

EPFL

2019

Annual Report

Overview of activities

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Foreword

As I sit here, trapped in my apartment, for the seventh consecutive week, gazing out on a beautiful, and unnaturally peaceful, Swiss landscape, I think about missed risks and fantasize about missed opportunities to respond appropriately. The Covid-19 pan-epidemic was not an unpredictable “black swan” event; it was the product of many bad decisions that misjudged the risk of a global epidemic, misallocated resources, and made slow and poor decisions—as the recent [IRGC spotlight documents](#).

The epidemic makes a compelling argument for the necessity of IRGC, which fought the lonely battle to get governments and industry to think systematically about risks and to plan for them. EPFL, as a global leader in science and technology, is fortunate to have a strong and growing relationship with IRGC, which can draw on the expertise of the EPFL faculty as well as assist professors and students in seeing the larger context of their work and its unforeseen risks.

I am very pleased to be the academic director of IRGC. I am dean of, and a professor in, the School of Computer and Communications Sciences at EPFL.

Before this, I worked at Microsoft Research and was a professor at the University of Wisconsin, Madison. I am fortunate to have been working with Marie-Valentine and IRGC since arriving at EPFL six and half years ago. I confess responsibility for pulling some of IRGC’s focus to the problems of computer security and artificial intelligence—hopefully not to the detriment of its activities in other areas, such as the life sciences.

I would like to see IRGC grow in size and scope over the next few years and become a strong and trusted voice arguing for the necessity of, and providing techniques for, analysing risks and planning responses. As Covid demonstrates, threats can arise in well-known areas, not just new and leading-edge technologies. EPFL and IRGC are well-positioned to provide the scientific and methodological foundations for risk analysis and planning, so that future crises can be averted.

30 April 2020

James Larus
Academic Director

Table of contents

03 Introduction

04 Key projects

Activities at a glance

Synthetic biology: emerging security threats

Machine learning: governing deepfake risks

Precision medicine: value creation in healthcare

EU Horizon 2020: IRGC partnership in multiple projects

10 IRGC and the EPFL community

13 Communication, outreach and impact

Presentations and papers

Research citations

Newsletter and website

How our work is used by others

Measuring impact

19 Looking ahead

20 Acknowledgements

20 About IRGC

Introduction

The EPFL International Risk Governance Center (IRGC) exists to help policymakers and other stakeholders identify, understand and respond to the complex, uncertain and ambiguous risks that increasingly characterise the world. Our goal is to give stakeholders the information they need to make risk-related decisions based on solid scientific and technological foundations.

Risk governance includes the totality of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed or communicated and how the risk management decisions are taken. Getting it right means involving a wide range of disciplines and stakeholders. So, we work by convening cross-disciplinary groups of researchers and practitioners in structured dialogue designed to generate concrete options and recommendations. These typically take one of two forms: sometimes we develop concepts, frameworks or guidelines that can be applied widely; sometimes we home in on the risk governance challenges in specific domains.

Much of our domain-specific work focuses on technology. Many technologies are developed in order to reduce risks – for example, in relation to climate change, treating disease or managing natural disasters. This link between risk reduction and technological innovation is a source of important societal opportunities and benefits. However, new technologies can also have adverse impacts and spillovers and one of our core tasks at the IRGC is to highlight these risks, help create the context in which they can be evaluated and addressed, and to help identify possible strategies to deal with them.

In the pages that follow, we outline our key activities during 2019. Our work on risk-governance concepts focused on resilience, and in particular the potential

lessons to be learned from the insurance sector. In our work on specific risk domains, we continued to focus on two broad areas that align with core EPFL strengths – digitalization and the life sciences – with projects on topics including deepfakes, precision medicine and synthetic biology.

I would like to take this opportunity to thank all of those who have participated in and contributed to our work over the past year. I would like to thank the IRGC Foundation, which originated the risk governance work that we now take forward at EPFL and which remains a crucial part of our community. Particular gratitude is owed to Granger Morgan, CMU Engineering and Public Policy, for his continuous support and dedication to IRGC since 2003, and to Jim Larus, EPFL Dean of Computer and Communication Science, who recently accepted the challenge of acting as IRGC@EPFL academic director.

Marie-Valentine Florin
Executive Director

Key projects

Activities at a glance

Expert workshops

January – IRGC Annual Strategy Meeting
Lausanne, EPFL

February – SmartResilience: resilience and insurance
(Organised with the Swiss Re Institute)
Zurich, Swiss Re Centre for Global Dialogue

July – Emerging biosecurity threats
(Organised with the US Army Engineer Research & Development Center under the auspices of the NATO Science for Peace and Security Programme)
Lausanne, EPFL

September – Governing deepfake risks
(Organised with the Swiss Re Institute)
Zurich, Swiss Re Centre for Global Dialogue

December – Value creation in precision medicine
(Organised with Health 2030 and the Brocher Foundation) Hermance, Brocher Foundation

Publications

Critical Infrastructure Resilience: Lessons from Insurance
<https://infoscience.epfl.ch/record/273295/files/Critical%20Infrastructure%20Resilience.pdf>

Forged Authenticity: Governing Deepfake Risks
<https://infoscience.epfl.ch/record/273296/files/Forged%20Authenticity%20Governing%20Deepfake%20Risks.pdf>

Synthetic biology: emerging security threats

Concerns are intensifying about the need for robust governance arrangements, to maximise the benefits and minimize the risks stemming from synthetic biology research. Synthetic biology allows the construction of new biological systems and functions. Research and applications of synthetic biology within medicine, environmental sustainability, energy innovation, and other fields can support humanity and our vital resources. However, inadvertent or deliberate misuse of synthetic biology's capabilities can expose these same systems to both known and unknown threats. Synthetic biology is therefore a great example of the challenges involved in balancing the possibility of making technological advances for the common good against the risk of causing harm to people and the environment.

