Soil Thematic Strategy as one of the seven most important threats to soil quality.

Soil organic matter is vital in maintaining its fertility, filtering capacity for percolating water and infiltration capacity, thereby reducing the risk of groundwater pollution and local flooding. Soil organic matter has declined in cropland soils over the last fifty years. Monitoring of soil organic matter content is vital in order to delineate high risk zones and propose agricultural practices that can reverse this decline. Apart from monitoring, techniques are developed to enhance the detection of a decline in soil organic matter, consisting of :

- ▶ fractionation of organic matter in order to isolate the most reactive components
- ▶ spectroscopic tools to increase analytical efficiency.

Representative References

- ▶ VAN WESEMAEL B., PAUSTIAN K., ANDRÉN O., CERRI C.E.P., DODD M., ETCHEVERS J., GOIDTS E., GRACE P., KÄTTERER T., McCONKEY B.G., OGLE S., PAN G., SIEBNER, C. How can soil monitoring networks be used to improve predictions of organic carbon pool dynamics and CO₂ fluxes in agricultural soils? *Plant and Soil* 338(1-2): 247-259. **2011**.
- ▶ MEERSMANS J., VAN WESEMAEL B., GOIDTS E., VAN MOLLE M., DE BAETS S., DE RIDDER F. Spatial analysis of soil organic carbon evolution in Belgian croplands and grasslands, 1960-2006. *Global Change Biology* 17(1): 466-479. **2011**.
- ▶ VAN WESEMAEL B., PAUSTIAN K., MEERSMANS, GOIDTS E., BARANCIKOVA G., EASTER M. Agricultural management explains historic changes in regional SOC stocks. *Proceedings of the National Academy of Sciences of the United States of America* 107(33): 14926-14930. **2010**.
- ▶ STEVENS A., UDELHOVEN T., DENIS A., TYCHON B., LIOY R., HOFFMANN L., VAN WESEMAEL B. Measuring soil organic carbon in croplands at regional scale using imaging spectroscopy. *Geoderma* 158(1-2): 32-34. **2010**.

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Funding

- ▶ European Union
- ▶ Fédération Wallonie-Bruxelles
- ▶ Belspo

Partnership

- ▶ European Commission Joint Research Centre
- ▶ Centre de Recherche Gabriel Lippmann (Luxembourg)
- ▶ Centre de Recherche Agronomique de Gembloux

Main Equipment

- ▶ CN analyzer, Variomax
- ▶ Percussion drilling equipment
- ▶ Spectrometer ASD fieldspec pro

Products and Services

- ▶ Soil organic matter monitoring at Belgian and EU scale

Keywords

Soil organic matter
Soil monitoring
Visible and near infrared Spectroscopy
Organic matter fractionation
Soil degradation

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Development of emotional competence to reduce psychosocial risks

SENIOR SCIENTISTS

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- ▶ Jacques GRÉGOIRE

Research Field and Subjects

The aim of this research is to reduce psychosocial risks via Emotional Competence (EC) trainings. EC—also labelled “Emotional Intelligence” (EI) or “emotional skills”—refers to the ability to identify, express, understand, regulate and use one’s own and others’ emotions flexibly and constructively. Individuals with high EC are able to identify their own and others’ emotions, express them in a socially acceptable manner, understand their causes and consequences, regulate them when they are not appropriate to the context or their goals, and use them to improve their life. While they take advantage of emotions without letting them lead them astray, individuals with low EC have a hard time taking into account the information emotions convey while at the same time being regularly overwhelmed by them.

The level of EC has far-reaching consequences for adaptation. Specifically, a growing body of evidence indicates that the level of EC is a significant predictor of psychological, physical, social and work adjustment. People with higher EC are less at risk for stress-related disorders, have a lower risk of developing psychological disorders or burn-out. They have higher job performance and greater managerial competences, resulting in more efficient and less stressed teams.

Given the above, the team has sought to determine whether EC could be improved among adults and whether this increase would lead to improvements in psychological and physical health, social relationships and work performance.

The team has therefore developed and validated a brief psychological intervention (18-hour on-site training + a 1-month email follow-up) designed to improve EC. The results show that subjects in the training group become happier, less stressed (25% decrease in subjective stress; 14% decrease in the stress hormone cortisol) and more efficient than subjects in the control group. The quality of social relationships of the former also increases, which is interesting, because social relations have a buffering impact on stress. All the training benefits are maintained over time, as indicated by our 6-month and 1-year follow-ups.

Representative References

- ▶ MIKOLAJCZAK M., NELIS D., KOTSOU I. Efficient programs to improve trait and ability emotional intelligence in adults: lessons learned from the Louvain emotional competence training. *In* PÉREZ-GONZÁLEZ J.C., MAVROVELI S., ANAYA D. Assessment and education of emotional intelligence. **2013**.
- ▶ KOTSOU I., GREGOIRE J., NELIS D., MIKOLAJCZAK M. Emotional plasticity: conditions and effects of improving emotional competence in adulthood. *Journal of Applied Psychology* 96: 827-839. **2011**.
- ▶ NELIS D., KOTSOU I., QUOIDBACH J., DUPUIS P., WEYTENS F., HANSENNE M., MIKOLAJCZAK M. Increasing emotional competence improves psychological and physical well-being, social relationships and employability. *Emotion* 11: 354-366. **2011**.
- ▶ MIKOLAJCZAK M., QUOIDBACH J., KOTSOU I., NELIS D. Les compétences émotionnelles [*Emotional competence*]. *Psycho Sud*, Dunod, Paris, 336 p. **2009**.

Funding

- ▶ Fonds National pour la Recherche Scientifique (F.R.S. - FNRS)
- ▶ Wallonie (First Spin-Off grant)

Partnership

- ▶ Stanford University, USA
- ▶ University of Liège, Belgium

Products and Services

- ▶ Emotional Competence Trainings for middle and top management
- ▶ Assessments of Emotional Competence
- ▶ Advice and consultation

Keywords

Emotional competence
Emotional intelligence
Stress
Burnout
Employability
Job performance

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Addictive behaviors : risk factors, prevention and psychological intervention

SENIOR SCIENTISTS

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- ▶ Pierre MAURAGE
- ▶ Stephan VAN DEN BROUCKE

Research Field and Subjects

Addiction involves the uncontrolled use of a psychoactive substance (drug addictions) or excessive involvement in specific activities (behavioural addictions, e.g. gambling, shopping, online games) impacting on various domains of daily life (personal, social, professional). The prevalence of addictive behaviours (both substance and behavioural addictions) is increasing and addictions represent a serious threat to the health and wellbeing of the population.

The research program, which combines exploratory investigations (e.g. online surveys), experimental studies conducted in the laboratory and clinical single case studies, is split into four main themes:

- ▶ Exploration of risk and protective factors (psychological, biological, socio-demographical) for the development of addictive behaviours. In particular, the researchers are interested in clarifying the specific role of certain psychological factors (e.g., impulsivity traits, attitudes, cognitive bias and impairments, environmental cues, control beliefs) that play a predisposing enabling or reinforcing role in the onset and maintenance of addictive behaviours.
- ▶ The development, (pre-)testing and evaluation of evidence-based methods to prevent addictive behaviours by way of reducing psychological and environmental risk factors and strengthening protective factors.
- ▶ The development of new psychological interventions targeting certain key aspects involved in maintaining and relapse of addictive disorders (e.g., "cravings" or urges, self-control impairments).
- ▶ Exploration of the cognitive (e.g., attention, memory, inhibition), emotional (e.g., empathy) and cerebral consequences of addictive behaviours among adults (alcohol-dependent individuals) and populations at risk for developing addictions, particularly adolescent and young adult binge drinkers.

Representative References

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Partnerships

- ▶ Addictology Divisions of several French speaking European University Hospitals (e.g., Bruxelles, Geneva, Paris, Marseille).
- ▶ Other French speaking universities (e.g., ULg, ULB, university of Paris-Nanterre La Défense, university of Geneva, university of Lille, university of Caen)
- ▶ Universities in Flanders (KU Leuven, U Gent), in the Netherlands (Maastricht University) and in the UK (University of Glasgow)
- ▶ Behavioural and Clinical Neurosciences Institute, University of Cambridge, United Kingdom.
- ▶ European Network for Smoking Prevention (ENSP)
- ▶ International Union for Health Promotion and Education (IUHPE)

Products and Services

- ▶ Review and expertise of research protocols
- ▶ Development and validation of material for use in addiction research (e.g. questionnaires, stimuli, laboratory tasks ...)
- ▶ Dissemination of empirically based techniques to prevent or treat specific aspects of addictive behaviours
- ▶ Process and effect evaluation of preventive interventions
- ▶ Advice and consultation

Keywords

Addictions
Risk factors
Cyber-addictions
Gambling
Drug
Tobacco
Alcohol
Prevention

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Health needs of children and adolescents growing up with a chronic condition

SENIOR SCIENTISTS

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- ▶ Raymond REDING
- ▶ Dominique CHARLIER
- ▶ Antoine MASSON
- ▶ Christiane VERMYLEN

Research Field and Subjects

In order to prevent multiple health risks and additional psychosocial burden in children and adolescents who grow up with chronic health disorders, the research looks at the complex and interrelated challenges met by this vulnerable population. The research team seeks to develop innovative best practice models, in order to empower caregivers and the healthcare system to adequately support self-care capacity, healthy psychological development, and social integration in this vulnerable population. The topic is covered by five transverse areas of research:

- ▶ Prevalence of psychological co-morbidity and risky health behaviours in adolescents and young adults with a chronic condition
- ▶ Psychological self-regulation processes through which young patients internalise motivation to self-care and develop independence from their caregivers for the management of their condition
- ▶ Parenting practices and clinical communication best suited to support self-care and adherence in young patients
- ▶ Organisational and communication aspects of healthcare services to prepare and support transition from paediatric care to adult-oriented care
- ▶ Relevant psychosocial outcomes to establish the readiness to transfer in adolescents and young adults.

