# GYA connections

The magazine of the Global Young Academy

# Pollution

GLOBAL YOUNG ACADEMY

Issue 6 — May 2018

# GYA connections - Issue 6

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# Editorial

**by Marian Asantewah Nkansah**
Connections Editor 2017/18, GYA member 2017-2022

Human activities continue to contribute to the pollution of our environment. Indeed, pollution has been associated with the contamination of food, water, soil and air through activities such as mining, building, road construction and industrial processing. This continuous release of toxic substances and improper waste disposal has led to an increase in the disease burden of the world for both humans and animals.

The theme for this issue is pollution, which was chosen because of the universal nature of pollution and the fact that pollutants have no boundaries. Rather, pollutants are transported freely in the environment under the influence of physical and chemical processes without a care for geographical borders: waste deposited on one side of the globe can eventually find its way to the other side. Therefore, there is the need to consider matters relating to pollution and waste disposal as a shared, global responsibility and not the obligation of only a few.

The pollution-themed articles in this issue explore techniques for wastewater treatment and reuse, household air pollution, and how surfactants affect the fate of environmental pollutants. There is also an item titled `Pieces on Plastic´ that features various GYA Members and their reactions to the ubiquitous nature of plastic (including a story about conference attendees wasting water!).

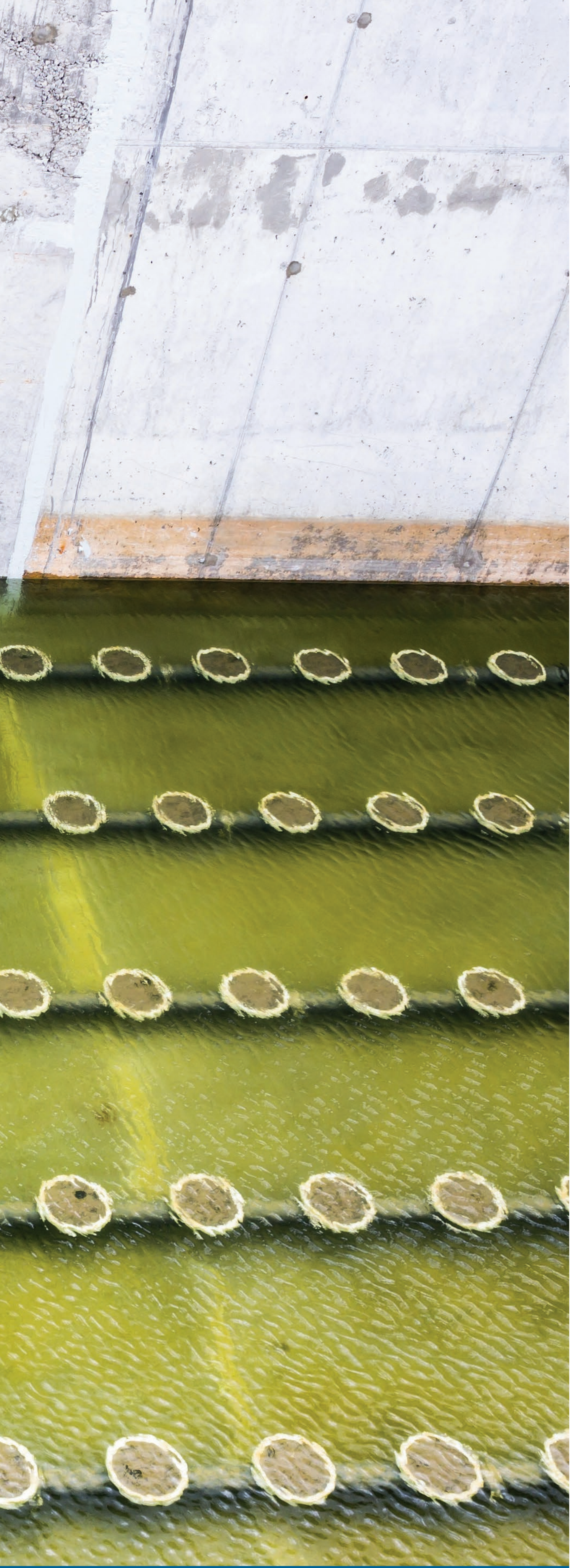
The GYA Activities pages then feature a thoughtful piece on our efforts to address the challenges faced by at-risk scholars, an interview on creativity carried out in the spirit of the 2016 GYA publication titled 'Words of Wisdom'., a feature on GloSYS, and a brief history of the GYA.

In closing, we wish you every success in your professional lives in 2018, and for those of you reading this at the AGM in Thailand, welcome!

