



Research Fund


A large, circular collage of images is centered on the page. The collage features a crowd of people walking on a crosswalk, a woman talking on a mobile phone, a man in a suit, and a hand holding a device. The images are layered and semi-transparent, creating a sense of depth and activity. The background of the collage is a mix of green and yellow tones.

2022 Activity Report

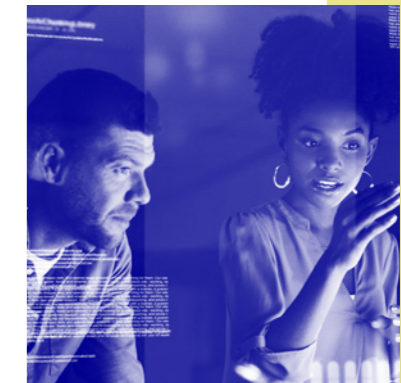
About The AXA Research Fund

The AXA Research Fund was launched in 2008 to better address the major risks faced by our planet through science. AXA has committed a total of €250M to scientific funding and supported over 700 research projects in the areas of health, climate and environment, and socioeconomics. The AXA Research Fund's mission is to support transformative scientific research and to help inform science-based decision-making in both the public and private sectors.

www.axa-research.org

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Foreword



Marie Bogataj

Head of the AXA Research Fund and Group Foresight

Risks have become more complex and interconnected in nature. Managing them requires a multifaceted approach to best face their severity and unpredictability. Interdisciplinary research, multisector dialogue, collaboration, and sound decision-making are critical in building resilience in this new era of “poly-crises.”

The AXA Research Fund’s mission is to support transformative science in the areas of health, climate & the environment, and socioeconomics through funding, disseminating findings, and promoting collaboration among relevant stakeholders.

2022 was an exceptionally active year for the Fund, with research funding being committed to a post-doctoral call on the impact of climate change on health and the launch of an AXA Chair on plastic upcycling through CO₂ valorization. In terms of dissemination, the Fund focused its annual publication on societal resilience, based on a discussion of inclusive growth strategies by experts from academia, government, and industry. We also committed to working with research-based public policy-making bodies and developed project-funding partnerships with leading organizations such as IPBES, UNESCO, and the Geneva Health Forum.

Just as importantly, the AXA Research Fund received approval for a new 5-year mandate starting in January. This mandate will further accelerate the transdisciplinary exploration of emerging risks, consolidate the connections between academia, industry, and the public sector, and strengthen the Fund’s mission of sharing scientific knowledge.

This report provides a snapshot of the year’s achievements and how we contribute to AXA’s mission of acting for human progress by protecting what matters.

Governance



“
The AXA Research Fund provides an amazing opportunity to enable scientific research that responds to some of the most urgent and critical risks of our time. By directly supporting both established and emerging change-makers in a diversity of fields, the Fund helps expedite action towards a more equitable, sustainable and safer society for all.
”

Prof. Debra Roberts

President of the AXA Research Fund Scientific Board

Two boards govern the AXA Research Fund to ensure the supported projects’ relevance, excellence, and independence.

The Advisory Board, consisting of a C-suite of AXA Group Experts, provides input on overall strategy and research areas and sponsorship of research projects and strategic partnerships.

The Scientific Board is composed of top-tier scientists from relevant research areas and ensures the scientific excellence and high transformative potential of selected research projects.

In January 2023, with the approval of a new 5-year mandate, the AXA Research Fund was honored to nominate **Prof. Debra Roberts as the new President of the Scientific Board**, succeeding Prof. Thomas Kirkwood. Prof. Roberts heads the Sustainable and Resilient City Initiatives function in eThekweni Municipality in Durban, South Africa. With over 30 years of experience in local government, Prof Roberts has been responsible for diverse portfolios, including sustainable development, environmental management, biodiversity planning and management, climate change adaptation, and resilience. In 2015, Prof. Roberts was elected Co-Chair of Working Group II (Impacts, Adaptation, and Vulnerability) of the Intergovernmental Panel on Climate Change (IPCC) for the sixth assessment cycle.

Key Figures*

250M€
committed

708
research projects

334
academic partners

39
countries

42%
of the projects
are led by women

*as of January 1st, 2023

2022 At a Glance

3 March Launch of AXA-Paris School of Economics Chair for a Successful Energy Transition

The AXA Research Fund and AXA Investment Managers joined forces with the Paris School of Economics (PSE) to launch a research chair aimed at identifying the conditions for a successful energy transition to a net-zero emissions world.



5 April Call for Projects on Health Impacts of Climate Change

This AXA Fellowship is geared towards assessing, identifying, quantifying, and understanding the impact of climate change on human health and exploring solutions to mitigate new health risks.

9 May Launch of AXA Fellowship in Harmful Substances

The AXA Research Fund earmarked €1.25 million to support 10 postdoctoral research projects in leading universities to advance a solid multidisciplinary understanding of contaminants' effects on human health and the environment.

The selected projects will inform industrial and risk-management strategies and enable public policy design to prevent long-term exposure to harmful substances and alleviate adverse impacts on human health and the environment.



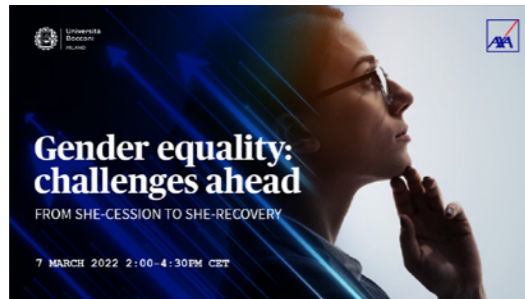
20 June Conference on Inflation and Interest Rates during COVID and War with the Barcelona School of Economics

Prominent policymakers, economists, and business leaders discussed the challenges raised by inflationary pressures and high uncertainty. The conference was organized by the AXA-BSE Chair on Macroeconomic Risk, led by Prof. Albert Marcet.

7 March AXA-Bocconi Gender Equality Conference

Bocconi University and AXA organized a conference on gender equality as part of the AXA Research Lab on Gender Equality, chaired by Professor Paola Profeta. The Lab focuses on gender economics, gender policy, and gender diversity management.

The conference delved into the implications of COVID-19 on gender equality across several European Union nations and explored the critical steps necessary for achieving a successful "she-recovery."



5 May Announcement of the Grand Jet d'Or de Genève Prize Winner

The research group "Healthy Forests, Healthy People: Health in Harmony, Harvard T. H. Chan School of Public Health and Zoo New England and Partners" won the 2022 Prize for their work in supporting the preservation of human and environmental health. The prize is a joint initiative of the AXA Research Fund and the Geneva Health Forum.



20 May AXA-IPBES Collaboration for Biodiversity Research

A multi-year financial contribution was made to the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and will support early-career researchers studying the interlinkages between biodiversity, water, food, and health. It will also assess the underlying causes of biodiversity loss, determinants of transformative change, and options for achieving the 2050 Vision for Biodiversity.

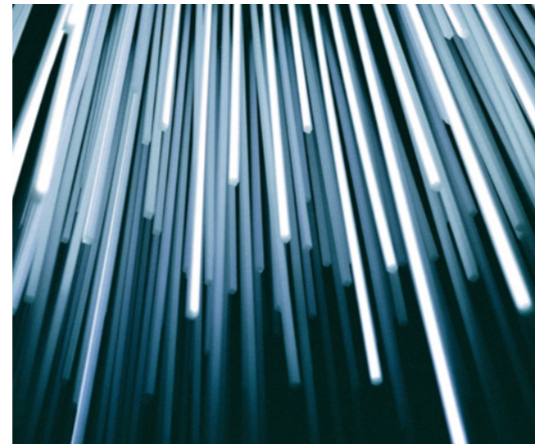
8 June Announcement of the AXA-UNESCO Fellowships on Coastal Livelihoods

Eight innovative postdoctoral research projects were selected to strengthen science-based intervention in the area of coastal livelihood preservation and resilience, following a joint call launched in the context of the Ocean Decade. The projects tackle issues such as floods, sustainable fisheries, tsunamis, and community engagement in climate adaptation.



8 July
Share Your AXA Research

During the Share Your AXA Research event, 14 AXA Fellows presented their research projects in a 3-minute pitch, following a dedicated media training session. Nine AXA Fellows on Harmful Substances showcased their research on emerging contaminants, while five Inclusive Growth Fellows shared their research on building a more socially and economically inclusive society.



3-6 October
The AXA Research Cyber Talks

On AXA Security Week, the AXA Research Fund and AXA Group Operations organized internal webinars with scientists on key topics related to cyber risks.

22 November
Building Societal Resilience Publication

The latest publication from the AXA Research Fund brought together perspectives from academia, public organizations, and businesses on inclusive growth and its role in strengthening societal resilience — a key pillar for a sustainable future in an increasingly volatile world with compounding shocks.

It explored some key manifestations of inequality, such as gender, age, and geography-based factors, and how they affect global society. It addressed the issues where institutions, including government agencies, NGOs, grassroots organizations, and private enterprises, have a leading role to play in the field. Lastly, the report explored how insurers can contribute to social inclusion, from providing coverage to emerging markets to addressing protection gaps.



8 July
iRisk Conference on Decision Making Under Uncertainty

This conference organized by IÉSEG School of Management in partnership with the AXA Research Fund provided a platform for dialogue between industry, policymaking, and academic experts on the challenges of decision-making under risk and uncertainty.

21 September
AXA Wildfires and Climate Masterclass

Dr. Apostolos Voulgarakis, AXA Chair at the Technical University of Crete, discussed the impact of wildfires on the environment and humans in a masterclass organized in collaboration with AXA XL.