Although the research looks at commonalities across various chronic health conditions, specific expertise has been developed for several years in the field of paediatric liver transplantation, with research looking at the challenges met by young transplant recipients and their families, in terms of: (i) post-transplant family dynamics; (ii) identity construction and sense of self in young transplant recipients; (iii) the phenomenology of the gift-relationship in the event of a living-related donation (usually from parent to child).

The research is embedded in an interdisciplinary collaboration which brings together specialists from different backgrounds: medicine, adolescent health and medicine, psychology, public health and health education, philosophy and medical ethics, sociology and anthropology.

Representative References

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- ▶ AUJOLAT I. Le passage en médecine d'adulte: impératif de développement pour le patient... un défi pour les soins ! *Percentile* 16(4): 109-112. **2011**.
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- ▶ PÉLICAND J., FOURNIER C., AUJOLAT I. Observance, auto-soin(s), empowerment, autonomie : quatre termes pour questionner les enjeux de l'éducation du patient dans la relation de soins. *Actualités et Dossiers en Santé Publique* 66: 21-23. **2009**.
- ▶ AUJOLAT I., SIMONELLI F., DECCACHE A. Health Promotion needs of children and adolescents in hospitals: a review. *Patient Education & Counseling* 61(1): 23-32. **2006**.

Funding

- ▶ Fonds National de la Recherche Scientifique (FNRS)
- ▶ Fonds spécial de recherche UCL (FSR)
- ▶ Secteur des sciences de la santé UCL (Mandats de recherche clinique)
- ▶ Région de Bruxelles-Capitale

Partnerships

- ▶ KUL, Leuven, Belgium
- ▶ FUNDP, Namur, Belgium
- ▶ University of Liverpool, UK
- ▶ University of Paris 7, France
- ▶ University of Nancy I, France
- ▶ Deakin University, Australia
- ▶ HPH-CA : Health Promotion for children and adolescents in and by hospitals
- ▶ ELPAT-Ethical, Legal and psychosocial Aspects of Organ Transplantation
- ▶ The Leuven-Basel Research group on Adherence in Transplantation
- ▶ International Pediatric Transplantation Association (IPTA), Allied Health Professionals Committee

Keywords

Child and adolescent health
Chronic conditions
Patient education and counselling
Psychosocial issues
Paediatric transplantation
Self-management support
Transition

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Social diversity at work

SENIOR SCIENTISTS

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Research Field and Subjects

Because of the growing diversity of the workforce, organisations are concerned with managing processes related to the relations between social groups. In particular, stigmatization and discrimination of members of minorities can act as stressors which are psychosocial risks.

Consequently, besides other strains such as working conditions, they are likely to have deleterious effects on organisational performance and prejudice workers' wellbeing.

Addressing both employers' and workers' attitudes, these studies examine psychosocial processes that are activated in social diversity contexts and their impact on employment security and job quality, workers' well-being, equal opportunities, etc. The aim is to reveal conditions required for successful social diversity at work, especially in relationship with age and ethnic diversity issues.

Representative References

- ▶ BECKER M., VIGNOLES V.L., OWE E., BROWN R., SMITH P.B., EASTERBROOK M., HERMAN G., DE SAUVAGE I., BOURGUIGNOND., TORRESA., CAMINO L., SILVEIRA LEMOS F.C., FERREIRA M.C., KOLLER S.H., GONZÁLEZ R., CARRASCO D., LAY S., MUSA R., WANG Q., BOND M.H., VARGAS TRUJILLO E., BALANTA P., VALK A., MEKONNEN K.H., NIZHARADZE G., FULOP M., REGALIA C., MANZI C., BRAMBILLA M., HARB C., ALDHAFRI S., MARTIN M., MACAPAGAL M.E.J., CHYBICKA A., GAVRELIUC A., BUITENDACH J., SCHWEIGER, GALLO I., OZGEN E., GUNER E.U., YAMAKOGLU N. Culture and the distinctiveness motive: Constructing identity in individualist and collectivist contexts. *Journal of Personality and Social Psychology* 102(4): 833-855. **2012**.
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Funding

- ▶ Fonds Spécial de Recherche UCL (FSR)
- ▶ Action de recherche concertée (ARC), Fonds de recherche de la Fédération Wallonie Bruxelles

Partnership

- ▶ Scientific collaborations with University of Tilburg, University of Toronto, University of Metz, Sussex University
- ▶ Partnerships with public and private organizations: e.a., Centre pour l'égalité des chances et de lutte contre le racisme, Cliniques Universitaires Saint-Luc, Forem, Bruxelles-Formation...

Products and Services

- ▶ Evaluation of diversity-related management policies and practices
- ▶ Applied research on diversity-related topics

Keywords

Social diversity
Intergroup relations
Discrimination
Integration
Wellbeing

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Analysis of international crisis management, conflict transformation and resolution

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Research Field and Subjects

The Study Center on International Crisis and Conflicts (Centre d'études des crises et des conflits internationaux – CECRI) unites academics and researchers in International Relations. The research activities cover a wide range of fields, such as geopolitics, foreign policy, humanitarian action, crisis management, conflict prevention, management and transformation. The analytical focus on conflict triggers and their management instruments (negotiation, sanctions and economic incentives, coercive diplomacy, foreign policy tools, peace operations, humanitarian responses,...), is combined with the empirical study of international disputes, peace processes and specific area studies. The Center's scientific activities are based on three research programs that produce collective and individual publications, seminars, doctoral research and involvement in international partnerships and networks:

- ▶ Memory and Conflict Resolution;
- ▶ International Conflict Management in the 21st Century;
- ▶ Powers on the International Stage – Geopolitics and Foreign Policy (including close links with the Chair InBev-Baillet Latour "European Union – China").

Representative References

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- ▶ AIT-CHAALAL A., KHADER B., ROOSENS C. Proche Orient, Entre espoirs de paix et réalités de guerre. GRIP, Bruxelles, 323 p. **2010**.
- ▶ PELLON G., LIEGEOIS M. Les organisations régionales européennes et la gestion des conflits – Vers une régionalisation de la sécurité ? Peter Lang, Bruxelles, 353 p. **2010**.
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Funding

- ▶ European Cooperation in Science and Technology (COST)
- ▶ EU
- ▶ Fonds National de la recherche Scientifique (FNRS)

Partnership

In Belgium:

- ▶ University of Namur (Chaire Tocqueville in European Security Policy), KU Leuven, University of Ghent, Groupe de Recherche et d'Information sur la Paix et la Sécurité (GRIP), Egmont Institute.

International partnerships:

- ▶ COST network EU-Pax on New challenges of Peacekeeping and the EU's role in Multilateral Crisis Management
- ▶ Network on Humanitarian Action (NOHA)
- ▶ Processes of International Negotiation (PIN), Netherlands Institute of International Relations (Clingendael Institute)
- ▶ Réseau francophone de recherche sur les Opérations de Paix (ROP)

Products and Services

- ▶ Consultancy and advice to public and private institutions
- ▶ Organization of conferences, congress and seminars
- ▶ Seasonal schools and customized training sessions
- ▶ Online training for professionals
- ▶ Media activities
- ▶ Online database and map creation

Keywords

International Security
Geopolitical Analysis
Foreign Policy Analysis
International Crisis Management
International Conflicts Resolution and/or Transformation
Peace Operations Management and Analysis

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Organizational regulations of societal risks

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Research Field and Subjects

A large number of public and private organizations are designed to face situations characterized by societal risk. One characteristic of risk is its ability to unravel most of conventional management, based on general and routine principles, even among organizations that are specifically designed to handle it. In such a context, societal risk prevention and management require adaptable, innovative strategies as well as specific competencies. More specifically, the objective of our research project is threefold. Firstly, it aims to question the internal regulations produced by each organization when facing societal risk. Secondly, by comparing the way societal risk has been tackled at different times within the same organization, we intend to identify how this organization has transferred its knowledge of societal risk management from one situation to another. Thirdly, it will compare how several organizations have regulated societal risks and what kind of knowledge transfer occurred.

The main research questions we address can be summarized as follows:

- ▶ Considering organizational regulations, how do organizations respond to societal risks ?
- ▶ Considering knowledge transfer, do we observe a learning effect in the long term ?
- ▶ Do organizational patterns exert an influence on risk handling (efficacy) ?

The research project runs from 2010 to 2014.

Representative References

- ▶ DONIS C., RAONE J., SCHIFFINO N., TASKIN L. Understanding the organizational regulation of societal risk through the combination of New Institutionalism and Social Regulation Theory. A proposal. Working paper ISPOLE 2012-1. **2012**.
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Funding

- ▶ Action de Recherche Concertée (ARC)

Products and Services

- ▶ Journal papers
- ▶ Conferences
- ▶ Decision-making tool

Keywords

Risk
Societal risk
Organization
Regulation
Knowledge
Management
Administration

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Risks and liability in healthcare and biomedicine

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Research Field and Subjects

Tremendous advances in healthcare and biomedicine entail new risks. With these new risks, questions arise regarding the issue of liability and compensation of healthcare-related injuries.

The research is interdisciplinary (law, medicine, bioethics, psychology, sociology,...) and looks at which social, ethical, deontological and legal responses are most appropriate in dealing with new problems associated with biomedical risks. It analyzes the Belgian regime, the schemes used in other countries (e.g. Canada, Belgium, France, Iran, New Zealand, Spain, Sweden, United States, Switzerland) and the relevant European instruments and international conventions.