In July 2019, we hosted a workshop to consider one aspect of the potential risks that synthetic biology presents, namely the defence and security implications. Co-organised with the US Army Engineer Research & Development Center and under the auspices of NATO's Science for Peace and Security Programme, we brought together international scientists, regulators, security agencies and businesses to clarify the causes and potential consequences of biosecurity risks and to explore potential response strategies. The workshop

organised participants into five working groups: hard-law approaches to synthetic biology governance; bottom-up governance approaches; information hazards posed by disseminating research that could be co-opted by nefarious actors; technical aspects related to screening, attribution and traceability; and foresight.

A key conclusion of the workshop was that with barriers for access being lowered rapidly to synthetic biology's capabilities, existing policies do not wholly ensure security for vulnerable populations. With this in mind, three strategies were identified for improving biosecurity. First, security should be treated as an investment bearing a positive return, not as a deadweight cost. Second, social scientists and policy makers should be involved in the technology's development. And third, there should be global coordination in identifying and ensuring acceptable levels of risk.

A book building on the workshop proceedings is forthcoming in 2020, but an initial summary of the highlights¹ can be found on our website. You can also find interviews with some of the participants in "From bioerror to bioterror"², an Australian Broadcasting Corporation podcast hosted by Natasha Mitchell.



¹ www.epfl.ch/research/domains/irgc/wp-content/uploads/2019/11/IRGC-2019.-Security-for-Emerging-Synthetic-Biology-and-Biotechnology-Threats-Workshop-report.pdf

² www.abc.net.au/radionational/programs/sciencefriction/from-bioerror-to-bioterror---should-we-worry-about-synthetic-bi/11510726

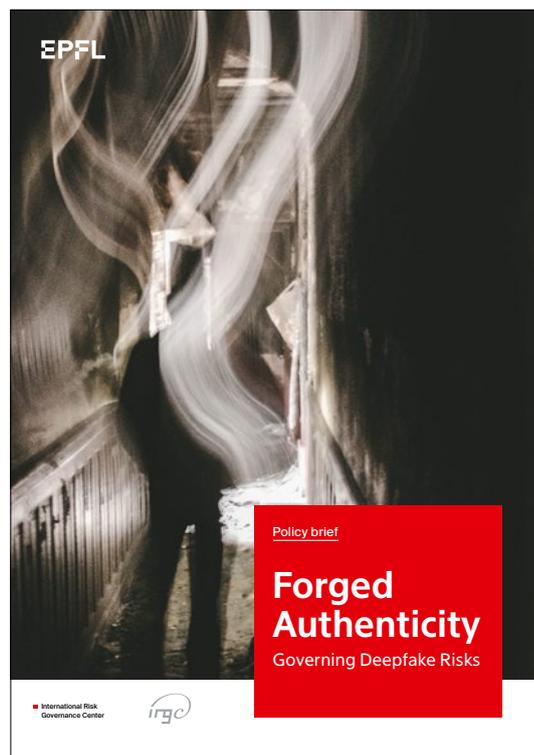
Machine learning: governing deepfake risks

The “deepfake” phenomenon – using machine learning to generate synthetic images, video, audio and text – is a prominent example of how quickly new technologies can be diverted from their original purposes. Month by month, it is becoming easier and cheaper to use machine learning algorithms to create synthetic content that is increasingly difficult to distinguish from authentic artefacts. At a workshop in September 2019, at the Swiss Re Institute, we convened an interdisciplinary group of experts to assess the potential risks that deepfakes might pose: from personal abuse and reputational damage to the fabrication of evidence and the manipulation of public opinion.

The report also identifies fifteen potential deepfake responses that warrant further attention. These covered technological responses, such as improved deepfake-detection and provenance-verification techniques, as well as legal moves including guidance on how existing laws (for example data-protection rules) apply to deepfakes, and prohibitions for deepfakes where harm can be demonstrated. The report also called on organisations to incorporate deepfakes into their risk assessments in order to better gauge the extent to which synthetic digital content is already being used for fraud and similar purposes. The policy brief was widely cited in the Swiss media, including Swiss Info⁴ and Tagblatt⁵.