His research focuses on high-latitude wildfires, using advanced fire modeling, Earth system modeling, satellite and in-situ observations, and machine learning techniques to better understand and predict wildfire hazards.



3 November
Webinar on the Emerging Threat of Sand and Dust Storms

Prof. Carlos Pérez Garcia-Pando, AXA Chair at the Barcelona Supercomputing Center, and Christelle Castet, Climatologist at AXA Climate, discussed the causes of sand and dust storms, their consequences, and how to improve forecasting for better mitigation.



28 November
Launch of the AXA Chair on Plastic Waste Upcycling by CO₂ valorization

Globally, around 250 million metric tons of plastic waste are generated each year, of which only 30% is recycled. In addition, according to 2021 estimates, 1 million kg of carbon dioxide is emitted every second, and 39 gigatons were emitted that year.

The new AXA Chair, led by Prof. Olivier Coulembier at the University of Mons in Belgium, aims to address these two major environmental pollution issues by developing a plastic recycling method with a low carbon footprint.



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Building Cities' Resilience in Response to Droughts

Professor
Gina Ziervogel
AXA Award at the
University of Cape Town



After three years of its worst recorded drought, Cape Town narrowly avoided “Day Zero” — the day taps would run dry. On the brink of emergency water rationing, shortcomings in infrastructure and resource inequality lay exposed, and the City of Cape Town (CoCT) government was forced to re-examine its approach to water resilience. Supported by the AXA Research Fund, the University of Cape Town’s Prof. Gina Ziervogel has made far-reaching theoretical and social contributions to understanding disaster and resource management. Here, she shares her involvement in Cape Town’s governance, collaborative efforts with NGOs and community groups, and hopes for the future of urban resilience.

Cape Town narrowly avoided “Day Zero” in 2018. How important is it to prepare for a worst-case scenario?

Day Zero was a scary prospect for Cape Town, but also an important example for the rest of the world. We are acutely aware of the impacts of climate change, such as increasing variability in rainfall and increasing extreme events, and so cities around the world need to grapple with what it means to have extended droughts. However, cities do not always have the necessary capacities or resources in place before these events happen — this pushes the boundaries of what it means to manage water in a city.

Your research into the Cape Town drought has highlighted some key lessons. How can other cities use these to guard against future shocks and stresses when faced with severe drought?

One wake-up call in Cape Town was that the water department alone could not deal with the drought, even though it was a water-related shock. Extreme climate events cause city-wide problems that call for cross-sectoral government approaches, but well-established governance mechanisms for multi-sector responses are lacking in Cape Town and many other cities. To set up systems that can manage a complex crisis, cities need to have strong leadership and flexible governance. Another lesson was the importance of establishing partnerships, networks, and alliances before a crisis, which Cape Town had not done. The importance of data also

emerged quite strongly; as well as improved system modeling to understand climate scenarios and adapt to future events, there was also a clear need to better understand the lived experience of residents, particularly those in low-income areas. How do people on the ground actually experience the responses that the city is putting in place? Finding ways to input qualitative data — people’s stories — could become more important globally.

An area of interest for the AXA Research Fund is to better understand and support disadvantaged or voiceless communities. How does your work contribute to this?

The inequality in access to resources in Cape Town emerged quite starkly during the drought. This inequality is undermining resilience in our cities, and the well-resourced do not understand this sufficiently—they want to continue their privileges, but by doing so, are undermining the socio-ecological basis on which everyone’s well-being rests. For example, many wealthy families put in boreholes during the drought to continue having water on their property, but the groundwater table was dropping. It also meant that these households were paying less for municipal water, which compromised Cape Town’s cross-subsidization system for poorer households. Understanding the lived reality of marginalized groups whose voices are not prioritized is also key to addressing inequality. Together with the Environmental Monitoring Group and Western Cape Water Caucus, my colleagues and I worked with low-

income communities who are passionate about improving their local areas and, through our “citizen science” initiative, were able to advance their research skills. We worked together on the SenseMaker project (part of the Community Resilience in Cape Town project) and produced “Making Sense Of A Water Crisis”, a documentary on the process used to capture residents’ stories. Through this work, local actors could build their voices and lobby the government with actual evidence.

How else might your research help local governments strengthen urban water resilience and adapt better to climate risk?

The theoretical impetus of my work is that we need to strengthen multi-level governance around urban climate adaptation and resilience. For this, governments need to engage with citizens in more creative, inclusive, and intentional ways that move away from the tokenistic participation we have seen in the past. Out of my work in Cape Town has come a greater focus on co-production approaches, where different groups of actors tackle questions together. The importance of “learning” also emerged —when you start collaborating and listening, you begin to see things differently. For example, my theoretical concepts of resilience and adaptation have been useful for the CoCT’s internal learning, and my appointment to the CoCT’s Water Resilience Advisory Committee in 2017 has led to further partnerships and materials that include more diverse perspectives.

What are some of the other barriers to effectively responding to drought?

Often, there is limited trust between the government and citizens in Southern Africa. To overcome this, governments need to communicate more clearly what is happening inside the government. My work, such as the book “Day Zero” I wrote with Leonie Joubert, has helped to open that up. Citizens also need to hold governments accountable, which is hard if they do not know what the government is actually doing. Another barrier is understanding water catchment from a broader systems approach that appreciates social, economic, and environmental aspects. For example, removing alien vegetation from our water catchment, including eucalyptus and pine, means more available water for the city, but this requires a collaborative approach that government systems are not necessarily set up for.



What meaningful changes would you like to see next?

Part of the next step is building relationships in between extreme crisis situations. The CoCT is now reaching out to NGOs and local groups to actively listen to challenges and address these, but activists are suspicious as they feel that past requests have fallen on deaf ears. Increasingly, the CoCT is also trying to deal with the high level of informality in Cape Town. These challenges do not necessarily require technological responses, which is what the CoCT knows best, but rather a hybrid of social, political, cultural, and ecological ways of working, and the sector response needs to be broadened to a multisystem approach that enables innovation.

How can cities learn from each other?

Understanding government responses in Australia, Singapore, and Mexico City was useful to the CoCT when they were deciding how best to respond to the drought, as were international experts who could share different ways of thinking with officials. Yet, during the drought, Cape Town government officials struggled to find information on how other cities had responded to city-wide drought crises in the past. This is partly because the available material is often an internal report or academic papers that officials do not always find accessible. We, therefore, need to create learning networks across cities. We also need to know how to take context-specific information from other places and make it work locally. For example, I recently spent 6 months in California —despite socio-economic differences, drought is a shared issue, and knowledge around groundwater could potentially be exchanged. Groups in Seattle and the University of California Santa Cruz were very supportive and interested in my work on governance and community engagement in South Africa, and I was able to strengthen relationships with people in the California water sector.

From a personal perspective, what has been the most rewarding part of this project?

I have loved working in my home city to make it a better place for my fellow citizens. Really special has been working as an intermediary between academia and practice over the last few years, and I feel privileged to have supported and learned from the Western Cape Water Caucus and Environmental Monitoring Group, and from people who are exposed in ways that I am not. I won the University of Cape Town’s Social Responsiveness Award in 2020, which was wonderful because the socially responsive angle is what keeps me in academia. I also feel strongly about communication and presenting information in various formats. For example, I put together briefing notes to make the material more accessible to non-academics and was part of the Drought Response Learning Initiative, which filmed interviews of first-hand reflections of the drought from a wide range of perspectives.

How do you feel about the sustainability of recent changes in Cape Town?

My report for the CoCT on building capacity to respond to city-wide stresses such as COVID remained internal, but informed their discussions on structuring the governance of disaster management to better cope with crises like this in the future. I have emphasized the importance of social issues while on the Water Resilience Advisory Committee, and am glad to see that these have been put on the agenda more —this is central to supporting transformative climate adaptation. It has been encouraging to see increased engagement between the CoCT and the Western Cape Water Caucus emerging from the SenseMaker project, but there is a long way to go until we see lives changed substantially for the better.

March 2022

Sand & Dust Storms and Their Impacts on Health, the Economy, and the Environment



Professor
Carlos Pérez García-Pando
AXA Chair at the Barcelona
Supercomputing Centre

A remarkable springtime dust storm passed over Europe in March 2022. While this was a rare event, dust storms occur daily in other parts of the world. AXA Chair awardee, Prof. Carlos Pérez García-Pando at the Barcelona Supercomputing Center, has been engaged in extensive fundamental and applied research to better understand, predict, and manage the impact of sand and dust storms. Here, he explains how something so fine as dust particles can have mammoth implications for human society, and how his work steers forecasting into action.

How important is it to predict sand and dust storms?

Dust storms are a vital part of the ecosystem, but can be a serious hazard for agriculture, transportation, the economy, and health in many countries, particularly in some of the least developed ones. We can’t easily avoid or control dust storms, so preparation for their negative effects is key. Yet, information from MET services is still not streamlined properly. For example, many terraces in Madrid were unusable after the recent dust storm over Europe, and bars and restaurants were asking why they hadn’t been properly alerted by the regional government.

How has your fundamental research contributed to new knowledge?

To understand and predict dust, we need models. However, a lack of knowledge means that these often contain uncertainties, a major one being the emission term —how much dust is produced, and where. To address this, through an ERC grant entitled FRAGMENT, I’m exploring fundamental aspects of the dust emission process in deserts across the world, as well as relationships between mineralogy and particle size. We are testing this in our models to better estimate the effect of dust on the climate.