It is conducted, at the UCL, by the Center for medical and biomedical law, at the Institute JUR-I. Other UCL, national and international partners are also involved, as mentioned further.

The implications of using human body material and organs (therapeutic purposes or research), reproductive technologies or surrogate motherhood, biobanks, commercialization of genetic testing and (pediatric) clinical trials are notably analyzed, as well as patients' rights and some therapeutic practices of health professionals. The (dis)advantages of the current regimes of criminal and civil liabilities are also studied compared with modern forms of injury resulting from new biomedical risks. A comparison between some recent new compensation schemes is made (in France, the *Office national d'indemnisation des accidents médicaux*; in Belgium, the *Medical Accident Compensation Fund*). Alternative dispute resolution is also examined, such as mediation in health care. New prospects and proposals for the future are also suggested.

Representative References

- ▶ SCHAMPS G. The extent of minor autonomy and medical care in Belgian law. *In* Adolescents, Autonomy and Medical Treatment. Ed. B. FEUILLET-LIGER, R. IDA, Th. CALLUS (Dir.). Bruylant, Brussels, pp 81-136. **2012**.
- ▶ SCHAMPS G. (Dir.) Nouvelle réglementation relative à l'indemnisation des dommages résultant de soins de santé. Recueil systématisé des lois, documents parlementaires et arrêtés d'exécution. DERESE M.N., HAUSMA J.M., SCHAMPS G., SQUIFFLET A.C. Collections Lois actuelles, Kluwer, Mechelen, 375 p. **2011**.

- ▶ SCHAMPS G., DERESE M.N. Anonymity and ART in Belgian law: Legislation for existing practice in the law of 6th July 2007. *In* Who is my genetic parent? Ed. B. FEUILLET (dir.). Bruylant, Brussels, 121-147. **2011**.
- ▶ SQUIFFLET A.C. L'action de l'Union européenne en matière de prélèvement et de transplantation d'organes : commentaires à propos du plan d'action 2009-2015 et de la directive du 7 juillet 2010. *Revue de Droit de la Santé/Tijdschrift voor gezondheidsrecht* 5:382-397. **2011**.
- ▶ DERESE M.N. Mediation in the Belgian healthcare sector. Analysis of a particular issue: the material scope of application of mediation. *Medicine and Law* 30(2): 225-238. **2011**.
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- ▶ VAN OVERSTRAETEN M. Une manifestation particulière du droit du patient au consentement libre et éclairé : la faculté de rédiger une déclaration anticipée. *In* Evolution des droits du patient. Indemnisation sans faute des dommages liés aux soins de santé : le droit médical en mouvement. Ed. G. SCHAMPS (Dir.). Bruylant, Brussels, Paris, 83-153. **2008**.
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Awards

- ▶ Prix quinquennal Baron E. VAN DIEVOET, **1999**.
- ▶ Prix quinquennal de la Revue Critique de Jurisprudence Belge, **2001**.

Funding

- ▶ Agence Nationale de la Recherche (Paris)
- ▶ Fonds National de la Recherche Scientifique (F.R.S. - FNRS)
- ▶ Fonds Spécial de Recherche UCL (FSR)
- ▶ Fondation Roi Baudouin and Loterie Nationale
- ▶ Commission canadienne pour l'UNESCO
- ▶ Relations internationales Québec
- ▶ Wallonie
- ▶ Université Mc Gill (Montréal) and Université Pierre Mendès France (Grenoble)

Partnership

The research is conducted, at the U.C.L., by the Center for medical and biomedical law (Institute JUR-I) and by some members of the Institute of Health and Society. There is also collaboration with the following partners:

- ▶ International Academic Bioethics Network (RUIB)
- ▶ Institut Droit et Santé (Université Paris Descartes, France)
- ▶ Faculty of Law of McGill University (Canada)
- ▶ Université Pierre Mendès (France)

Other partners in Belgium:

- ▶ Groupe de référence institutionnelle en matière de bioéthique (UCL)
- ▶ CIDES, FUNDP Namur
- ▶ Centrum voor Biomedische Ethiek en Recht (KULeuven)
- ▶ Other Universities (Antwerpen, Gent, Ulg, ULB, VUB)

Other partners abroad:

- ▶ Groupe de recherche en droit de la santé (University of Sherbrooke, Canada)
- ▶ Centre européen d'études et de recherche droit et santé (Université de Montpellier, France)
- ▶ Réseau francophone de Bioéthique
- ▶ Fondation Brocher (Geneva, Switzerland)
- ▶ Swiss Institute of Comparative Law

Products and Services

- ▶ Constructive analysis and case studies of the relevant legal regimes in domestic, European, international law and commentary of ethical and deontological rules, on specific questions associated with biomedical risks
- ▶ Advice on the preparation or revision of legislation and regulations
- ▶ Publications (books, chapters of books, contributions in international reviews)
- ▶ Legal advice and consultation
- ▶ Membership or presidency of Belgian or foreign health institutions (Federal Commission Patients' rights, Medical Accident Compensation Fund, Belgian Advisory Committee on Bioethics, Office national d'indemnisation des accidents médicaux, France)

Keywords

Health Law – Medical and Biomedical Law Patient's Rights
Civil or Criminal Liability – (No-Fault) Compensation Scheme
Alternative Dispute Resolution – Mediation
Human Corporal Material and Organs
Reproductive Technologies and Surrogate Motherhood
Biobanks and Genetic Testing
Bioethics and Research

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Risk analysis and management tools in agriculture

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- ▶ Bruno HENRY DE FRAHAN

Research Field and Subjects

Nowadays, farmers' main concerns have to do with risk, whether economic (unpredictability of input and output prices), financial (funding sources), natural (weather and crop/livestock performance), institutional (policy), or personal (hazards affecting farm managers).

In this context, interdisciplinary research in risk analysis and risk management tool evaluation is aimed to assess and, in particular, mitigate production and market risks in the agricultural sector at the national, regional and community level.

The research team is composed of experienced economists, including agricultural economists, and can call on experts in statistics, laws, agronomy, epidemiology and meteorology. They use state-of-the-art methods for conducting their analyses and evaluations, and rely on theoretical and empirical models to draw and test their recommendations. Their economic models can be analytical, mathematical or econometric depending on the aim and focus of the study.

The research team has recently conducted an analysis of agricultural risks in Wallonia, Belgium, and proposed alternative insurance tools to mitigate those risks. They have also analyzed, theoretically and empirically, the farmers' responses to different weather risks in rural Madagascar, confronting individual risk-taking behaviours, also called "self-insurance", with mutual risk sharing opportunities.

Insuring farmers in developing countries is challenging because of the many market failures. Some of the ongoing projects pertain to the analysis of mechanisms such as weather index or area yield insurance whose importance is growing in development policies.

Analyses and recommendations are generally communicated in scientific congresses and published in peer-reviewed scientific journals.

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Funding

- ▶ Wallonie : Direction Générale de l'Agriculture, de l'Environnement et des Ressources naturelles
- ▶ European Commission
- ▶ Fonds National de la Recherche Scientifique (FNRS)
- ▶ Université catholique de Louvain

Partnership

- ▶ Centre de droit privé, Institut pour la recherche interdisciplinaire en sciences juridiques, UCL, Louvain-la-Neuve
- ▶ Institut de Statistique, Biostatistique et Sciences Actuarielles, UCL, Louvain-la-Neuve
- ▶ Centre de recherche en économie du développement, FUNDP, Namur
- ▶ Centre d'Etudes de Populations, de Pauvreté et de Politiques Socio-Economiques / International Network for Studies in Technology, Environment, Alternatives, Development (CEPS/INSTEAD), Luxembourg
- ▶ Unité de recherche en épidémiologie et analyse de risques appliquées aux sciences vétérinaires, Département des maladies infectieuses et parasitaires, ULg, Liège
- ▶ Department of Agricultural and Resources Economics, University of California, Davis

Products and Services

- ▶ Risks analysis in agriculture
- ▶ Evaluation of risk management tools in agriculture
- ▶ Case studies at national, regional and community levels

Keywords

Risk
Uncertainty
Moral Hazard
Adverse Selection
Agriculture
Belgium
Europe
Developing Country

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Risk and environment : historical, socio-anthropological, and ethical approach

SENIOR SCIENTISTS

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- ▶ Nathalie FROGNEUX
- ▶ Isabelle PARMENTIER
- ▶ Olivier SERVAIS

Research Field and Subjects

Representations and social uses of nature and implications on anticipation or environmental risk management is the central interest of these researchers. It is structured in three themes, which are all included in the research group.

A first historical and ethnographic theme develops a long-term study of the perception and management of industrial risks. It covers work done in Belgium (Wallonia), and considers comparisons with cases outside Europe (Canada, Colombia, Guatemala, Peru). Chronologically, it ranges from the early 18th century to the present day. Through the study of different actors, this theme hopes to understand, identify and characterize the different fears caused by installations, and their relationship with the environment they create. Particular interest is shown for the transformation of this relationship to nature in connection with the representations and associated socio-political issues.

A second theme conducts in-depth analysis of empirical cases in non-European countries (Guatemala, Cuba) by focusing on risk management and socio-natural hazards in a context of Disaster Studies. These include analysis of the representations and cultural management of risk and comparison with scientific practices and representations. In an interdisciplinary context, this theme includes socio-anthropology, geography and agronomy. Finally, a third, more speculative theme, has the objective of reconceptualizing the concept of risks linked to energy, in relation to environmental socio-anthropology. The ideas of concepts such as energy "needs" or policy instruments (personal carbon trading, prepayment meters...) are thus recast into socio-political stakes with a broader framework of social justice, in Belgium or in a more global context. This research includes an analysis of good living conditions and dignity.