Image : © Marian Asantewah Nkansah

# Wastewater treatment and re-use: Perspectives of innovation

01 Pollution



**by Lahcen El Youssfi**

Water resources are limited, delicate, and very unequally distributed across the planet. During the second half of the 20th century, water demand increased dramatically.[11] In many countries, water use is approaching the limit of available resources. Water supplies are endangered by over-exploitation of renewable underground water (which may lead to salt-water intrusion) and the exploitation of non-renewable resources (including fossil water).[5] Climate changes are expected to result in even more negative impacts. Agriculture, industry and domestic wastewater are making clean water scarcer and intensifying pollution of both surface water and groundwater resources.[8] Water resource management is increasingly reliant on techniques for augmenting the limited natural water supply such as desalination, water reuse, rainwater harvesting, enhanced groundwater recharge and inter-basin transfers.[8]

Treated wastewater can be thought of as a 'new/old' water resource, which can be added to the general water balance of a region. Such water can replace potable water for irrigation or other purposes besides drinking. Indeed, doing so relieves some of the demand on water resources.[12] Thus, the benefits of treated wastewater are manifold, especially to agricultural countries facing chronic water shortage.[7] It is estimated that global freshwater withdrawals are around 4,000 $km^3$ per year: 44% of this water is consumed, mainly by agriculture through evaporation in irrigated cropland. The remaining 56% is released into the environment as wastewater in the form of municipal and industrial effluent and agricultural drainage water.[1] In fact, more effort is required from all of us to encourage the treatment and reuse of treated wastewater worldwide.

**Half of the freshwater released into the environment is released as wastewater. Thus, it makes sense to ask how much of this water is treated before being released.**

On average, high-income countries treat about 70% of the wastewater they generate. That figure drops to around 30% in middle-income countries (see figure 1). In low-income countries, only 8% of industrial and municipal wastewater undergoes treatment of any kind.[6] This exacerbates the situation in poor areas, particularly in slums, where people are often directly exposed to untreated wastewater.[8]

## What is the environmental impact of inadequately treated wastewater?

The discharge of untreated wastewater into seas and oceans partially explains why de-oxygenated dead zones are rapidly growing. An estimated 245,000 km² of marine ecosystems are affected, with consequences for fisheries, livelihoods, and food chains.[2,10] Moreover, increased discharges of inadequately treated wastewater are contributing to the further degradation of water quality in surface and groundwater since water pollution critically affects water availability. This degradation takes the form of organic pollution coming from wastewater, which can have severe impacts on inland fisheries, food security and notably livelihoods of poor rural communities. Severe organic pollution already affects around one-seventh of all river stretches in Africa, Asia and Latin America, and has been steadily increasing for years.[8]

Household sanitation facilities globally have improved markedly since 1990. However, waste still poses significant public health risks due to poor containment, leakages during emptying and transport, and ineffective sewage treatment. It is estimated that only 26% of urban and 34% of rural sanitation and wastewater services are managed with adequate control and safety measures that prevent human contact with excreta along the entire sanitation chain.[3]

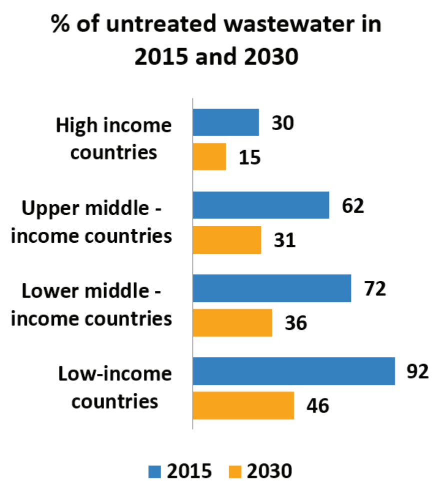



Figure 1: Percentage of untreated wastewater estimations in 2015 and 2030
Source: Based on data from UN World Water Development Report (2017).[1]

If things carry on this way, the risks will of course intensify. The question is how we can effectively limit and reduce pollution by wastewater. The challenge is complex because the concerns are varied and wide-ranging. Human health and preservation of the environment are priorities, but they will have to be pursued in the context of local regulatory frameworks, territorial constraints, and limited funding of wastewater management authorities.

*Worldwide, annual capital expenditures on water infrastructure and wastewater infrastructure by utilities have been estimated at US$100 billion and US$104 billion, respectively.*[8]

*The benefits to society of managing human waste are considerable, for public health as well as for the environment. For every US$1 spent on sanitation, the estimated return is US$5.5.*[8]

## Water reuse after advanced (tertiary) treatment

The purification of wastewater consists of decanting the particulate pollutants and extracting the dissolved elements through many steps of treatments. Depending on the number and the kind of steps, the level of treatment passes from a simple, primary treatment to a secondary treatment characterised by physicochemical and biological interventions. If the process includes disinfection, denitrification, or phosphorus removal steps, the treatment is classified as a tertiary one.