	Impact		
	Reputational damage	Financial	Manipulation of decision-making
Individual level	<ul style="list-style-type: none"> • Intimidation/abuse • Defamation 	<ul style="list-style-type: none"> • Identity theft • Phishing-type scams • Extortion 	<ul style="list-style-type: none"> • Attacks on politicians
Organizational level	<ul style="list-style-type: none"> • Brand damage • Undermining of trust in the organization 	<ul style="list-style-type: none"> • Stock-price manipulation • Insurance fraud 	<ul style="list-style-type: none"> • Fabricated court evidence • Media manipulation • Faked education papers • Attacks on political parties, advocacy groups, etc.
Societal level	<ul style="list-style-type: none"> • Damage to societal cohesion, norms of trust and truth, etc. • Domestic or foreign electoral manipulation • Deliberate stoking of tension/panic/conflict 		

Following the workshop, we published a policy brief, *Forged Authenticity: Governing Deepfake Risks*,³ which outlined a series of initial proposals for identifying and responding to deepfake risks. We highlighted three key potential impacts (reputational damage, financial harm and manipulation of decision-making) and three levels at which these impacts can occur (individual, organizational and societal), as outlined in the matrix above.



³ www.epfl.ch/research/domains/irgc/specific-risk-domains/projects-cybersecurity/forging-authenticity-governing-deepfake-risks

⁴ www.swissinfo.ch/eng/sci-tech/manipulated-media_how-swiss-scientists-are-trying-to-spot-deepfakes/45595336

⁵ www.tagblatt.ch/leben/gefahr-durch-deepfake-videos-schweizer-start-up-will-den-betrug-stoppen-ld.1188305

Precision medicine: value creation in healthcare

In December 2019, we worked with Health 2030 (health2030.ch) and the Brocher Foundation (brocher.ch) to organise a workshop on the question of value creation in precision medicine. This continues a stream of work that the IRGC has been pursuing for the last four years, which aims to deal with various obstacles and challenges that arise when attempting to deploy precision medicine in response to some of the healthcare risks that face contemporary societies.

The workshop focused on the need to reassess the way in which the value of medical care and health is created and accounted in order to accommodate advances in precision medicine. The aim is to ensure that investments in precision medicine can be capitalized for the benefit of patients and society. There are two key drivers in this. First, there is the need to capture new value that is being created by using new technological synergies to develop innovative diagnostics, therapeutics and biomarkers. Second, there is the need to ensure that the value of preventive intervention and maintaining a healthy quality of life is not overlooked – the

importance of prevention must be re-evaluated in light of developments in precision prevention and personalised health.

The workshop highlighted three key areas where precision medicine can contribute to value creation:

- **Prevention** – Technologies such as genomic sequencing and machine learning enable predictive diagnostics, which put more emphasis and means on prevention. While representing an initial investment, full genome sequencing followed by more incentives for prevention is not yet acceptable to society and health care systems. The balance between treatment and prevention in terms of investment, reimbursement and value needs to be reassessed.
- **Therapies** – When fully personalized therapies are found to be the best solution for a patient, instead of focusing narrowly on technology and affordability assessments, healthcare systems should ideally evolve to focus on the potential broader economic and societal value of the therapy. There is an opportunity to frame such healthcare spending as an investment in the future rather than as an ongoing “maintenance cost”.
- **Payment** – Pricing and licensing around precision medicine must take into account the fact that health care systems are very resource constrained. The shift to ‘value-based health care’ is perceived as a solution, because it considers the total cost of illness over the life of a patient and has a more holistic approach to the pricing for drugs and treatments, which would be priced in relation to the benefit, or added value, that they deliver to society. But few healthcare systems are prepared to adopt it widely.

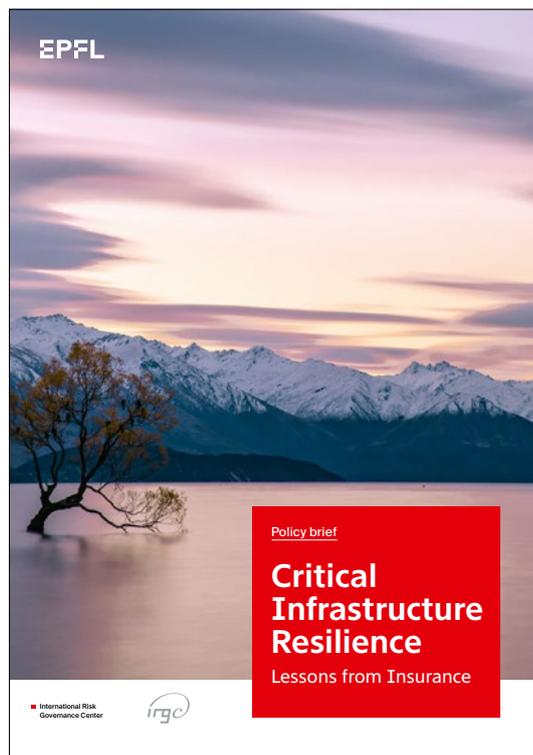


EU Horizon 2020: IRGC partnership in multiple projects

Resilience: SmartResilience

IRGC was a partner in the SmartResilience⁶ project (ended in 2019), the objective of which was to develop indicators and tools related to the resilience of critical infrastructure. Our role was to assess the potential contribution of the insurance sector to this goal. We organised a workshop in February at the Swiss Re Institute, which focused on improving the ability of critical infrastructure owners and operators to use insurance solutions as a means of developing their resilience. This formed the basis of a project report and a presentation at the Cambridge Centre for Risk Studies.