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Funding

- ▶ Conseil Interuniversitaire de la Communauté Française – Commission Universitaire pour le Développement (CIUF-CUD) : PIC Project (UCL)
- ▶ Fonds National de la Recherche Scientifique (FNRS - Research grants - FUNDP)
- ▶ Fonds National de la Recherche Scientifique (FNRS - Research grants - UCL)
- ▶ Action de recherche concertée (ARC FUNDP)
- ▶ Fonds spécial de recherche UCL (FSR)

Partnership

- ▶ Université de Liège – Centre d’histoire des sciences et des techniques
- ▶ Université de Liège – Laboratoire pour l’analyse des lieux, des paysages et des campagnes européennes
- ▶ Archives générales du Royaume et Archives de l’Etat dans les provinces
- ▶ University of Oslo - Environmental change and sustainable energy (MILEN)
- ▶ University San Carlos de Guatemala
- ▶ Université Laval - Interuniversity Center for aboriginal studies and research (CIERA)

Keywords

Environmental long-term analysis
Neighbourhood- NIMBY
Natural disasters
Industrial Infrastructures
Energy Plants
Social Justice

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Epidemiology of natural disasters and civil conflicts

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- ▶ Bernadette DUBUS

Research Field and Subjects

The Centre for Research on the Epidemiology of Disasters (CRED) has been active for over 30 years in the fields of international disaster and conflict health studies with research and training activities linking relief, rehabilitation and development. It undertakes research and provides evidence based on the burden of disease and health issues arising from natural disasters to improve preparedness and responses to humanitarian agencies. It also provides training and technical expertise. The main area of research are: analysis of the human impacts of natural disaster, conflict and health research, database and information support and capacity building and training.

- ▶ GUHA-SAPIR D., VOS F. Quantifying global and environmental change impacts: Methods, criteria and definitions for compiling data on hydro-meteorological disasters, forthcoming. *In* Coping with Global Environmental Change, Disasters and Security. Threats, Challenges, Vulnerabilities and Risks. Ed. H.G. BRAUSCH, Ú. OSWALD SPRING, C. MESJASZ, J. GRIN, P. KAMERI-MBOTE, B. CHOUREOU, P. DUNAY, J. BIRKMANN. Hexagon Series on Human and Environmental Security and Peace, vol.5, Springer-Verlag, Berlin, pp 693-717. **2009**.
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Representative References

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Awards

- ▶ Peter Safar Award received for contributions to the science of disaster health; World Association for Disaster and Emergency Medicine (WADEM) Executive Committee, May 2009

Funding

- ▶ European Commission – FP6 & FP7
 - MICRODIS: Integrated Health Social and Economic Impacts of Extreme Events: Evidence, Methods and Tools, 2007-2011
 - MICROCON: Micro Level Analysis of Violent Conflict, 2006-2012
 - emBRACE: Building resilience amongst communities in Europe, 2011-2015
- ▶ DFID – UK government
 - Morbidity and mortality in civil conflicts, 2008-2011
- ▶ USAID
 - Global database and analyses of disasters, 1999-2015
 - ▶ Fonds national de la Recherche Scientifique (FNRS – F.R.S.M.)
 - Epidemiological patterns of health consequences in natural disasters and civil conflicts

Partnership

- ▶ WHO collaborating centre
- ▶ United Nations Development Program

Products and Services

- ▶ EMDAT- database
- ▶ EMBIB- database
- ▶ CEDAT- database

Keywords

Natural disasters
Conflict
Epidemiology
Environment
Public health
Statistics

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Stochastic modelling of dependence in quantitative risk management

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- ▶ Christian HAFNER
- ▶ Jan JOHANNES
- ▶ Rainer VON SACHS
- ▶ Johan SEGERS

Research Field and Subjects

Quantitative Risk Management (QRM) becomes increasingly important as human society becomes more complex and new types of risks emerge. The dependence of multiple financial risks upon each other, their own past values and common, economic factors is one of the main causes of financial distress in companies worldwide. Similarly, the tendency of wind or rain storms to form clusters in space and time can cause an accumulation of adverse weather events responsible for widespread material damage and loss of life. A realistic quantification of the full impact of such events requires reliable models of the interdependence of risk factors, particularly during periods of distress. From a practical point of view, positive dependence (with “large” or “small” values of multiple risk factors occurring simultaneously) is often the more dangerous kind of dependence: risk diversification in a credit risk portfolio may be smaller than hoped for, and multiple natural calamities may occur in a short time. QRM involves combining past observations, expert opinions, and exogenous data to forecast possible future scenarios for the risk factors of interest and to assess the uncertainties surrounding these forecasts. The forecasts are to be based upon models that need to be constructed, calibrated, and validated. The data upon which these tasks are to be performed may range from simple time series to high-dimensional data structures such as curves, spectra, or images. The changing nature of the economic or geographical environment has to be taken into account for predictions to be meaningful. Events occurring with low frequency but potentially high severity require special attention as data about them are evidently scarce.

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Funding

- ▶ Fonds Spécial de Recherche UCL (FSR)
- ▶ Fédération Wallonie-Bruxelles
- ▶ Service Public Fédéral de la Politique Scientifique (BELSPO)
- ▶ Wallonie

Partnership

- ▶ CentER, Tilburg University
- ▶ Centre for Risk and Insurance Studies, KULeuven
- ▶ CORE, Université catholique de Louvain

Products and Services

- ▶ Developing models for conditional variances and correlations to allow for volatility spill-overs, news surprises, and high-frequency data
- ▶ Constructing and calibrating stochastic models for complex data structures, notably functional data, with emphasis on temporal dependence and nonstationarity
- ▶ Developing dimension reduction techniques for modelling dependence between rare events when a high number of risk factors is involved
- ▶ Analysing the impact of dependence on actual decision making

Keywords

Conditional correlation
Copula
Decision making
Dimension reduction
Extreme event
Functional data
Quantitative risk management
Tail dependence

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Audit, control and governance

SENIOR SCIENTIST

▶ Gerrit SARENS

Research Field and Subjects

Different aspects of audit, control and governance are studied in both a national and international context.

Current research subjects:

- ▶ Combined assurance and organizational governance;
- ▶ The relationship between internal audit and the audit committee;
- ▶ The relationship between internal audit and senior management;
- ▶ An in-depth qualitative study of internal audit effectiveness;
- ▶ Role of the internal audit in the public sector;
- ▶ The implementation of company risk management;
- ▶ The relationship between audit committees and financial statement quality;
- ▶ Collaboration between internal and external auditors;
- ▶ Management of an internal audit function/department;
- ▶ Loyalty between accountants and SMEs;
- ▶ Impact of business advice provided by accountants on a firm's performance;
- ▶ The role of the external auditor in SMEs.

Representative References

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Funding

- ▶ The Institute of Internal Auditors Research Foundation (IIARF – US)
- ▶ Fonds Spécial de Recherche UCL (FSR)
- ▶ The Belgian External Audit Institute (IBR/IRE)

Partnership

- ▶ Bentley University (US)
- ▶ Kennessaw State University (US)
- ▶ Manchester Business School (UK)
- ▶ Curtin University of Technology (Australia)
- ▶ Ghent University (Belgium)
- ▶ Centre de Recherche Henri Tudor (Luxemburg)

Keywords

Audit
Control
Governance

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Pension funding and solvency

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Research Field and Subjects

The purpose of this project is to analyse the future financial evolution of pension systems in Belgium, taking into account the various risks affecting their actuarial equilibrium, and to develop quantitative models in order to propose concrete ways of reforming the Belgian situation for the first pillar pension (social security) as well as the second and third pillars (employee benefits and personal pensions).

The main topics of the research are:

- ▶ solvency analysis of a pension fund
- ▶ financial, demographic and longevity risks for a pension system
- ▶ modelization of new funding mechanisms for public pension schemes (notional defined contribution plans)
- ▶ social security reform
- ▶ optimal asset allocation for pensions.

The research is conducted at the UCL by the Institute of Statistics, Biostatistics and Actuarial Sciences.

Representative References

- ▶ DEVOLDER P., JANSSEN J., MANCA R. Stochastic methods for pension funds. Applied Stochastic methods series, Wiley, 480 p. **2012.**
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Funding

- ▶ Chair AG
- ▶ Chair Generali

Keywords

Pension Funding
Financial risk
Longevity risk
Solvency
Reform of the social security

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Financial risks in insurance and energy markets

SENIOR SCIENTIST

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Research Field and Subjects

In recent years, quantitative finance has become an extraordinary field of research and interest, from an academic point of view as well as for practical applications. Convergence between Finance and Insurance has largely increased and is now a reality. The purpose of the project in this context is to develop and apply mathematical finance tools in order to model and value insurance liabilities in life and non-life insurance. The pricing and hedging of electricity derivatives can also use these kinds of methodologies.

The main topics of research are:

- ▶ modelling of financial and insurance risks based on mathematical finance;
- ▶ fair valuation of complex life insurance contracts;
- ▶ pricing and hedging of commodities derivatives;
- ▶ stochastic mortality and longevity models
- ▶ optimal control and insurance contracts
- ▶ securitization of insurance liabilities

The research is conducted at the UCL by the Institute of Statistics, Biostatistics and Actuarial Sciences.