How important is multidisciplinary research in this field?

Dust has multifarious links to the natural environment and anthropogenic perturbations, so multidisciplinary research is absolutely critical. One potential paradigm shift is the EMIT Mission, in which I participate as a Co-Investigator. Using a spectrometer on the International Space Station, we will collect surface mineralogy data at a 60-meter resolution to obtain the first-ever mineralogy map of the Earth’s arid and semi-arid regions. The applications of EMIT extend beyond dust, such as obtaining data on vegetation type and color, which is currently an uncertainty, particularly in semi-arid regions.

How does your work contribute to the issue of global health?

I’m interested in the effects of pollutants and dust on respiratory and cardiovascular disease. Through different projects, I’m looking at chemical interactions of dust with anthropogenic pollutants and contributing to quantifying their health and socioeconomic impacts across Europe. Building on past research, I also plan to further investigate the effect of dust during meningitis epidemics, as dust could render people more susceptible to developing



meningitis. Although not directly related to sand and dust storms, we have recently looked at air quality changes resulting from Covid lockdowns and assisted Copernicus to calculate associated emissions and health impacts.

How have you supported technological advances?

Our WMO Regional Dust Center forecast model now includes state-of-the-art parameterizations that comprise the most recent scientific advances. Also, our new and unprecedented 10 km-resolution dust reanalysis dataset for Northern Africa, the Middle East, and Europe could be useful to health, solar radiation, transportation, and aviation communities. Our data could help optimize the life expectancy of plane engines, which can be sensitive to dust and minerals. We are also linking our forecasts to the operational maintenance software of solar power plants. Cleaning dust deposits from solar panels is costly, especially where water is scarce, so predictions could help to plan cleaning cycles. Importantly, our datasets and model are open sources to facilitate further progress and other applications.

Other than through an open-access approach, how can industries be reached?

We contribute heavily to CAMS-COPERNICUS to improve air quality forecasts in Europe, which can be adopted for commercial applications. In the AQ-WATCH project, we've established connections with providers of meteorological information, and have created forecasts for Chile, the US, and East Asia. We've been very active in getting feedback and recommendations from sectoral end-users about its envisioned output through the participation and organization of Training Schools and User workshops.

How has AXA facilitated collaborations?

We now have the funding to invest in this core activity. We've put together a community of developers, modelers, and users across Europe, Northern Africa, and the Middle East. As well as sharing methods between modelers and experimentalists, we have connected with users in companies, aviation, and the health sector to find out what they need. Dr. Sara Basart, a member of the AXA Chair and Chair of the inDust Cost Action, has been key in this effort. Another challenge is collaborative action — countries in the Middle East have different ways of dealing with things, so coordination isn't easy when faced with a regional problem.

What are some of your knowledge-sharing and communication activities?

Other than academic publications and conferences, we've produced informative videos for the public and content for children. We also engage with governments and policy-makers. As well as being the first official regional center of the WMO for dust prediction, members of our center sit in the Global Steering Committee and are involved in an advisory group on sand and dust storms within the United Nations Convention to Combat Desertification.

Other future directions?

One big question is what sand and dust storms will look like towards the end of the century. As well as wildfires and uncertainty in land management and vegetation, a warming world will impact dust storms — in turn, dust storms affect climate. Representing long-term changes comes with many challenges. We're now developing Earth system models to include new processes that better represent long-term variability along with the associated effects. I'm also interested in the possibility of extending forecasting to sub-seasonal to seasonal scales.

March 2022

The Use of Virtual Reality for the Treatment of Mental Health Issues

Professor
Winnie Mak
from the Diversity & Well-Being Laboratory at the Chinese University of Hong Kong

Doctor
Yi Mien Koh
of AXA Hong Kong

Doctor
Amy Chan
previously at the Chinese University of Hong Kong



The inaccessibility of timely mental health care services in Hong Kong, especially for individuals with a strong aversion to social interactions, has led researchers to look towards virtual reality (VR) as a viable mode of therapy. An innovative research project funded by AXA Hong Kong and supported by the AXA Research Fund has shown that VR therapy can reduce anxiety, depression, and social avoidance. These results could bring us closer to a “hybrid” model of healthcare, whereby an online or self-guided element could complement existing therapies. The joint research initiative included AXA Hong Kong’s Dr. Yi Mien Koh, Prof. Winnie Mak from the Diversity & Well-Being Laboratory at the Chinese University of Hong Kong, and Dr. Amy Chan, previously at the Chinese University of Hong Kong.

How urgent is it to address social avoidance?

Winnie Mak (WM): Social avoidance is a common manifestation of many mental disorders, such as depression and anxiety — an estimated 25% of people will experience anxiety and depression at some point in their lives. However, avoiding other people can worsen depression, loneliness, and low self-esteem, leading to further withdrawal from social situations and creating a vicious cycle.

Yi Mien Koh (YMK): Waiting times to see a psychologist in the Hong Kong public health system are long, and private consultations are expensive. As a leading health insurer, AXA wanted to find affordable access to mental health support. The project name “Yes I Can” reflects the idea of self-efficacy and confidence that one can do it. As well as destigmatizing mental health issues, we wanted to explore how VR could help people feel safer and more confident in social situations.

How has technology already been successfully used in mental health promotion?

WM: Our trials with the WiseLiving, Living With Heart, and TourHeart online interventions have demonstrated that mindfulness-based and cognitive

behavioral interventions can be successfully delivered online to reduce depression and anxiety symptoms and elevate well-being. And, VR has already been used to treat phobias and post-traumatic stress disorder.

Amy Chan (AC): While VR technology has become more realistic and sophisticated over the past 10-20 years, it hasn't been fully leveraged to address depression, generalized anxiety, or social avoidance, so our work is pioneering in that sense.

What were the major results of your randomized control trial?

WM: Over the three VR sessions, we saw a significant reduction in social avoidance, and this effect was sustained at the 1-month follow-up. After the intervention, people had less social avoidance, social anxiety, depression, and fear of negative evaluation.

AC: The self-guided VR program includes five scenarios to choose from: a convenience store, a café, a bus, a street, and a medical clinic. A “virtual coach” guides participants through a series of graded tasks, such as placing an order at a café or making eye contact. There are five levels of difficulty, with increasingly noisier scenes, more people, and more challenging tasks.

Why does AXA Hong Kong find VR such an attractive tool with which to address mental health issues?

YMK: Mental health conditions such as anxiety and depression are common in the general population, so simple and affordable digital tools are needed. Five years ago, very few people were looking at VR. After learning that the NHS was offering VR treatments developed by Professor Daniel Freedman of Oxford University, I thought it would be great to transport that into Asia.

What was the impact of the COVID-19 pandemic on your protocol studies?

AC: The multiple suspensions and interruptions greatly impacted recruiting and retaining participants. Also, many participants told us that they felt less urgency to treat their social avoidance symptoms during the pandemic, as online meetings and social distancing meant they didn't need to interact with people in person. At the same time, they told us that the absence of in-person contact limited the opportunities to practice skills they had acquired during the VR program. "While VR technology has become more realistic and sophisticated over the past 10-20 years, it hasn't been fully leveraged to address depression, generalized anxiety, or social avoidance, so our work is pioneering in that sense."

What was the role of Oxford VR in designing the VR device?

YMK: I visited Prof. Freedman's lab in Oxford and was inspired by his results in people with phobias. We decided to bring Oxford VR's commercialized technology to Hong Kong and localize it so that it was culturally relevant.

WM: Hong Kong is one of the most crowded areas in the world, and even people with social avoidance are used to large crowds. So, in addition to changing the language to Cantonese, we needed the scenes to be more intense to fit with the local culture.

AC: For this, there were some technical constraints, such as the VR hardware's computing power. We worked with Oxford VR to overcome these constraints by increasing the background noise and adding more background objects to increase the feeling of busyness without draining computing power. Oxford VR also made the characters more Asian-looking and took references from Hong Kong social settings, such as mask-wearing, to create a more realistic virtual environment.

How important is collaboration in interdisciplinary work?

WM: Our team includes psychologists, engineers, researchers, journalists, people in marketing, and people with a business background. We need different perspectives to help us be more creative in our thinking. Even Yi Mien and I, while we share the vision of tackling stigma and promoting mental health, I come from an academic and psychological perspective, and she has a medical and business perspective. I appreciate the collaboration with academics and corporations like AXA because I think it's important to have public and private partnerships to make things work.

Strict lockdowns were imposed on millions of people worldwide during the COVID-19 pandemic. How do long periods of isolation affect mental health, and how might VR interventions be useful?

WM: The lockdowns may have exacerbated psychological distress, and economic, employment, and political uncertainties may have worsened anxiety, especially for

deprived and disadvantaged people. While they cannot "solve" sociopolitical issues, telehealth, VR technology, and online interventions could complement what wasn't possible during the pandemic, such as face-to-face treatment.

YMK: The average waiting time to see a psychologist in Hong Kong public health services is 18 months, and that's after waiting for a consultation with a psychiatrist. Winnie and I wanted to work towards inexpensive, accessible, and sustainable services that could transform treatment.

How soon can we expect to see immersive VR therapy in public healthcare programs?

AC: Users told us that this kind of therapy would be effective because it was personalized, on-demand, and fit their needs and schedules. With progress in technology and as the device becomes more comfortable and affordable, there's potential for widening the public's access to evidence-based treatment.

YMK: We've shown that VR intervention is clinically effective and can be used anywhere — even at home. The next step is to form an integrated care program with healthcare providers. Healthcare professionals may not know what VR can do, and most doctors adopt a traditional approach to mental health. The biggest challenge will be to educate them on how VR complements what has always been traditionally available. Due to our payor role, insurers can play a pivotal role in bringing ecosystem players together.