Building on this Horizon 2020 work, we subsequently developed a related IRGC policy brief, *Critical Infrastructure Resilience: Lessons from Insurance*.⁷ One of the report's starting points is that a focus on resilience complements more conventional forms of risk management – particularly when it comes to unexpected and severe risks – and that insurance has a role to play in managing resilience. This report highlights a series of use cases and suggests enabling factors that might guide and inspire attempts to develop resilience-based insurance solutions. It emphasises the existence of a positive feedback loop between insurance and resilience, but it also notes the potential tension between the utility of resilience for grappling with uncertainty and unquantifiability and the fact that quantifiability is a basic principle and requirement for insurance.



⁶ See www.smartresilience.eu-vri.eu. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 700621.

⁷ infoscience.epfl.ch/record/273295/files/Critical%20Infrastructure%20Resilience.pdf

Governance of and by technology: Trigger

The Trigger project (2019–2022)⁸ focuses on the role of the European Union in the evolving global governance landscape. We lead one of the project’s work streams, which focuses on “governance of and by digital technology”. With a number of international partners, we are seeking to understand how global governance and emerging digital technologies interact, and what role the EU plays in this respect. In 2019, our work focused in particular on artificial intelligence and machine learning. We reviewed a range of governance initiatives across countries and domains, identifying key cross-cutting themes that might highlight important points of leverage for the design and implementation of successful EU policy strategies in this field.

Drawing on our previous work on the benefits and risks of algorithmic decision-making, our Trigger work highlighted a number of overarching priorities that should frame the development of these technologies, such as accuracy, dealing with bias, accountability and explainability, privacy, transparency and appropriate human oversight. However, one of the recurring themes in our analysis is the need to go beyond overarching principles to consider how artificial intelligence and machine learning are used in specific domains. We suggest that general patterns and priorities must be sharpened into the identification of specific machine-learning challenges or problems that require concrete governance responses. We focused on three illustrative domains: autonomous vehicles, aspects of public administration, and healthcare. We suggest that the EU’s influence on global governance of machine learning is likely to be strongest in those domains where normative principles and ethical values play a particularly strong role, such as policing and criminal justice for example.



Nanotechnology: Nanorigo

The third Horizon 2020 project we were engaged on in 2019 was Nanorigo (2019–2023)⁹, which is tasked with developing a Risk Governance Framework (RGF) and Risk Governance Council (RGC) for manufactured nanomaterials and nano-enabled products. IRGC is one of 28 partners on the project, and we are providing the core principles for the development of the RGF, as well leading work on establishing the RGC. We bring to the Nanorigo project our long-standing expertise in international risk governance, as well as direct access to complementary expertise and best practices in various other technology sectors that are of relevance to the field of nanotechnology. Our priority will be to support the development of multidisciplinary and multistakeholder collaboration in the assessment and management of risks involved in future nano-based products or systems, most of which will result from converging technologies, and could raise environmental sustainability challenges.



⁸ See trigger-project.eu. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 822735.

⁹ See nanorigo.eu. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814530.

IRGC & the EPFL community

All major universities around the world have an institute or centre that studies the link between technology and public policy. The concept of risk is central because it is what justifies public intervention. However, the risk governance approach that we take encompasses more than simple risk management. For a university like EPFL, it means creating the conditions necessary for new technologies to be deployed and adopted. For example, we commonly recommend that new technological applications must not only improve existing performance in some way, but they must also be economically viable and generally responsible, i.e. socially acceptable and environmentally respectful.

In contrast to risk management, widely used in engineering, the risk governance framing strengthens the proactive control of strategic risks with regard to transitions and transformation (like in climate change or low-carbon economy) or business model adaptation to changing risk landscapes. A focus on risk governance sets the agenda for sustainability-oriented and value-oriented technological innovation