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Funding

- ▶ Chair GDF - Suez
- ▶ Chair DKV

Keywords

Insurance Risks
Electricity Risks
Stochastic mortality
Derivatives
Fair valuation
Quantitative Finance
Securitization

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Financial liquidity risk

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- ▶ Isabelle PLATTEN

Research Field and Subjects

Financial markets are sometimes trapped in “liquidity black holes”, i.e. markets where liquidity vanishes for a while. Under such stressful market conditions, it becomes extremely difficult for market participants to make wise investment decisions, as volatility increases substantially.

Even under normal market conditions, market participants and policymakers need to address the following issues:

- ▶ How costly is it to buy or sell a given asset on a given market?
- ▶ How can the quality of a market be improved?
- ▶ How can trading costs best be monitored and possibly forecasted?
- ▶ What is the expected price impact of a given investment decision?
- ▶ What is the best timing to place orders?
- ▶ How can best execution be achieved?
- ▶ How can financial assets be best valued when liquidity risk is substantial?

Representative References

- ▶ DE WINNE R., GRESSE C., PLATTEN I. Liquidity and Risk Sharing Benefits from the Introduction of an ETF. *Journal of Financial Services Research* DOI: <http://dx.doi.org/10.2139/ssrn.1253181>. **2012**.
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Funding

- ▶ ARC 09/14-025
- ▶ BNP Paribas Fortis (2009-2011)
- ▶ NYSE Euronext – Brussels

Partnerships

- ▶ Paris –Dauphine University
- ▶ KULeuven
- ▶ Maastricht University
- ▶ IESEG
- ▶ Degroof Bank

Products and Services

- ▶ Trading cost monitoring at the asset, institutional, or market level.
- ▶ Determining the fair value of an asset in illiquid markets.
- ▶ Improving the timing and the execution of investment decisions.
- ▶ Quantifying the liquidity risk premium for new assets and markets.
- ▶ Quantifying the liquidity risk premium for new assets and markets.
- ▶ Measuring, monitoring, and improving market quality.

Such services are provided to exchanges, regulators, banks, investment companies, hedge funds, insurance companies, pension companies, indexing companies

Keywords

Trading costs
Liquidity
Financial stability
Fair value
MiFID
Volatility
Market quality

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Investment risk in actively-managed strategies and structured products

SENIOR SCIENTISTS

- ▶ Pierre GIOT
- ▶ Mikael PETITJEAN

Research Field and Subjects

Assessment of the risk and profitability of investment strategies is a key role in determining the portfolio's overall risk and return. This research is conducted on actively-managed strategies and option-embedded structured securities, which have become very popular among retail investors and require better monitoring given the high level of information asymmetry. This research is currently focused on the design of a robust scoring methodology for structured products.

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- ▶ LEBRUN S., PETITJEAN M. Risk management and hedge fund investing: the Amaranth case. *Revue Sciences de Gestion* 46(249-250): 27-32. **2011**.
- ▶ GIOT P., PETITJEAN M. Short-term market timing strategies using the Bond-Equity Yield Ratio. *European Journal of Finance* 15(4): 365-384. **2009**.
- ▶ MAZZA P., PETITJEAN M. An intra-day performance analysis of the MACD technical indicator. *Revue Bancaire et Financière (Bank- en Financieuzen)* 6: 445-450. **2009**.

Partnerships

- ▶ European Central Bank
- ▶ McGill University
- ▶ PwC, Luxembourg
- ▶ UMons
- ▶ FSMA

Products and Services

- ▶ Measuring the performance of investment strategies
- ▶ Comparing indexing and actively-managed investment strategies
- ▶ Determining the risk profile and fair value of structured products
- ▶ Providing a score (or rating) for structured products targeted to retail investors

Such services are provided to regulatory authorities, banks, investment companies, hedge funds, insurance companies, pension companies, indexing companies, high-net worth individuals.

Keywords

Strategy testing
Risk profile
Fair value
Indexing

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Goal-oriented risk analysis for software requirements engineering

SENIOR SCIENTIST

▶ Axel VAN LAMSWEERDE

Research Field and Subjects

The focus of our group is the identification and resolution of risks related to software errors and their consequences. Such errors are known to be most often caused by poor engineering of the requirements the software should meet.

Requirements Engineering (RE) is concerned with eliciting the objectives to be achieved by a software-intensive system, the operationalization of such objectives into software specifications and environmental assumptions, the assignment of responsibility for the specifications to agents such as humans, devices and software, and the evolution of such requirements over time and across system families.

Obtaining high-quality requirements is difficult and critical. Requirement completeness, in particular, is among the most important challenges. Missing requirements are known to be the major cause of software failure.

Incompleteness often arises from the lack of anticipation of exceptional conditions under which the software should behave adequately. The natural inclination is rather to conceive idealised systems; this prevents adverse events or conditions from being properly identified, and as a result, the specifications for suitable countermeasures in such circumstances are missing. Risk analysis is therefore at the heart of the requirements engineering process.

The UCL group in Louvain-la-Neuve has pioneered a goal-oriented approach to requirements engineering for mission-critical software systems. The approach is model-based and integrates a goal-oriented form of risk analysis known as *obstacle analysis*. An obstacle to a goal is a precondition for non-satisfaction of this goal. Depending on the category of goal being obstructed, obstacles may correspond to safety hazards, security threats, inaccuracy in software input/output variables with respect to their environment counterpart, and so on.

Obstacle analysis roughly consists of three steps: (a) identify as many obstacles as possible to every leaf goal in the systems goal refinement graph, (b) assess the likelihood and severity of each obstacle; and (c) resolve likely and severe obstacles through systematic transformation to the goal model using appropriate countermeasures.

The obstacle analysis method developed at UCL supports these three steps systematically, using formal techniques, heuristics, and associated software tools.

This method has been used worldwide and in industrial environments, for example, for the classification and analysis of post-launch software anomalies at NASA (USA) and for producing a comprehensive threat model of terrorist intentions against large civil aircraft at Airbus/British Aerospace (EU).

Current research efforts are aimed at expanding this approach in a number of directions including:

- ▶ Full automation of the obstacle identification phase through a combination of algorithmic model checking and inductive machine learning (joint work with Imperial College London).
- ▶ The generation of application-level security attacks for anticipated countermeasure deployment.
- ▶ The handling of probabilistic goals and obstacles for risk assessment and countermeasure selection.
- ▶ Specialized forms of obstacle analysis dedicated to workflow models of safety-critical therapies (joint work with UCL Cancer Institute).

Representative References

- ▶ ALRAJEH D., KRAMER J., VAN LAMSWEERDE A., RUSSO A., UCHITEL S. Generating Obstacle Conditions for Requirements Completeness. Proceedings of the 2012 International Conference on Software Engineering, IEEE/ACM, Zürich, pp 705-715. **2012**.
- ▶ VAN LAMSWEERDE A. Requirements Engineering: From System Goals to UML Models to Software Specifications. J. Wiley & Sons, 682 p. **2009**.
- ▶ VAN LAMSWEERDE A. Engineering requirements for system reliability and security. In Software System Reliability and Security. Ed. M. BROU, J. GRUNBAUER, C.A.R. HOARE. NATO Security through Science Series - D: Information and Communication Security, Vol.9., IOS Press, pp 196-238. **2007**.
- ▶ VAN LAMSWEERDE A., LETIER E. Handling obstacles in goal-oriented requirement engineering. IEEE Trans. On Software Engineering 26(10): 978–1005. **2000**.

Awards

- ▶ ACM Sigsoft Outstanding Research Award, 2008
- ▶ IEEE Most Influential Paper Award International Requirements Engineering Conference, 2011
- ▶ ACM Sigsoft Distinguished Service Award
- ▶ ACM Fellow
- ▶ SWIFT Award

Funding

- ▶ Fonds National de la Recherche Scientifique (FNRS)
- ▶ European Union
- ▶ Wallonie
- ▶ Fédération Wallonie-Bruxelles
- ▶ ARC
- ▶ Interuniversity Attraction Poles (IAP)

Partnership

- ▶ Imperial College London (UK)
- ▶ University College London (UK)
- ▶ University of Oregon (USA)

Keywords

Software risk analysis
Goal-oriented requirements engineering
Model-driven software engineering
Model checking
Inductive learning

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Cryptography

SENIOR SCIENTISTS

- ▶ Olivier PEREIRA
- ▶ François-Xavier STANDAERT

Research Field and Subjects

Cryptography is the science of information security. Cryptography allows, for example, the secrecy of a document to be preserved through encryption, ensuring its authenticity through electronic signature, and many other applications such as electronic elections, or digital right management.

The UCL Crypto Group includes 2 full-time professors, 7 post-docs and 12 PhD students with backgrounds in microelectronics, telecommunications, computer science and mathematics. This wide diversity of knowledge has allowed the group to develop high expertise in cryptography but also in its applications to various security-related issues, including physical attack and countermeasures (on smart-cards, FPGAs, ASICs), physically unclonable functions (PUFs), efficient implementation of cryptosystems, design and analysis of cryptosystems and protocols, elliptic curves, formal foundations of cryptography, zero-knowledge identification, privacy-enhancing technologies, secure multiparty computation, voting systems, etc.

Through its strong commitment to academic research (more than 150 international publications since 2004) and its numerous collaborations with industrial partners, the UCL Crypto Group is intensively involved in the evolution of security technology, including design of the next generation of smart-cards, sensor network security, election systems, etc.

The UCL Crypto Group has also given rise to several spin-offs: Octalis (2000), K2Crypt (2003) and IntoPix S.A. (2006).