WM: A hybrid model of online and offline interventions could be integrated into the mental health services system. For that, we need more advocacy with the government, funders, and healthcare providers. Some people wait years to receive treatment, so why not provide them with evidence-based digital tools with which they can help themselves in the meantime?



Quantifying Climate Risk to Water and Food Security in Southern Africa

Professor
Mark New
AXA Chair at the University
of Cape Town



African countries are particularly vulnerable to climate change. In the first of three successional 5-year AXA Chairs in African Climate Risk, Prof. Mark New, Director of the African Climate and Development Initiative (ACDI) at the University of Cape Town, has made strides in quantifying the changing nature of climate risk and the impact of human activity. Prof. New's work has crucial implications for water and food security in southern Africa, the societal consequences of which are likely to snowball in the future, especially given the predicted doubling of the population in the next 25 years.

Why are African countries among the most vulnerable to climate variability and change?

Sub-Saharan Africa is not necessarily more exposed to climate hazards than other regions of the world. But, with some of the least developed and lowest income emerging economies, it has a lower capability to manage those risks. Much of my work during the AXA Chair was focused on demonstrating the links between a changing climate and food and water security. For example, heat stress means that many crops are at their thermal limits and reach lower yields. Rather than simply documenting climate change, this approach allows us to define its societal impacts.

What has your work revealed about the changing nature of climate risk and how human activity affects this?

The main focus of my Research Chair was quantifying how the risks of different types of climate hazard have changed because of human influence on climate, and how that "attributable change" in climate hazard alters risk on the ground. One focus has been water security, for which we used the 2016-2018 Cape Town multi-year drought as a case study. We found that while the likelihood of the rainfall drought had increased threefold, there was a four-fold increase in the risk of hydrological drought — so, the impact on

the ground was amplified compared to the climate change signal. Another threat to water security in the Western Cape area is alien vegetation, such as the thirsty, non-native pine and acacia trees that are invading the mountain catchments and exacerbating the water security issue. Our modeling revealed that removal of alien vegetation would reduce, but not entirely offset, the water security risk.

A second focus was on sovereign drought insurance. For this, I collaborated with the African Risk Capacity, which offers insurance to African nations to help them deal with the immediate response costs of drought on food security. Insurers use risk models to estimate the likelihood of particular perils using historical climate data, and then calculate a premium. When applying our attribution methodology to this risk model, we found that climate change has dramatically increased the costs of insurance in some countries.

How have your findings helped southern Africa to build resilience and adapt management?

As well as engagement with the African chapter of the Principles for Sustainable Insurance, we have shown that methods used to estimate perils need to be updated to better understand the risk that insurers are offering products for. More generally, quantifying

how the likelihood of different perils have changed has helped to reflect on risk management approaches and whether they're fit for purpose. Our Cape Town work, for instance, has implications for designing future water resource systems.

Yet, it takes a long time for ideas to propagate through to action on the ground. In Africa, many countries have suboptimal or non-existent climate observation networks, which makes quantitative risk work difficult. Many countries in southern Africa are also reluctant or unable to invest in updating systems, especially as resources are already thinly stretched.

Does your work have implications for human health?

There's been limited work done in Africa on climate-health relationships. Professor Lara Dugas, a new AXA Research Chair at UCT, and I are interested in whether it is possible to detect climate change signals within longitudinal human health data, as well as the effects of climate on nutritional status. This could have implications for managing food security.

How has the AXA Chair facilitated climate change research in southern Africa?

The AXA Chair enabled me to support the development of MSc and PhD students and postdoctoral researchers, including Dr Romaric Odoulami, now a leading expert in assessing the risk and benefits of solar geoengineering of climate, Dr Petra Holden who is working on modelling trade-offs between Nature Based Solutions to climate, and Christopher Trisos who I have supported in building his own Climate Risk Lab at the ACIDI in Cape Town.

As well as being good leverage for additional research funding, the AXA Chair also enables ownership of the research agenda, and allows researchers overwhelmed with teaching commitments — which is common in Africa — to be more productive.

How has AXA facilitated key collaborations within southern Africa and abroad?

Another development in the last 5 years has been creation of the ARUA Centre of Excellence in Climate and Development, which is a partnership between the Universities of Cape Town, Nairobi, and Ghana. Climate risk is included as a strong theme in that. My involvement in the Intergovernmental Panel on Climate Change 6th Assessment report, published in 2022, also inspired fruitful collaborations and allowed us bring our climate change attribution work into the Africa chapter of the Working Group II IPCC report.

How important has it been to communicate your research findings?

Developing long-term relationships and trust is key. At the ACIDI, we take a transdisciplinary approach, which involves bringing societal actors on board and consulting with them on an ongoing basis, such as engaging as an expert with resilience managers in the city of Cape Town or the local department of water affairs. In this way, we can help people to think about challenges and potential avenues for change.

October 2022



Gene Targeting Research: Advancing Cancer Treatment

Professor
Mariano Barbacid
AXA Chair at the Spanish
National Cancer Research Center
(CNIO)



Prof Mariano Barbacid, Permanent AXA Chair, aims to discover treatments for cancers with some of the lowest survival rates. In 1982, Prof Barbacid was among the first to discover the first human oncogene — a gene that can, under certain circumstances, transform a cell into a tumor cell. This led to the revelation that cancer is a genetic disease caused by mutations in key genes. Since being awarded the AXA Chair, he has continued to research the K-Ras oncogene, which is the most frequent mutation in lung, colorectal, and pancreatic cancers. Here, Prof Barbacid shares some of his recent innovative gene targeting research, as well as the welcome news that we are slowly but surely winning the fight against cancer, even if the enemies are complex.

Why is it so important to understand the underlying mutations of different cancers?

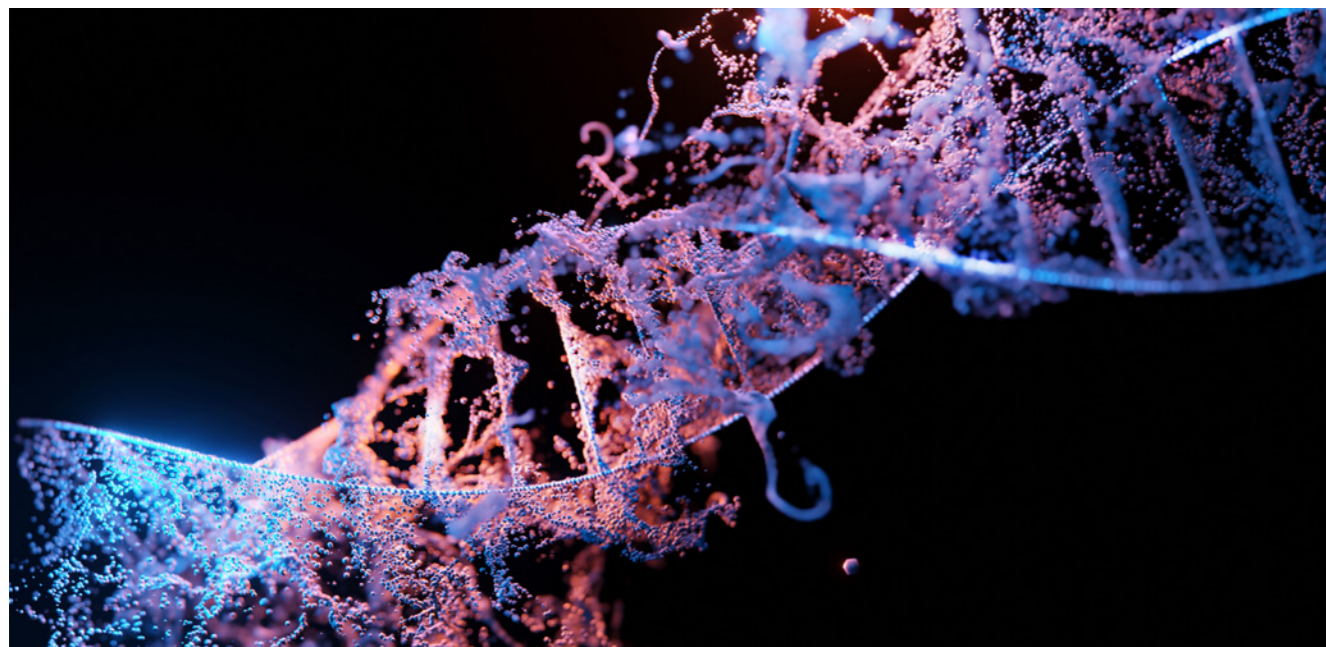
Each cancer type has to be understood individually according to its pathology, stage, metastatic status, and underlying mutations. For instance, K-Ras is mutated in 20% of human tumors, and is the most frequent mutation in three of the big killers: lung, colorectal and pancreatic cancer. Targeting K-Ras will be a major advance for the treatment of these tumors. In my laboratory, we work with lung and pancreatic cancer, for which K-Ras is the initiating mutation, so blocking K-Ras activity can be expected to have better therapeutic consequences than in tumor types for which K-Ras is not the initiating mutation, such as colorectal cancer.