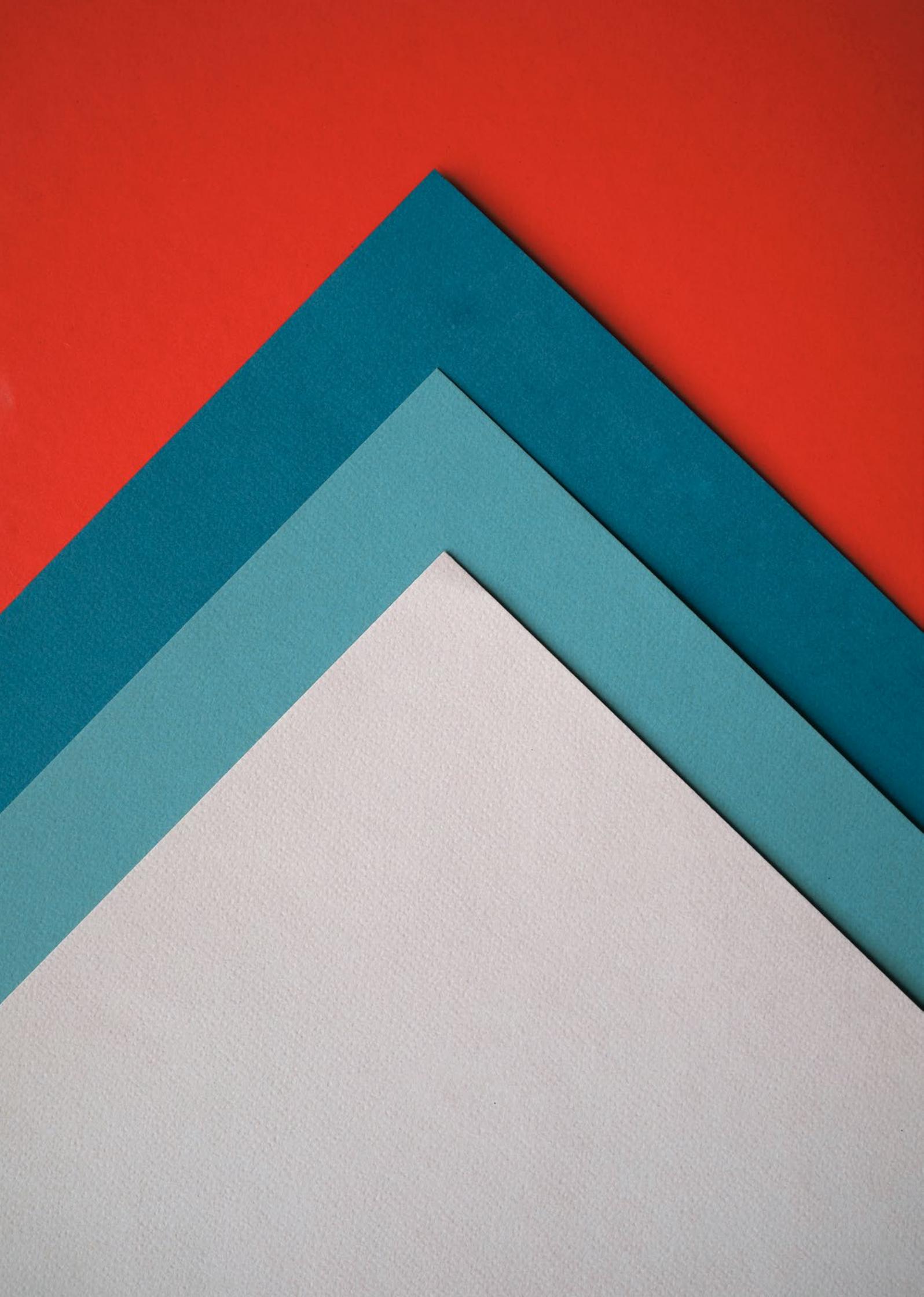
Our role at EPFL is first to answer researchers' questions about such topics. We can also be more proactive in certain areas, such as insisting on the importance of taking cultural differences into account when assessing risk acceptability – in genome editing, for example – and raising awareness of the role and place of sustainability, ethics and responsibility in researchers' work. IRGC also participated in two roundtable discussions during

the EPFL open days in September, one on the impact of new technologies on health, the other on animal experimentation.

Each year, IRGC provides an undergraduate course on risk governance within the EPFL Social Sciences and Humanities (SHS) programme. Last year two additional graduate courses were provided by Professor Kenneth Oye, a longstanding member of IRGC's advisory board, who spent the 2018-2019 as a Visiting Professor at EPFL's School of Life Sciences. These were a PhD course on "Governing Risks of Emerging Technologies" and a Masters course on "Non-Market Competition and Risk Governance". Also, several doctoral students participated and made significant contributions to our work on biosecurity risk governance.

Our collaboration with key competences on campus contributes to enhancing EPFL's reputation and profile in the field of risk governance.





Communication, outreach and impact

Presentations and papers

In addition to her papers and events listed below, in 2019 the IRGC Executive Director, Marie-Valentine Florin, received a fellowship award from the Society for Risk Analysis and continued her membership of the World Economic Forum's Global Risks Report advisory board.

Papers authored or co-authored

"Risk governance and 'responsible research and innovation' can be mutually supportive", in *Journal of Risk Research*
doi.org/10.1080/13669877.2019.1646311

"Applying resilience to hybrid threats", in *IEEE Security and Privacy*
doi.org/10.1109/MSEC.2019.2922866

"Editing the human genome", blogpost for the World Economic Forum
weforum.org/agenda/2019/03/editing-the-human-genome-do-the-risks-outweigh-the-rewards

External events with IRGC contribution

26 January – SRA Benelux, on the topic of space debris, Luxembourg, by M.-V. Florin.

29 January – "Safe Chassis: Planning for a Workshop on Data Needs and Testing," Wageningen University, Wageningen, by Prof. K. Oye.

19 February – "Adaptive Licensing of Pharmaceuticals: Perspectives from Supporters and Critics," Swiss Federal Institute of Technology Zurich (ETH Zurich), Institute of Science, Technology and Policy, Zurich, by Prof. K. Oye.

15 May – OECD BNCT, on the topic of governance of emerging technologies, Paris, by M.-V. Florin.

27 May – "Computer-generated Genome: The first step to artificial life?" Panel with Prof. K. Oye, Zurich.

12 June – EuroNanoForum 2019, on the topic of governance of nanotechnology risks, Bucharest, by M.-V. Florin.

17 June – "Security Implications of Advances in Synthetic Biology", presentation to UN Biological Weapons Convention Workshop, Geneva, by Prof. K. Oye.

4–9 August – "Banff Climate Engineering summer school", Alberta, participation of M.-V. Florin.