Representative References

- ▶ BERNHARD D., CORTIER V., PEREIRA O., SMYTH B., WARINSCHI B. Adapting Helios for provable ballot privacy. *In* Computer Security – ESORICS 2011. Lecture Notes in Computer Science, Vol. 6879. Ed. V. ATLURI, C. DIAZ. Springer-Verlag, Berlin, Heidelberg, pp 334-354. **2011**.
- ▶ ARMKNECHT F., MAES R., SADEGHI A-R., STANDAERT F.-X., WACHSMANN C. A Formalization of the Security Features of Physical Functions. *In* SP '11 Proceedings of the 2011 IEEE Symposium on Security and Privacy. IEEE Computer Society, Washington, pp 397-412. **2011**.

- ▶ YU Y., STANDAERT F.-X., PEREIRA O., YUNG M. Practical leakage-resilient pseudorandom generators. *In* CCS '10 Proceedings of the 17th ACM conference on Computer and communications security. ACM, New-York, pp 141-151. **2010**.
- ▶ DELAUNE S., KREMER S., PEREIRA O. Simulation based security in the applied pi calculus. *In* Proceedings of the 29th Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS'09). Ed. R. KANNAN, K. KUMAR. Leibniz International Proceedings in Informatics, pp 169-180. **2009**.
- ▶ STANDAERT F.-X., MALKIN T.G., YUNG M. A Unified Framework for the Analysis of Side-Channel Key Recovery Attacks. *In* EUROCRYPT '09 Proceedings of the 28th Annual International Conference on Advances in Cryptology: the Theory and Applications of Cryptographic Techniques. Springer-Verlag Berlin, Heidelberg, pp 443-461. **2009**.

Products and Services

- ▶ Cryptosystems and security infrastructure evaluation
- ▶ Security evaluation of integrated circuit against tampering and eavesdropping (side-channel power and electromagnetic attack)
- ▶ Expertise on high throughput and low-cost implementation of processors for asymmetric and symmetric cryptography
- ▶ Secure multiparty computation protocols
- ▶ Universally verifiable voting systems

Main Equipment

- ▶ Test bench for side-channel (passive and active) cryptanalysis, including:
 - a large bandwidth oscilloscope Tektronix TDS7104,
 - clock generators TaborElectronics WW1072 and Agilent 33250A
 - near-field emission probes Rohde&Schwarz HZ15
 - a customized board interfacing the analysed devices.

Awards

- ▶ EDAA Outstanding dissertation award, 2004 (received from the European Design and Automation Association for the best PhD thesis in category “innovative embedded system design”)
- ▶ European Research Council (ERC) Starting Grant for project CRASH: development of concrete basements for the next generation of cryptographic algorithms and their implementation
- ▶ Best paper award: Ben Adida, Olivier de Marneffe, Olivier Pereira, and Jean-Jacques Quisquater. Electing a University President Using Open-Audit Voting: Analysis of Real-World Use of Helios, In D. Jefferson, J.L. Hall, T. Moran, editor(s), Electronic Voting Technology Workshop/Workshop on Trustworthy Elections, Usenix, August 2009

Partnership

Member of the networks:

- ▶ ECRYPT II European Network of Excellence in Cryptology
- ▶ LSEC information security cluster
- ▶ MUSICS and GRASCOMP graduate schools
- ▶ Research Community “Veilige ICT”, Fonds Weenschappelijk Onderzoek, Flanders
- ▶ Academia: Columbia University, INRIA, Massachusetts Institute of Technology, IAIK, ETH Zurich,...
- ▶ Industry: Orange France Telecom R&D, ST Microelectronics, NXP, Thales...

Funding

- ▶ Europe : TAMPRES, CRASH, B-CCENTRE
- ▶ Belgium: BCRYPT
- ▶ Wallonie: MIPSS, CAMUS, SEE, TRACEA, SCEPTIC, NANOTIC
- ▶ Fédération Wallonie Bruxelles: ARC-SCOOP

Keywords

Cryptographic protocols (design, formal analysis)
FPGA (implementations)
Information security
Physically unclonable functions
Privacy-enhancing systems
Sensor networks
Side channel analysis
Voting technologies

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Secure implementation of cryptographic tokens

SENIOR SCIENTIST

► François-Xavier STANDAERT

Research Field and Subjects

When a security device is running, its physical behaviour may leak information concerning the operations being performed and the data being manipulated, including secret keys.

Physical attacks, or hardware attacks, aim to break a cryptographic device by taking advantage of this information. Physical attacks are typically divided in 3 categories, depending on whether they work by:

- observing the physical memory or data buses of the devices, e.g. using an electronic microscope (**probing attacks**);
- tampering with the device during execution in order to induce errors, in such a way that the erroneous output will leak information about the secret parameters (**fault induction attacks**);
- exploiting information related to the physical behavior of the device, such as running time, power consumption, or electromagnetic radiation emitted (**side-channel attacks**).

Since their discovery in the 90's, physical attacks have been taken very seriously by the industry, as they may prove very practical in hampering the security of devices such as smart cards or security tokens. This topic has triggered a lot of research, at both fundamental and applied level.

A recent related topic is the concept of **physically unclonable functions**, or **PUFs**. A PUF is a function embodied in a physical structure that consists of many random characteristics originating from uncontrollable process variations during manufacture. PUFs are considered unclonable because it is extremely difficult to reproduce the random characteristics in another device. Among other applications, PUFs are a promising tool for secure key storage, whereby the key becomes an integral part of the device's structure: the device can reconstruct the key when needed by probing its physical structure, but this key cannot easily be read by an external observer.

The UCL Crypto Group has been a pioneer in the study of these fields since they first appeared in the literature, and has been involved in most relevant international projects in the field (e.g. European projects SCARD, G3CARD, INSPIRED, ECRYPT, ECRYPT II). Throughout the year, the group has acquired internationally acknowledged expertise in these fields, with more than 50 publications in international journals and conferences.

Representative References

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- YU Y., STANDAERT F.-X., PEREIRA O., YUNG M. Practical leakage-resilient pseudorandom generators. *In CCS '10 Proceedings of the 17th ACM conference on Computer and communications security*. ACM, New-York, pp 141-151. **2010**.
- STANDAERT F.-X., MALKIN T.G., YUNG M. A Unified Framework for the Analysis of Side-Channel Key Recovery Attacks. *In EUROCRYPT '09 Proceedings of the 28th Annual International Conference on Advances in Cryptology: the Theory and Applications of Cryptographic Techniques*. Springer-Verlag, Berlin, Heidelberg, pp 443-461. **2009**.

Awards

- EDAA Outstanding dissertation award, 2004 (received from the European Design and Automation Association for the best PhD thesis in category "innovative embedded system design").
- European Research Council (ERC) Starting Grant for project CRASH: development of concrete basements for the next generation of cryptographic algorithms and their implementation

Funding

- ▶ Europe : TAMPRES, CRASH, B-CCENTRE
- ▶ Belgium: BCRYPT
- ▶ Wallonie: MIPSs, TRACEA, SCEPTIC, NANOTIC

Partnership

Member of the networks:

- ▶ ECRYPT II European Network of Excellence in Cryptology
- ▶ LSEC information security cluster
- ▶ MUSICS and GRASCOMP graduate schools
- ▶ Research Community "Veilige ICT", Fonds Wetenschappelijk Onderzoek, Flanders
- ▶ Academia: Columbia University, INRIA, Massachusetts Institute of Technology, IAIK, ETH Zurich...
- ▶ Industry: Orange France Telecom R&D, ST Microelectronics, NXP, Thales...

Main Equipment

In order to analyze the power consumption of enciphering devices, the group has built a test bench made of a large bandwidth oscilloscope Tektronix TDS7104, clock generators TaborElectronics WW1072 and Agilent 33250A and a customized board to plug the device in. The power supplies and clock can be finely controlled, and glitches can be inserted in those to check the chip fault-resistance. We also record its electro-magnetic radiations as an image of the local currents flowing in the silicium die, with near-field emission probes Rohde&Schwarz HZ15.

Products and Services

- ▶ Introductory to advanced training in physical security
- ▶ Security evaluation and advice

Keywords

Cryptography
Physical security
Side-channel
Cryptanalysis
Physically unclonable functions
PUFs

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Secure protocols

SENIOR SCIENTIST

► Olivier PEREIRA

Research Field and Subjects

In numerous contexts, different entities need to communicate in order to perform a task jointly. This might be for accessing specific portions of a database, being granted access to some resources, negotiating a business arrangement, or running an election.

However, this communication needs to provide some security guarantees. These guarantees can relate to external parties (pirates, competitors...) or communication participants (accountability, minimum disclosure, resilience to disasters...).

It is the purpose of cryptographic protocols to specify how such communication can be made in order to achieve the expected task while offering appropriate security guarantees.

The UCL Crypto group has developed thorough expertise in the accurate modelling, design and analysis of cryptographic protocols. An accurate model is needed to express the guarantees that we want a cryptographic protocol to offer. Cryptographic protocols can then be designed in such a way that the targeted task can be carried out while preserving the expected security properties and taking into account the operational requirements such as efficiency and usability. The UCL Crypto Group also builds security proofs that allow one to identify the specific assumptions under which the designed cryptographic protocols offer the properties defined in the model.

Representative References

- BERNHARD D., CORTIER V., PEREIRA O., SMYTH B., WARINSCHI B. Adapting Helios for provable ballot privacy. *In* Computer Security – ESORICS 2011 - Lecture Notes in Computer Science. Vol. 6879. Ed. V. ATLURI, C. DIAZ. Springer-Verlag, Berlin, Heidelberg, pp 334-354. **2011**.
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Awards

Best paper award: Workshop on Trustworthy Elections, Usenix, August 2009

Funding

- ▶ Europe: B-CENTRE
- ▶ Belgium: BCRYPT
- ▶ Wallonie: CAMUS, SEE
- ▶ Fédération Wallonie-Bruxelles:ARC-SCOOP

Partnership

- ▶ Member of the networks:
 - ECRYPT II European Network of Excellence in Cryptology
 - LSEC information security cluster
 - MUSICS and GRASCOMP graduate schools
 - Research Community “Veilige ICT”, Fonds Wetenschappelijk Onderzoek, Flanders
- ▶ Academia: Columbia University, INRIA, Massachusetts Institute of Technology...
- ▶ Industry: Orange France Telecom R&D...