Ironically, K-Ras was thought to be undruggable just 5 years ago, and chemotherapy has been the standard of care for K-Ras mutant tumors for the past 39 years. In June 2021, the FDA approved the first selective inhibitor against K-Ras, Sotorasib (Amgen). This is the beginning of an explosion of new drugs to treat this cancer type. Unfortunately, Sotorasib is only active against one of the different types of K-Ras oncogenes. Therefore, its use is limited to some types of lung cancer and to a lesser extent, colorectal cancer. Yet, K-Ras inhibitors against the other mutations are currently being generated in several pharma companies. Indeed, we are witnessing the beginning of an explosion of new drugs to treat those cancers induced by K-Ras oncogenes.

Could you describe some of your main findings?

We use genetic manipulation to first define what's relevant. For this, we create genetically engineered mouse models by introducing mutations present in patients into mice DNA, which causes the growth of tumors that are similar to human tumors. Mouse tumors are smaller and have fewer mutations than human tumors, but are the closest experimental models we can work with. We use these mouse tumor models to identify therapeutically relevant targets. Our strategy is, conceptually, relatively simple. Once the mice have developed the corresponding tumors, we use molecular scissors to eliminate potential therapeutic targets, that is, targets whose elimination will cause the tumor to either stop growing, regress, or even disappear. Needless to say, those targets whose elimination have little or no effect on tumor growth are no longer considered.

In a mouse model of lung cancer, we found that elimination of one of the three direct downstream signaling targets of K-Ras, a protein named RAF1, resulted in the regression of almost two thirds of all tumors, including the complete elimination of about 10% of them. Hence, these studies have indicated that we should concentrate our future studies to selectively targeting RAF1. We have also carried our similar experiments with genetically engineered mouse models of pancreatic tumors. In this case, elimination of RAF1 did not produce any therapeutic



benefit. However, when we combined RAF1 ablation with the elimination of a second target, the EGF Receptor, we observed the complete regression of these pancreatic tumors in about half of the mice. This is the first time anyone has reported the complete regression of pancreatic tumors.

How does this work facilitate the next stage of drug discovery?

Our mouse tumor models have allowed us to identify potential therapeutic targets. Other than K-Ras itself, our studies have shown that RAF1 is the most suitable target by which to block K-Ras mutant cancers.

Since RAF1 is a specific kind of enzyme known as a “kinase”, the pharma industry has developed kinase inhibitors — none of which have shown significant therapeutic activity. Last year, we provided a potential explanation for the failure of these inhibitors in the clinic. Unexpectedly, using our genetically engineered mouse tumor models, we discovered that RAF1 does not participate in tumor progression via its kinase activity. Hence, making RAF1 kinase inhibitors is useless for the treatment of K-Ras mutant tumors.

These observations have forced us to change our drug discovery strategy and we are now concentrating on eliminating RAF1 itself rather than blocking its kinase activity. To try to unveil the best strategy to degrade RAF1 we decided to determine its 3D structure using cryo-electron microscopy in collaboration with Dr. Guillermo Montoya, Head of the cryo-EM facility at the University of Copenhagen. The results of this collaboration have been recently reported in Molecular Cell. We have identified some “structural vulnerabilities” in RAF1 that will allow us to start a drug discovery program to find ways to destroy the RAF1 protein in human cancers.

How much closer do your findings bring us to new treatments for lung/pancreatic cancer?

Science doesn’t always generate immediate results, as with K-Ras oncogene — the first drug came almost 40 years after its discovery. The good news is that there have been many advances in the overall treatment of cancer, and every year there’s a breakthrough in one type of cancer. The fight against cancer is being won slowly but steadily.

Just 24 years ago, there were no targeted therapies, and cancer was treated with chemotherapies. In 1998, the first targeted

product, Herceptin, was approved — a monoclonal antibody for the treatment of certain types of breast cancer. We now have targeted therapies for many different types of cancer. Still, the problem with precision medicine is that each target needs its own drugs. In just 20 years, pharmaceutical companies have used information generated by many translational research groups to develop selective drugs for more than two dozen oncogenes and their related products, thus providing useful and less toxic therapeutic options for many patients with cancer.

Likewise, immunotherapy, which is a therapy that inhibits the ability of tumors to suppress the immune response of the patient, was an experimental therapy only 10 years ago. Today, immunotherapy has become the best therapy for many cancer types since it doesn’t depend on specific mutations, so the same drugs are active against many different cancers. We can say without any doubt that the last 20 years have seen incredible advances for the treatment of many cancer types, which is resulting in increased rates of survival for most patients with cancer and significant improvements in their quality of life.

What’s next?

Cancer research is a marathon, not a sprint. I will continue working on K-Ras, since the discovery of its first inhibitor is just the tip of the iceberg. The approved drug, Sotorasib, is only active against one of the multiple K-Ras mutations, so there are still many things to do. I hope no one will confuse our commitment to K-Ras research with a lack of innovation—with 1 in 5 patients with cancer still dying from this mutation, continuing to work on inhibiting K-Ras mutant cancer is a top priority, and an unresolved medical need.

For instance, Sotorasib is not suitable for the treatment of pancreatic cancer. We also need to identify additional targets to expand the therapeutic opportunities for those tumors that did not respond to our previous approaches. In addition, it is essential to identify drugs that are capable of eliminating RAF1 from K-Ras mutant tumors. This is not an easy task, especially as it will require the involvement of the pharma industry. However, we can now draw the road map towards reaching this goal, based on our pioneering results on the structure of RAF1. In summary, there is still a lot of work ahead of us. Fortunately, the scientific community is generating exciting breakthroughs that suggest that targeting K-Ras mutant tumors could be a reality in a not-too-distant future.

October 2022

Harnessing Soil Microbes to Reduce Nitrogen-Based Fertilizer Emissions

Professor
Graeme Nicol
AXA Chair at
École Centrale de Lyon



To feed an ever-growing population, fertilizers are a necessity. Nitrogen-based fertilizers deliver essential nitrogen to the soil to help crops grow — that’s good — but also accelerate natural nitrogen cycle processes to exacerbate atmospheric and water pollution — that’s not good. This creates a dilemma: how do we produce enough food while minimizing the damaging effects of excess nitrogen? AXA Chair Professor Graeme Nicol of the Environmental Microbial Genomics Group at École Centrale de Lyon has spent the last 5 years investigating how minuscule organisms found in the soil might hold the key to this puzzle. With more available nitrogen in the soil through fertilizer use, nitrogen-converting soil microorganisms go into overdrive, and this can cause an overproduction of various forms of polluting nitrogen. In uncovering the basic physiological characteristics of these microorganisms and their role in the nitrogen cycle, Prof Nicol’s work could help to drastically reduce the environmental pollution caused by nitrogen-based fertilizer use.

What are the consequences of nitrogen-based fertilizer use, and why is this research so urgent?

Nitrogen, an essential component of all living organisms, helps crops grow. Artificial nitrogen-based fertilizer is the product of the “Haber-Bosch” process, whereby atmospheric nitrogen is “fixed” with hydrogen to produce ammonium, which farmers then add to the soil to stimulate plant growth. While an estimated 50% of the nitrogen that all humans eat is derived from fertilizers, fertilizer use also accelerates the natural processes of the nitrogen cycle, with harmful consequences. For example, putting more nitrogen in the soil by adding fertilizer means that excess nitrate — a mobile form of nitrogen produced by microbial transformation of ammonium — can get washed into waterways and the ocean, resulting in an overabundance of nutrients that causes algal blooms that kill fish or nitrate-pollution of drinking water.

Also accelerated is the conversion of nitrogen into the gas nitrous oxide, which then gets released into the atmosphere. Nitrous oxide has an atmospheric lifetime >100 years — it has 265 times the greenhouse warming potential of carbon dioxide. It will also

be the primary compound responsible for ozone depletion in the 21st Century. Our reliance on fertilizers will only increase with the growing global population, as will the contribution to global warming, so the situation is as imminent as reducing carbon emissions. We need to work out how to feed a growing human population while minimizing the negative consequences of using artificial nitrogen-based fertilizers.

What has your work over the past 5 years revealed about the biogeochemical transformation of nitrogen?

We’ve focused on understanding the relative contribution of different organisms in the soil to nitrogen cycle processes. Bacteria and archaea look the same through a microscope but are separated by 3 billion years of evolution, meaning that their evolutionary paths diverged a very long time ago. Scientists only discovered archaea in the late 1970s, prior to which archaea were simply thought to be bacteria given their similar appearance. More recently, only 17 years ago, we discovered abundant “ammonia-oxidizing” archaea, which can transform

ammonia into nitrite, which is then converted into polluting nitrate by other soil bacteria.

One of our major discoveries is that ammonia-oxidizing bacteria produce twice as much nitrous oxide than ammonia-oxidizing archaea, so contribute far more to atmospheric pollution. We also found that bacteria, the “bad guys,” use typical synthetic ammonium fertilizer, whereas archaea use more organic sources of nitrogen, such as decomposing material from dead plants and animals. This could potentially help to design fertilizer that pollution-producing bacteria can’t access as easily.

What are the broader implications of your research?

An overarching aim is to find a way to feed the human population with affordable, nutritious food while minimizing the production of nitrous oxide and nitrate. There are two potential ways to increase the ability of crops to take up the nitrogen fertilizer while simultaneously cutting down on fertilizer-associated pollution: by reducing the activity of ammonia-converting microbes and by using “smart” slow-release fertilizers. Slow-release fertilizers are fertilizers that are formulated to stop the fast release of ammonia in the soil but are added more slowly. This slow release reduces the ability of certain microbes to convert nitrogen into harmful forms that can leach into waterways as nitrate or be converted into nitrous oxide, and also means that plants are better able to take up nitrogen.

How have your breakthroughs impacted the scientific community?