The treatments can be either classic solutions or more innovative processes of an extensive or intensive nature involving ecological engineering. Tertiary treatment is an advanced level of wastewater treatment that is gaining importance. It is important to note that, of all the wastewater produced worldwide, only a very small fraction actually undergoes tertiary treatment. This is because it is technically more difficult and its cost is higher; these factors make managing authorities look for technologies with low cost and low labour requirements. Nevertheless, more research and development programs are being conducted worldwide that seek innovative solutions of wastewater treatment that are cost optimising financially and well adapted environmentally.

## Recycling wastewater components

Another major upside to wastewater treatment is that a surprising range of resources can be recaptured in the process, including green energy, bio-plastics and other organic materials. These by-products can be beneficial for agriculture, industry and a variety of urban uses. In the global context of resource scarcity, harnessing such resources not only limits the environmental impact of wastewater discharge, but also recoups some of the financial investment in wastewater treatment.

To provide one example, phosphorus is widely used in the manufacture of fertilizers. However, extractable phosphorus resources are predicted to become scarce or exhausted in the next 50 to 100 years.[9] Phosphorus recuperation from wastewater is thus a suitable and increasingly attractive alternative. An estimated 22% of global phosphorus demand could be satisfied by recycling human urine and faeces worldwide according to the United Nations.[8]

Recovering phosphorus in this way requires advanced technology. Scaling this technology to the required level is undoubtedly a challenge, but significant progress has been made in recent years. The payoffs are potentially great. Phosphorus is just one example, however, and this recovery process may also apply for other nutrients.

Recycling nutrients or extracting energy from wastewater constitutes a real opportunity for income generation, and enlarges the resource base available to poor households.[11] An example is composting toilets, which offer a low-cost route to increased agricultural productivity and improved nutrition. At the same time, they can reduce the health and environmental risks stemming from open defecation.[8]

### Reuse of treated wastewater

The reuse of treated wastewater has grown significantly over the past decade and has considerably reduced the pressure on water resources in some regions. However, this reuse is associated with sanitary and technical constraints depending on the targeted users, which range from agriculture, to parks and golf courses, industrial processes such as cooling systems, cleaning of soils or roadways, and aquifer recharge.

Municipal water demand corresponds to 11% of global water withdrawal. One-quarter of this volume is consumed and the rest is discharged as wastewater, representing 330 $km^3$ per year.[4] This could potentially irrigate 40 million hectares (with approximately 8,000 $m^3$ per hectare), or 15% of all irrigated lands.[4]

There is no comprehensive inventory of the amount of treated or untreated wastewater used in agriculture. Estimates of the total area that is being irrigated with raw and diluted wastewater are likely to range between 5 and 20 million hectares, with the largest share probably in China, which translates to between 2% to 7% of the world's total irrigated area.[4,8]

The reuse of wastewater for irrigation is not well controlled because of inadequate treatment and the resulting probability of large-scale water pollution. Indeed, many authors have revealed that the area irrigated with unsafe wastewater is probably ten times larger than the area using treated wastewater.[4]

Treated wastewater can be used for irrigation in agriculture, green spaces and golf courses, as well as to recharge groundwater and other purposes.

### UN Sustainable Development Goals and the future of wastewater

Due to the differences in current levels of wastewater treatment, the efforts required to achieve SDG Target 6.3 (which relates to wastewater management) will place a higher financial burden on low-income and lower middle-income countries. This strain will put these countries at an economic disadvantage compared to high-income and upper middle-income countries.[6] If the upstream portion of the sanitation and water chain has benefited from the dynamics of the UN Millennium Development Goals and is still a matter of concern, collection, treatment, and reuse should be placed at the forefront of the international political agenda. This will encourage the development of new international and national policies and strategies, in addition to the advancement of related innovation and research aiming at the implementation of best practices for wastewater treatment management and water preservation for future generations.