Products and Services

- ▶ Secure protocol definition and specification
- ▶ Security evaluation and advice

Keywords

Security
Protocols
Cryptography

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Fault tolerant electromechanical actuators and generators for high reliability energy conversion systems

SENIOR SCIENTISTS

- ▶ Bruno DEHEZ
- ▶ Ernest MATAGNE
- ▶ Paul SENTE
- ▶ Francis LABRIQUE (Professeur émérite)

Research Field and Subjects

Electromechanical systems coupled with power electronics are widely used today in a broad field of applications ranging from transportation to energy production and more and more frequently in critical applications (as for instance the actuation of airplane flight control surfaces) for which system malfunctioning may result in a major risk (air crash). Therefore, one of the most important issues, when designing electromechanical systems for such applications, is reliability, which can be greatly improved by including, in the design process, the possibility of withstanding partial failure without losing the ability to work properly.

Maintenance operations and repairs can therefore be delayed. This is, in particular, very important not only in aerospace applications but also in energy generation systems such as offshore wind generators, since such installations are not easily accessible.

Field research conducted at the UCL Centre for Mechatronics has so far concentrated mainly on aerospace applications via European Union projects and cooperation with industry, but could be easily transposed to other fields of application. The Centre for Mechatronics' expertise in the design of fault-tolerant electromechanical actuators ranges from the electromagnetic design of the actuator (combining analytical modelling, original optimisation methods such as topology optimisation and FEM analysis) to designing the associated power electronics and the development and implementation of appropriate control strategies (including health monitoring).

Representative References

- ▶ BAUDART F., DEHEZ B., MATAGNE E., TELTEU-NEDELCO D., ALEXANDRE P., LABRIQUE F. Torque control strategy of polyphase permanent-magnet synchronous machines with minimal controller reconfiguration under open-circuit fault of one phase. *IEEE Transactions on Industrial Electronics* 59(6): 2632-2644. **2012**.
- ▶ BAUDART F., DEHEZ B., LABRIQUE F., MATAGNE E. Analytical prediction of cogging torque in surface mounted permanent magnet motors. *Proceedings of the 10th International Conference on Modeling and Simulation of Electric Machines, Converters and Systems (ELECTRIMACS'11)*, Paris, France. **2011**.
- ▶ DE VIRON L., IVANOV S., BAUDART F., LABRIQUE F. Commande modulaire à tolérance de panne d'un actionneur synchrone à aimants permanents. *Proceedings de la conférence Electrotechnique du Futur 2011 (EF 2011)*, Belfort, France. **2011**.
- ▶ LABBÉ T., DEHEZ B. Topology Optimization Method Based on the Maxwell Stress Tensor for the Design of Ferromagnetic Parts in Electromagnetic Actuators. *IEEE Transaction on Magnetics* 47(9): 2188 - 2193. **2011**.
- ▶ LABBÉ T., LABRIQUE F., DEHEZ B. Two phase operation for a three phase PMSM using a control model based on a Concordia like transform associated to a classic Park transform. *Mathematics and Computers in Simulation* 81(2): 315-326. **2010**.
- ▶ LABBÉ T., DEHEZ B. Convexity-Oriented mapping method for the topology optimization of electromagnetic devices composed of iron and coils. *IEEE Transactions on Magnetics* 46(5): 1177-1185. **2010**.

Funding

- ▶ European Union projects on more electrical aircraft from 1990 to 2011 (ELAC, EPICA, ELISA, POA, DRESS)
- ▶ Fonds National de la Recherche Scientifique (FNRS)
- ▶ SABCA

Partnership

- ▶ École Polytechnique Fédérale de Lausanne - Laboratoire d'actionneurs intelligents, Switzerland
- ▶ Ecole Normale Supérieure de Cachan – Antenne de Bretagne, France
- ▶ Haute Ecole d'Ingénieurs (Polytechnicum), Lille, France
- ▶ SABCA

Products and Services

- ▶ Design of application specific actuators
- ▶ Design and prototyping of electronic and power electronic circuits
- ▶ Tests of power electromechanical converters (up to 5 KW) and power electronic converters

Main Equipment

- ▶ Workstations for real time prototyping of digital control (Dspace, Compact Rio...)
- ▶ Test benches for small power electrical machines
- ▶ Software for electronic circuits simulation and PCB design (ORCAD design 16.5)
- ▶ SMD station (ZEVAC DRS20)
- ▶ Data recording systems (Labview)
- ▶ DC power source
- ▶ Oscilloscopes up to 300 - 500MHz
- ▶ Voltage and current probes up to 50 MHz
- ▶ FEM software (COMSOL multiphysics)
- ▶ Simulation tools (Matlab-Simulink, Robotran)
- ▶ Electronic and mechanical workshops

Keywords

Failure risk reduction
Fault tolerance
Reliability
Green energy
Electromechanical systems
Power electronics
Control and monitoring

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In vitro food safety assessment at the intestinal level

SENIOR SCIENTIST

▶ Yves-Jacques SCHNEIDER

Research Field and Subjects

The risk/benefit assessment of food is clearly a contemporary question for authorities, consumers and scientists. Indeed, human food includes thousands of products, which form the basic nutrients that will be absorbed and delivered to the body, for both energy production and synthesis of macromolecules needed for growth, activity and body maintenance.

Food also contains many substances, *i.e.* bioactive compounds (phenolics, carotenoids), drugs, mycotoxins, heavy metals, pesticides, industrial residues, nanoparticles...

In addition to key metabolic functions, many molecules can modulate biological functions by: (i) inhibiting protein/enzyme activities; (ii) affecting gene expression and (iii) interfering with transduction cascades.

Finally, these molecules, mixed in the gastro-intestinal tract, encounter digestive enzymes, bile salts, microbiota... and undergo transformations before encountering the mucosa, the first biological barrier.

The research aims to develop and use different cell culture systems of increasing complexity, mimicking, *in vitro*, functions of the human intestinal barrier in physiopathological conditions. All include human Caco-2 cells, a widely used and validated human cell line:

- ▶ monocultures to mimic enterocytes
- ▶ bicultures with Raji cells for partial conversion into M cells
- ▶ bicultures with HT29 mucus secreting cells
- ▶ tricultures combining both characteristics
- ▶ further addition of macrophages and/or adipocytes
- ▶ some transformations occurring in the gastro-intestinal tract are mimicked by a previous *in vitro* digestion of food matrix in the sequential presence of salivary, gastric, pancreatic and intestinal enzymes.

Interactions between food substances and the intestinal barrier are studied in such systems and different parameters may be followed:

- ▶ Cytotoxicity
- ▶ Transport functions
- ▶ Tight junctions functionality
- ▶ Inflammation
- ▶ Biotransformations
- ▶ Gene expression

Representative References

- ▶ SERGENT T., PIRONT N., MEURICE J., TOUSSAINT O., SCHNEIDER Y.J. Anti-inflammatory effects of dietary phenolic compounds in an *in vitro* model of inflamed human intestinal epithelium. *Chemico-Biological Interactions* 188(3): 659-67. **2010.**
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Funding

- ▶ Wallonie
- ▶ Fonds Européen de Développement Regional (FEDER)
- ▶ Service Public Fédéral Santé Publique
- ▶ FRIA
- ▶ Fonds Spécial de Recherche UCL (FSR)

Partnership

- ▶ CERVA-CODA, BE
- ▶ Many companies involved in food industry

Main Equipment

- ▶ Animal cell technologies
- ▶ Cell and molecular biochemistry
- ▶ Access to confocal microscopy, LC-MS, GC-MS, ICP-MS
- ▶ Effects on intestinal inflammation, transport and biotransformation activities...

Products and Services

- ▶ Benefit/Risk assessment of natural products, biomaterials, dietary supplements, food nanoparticles...
- ▶ Evaluation of bioaccessibility and intestinal absorption

Keywords

Food safety
In vitro models
Cell culture systems
Intestinal barrier
Caco-2 cells
Intestinal inflammation

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The Namur Nanosafety Centre: an integrated platform for the risk assessment of nanomaterials

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Research Field and Subjects

In coming years, products based on nanotechnology are expected to impact nearly all-industrial sectors and will enter the consumer markets in large quantities. However, the unique physicochemical properties of manufactured nanomaterials (NM), that make them attractive for manufacturers, also give rise to concerns about their potential adverse effect on human health and the environment. Indeed, due to their nanoscale dimensions, nanoparticles can easily be taken up by cells and exhibit a high surface area per unit mass, leading to an increased potential for biological interaction and activity.

In order to fill a critical knowledge gap, *i.e.* have a better understanding of the mechanisms that trigger NM toxicity, the University of Namur has set up a multidisciplinary platform that includes physicists, biologists, and pharmacists, who work together to develop relevant toxicity assays for NM safety assessment. Particular attention is paid to comply with OECD Guidelines for the Testing of Chemicals, with the EU policies on cosmetics (Council Directive 2003/15/EC) and chemicals (REACH). Since NM toxicity is clearly influenced by nanoparticle-specific properties, extensive characterization of nanoparticle properties and validation of test systems are performed.