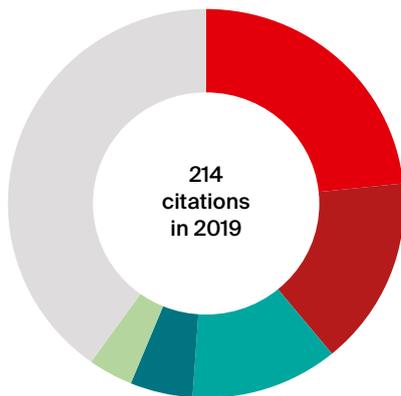
25 September – "Annual conference of the Gov4Nano project, on the topic of a risk governance framework for nanotechnology", Amsterdam, by M.-V. Florin.

21 October – "Future of regulatory systems", at the Lloyds Register Foundation, London, by M.-V. Florin,

7 November – "SRA Nordic, on the topic of governance of emerging technologies", Copenhagen, by M.-V. Florin.

Research citations

IRGC's publications remain widely cited in academic publications. Google Scholar records 214 citations in 2019. The majority of these citations relate to our work on core concepts of risk and risk governance, with almost 40% of the publications relating to the 2005 white paper "Risk Governance: Towards and Integrative Approach" and the related 2017 summary "Introduction to the IRGC Risk Governance Framework".



- 23% IRGC (2005) Risk Governance: Towards and Integrative Approach
- 16% IRGC (2017) Introduction to the IRGC Risk Governance Framework
- 12% IRGC (2016) Resource Guide on Resilience, Volume 1
- 5% IRGC (2018) Resource Guide on Resilience, Volume 2
- 4% IRGC (2015) Guidelines for Emerging Risk Governance
- 40% Others

Source: Google Scholar

“In order to undertake this retrospective analysis, the risk governance framework developed by the International Risk Governance Council (IRGC) is used as a heuristic because it includes and goes beyond the ISO 31000:2009 risk approach that was used in practice.”

van der Vegt, R.G. (2019). Risk management and risk governance of liquefied natural gas development in Gladstone, Australia, *The Extractive Industries and Society*, Vol. 6, Issue 1, Pages 58–66, doi.org/10.1016/j.exis.2018.07.001

“The International Risk Governance Council (IRGC) has proposed and developed a model known as the IRGC framework that has been widely acknowledged and deployed as a consistent, comprehensive and inclusive model.”

Liaropoulos, A., Sapountzaki, K. & Nivolianitou, Z. (2019). Adopting risk governance in the offshore oil industry and in diverse cultural and geopolitical context: North Sea vs Eastern Mediterranean countries, *Safety Science*, Volume 120, Pages 471–483, doi.org/10.1016/j.ssci.2019.07.032

“IRGC proposes an innovative risk governance framework and guidelines on how to address emerging risks.”

UN Office for Disaster Risk Reduction (UN DRR) (2019), *Global Assessment Report on Disaster Risk Reduction*, Geneva, Switzerland, United Nations Office for Disaster Risk Reduction (UNDRR). Retrieved from gar.undrr.org/sites/default/files/reports/2019-05/full_gar_report.pdf

Examples of IRGC citations in research

“Through this analysis we find that the IRGC’s ERG [emerging risk governance] guidelines would add value to management of the complex, uncertain, and ambiguous emerging risks presented by the development and use of SAI [stratospheric aerosol injection]. The five steps outline a clear process for the identification of emerging risks and their subsequent handling and monitoring.”

Grieger, K.D., Felgenhauer, T., Renn, O. et al. (2019). Emerging risk governance for stratospheric aerosol injection as a climate management technology. *Environ Syst Decis* 39, 371–382 (2019). doi.org/10.1007/s10669-019-09730-6

“The IRGC emphasises that the evidence base must be sound and outline the contribution that the social sciences can make to the true assessment of risk and concern. It seems crucial that wherever applied, these other legitimate factors have as sound a basis as the other types of empirical evidence provided to risk managers and risk communicators, and that evidence provided on these is documented as transparently as other evidence.”

Patel, M. (2019). Understanding people. *EFSA Journal*, 17(S1):e170716, 10 pp. doi.org/10.2903/j.efsa.2019.e170716

“The IRGC framework challenges regulators to think beyond a strategy of ‘pick the biggest problem and fix it’ and to develop and adhere to transparent, legitimate and accountable processes for both the ‘picking’ and the ‘fixing’ of problems. The IRGC framework does not spell out how this needs to be done but provides helpful starting points for thinking through important choices.”

van der Heijden, J. (2019). Risk Governance and Risk-Based Regulation: A Review of the International Academic Literature. State of the Art in Regulatory Governance Research Paper Series. [dx.doi.org/10.2139/ssrn.3406998](https://doi.org/10.2139/ssrn.3406998)

“This case demonstrates that two major advantages of the IRGC framework are that it establishes a comprehensive view of the risk landscape and it provides a basic form which to make judgements about future action to improve risk governance posture.”

Lippert, H. T. (2019). NATO, Climate Change, and International Security: A Risk Governance Approach. Springer.

“Systematic approaches to risk management are elaborated in general frameworks like the ISO 31000 of 2009 and the International Risk Governance Council (IRGC) Risk Governance-framework.”

Olsen, E.O., Juhl, V. K., Lindøe, P. & Engen, A. O. (2019). Standardization and Risk Governance. A Multi-Disciplinary Approach. London: Routledge. doi.org/10.4324/9780429290817

“The IRGC (2013) identifies slow-developing catastrophic risk (SDCR) – such as the build-up of credit that gave rise to the GFC, or today’s crisis of global warming – as a crucial risk category. SDCR, as the name indicates, builds slowly, but reaches a tipping point at which crisis suddenly breaks.”