Our work identifying principles of how microorganisms function could inform future systems-based and modeling research that tests our findings in different ecosystems and for different crops, for instance. On a methodological level, we’ve highlighted the importance of spatial scale when investigating ecological mechanisms that influence soil microbial community structures. We also demonstrated to the research community that one single test, or “assay”, shouldn’t be used to characterize very complex microbial communities because soils contain different organisms with different physiologies.

How has the AXA Chair facilitated the acquisition of new knowledge via international collaborations?

Most publications that have come out of the AXA Research Fund had an international collaborator. With colleagues in China at the Chinese Academy of Science, where there are many environmental problems, we’ve researched the nitrogen cycle in uniquely Chinese soils, such as tea soils, which are very acidic. We’ve also collaborated with the University of Vienna and the University of Aberdeen, who also study different representatives of soil ammonia oxidizers

so that we can characterize and find a consensus of traits between different evolutionary groups of ammonia oxidizing archaea and bacteria. Through these collaborations, we now have a good understanding of the physiology of ammonia oxidizers from different soils.

Has your work reached the industry or decision-makers?

We haven’t moved into the industry yet, but we’re very conscious of it. What we have done is share our data on the potential of slow-release fertilizers to reduce nitrous oxide and nitrate emissions with companies that produce fertilizers. In our laboratory systems, we see a 50% reduction in nitrous oxide emissions when using slow-release fertilizers compared to traditional synthetic fertilizers. While these findings need to be validated in the field, they show the potential for huge reductions in emissions simply by understanding the physiology of organisms that transform nitrogen.

What’s next?

Three new strands of research have come out of the research funded by AXA. First, we have recently received a €1.5 million grant with the University of Thessaly and the University of Vienna called ACTIONr, where we’re looking at the effect and safety of synthetic “nitrification inhibitors,” which are compounds that reduce nitrification activity. In the second strand of research funded by the Grantham Foundation, we’re trying to understand biological nitrification inhibitors produced by plants. Using these biological nitrification inhibitors would avoid the disadvantages of artificially synthesized nitrification inhibitors. Third, through a new ANR-funded program, we’re looking at the impact of native ammonia oxidizer viruses on nitrification in soil, which we know almost nothing about. Understanding these viruses could allow us to control nitrification activity using a natural and highly targeted approach without worrying about the impacts of chemicals on soil health.

November 2022



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How COVID Broke Supply Chains, and How AI and Blockchain Could Fix Them



Andreea Minca

AXA Award at Cornell University

When the coronavirus crisis erupted in 2020, it became apparent that the medical emergency was accompanied by severe shortages, especially in some medical devices.

The pattern was first observed for ventilators: demand spiked everywhere and the supply chain was disrupted. This was because production of the devices spanned multiple countries, with each part dependent on other parts manufactured in different locations. The longer the chain and the more complex the dependence, the greater the exposure of any point to the disruption of another one, and to mandated shutdowns.

Now, two years since Covid first hit, this pattern has affected almost every sector of the global economy. "Supply chain issues" have become so widespread that they are now a running joke, affecting everything from furniture to groceries. But why has Covid had such a severe effect on how we receive products and goods?

In recent decades, supply chains became lean, and they lengthened as they became more cost-efficient: more and more steps were added in the manufacture and transportation of any given product in the name of speed and cost. This means there are more and more places where something can go wrong between you ordering something online and it arriving to your door.

Today, downstream suppliers — such as those who provide vehicle control systems to your car manufacturer — depend on upstream suppliers — such as chip manufacturers — to deliver on time so they can in turn deliver on time to you.

With long chains, risks are now shared between multiple entities all around the world.

Using AI and blockchain to protect trade

Supply chain problems have a knock-on financial effect known as trade credit contagion. This is where firms delay payments to suppliers because their customers delay payments to them. The pay-on-delivery model can lead to cancelled or delayed shipments which can in turn lead to bankruptcies.

While a high proportion of trade credit risk remains uninsured today, a post-pandemic world may see insurance and reinsurance firms fill in this protection gap.

Researchers are currently working to develop methodologies to identify vulnerabilities in global supply chains and to understand their trade credit contagion risks. The goal is to make these systems more robust overall.

How can we design ways to design insurance and reinsurance contracts in order to effectively share the risk and mitigate vulnerabilities? How can reliable trade credit lead to fewer delays in supply chains and replace the familiar predicament we face now, of paying for something in advance with an unknown delivery date?

Artificial intelligence and complex network theory are helpful in identifying the structures that could pose systemic risk. They help us ask: which patterns of connections are likely to lead to delay and trade credit contagion and which are more robust?

Using these tools, we can create large-scale simulators of global supply chains responding to a wide variety of shocks and then use machine learning techniques to detect the problematic parts of the chain. This knowledge can then be used in market designs that strengthen the system before another pandemic or disaster occurs.



Other novel technologies such as blockchain bring the promise of using high quality data to analyse supply chain dependencies. blockchain technology uses real-time data and transparent verification carried out by multiple parties. In combination with other features, such as smart contracts, this could lead to timely resolution in cases of disputes along the supply chain.

My research involves using blockchain to streamline record-keeping and payments. This problem is challenging because the adoption of blockchain depends both on the specifics of the technology and the cost.

The problem of adopting technology in the presence of positive externalities (whereby firms adopting the technology in turn improve the operations of external parties) is an old one in economics, but now these externalities are systemic in nature: the effects propagate along the chains. The cost of the technology depends on how many firms adopt it, and each one faces business specific costs based on its position in the supply chain, its risk tolerance and its costs to insure these risks.

Real-time recording keeping, the traceability of transactions, and the immutability of blockchain can all help supply chains become more efficient. This is all the more true if we consider the full length of the chain, where transactions need to be verified by several parties: participants in the supply chain, insurance and reinsurance firms.

The future of supply chains

Trade credit insurance is likely to grow after the pandemic. It may rely on private-public partnerships — the pandemic has shown that governments become important players when they impose shutdowns in certain areas.

These funds can be used to make up for payment delays, reduce losses and jump-start critical production where necessary. But not all links in a chain can be insured, and an important challenge is to identify the most important stages under different shock scenarios.

Supply chains can also be rewired — large-scale algorithms can identify which suppliers need to be replaced and which new ones need to emerge.

In a few years, supply chains may look different, as the overall goal shifts from minimising costs, as was the case before the pandemic, to minimising delays and trade credit risks. The end consumer will drive the need to rewire the network, as demand shifts. Ultimately, the flexibility of the customer determines the resilience of the supply chain.

January 2022

How Does the Cockpit Pecking Order Impact Decision-Making During the Final Approach?



Eve Fabre
AXA Fellows at ISAE-Supaero

Deciding whether to land or to make a go-around is one of the most important and hazardous operations involved in flying. In fact, the vast majority of accidents in the past 20 years have occurred during the final approach or landing phases. While these are not the deadliest accidents (accounting for 9% of all deaths in commercial flights between 2015 and 2019), they nevertheless generate huge financial losses for airlines.

Airline pilots are expected to perform a go-around in the case of an unstabilised approach, which is characterised by a important deviation of at least one flight parameter (e.g., airspeed, flight path, altitude). However, a 2011 study showed pilots chose to continue the landing in 95% of unstabilised approaches for which a go-around should be performed (unstabilised approaches representing 3.5% of all approaches). The Flight Safety Foundation estimates that 83% of runway excursions and 54% of all accidents that occurred between 2000 and 2015 could have been avoided had the pilots chosen to go around.

An extensive study carried out in 2017 looked at the reasons why pilots struggle to opt to go around during an unstabilised approach. On top of the complexity, cost, and risks associated with this course of action (with one in ten go-arounds resulting in a hazardous outcome), the research also demonstrated that pilots are reluctant to call it due to feeling certain pressure from the rest of the crew to go ahead with a landing, as well as great unease when it comes to challenging the judgement of other pilots.

While the captain is both legally responsible for the aircraft operation and more experienced than the first officer, the onus is on the crew to execute the go-around if one of the pilots (regardless of status) has called

it. Interestingly, studies have shown that go-around requests are issued less frequently by first officers than by captains.

Hierarchical influence and risk-taking during landing

Just before the start of the pandemic, my colleagues and I investigated the behaviour of young, inexperienced first officers during more or less stable approaches, with an emphasis on the captain's influence on their propensity to take risks during landing.

Participants were student pilots nearing the end of their training, all of whom possessed the necessary knowledge to fly an aircraft, but had no professional experience as commercial pilots. The captain, an A380 pilot for Air France, acted as our accomplice during the experiment.

The participants had to decide, both alone (in the first part of the experiment) and within a crew (in the second part), whether to land or to go around during various landing situations rated as (1) safe, (2) moderately risky, (3) highly risky, and (4) extremely risky.

Following the completion of the first part of the experiment, the participants were told that they would have to make decisions as first officers alongside a real A380 captain for Air France, who had agreed to take part in the study.

The uniformed captain was then invited into a room where he greeted the newly appointed first officer participant with a firm handshake. This exercise was intended to induce a strong hierarchical imbalance between the two pilots.

After introducing himself, the captain spoke to the participants of the potential difficulties in decision-making that could arise during landing, using the example of a hazardous situation (i.e., strong wind, slight overspeed, etc.) in which he had recently found himself and explaining how he had managed to land despite the adverse conditions.

This (entirely fabricated) story aimed to lead the participants to believe that their captain had a certain propensity for taking risks. At the end of his speech, the captain then walked out of the room, leaving the pilots to their own devices.