The Namur Nanosafety Centre (NNC) has gained outstanding expertise in nanosafety through its participation in various high level research programs, leading to the set up of appropriate methods for:

- ▶ NM physicochemical characterization (pristine forms, dispersions and complex matrices including food),
- ▶ NM fate and biodistribution studies,
- ▶ NM toxicity assessment (*in vitro* and *in vivo* testing), animal whole-body exposure to well-characterized airborne nanoaerosols, haemocompatibility,
- ▶ NP-induced changes in cellular signaling and gene expression at transcriptomic and proteomic levels.

The NNC also participates in metrology, cross-validation and standardization of assays for regulatory purposes.

Representative References

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Patents

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- ▶ Radiotherapy device and method 2006, WO2006063419 - 2006-06-22
- ▶ Radioactive device 2006, WO2006063418

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 - 'Nanotoxico' Pole of Excellence n°516252
 - 'Silicalloy' Research convention n°6144
- European Union-sponsored projects (Infrastructure 'Qnano')
- Integrated Project 'Nanovalid'.

Partnership

The Namur Nanosafety Centre is a validated supplier of the Institute for Reference Materials and Measurements Reference Material Unit (IRMM-European Commission-Joint Research Centre) for nanoparticle characterization via centrifugal liquid sedimentation and electron microscopy.

Main Equipment

For NM physicochemical characterization:

- 2 MeV Tandem linear accelerator (Altaïs) for nuclear reactions based spectroscopy.
- Field Emission Gun - Scanning Electron Microscope JSM-7500F /Jeol (resolution 0.6 nm) with EDX detector.
- CPS 24000 Disc Centrifuge for nanoparticle size analysis.

For NM toxicity assessment:

In vivo / ex vivo testing

- Impact-R®, PFA-100®, light transmission aggregometry, electron microscopy, KC-10®, cTGT for NM impact on blood
- Whole body inhalation exposure models for rodents equipped with RBG-1000® (aerosol generator) and ELPI® (aerosol analyzer)

In vitro testing

- Cell culture platforms for *in vitro* studies (cytotoxicity, proliferation, differentiation, oxidative stress, pro-inflammatory response) using a variety of mouse and human cell lines and primary cells.
- Confocal microscopy (Leica TCS SP5).
- Gene expression profiling platform: NanoDrop™ spectrophotometer, Agilent Bioanalyzer, 7900HT Fast Real-Time PCR system.
- Proteomic platform: based on gel-dependent (2D-DIGE technology; Typhoon Confocal scanner and DeCyder 2D Software) and gel-free facilities (1- an ion trap HCT ultra (Bruker) with the possibility of electron-transfer dissociation (ETD) fragmentation. This MS can be coupled to a Dionex Ultimate 3000 nanoLC system; 2- A maXis (Bruker) mass spectrometer. This electrospray ionisation MS is coupled to a 2D-LC system for gel free analysis).

Products and Services

- Physico-chemical characterization (size, distribution and morphology)
- Multielemental determination in complex matrices (solid and liquid)
- Human health impact assessment (*in vivo*, *ex vivo* and *in vitro* testing): cutaneous, digestive, respiratory and blood exposure studies.

Keywords

Nanotoxicology
Physicochemical characterization
Hazard assessment
Biodistribution
Haemocompatibility
Transcriptomics

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<http://www.fundp.ac.be/urbc>

<http://www.fundp.ac.be/sciences/physique/larn>

<http://www.fundp.ac.be/medecine/pharm>

Key Words Index

Addictions	44	Control	64
Administration	52	Control and monitoring	82
Adverse Selection	56	Copula	62
Agriculture	56	Cost of disease	20, 22
Alcohol	44	Critical Review	12
Alternative Dispute Resolution – Mediation	54	Cryptanalysis	78
Applied statistics	20, 22	Cryptographic protocols (design, formal analysis)	76
Atmospheric clusters	16	Cryptography	78, 80
Atmospheric pollutants	16	Cyber-addictions	44
Audit	64	Dams	30
<i>Bacillus</i> spp.	26	Decision making	62
Bacterial identification and typing	26	Derivatives	67
Bacterial toxins	26	Dermoscopy	22
Belgium	56	Detection	28
Biobanks and Genetic Testing	54	Developing Country	56
Biodistribution	86	Diffuse pollution	14
Bioethics and Research	54	Digital dermoscopy	22
Biological Monitoring	12	Dimension reduction	62
Biological threats	28	Discrimination	48
Biomarkers	18	Drug	44
Biosensors	28	Early diagnosis	22
Breaching	30	Ecophysiology	38
Burden of disease	20, 22	Electricity Risks	67
Burnout	42	Electromechanical systems	82
Caco-2 cells	84	Emotional competence	42
Carrier dewatering	34	Emotional intelligence	42
CBRN threat assessment	28	Employability	42
Cell culture systems	84	Energy Plants	58
Chemical Agents	12	Environment	60
Child and adolescent health	46	Environmental Exposure	12
Chronic conditions	46	Environmental long-term analysis	58
Civil or Criminal Liability – (No-Fault) Compensation Scheme	54	Environmental monitoring	38
Climate change	36	Epidemiology	60
Clinical trials	20, 22	Europe	56
Coagulation factor	20	Extreme event	62
Compound channels	30	Failure risk reduction	82
Concentration determination	16	Fair valuation	67
Conditional correlation	62	Fair value	70, 72
Conflict	60	Fault tolerance	82

Financial risk	65	Indexing	72
Financial stability	70	Inductive learning	74
Flood control	32	Industrial Infrastructures	58
Flooding	32	Inflammation	18
Flood plains	30	Information security	76
Floods	30	Insurance Risks	67
Fluvial hydraulics	30	Integration	48
Foodborne pathogens	26	Intergroup relations	48
Food quality and biosafety	26	International Conflicts Resolution and/or Transformation	50
Food safety	84	International Crisis Management	50
Food spoilers	26	International Security	50
Foreign Policy Analysis	50	Intestinal barrier	84
FPGA (implementations)	76	Intestinal inflammation	84
Functional data	62	Inundations	30
Functional decline	18	<i>In vitro</i> models	84
Gambling	44	Job performance	42
Gases at low and high temperatures	16	Karst	34
Genetics	28	Knowledge	52
Geophysics	34	Land cover	24
Geopolitical Analysis	50	Land use	24
Global changes	38	Lasers	16
Goal-oriented requirements engineering	74	Liquidity	70
Governance	64	Longevity risk	65
Green energy	82	Management	52
Groundwater	14	Market quality	70
Groundwater models	34	Medical geography	24
Haemocompatibility	86	Melanoma	22
Haemophilia	20	Meta-analysis	12
Hazard assessment	86	MiFID	70
Health	36	Model checking	74
Health Law – Medical and Biomedical Law Patient’s Rights	54	Model-driven software engineering	74
Health Risk Assessment	12	Modelling	38
Hospitalized older patients	18	Moral Hazard	56
Human Corporal Material and Organs	54	Mudflow	32
Hydrogeological map	34	Musculoskeletal	20
Hydrogeology	34	Nanotoxicology	86
Hydrological model	32	Natural disasters	58, 60
Identification	28	Neighbourhood- NIMBY	58
Immunosenescence	18	Occupational Exposure	12

Organic matter fractionation	40	Social diversity	48
Organization	52	Social Justice	58
Paediatric transplantation	46	Societal risk	52
Patient education and counselling	46	Software risk analysis	74
Peace Operations Management and Analysis	50	Soil contamination	14
Pension Funding	65	Soil degradation	40
Phages	26	Soil erosion	32
Physically unclonable functions	76, 78	Soil monitoring	40
Physical security	78	Soil organic matter	40
Physicochemical characterization	86	Solvency	65
Power electronics	82	Spatial epidemiology	24
Prevention	44	Statistics	60
Privacy-enhancing systems	76	Stochastic mortality	67
Proficiency testing	26	Storm basin	32
Protocols	80	Strategy testing	72
Psychosocial issues	46	Stress	42
Public health	60	Tail dependence	62
PUFs	78	Tobacco	44
Quantitative Finance	67	Tracer tests	34
Quantitative risk management	62	Trading costs	70
Rainfall	32	Training	28
Reform of the social security	65	Transcriptomic biomarkers	18
Regulation	52	Transcriptomics	86
Reliability	82	Transition	46
Reproductive Technologies and Surrogate Motherhood	54	Uncertainty	56
Risk	52, 56	Vector-borne diseases	24
Risk factors	44	Visible and near infrared Spectroscopy	40
Risk mapping	14	Volatility	70
Risk profile	72	Voting technologies	76
River flow	32	Water and nutrient constraints	38
Rivers	30	Water and nutrient cycling	38
Runoff	32	Water contamination	14
Securitization	67	Wellbeing	48
Security	28, 80	Zoonotic diseases	24
Self-management support	46		
Sensor networks	76		
Side-channel	78		
Side channel analysis	76		
Silviculture	38		



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The Research Administrations mission is multiple:

- to initiate and stimulate the relations between research laboratories, entreprises and / or public bodies;
- to facilitate knowledge transfer and contribute to the third mission of the university "service to society";
- to contribute to the regional economic development through cooperation with local actors;
- to promote the development of innovative products and services and the setting-up of spin-offs;
- to guarantee the best management of intellectual property;
- to inform the researchers (dissemination of the information on available funding sources) and to advise the researchers (legal and financial expertise);
- to assist the researchers at several stages of their research project (identification of the available funding sources, application for the funding best matching their needs, contract negotiation, appropriate management of the obtained funds during the project lifetime);
- to ensure the dissemination and monitoring of research contracts inside the academy.

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