Harrison, M., Xiao, G. (2019). China and Special Drawing Rights – Towards a Better International Monetary System. J. Risk Financial Management. Retrieved from www.researchgate.net/publication/332323253_China_and_Special_Drawing_Rights-Towards_a_Better_International_Monetary_System

“The traditional expert governance mode has put one-sided emphasis on rationality of science and technology. In contrast, the IRGC framework is more advanced in the sense that it also considers the cultural context factors and democratic participation decision into risk decision and governance, and attaches importance to the participation of stakeholders at the same time.”

Shi, D. P. (2019). Disaster Risk Science. Springer

“One recognized limitation of machine-learning approaches is their lack of interpretability (Pearl 2018; Shen 2018; Shen et al. 2018), which raises important questions of accountability when decision making is based on such approaches (EPFL IRGC 2018.”

Hering, G. J. (2019). From Slide Rule to Big Data: How Data Science is Changing Water Science and Engineering. Journal of Environmental Engineering. [doi.org/10.1061/\(ASCE\)EE.1943-7870.0001578](https://doi.org/10.1061/(ASCE)EE.1943-7870.0001578)

“Notably, the Chairman of the Joint Chiefs of Staff Manual (CJCSM) on Joint Risk Analysis (2016) cites a white paper published by the International Risk Governance Council (IRGC), Risk Governance: Towards and Integrative Approach, as foundational to the Department of Defense’s top-level literature on risk (Renn, 2006.”

Air Force Institute of Technology Wright-Patterson AFB United States (2019) Fuzzy Inference Systems for Risk Appraisal in Military Operational Planning. Technical Report, 01 Sep 2017, 01 Mar 2019. Retrieved from apps.dtic.mil/dtic/tr/fulltext/u2/1077525.pdf

“The IRGC framework is not only relevant for the way in which governmental or supranational authorities deal with risk but also it can be used in other settings.”

Nielsen, S. & Pontoppidan, C. I. (2019). Exploring the inclusion of risk in management accounting and control. Emerald Insight. Management Research Review. Retrieved from www.emerald.com/insight/content/doi/10.1108/MRR-10-2017-0342/full/html#sec008

Examples of IRGC references in research

Wicks, R., Pescaroli, G., Green, L. & Turner, S. (2019). Organisational Resilience for Severe Space Weather. (UCL Special Report 2019-01). UCL Institute for Disaster and Risk Reduction: London, UK.

Reynolds, L. J. (2019). Solar geoengineering to reduce climate change: a review of governance proposals. Proc. R. Soc. A.47520190255. doi.org/10.1098/rspa.2019.0255

T20 Japan (2019). Economic Effects of Infrastructures Investment and its Financing – Building Resilient Infrastructure System. Retrieved from www.g20-insights.org/wp-content/uploads/2019/05/t20-japan-tf4-5-building-resilient-infrastructure-systems-2.pdf

Garden, H., et al. (2019). “Responsible innovation in neurotechnology enterprises”, OECD Science, Technology and Industry Working Papers, No. 2019/05, OECD Publishing, Paris, doi.org/10.1787/9685e4fd-en

Stein, V., Wiedemann, A. & Bouten, C. (2019). Framing risk governance. Emerald Insight - Management Research Review. 122(33). ISSN: 2040-8269

Smith, E., McInroy, R. G., Smith, P., d'Angelo, C., Knack, A. & Bertscher, A. (2019). Insights into global food system risks and opportunities and their implications for the FSA. Santa Monica, CA: RAND Corporation. www.rand.org/pubs/research_reports/RR2830.html

Stavland, B. & Bruvoll, J. (2019). Resiliens-hva er det og hvordan kan det integreres i risikostyring? Norwegian Defence Research Establishment (FFI)

Bushnell, M. D. & Moses, W. R. (2019). Reliability, Safety, and Performance for Two Aerospace Revolutions - UAS/ODM and Commercial Deep Space. NASA. Retrieved from ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190025268.pdf

Camboni, M., Hanlon, J., García, P. R. & Floyd, P. (2019) A state of play study of the market for so called “next generation” nanomaterials. ECHA. Retrieved from pure.mpg.de/rest/items/item_3181346/component/file_3181347/content

Liu, D., Wu, Z., Guo, Q. & Shi, Y. (2019). Resilience and Its Thresholds of Scientific Collaboration Network. IEEE Access. PP. 1-1. doi.org/10.1109/ACCESS.2019.2911552

Science Advise for Policy by European Academies (SAPEA) (2019). Making Sense of Science for Policy under Conditions of Uncertainty and Complexity. Report to the EU Commission. Berlin: SAPEA. doi.org/10.26356/MASOS

Newsletter and website

The IRGC quarterly newsletter is sent to around 4500 recipients. The newsletter’s purpose is to inform subscribers about IRGC’s projects, publications and other news. In 2019, the largest readership was in Switzerland and the United States, followed by France, Germany and the United Kingdom.

There were a number of changes to the International Risk Governance Center website in 2019, notably including an overhaul of the design to align with the introduction of a new EPFL visual identity. This allowed for a number of changes to our content and digital strategy, which will be implemented during 2020.