In the second part of the experiment, the participants had two decisions to make:

- (1) a pre-decision, which was not communicated to the captain and made before being told his decision, and
- (2) a final decision, communicated to the captain and made after learning of his decision.

The captain chose to land the aircraft in safe, moderately risky, and highly risky situations, and to go around in extremely risky situations.

The captain's direct and indirect influence on the first officer

Our results show that the captain strongly influenced the participants' decisions in moderately and highly risky

landing situations, whereby their likelihood of proceeding with a landing increased respectively by 19% and 15% (in comparison with the earlier solo pilot configuration).

In moderately risky situations, participants were significantly more likely to go ahead with a landing even before knowing the captain's decision. Given this rate did not vary over time, this increase in risk taking may not result from a tendency to adapt to the captain's behaviour.

Several studies have shown that the mere presence of one or more other people increases an observed individual's motivation and desire to be perceived as competent by the observer(s).

Known as "social facilitation", this phenomenon can often result in increased risk-taking behaviour. Further research has also indicated that first officers make a great deal of effort to appear competent in the eyes of their captain.

With this in mind, our results suggest that the increased risk taking observed in moderately risky situations reflected participants' eagerness to impress the captain.

In highly risky situations, however, increased risk taking occurred at the moment of final decision, that is, only after the participants had been informed of the captain's own decision.

Moreover, the more the participants perceived their captain as authoritative, the greater their tendency

to adapt their decision to the Captain's. These results suggest that a fear of opposing the captain may have accounted for the increased risk taking during highly risky landing situations.

Inexperience and Dunning-Kruger effect

Although the landing rate observed during the solo pilot configuration was proportional to the risks associated with the landing situations (57%, 34% and 30% respectively in moderately, highly, and extremely risky situations), first officers' risk-taking was nonetheless elevated.

This result is coherent with previous studies, which had already shown that young, inexperienced pilots often struggled to assess the risk level in landing situations and decide to go around.

Of particular note in our study was the participants' behaviour in extremely risky situations. In 8% of such situations, participants chose to insist upon landing despite knowing the captain's wanted to go around (final decision).

This makes for a reassuring yet troubling statistic. We can find some reassurance in the fact that the captain's feedback considerably reduced the participants' risk-taking behaviour, which highlights the former's positive impact and important role in limiting such behaviour among first officers.

But while this figure may appear rather low, it becomes troubling when placed in the context of annual air traffic figures worldwide (i.e. 38.9 million flights).

This result is all the more surprising when we consider that the participants were essentially operating as pilot flying, meaning that they would have had the commands of the aircraft. It appears, therefore, that certain participants had an unrealistic vision of their flying skills. This phenomenon (which I have covered in other articles) is referred to as "overconfidence bias" or the "Dunning-Kruger effect".

It often affects beginners in a discipline, who tend to overestimate their skills by a significant degree. First officers under the influence of the Dunning-Kruger effect represent a risk to flight safety, especially when partnered with a captain who lacks assertiveness and/or authority. This was the case for instance with the accident that befell the Southwest Airlines 1248 Flight from Baltimore, Maryland to Chicago, Illinois, whereby the captain had given in to indirect pressure from his first officer and went ahead with a dangerous landing.

Communication between crew members: the cornerstone of flight safety

Flight safety depends largely on the pilots' ability to prevent, detect, and correct their own errors, as well as those of other pilots.

A hierarchical organisation is by far the most effective for flight crews, but if the hierarchy balance between the captain and first officers is inadequate, it can present a safety risk. This is in great part due to the fact that first officers often have difficulty challenging captains, mainly because they see them as more experienced, do not wish to damage their relationship, and/or fear potential retaliation.

Yet, in spite of their expertise, captains are still human and therefore fallible. In the large majority of commercial aviation accidents that are attributed (at least partially) to human error, it is the captain who made the initial error behind the accident, which then went on to be either undetected or uncorrected by their first officers.

While the implementation of Crew Resource Management — a set of crew training procedures that aims to prevent human error — has greatly improved inter-pilot communication and crew decision-making, hierarchical imbalance between captains and first officers remains a potential hazard factor.

Our study has revealed how young, inexperienced pilots are very likely to be swayed by their captain's influence in situations of particularly strong hierarchical imbalance. We are hopeful that our research will make captains more aware of how they may be influencing their first officers' decisions (even without meaning to).

Our protocol could also help assess how easily swayed student pilots are during their training, and strengthen their awareness of these associated risks. This would contribute to improving flight safety in commercial aviation, which is — lest we forget — still the safest form of transport available.

July 2022



Lifesaving Maternal Health Services Are So Close, Yet So Far for Pregnant Women Living in Sub-Saharan Africa's Largest Metropolis



Aduragbemi Banke-Thomas
AXA Fellow at the University of Greenwich

Every year around the world, 295,000 women die due to complications of pregnancy and childbirth. Seven in 10 of these maternal deaths occur in sub-Saharan Africa. These deaths are usually caused by excessive bleeding, infection, high blood pressure, obstructed labour and abortion. Many are preventable, especially when pregnant women can get prompt access to critical maternal health services, otherwise known as emergency obstetric care.

When complications arise, pregnant women need to travel to health facilities that can provide emergency obstetric care. Any delays in travelling to such health facilities affects pregnancy outcomes for them and their unborn child. However, some women need to travel long distances from outskirts of town to large hospitals or over a prolonged time due to traffic congestion in urban areas.

There is a misconception that women living in rural areas experience more challenges in travelling to care compared to those in urban areas. However, research has shown that there are significant challenges with geographical access even for women living in urban areas.

The past few decades has been characterised by the emergence of many large, densely populated, sprawling cities in sub-Saharan Africa. By 2050, two-thirds of the world's population is expected to live in urban areas and 40% of the projected additional 2.5 billion urban residents are likely to concentrate in Africa. As such, it is imperative to fully gather evidence on care outcomes in sub-Saharan African urban areas.

Some pregnant women live close but...

In an April 2022 study published in the journal *BMJ Global Health*, we mapped journeys of pregnant women who had an emergency to public hospitals in

sub-Saharan Africa's largest metropolis, Lagos. To do this, we extracted data from patient records reflecting their journeys to reach health facilities while in an emergency. These data were inputted into Google Maps, which had been shown to be able to provide closer-to-reality travel time and distance estimates for journeys of pregnant women to care.

Results from the study showed that almost two-thirds of maternal deaths occurred among pregnant women who travelled 10 kilometres or less directly from home and arrived at the hospital in 30 minutes.

Also, there was a higher likelihood of maternal deaths with a 10 to 15 kilometre distance from home. Travel of pregnant women to a hospital located in the suburbs was almost four times more likely to result in a maternal death compared to those in the city. On the other hand, travel to a hospital located in the outskirt towns was more than two times more likely to lead to a maternal death compared to those in the city. For pregnant women who were referred, the likelihood of maternal death was significantly higher even when travel of 10 to 29 minutes was required.

Addressing inequalities in care access

Indeed, the so-called "urban advantage" might be disappearing in sub-Saharan Africa. As such, there is a need to consider geographical access to health facilities with an urban versus rural lens in the region.

In citing services, it is not enough for governments to say health facilities have been "strategically located". Functional health facilities within 10km of every woman, supported by robust referral systems that can transfer women promptly if care elsewhere is deemed more beneficial must be available. Furthermore, pre-hospital services have to be able to support pregnant

women in crisis, as was the case for a pregnant women who fell into labour while in public transport.

As part of birth preparedness planning, pregnant women along with their care companions need to be proactively encouraged to commence journeys to the hospital early in the event of an obstetric emergency. If an emergency occurs, structures need to be in place to support her access to a hospital. This needs to be done while making consideration for pregnant women who are poor and those who live far from hospitals.

At a global level, the World Health Organization has long recommended that health facilities with capacity to provide emergency obstetric care should be "available within two to three hours of travel for most women". Evidence from our research suggests that this two-hour access benchmark warrants careful review, with many maternal deaths involving women who travelled less than an hour. These global guidelines also need to reflect delays permissible at referring facilities, recognising that some women still face additional

delays even if they make it to hospitals that can provide the care needed.

In conclusion, pregnant women living in urban areas (city or suburb) and even next to a hospital are not precluded from the risk of poor adverse outcomes in pregnancy. Priority needs to be given to fixing areas of access inequalities, especially in the suburbs. This will be crucial for efforts geared toward the realisation of the "leave no one behind" mantra of the sustainable development goals.

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New Research Reveals That Wildfires Can Influence El Niño



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Wildfire is a phenomenon that has affected pretty much every vegetated environment on Earth for millions of years. However, during the past few decades, the planet has been experiencing extraordinary wildfire activity, with widespread devastation in diverse places such as the Mediterranean, North and South America, Southeast Asia, Australia and even Siberia. The current year has already shown troubling signs of massive fires — for example, Europe’s total burnt area for the 2022 fire season is four times greater than the 2006-2021 average, according to the European Forest Fire Information System (EFFIS).

In addition to causing direct damage to ecosystems and communities, wildfires also lead to enormous quantities of pollutants being emitted into the atmosphere. Globally, wildfire emissions upset the carbon cycle and the Earth’s radiation equilibrium; a phenomenon known as climate forcing. They also influence temperature, clouds and rainfall, prompting air quality degradation and the subsequent death of around 300,000 people every year.

Despite the fact that catastrophic wildfires are rapidly intensifying and that their effects on people and the environment can be drastic, it is one of the most poorly understood processes in the Earth system. Given that wildfires emit greenhouse gases and aerosols (tiny smoke particles) that affect radiation in the atmosphere, it is expected with high confidence that they also result in disturbances to global and regional climate.