How our work is used by others

A report to be published as part of the RiskGone Horizon 2020 includes IRGC alongside the OECD, ECHA and EFSA as one of the key organisations involved in the risk governance of nanomaterials. The RiskGone project focuses on the same risk governance issues as the Nanorigo project of which IRGC is a partner (see page 9). In particular, the report acknowledges IRGC’s core values:

- **Openness** – project outcome are shared freely.
- **Accountability** – science-based project work and scrutinised recommendations, via peer review before publication.
- **Collaboration** – at the heart of the IRGC approach and vital integrated working methods.
- **Independence** – free choice of subjects to focus on, selection of experts and partner organisations for collaboration, and design of appropriate governance recommendations to deal with the risks addressed.



Measuring impact

Impact and effectiveness are of prime importance to IRGC, but the nature of our work means they are not easy to measure. The citations and feedback listed above demonstrate the ongoing relevance and utility of IRGC work, but they do not capture all of the wider recognition and influence that the IRGC enjoys. This is particularly true in relation to international policy and research organisations,

including the European Commission and the OECD, that increasingly share IRGC's focus on the need for appropriate risk governance. To give a concrete example, at expert meetings run by such organisations our work on systemic risks is increasingly mentioned as contributing to the understanding of problems and shaping of strategies regarding risks in complex adaptive systems. The value and usefulness of our concepts and frameworks for risk governance are reflected in the many invitations we receive to speak

at or co-organise events and to undertake project work across a wide variety of topics. This kind of interaction often does not result in academic citations or formal recognition of IRGC's work, but we believe that our engagement with national and international policymaking bodies demonstrates the breadth and depth of IRGC's reputation and expertise. This is for the simple reason that the work we do helps others to do a better job of preparing for and responding to risks of all sorts.

“ Very interesting policy brief. Great work. ”

Research institute about Critical Infrastructure Resilience policy brief

“ I have used the IRGC emerging risk framework for identifying new or emerging risks of chemicals (NERCs project) and the IRGC risk governance framework in Del. 6.2 of Gov4Nano project as a basis for risk governance background analysis. ”

Research institute about IRGC frameworks

“ Thank you for a hugely useful workshop. I must say I really enjoyed it and learned a lot. ”

Academia about Synthetic Biology workshop

“ Thank you very much for the report which provides a holistic analysis of the phenomenon. ”

Insurance company about Forged Authenticity policy brief

“ The five lessons drawn from the development of risk management practices in the insurance industry, ring loud and clear. As does your call for multi-stakeholder dialogues that lead to action and create real impact. ”

International Emergency Management about Critical Infrastructure Resilience policy brief

“ I want to thank you once more and congratulate you for having organized a very informative workshop. I learned a lot. ”

Biotechnology company about Precision Medicine workshop





Looking ahead

Our work in 2020 continues to span IRGC's two broad focus areas: (i) developing overarching concepts and instruments for risk governance, and (ii) generating tailored recommendations in specific risk domains. The following are among the projects currently on our agenda:

- Transition risks (with the Swiss Re Institute and IASS Potsdam)
- Risk governance of emerging or converging technologies
- Gene drive-based malaria control (with the Brocher Foundation)
- International governance of climate engineering
- Nanotechnology (the Nanorigo project discussed on page 9)
- Global governance "of and by digital technologies" (the Trigger project discussed on page 9)

'Spotlight on risk', a new short-form series of IRGC articles will be launched, to create a vehicle for highlighting the relevance of IRGC concepts and frameworks across a wider range of topics than we have the capacity to devote full workshops and reports to.

About IRGC

The EPFL International Risk Governance Center is an interdisciplinary unit within EPFL (Ecole polytechnique fédérale de Lausanne). It works to improve the understanding and governance of systemic risks with impacts on human health and safety, the environment, the economy and society at large. IRGC develops risk-governance concepts and frameworks, and provides policy advice to decision-makers in the private and public sectors on key emerging or neglected risks. IRGC's work focuses in particular on the governance of risks related to emerging technologies, as well as other areas characterized by high degrees of complexity, uncertainty and ambiguity.

The EPFL International Risk Governance Center works in close collaboration with the IRGC Foundation, which has shaped the global agenda on international risk governance since it was established in 2003 and which continues to play a guiding role in the work of the Center.

The two entities have separate governance and advisory structures.

EPFL International Risk Governance Center

Management Committee: James Larus, Academic Director, Marie-Valentine Florin, Executive Director, Gérard Escher, member of the management team.

Advisory Board: James Larus, Chair, David Bresch, Benno Bühlmann, Julia Marton-Lefèvre, Kenneth Oye, Janos Pasztor, Stephan Schreckenberg, Konrad Steffen, Gisou van der Goot

For further details, visit irgc.epfl.ch

IRGC Foundation

Foundation Board: Granger Morgan, Chairman, Andreas Mortensen, Vice-chairman, Martha J. Crawford, Antoine Flahault, Stéphane Jacobzone, Bruno Oberle, Ortwin Renn.

Advisory Committee: Philippe Gillet, John Drzik, Janet Hering, Charles Kleiber, Wolfgang Kröger, Arthur Petersen, Daniele Tonella, Margareta Wahlström, Jonathan Wiener, Lan Xue.

For further details, visit www.irgc.org

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