The limits of current models

However, the extent of such effects is highly uncertain. Models currently used for predicting the evolution of future climate, such as those participating in simulation

experiments in support of the Intergovernmental Panel for Climate Change (IPCC) reports, either do not include a representation of wildfire effects or do so in a way that is not satisfactory. Without models that can accurately represent influences of climate change on wildfires, and, in turn, influences of wildfire-generated pollution on climate (i.e., fire-climate feedbacks), the future climate change predictions that we have available as a society might be suffering from significant biases.

Fire emissions do not only have the potential to influence long-term climate, but they can also alter short-term weather conditions in different parts of the globe. This is also a poorly understood scientific topic, despite the existence of some sporadic studies that have attempted to examine it.

A recent set of experiments by our team of climate scientists from the UK and Greece is shedding light on this question. The work involved a set of novel state-of-the-art climate model simulations of El Niño events, through which the impact of intense wildfire emissions over Equatorial Asia that have accompanied strong El Niño events in recent decades have been quantified.

Longer dry seasons in Asia

El Niño is a climate phenomenon with significant societal impact, altering weather patterns around the Pacific region, as well as in multiple regions across the globe. One consequence is a deeper and prolonged dry season in Equatorial Asia. During recent large El Niño events, such as in 1997 and 2015, this has combined with expanding agricultural land clearance to produce vast fires in peat-dominated areas. These are some of the largest fires on Earth, attracting both scientific and media attention due to the blanket of smoke



they produce across the region lasting several weeks, impacting the health of millions of people.

Previous literature has focused on the magnitude of these El Niño-driven smoke emissions and their serious health impacts. However, there has been surprisingly little research on the climate feedback of this transient but very large aerosol radiative forcing. The hypothesis of the new study is that these smoke emissions can drastically influence atmospheric conditions in the western Pacific and therefore modify the development of the El Niño phenomenon itself.

The study represents the first time that the impact of intense smoke emissions over Equatorial Asia have been investigated in full-complexity climate simulations. These allowed the researchers to compare the development of El Niño events with and without the presence of large wildfire emissions from Equatorial Asia, using the intense 1997 fire season as a test case.

Wildfires’ impact on El Niño

The findings suggest that the intense smoke emissions result in a strong lower atmospheric heating over Equatorial Asia, which enhances local convection (ascending motion of air), cloud concentration and rainfall over the Maritime Continent. This in turn shifts cloud cover westward in the Pacific, and significantly strengthens the “Walker circulation”, which is the typical pattern of air flow in the tropical lower atmosphere. This opposes the typical El Niño circulation in the Pacific

(which is a weakening of the Walker circulation) and results in a negative feedback on the El Niño event itself. The researchers find that the El Niño event is weakened by around 22% on average due to the wildfire emissions that the El Niño event itself produces.

As well as being an indication of the climate impact that these exceptional El Niño-driven fire seasons in Indonesia can have, these findings also have clear implications for El Niño predictability. Including the impact of enhanced wildfire emissions during large El Niño events can significantly influence the progression and intensity of the El Niño itself. More generally, these findings pave the way for more such studies investigating the implications of fire-generated pollution for atmospheric circulation, rainfall, and temperatures, in a variety of world regions, both on short (weather) and on long (climate) timescales.

In addition to the scientific significance of this research, it also has the potential to significantly impact a variety of economic sectors and societal stakeholders. Better weather and climate forecasts resulting from an improved representation of wildfires in models is expected to lead to better-informed policy making, and to higher-quality weather/climate information available to businesses and to society as a whole.

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Just How Safe Are Cosmetics on the European Market?



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When was the last time you read the ingredient label on a bottle of shampoo? Have you ever sneezed when applying face powder? As you lay on the beach this summer, did you wonder what it was in your sunscreen that blocked the sun's UV light and protected your skin?

A large number of chemical substances are used in many such products. The HBO documentary series *Not So Pretty* investigates harmful chemicals used in the beauty industry and centres, in particular, on the experiences of consumers and workers who say that they were exposed to harmful substances in personal-hygiene products. Above all, it is a chilling exposé of the lack of regulation of cosmetics in the United States.

According to the US Food & Drug Administration (FDA), the United States has only banned 11 harmful substances in cosmetic products. By comparison, the European Union (EU), prohibits more than 1,300 substances, and restricts more than 250 with a concentration threshold.

The United States is one of the world's largest markets of the cosmetics industry. Studies conducted there, in Europe, and in Asia have confirmed that women tend to consume cosmetics and personal-hygiene products much more than men and tend to account for the vast majority of workers (90%) in professional beauty services such as hair and nail salons.

Some interviewed in the series claim to have contracted mesothelioma, a cancer that affects tissue surrounding bodily organs, due to asbestos detected in talc and make-up. Others explain they have suffered fertility problems and even miscarriages as a result of exposure to "everyday chemicals" upsetting hormones, formally known as endocrine disruptors. These include bisphenol A (BPA), which can be found in eye make-up and nail varnish, or phthalates, which keep nail polish from cracking and help the scent of perfumes linger.

The differences between the continents

Despite the parallels, the continents fundamentally differ over how they regulate substances in cosmetics and other personal-hygiene products.

The FDA has little power when it comes to demanding manufacturers disclose their products' ingredients and safety data. In the absence of such critical information, the agency must nevertheless bear the burden of proof and show that a certain substance is harmful in its intended use in order to withdraw it from circulation.

By contrast, in the EU the Cosmetic Products Regulation framework sets the rules for placing substances on the market on the basis of their human health impacts. The

Scientific Committee on Consumer Safety (SCCS) also advises the European Commission on the health and safety risks of cosmetic products and their ingredients. Lastly, and contrary to the US, the burden of proof of safety is on the manufacturer, which must add data on cosmetic products to the Cosmetic Products Notification Portal (CPNP) available to competent authorities, SCCS, and poison centres.

Keeping make-up users safe in Europe

In Europe, the manufacturer is always responsible for the safety of the products it places on the market, and each product must have undergone a safety assessment before it is sold. The rule of thumb is that substances that are classified as carcinogenic, mutagenic or toxic for reproduction (CMR) of category 1 or 2 are prohibited from cosmetics. Following a mandatory safety assessment by the SCCS, certain exceptions may be granted. Other EU chemicals regulations complement the safety provisions based on a classification procedure for hazardous substances such as CMR, as well as providing a safety net for environmental risks posed by cosmetics after they're washed off.

A quick glance over the prohibited substances list of the European Cosmetics Products Regulation reveals that asbestos is banned from all cosmetic products. Moreover, the production and marketing of asbestos is completely prohibited, except in the case of its use for the production of chlorine and sodium hydroxide, two chemicals found in household cleaners, according to the regulator. Asbestos is thus a clear and strict "no go" on the European cosmetics market.

Similarly, BPA and phthalates are also prohibited in cosmetics. BPA is officially classified in the EU as toxic for reproduction, an endocrine disruptor and included in the candidate list of substances of very high concern (SVHC). This means the consumer can request that manufacturers inform them of the presence of the chemical in their articles starting from 0.1% by weight in the article, as specified under the EU's REACH regulation.

What about titanium dioxide? A white and opaque powder, the chemical has been used for almost a century as a white pigment and can be found in colour cosmetics such as eye shadow and blush, loose and pressed powders. Its resistance to ultra-violet light also make it a key ingredient in many sunscreens. The EU classifies it as a category 2 carcinogen by inhalation, which means this substance is suspected to cause cancer when inhaled. Certain restrictions on its use in cosmetic products are in place and these are especially prevalent in products that are sprayed. For example, a limit threshold of 1.1% is set in professional hair aerosol spray products and in colourants. Powder applications that "may lead to exposure of the user's lungs by inhalation" are prohibited.

How confident can EU consumers be?

When it comes to the legal frameworks around chemicals and cosmetic products, the European market has extensive safety provisions.

However, regulation may be challenging to enforce within the realm of international trade and online sales. EU reports have highlighted the presence of some harmful substances in cosmetics and other personal-care products circulating on the European market. In 2018, one brand of make-up, including some items made in China destined for children, was found to contain asbestos in Czech Republic and the Netherlands.

The European enforcement authorities collaborate to avoid such products on the EU market, and the Safety Gate platform alerts consumers to non-compliant goods within the EU. Furthermore, the 2020 European Chemicals Strategy for Sustainability aims at an even higher level of consumer and environmental protection with its various actions such as the consideration of "cocktail effects" of chemicals.

Reducing your exposure to harmful chemicals: a checklist

For European consumers seeking to reduce their potential exposure to harmful chemicals, here are some safety guidelines and resources:

- If you are sensitive to common allergens, seek out unscented cosmetics whose labels do not contain the words fragrance or perfume.
- For the sake of the environment and personal health, try to limit the dosage used. Be it a shampoo or a cleaning agent, usually small amounts are enough for the purpose of getting your hair or a surface cleaned.
- Be wary of less-expensive imported cosmetic and hygiene products. The consumer could look at the label and check the country where the product has been manufactured. Manufacturers outside the EU are not necessarily aware of EU regulations and may pay less attention to product safety.
- Tell your medical professional about any unwanted side effects following the use of a product. Keep the product packaging and label for further reference.
- Use the help of European apps detecting chemicals in products, such as INCI Beauty (for cosmetics), ToxFox (for cosmetics and articles), and Scan4Chem (for everyday articles such as clothing, kitchenware, sports equipment, electronics, etc.)
- Use your right to know about SVHCs in articles by requesting information from suppliers.

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