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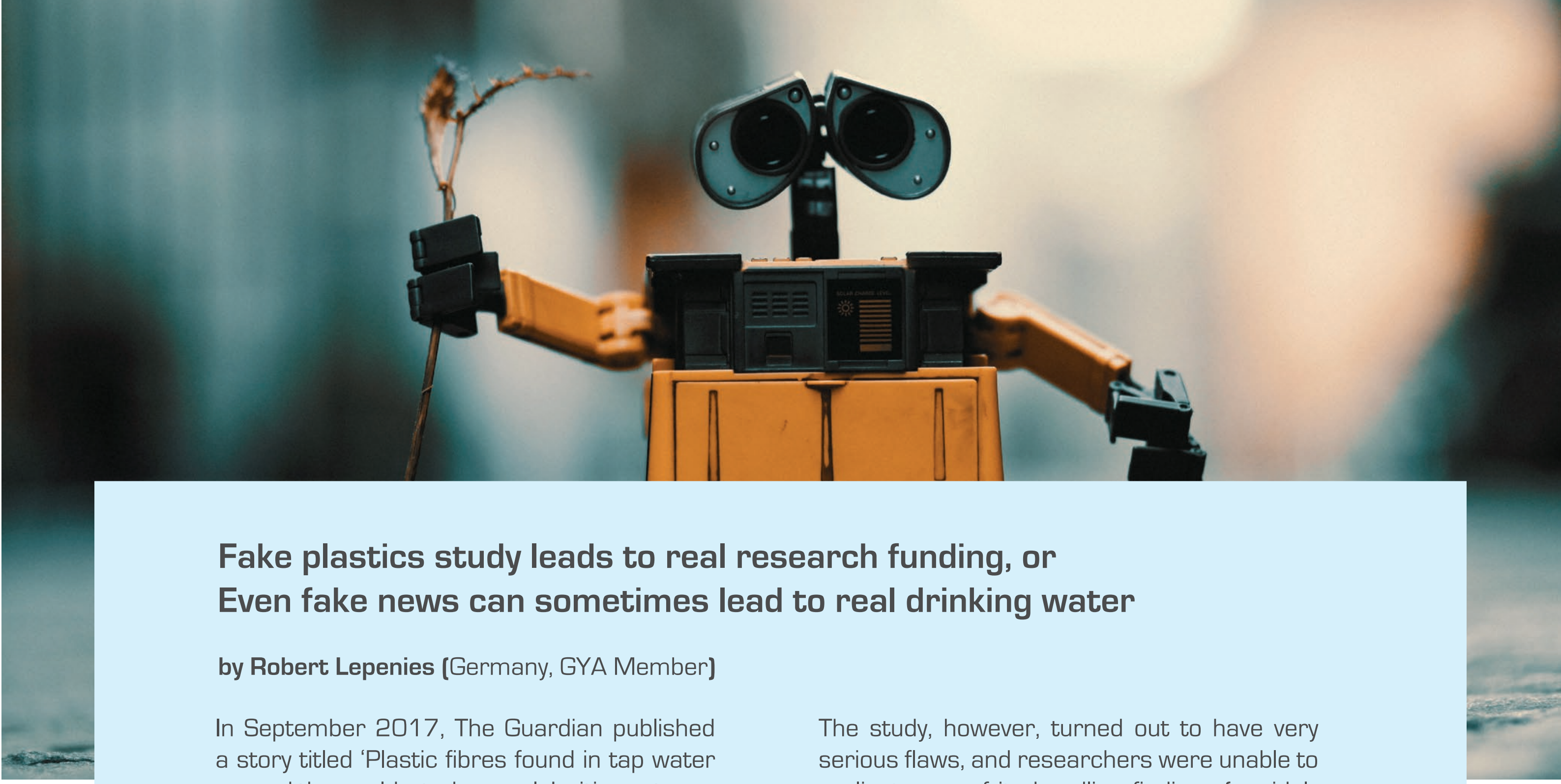

## Fake plastics study leads to real research funding, or Even fake news can sometimes lead to real drinking water

**by Robert Lepenies** (Germany, GYA Member)

In September 2017, The Guardian published a story titled ‘Plastic fibres found in tap water around the world, study reveals’, citing extraordinary results by Orb Media, an independent non-profit news site. The study claimed that more than 80% of water samples on all continents and in 14 countries around the world were contaminated by microscopic plastic particles, the health risks of which are still relatively unknown.

Widely shared on social media and even in reputable news outlets, the study alarmed water providers, policy makers and the wider public, all of whom who were eager to learn more about the new topic: almost overnight, investigations of tap water were prompted, and new research funding lines were granted.

The study, however, turned out to have very serious flaws, and researchers were unable to replicate any of its headline findings (a widely underreported result, which was in turn rarely shared).

Paradoxically, the 'fake' study had very real positive results. More funding is now available for water quality topics, and policy makers and water providers will likely have increased their knowledge about pollutants as public attention to the topic accelerated many ongoing projects. A negative result, and one that is much harder to measure, is the way in which the study contributed to the undermining of public trust in tap water. Hence, fake plastics news might have improved our water, but not the trust of those who drink it.


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# Reducing the impact of household air pollution: Challenges and opportunities for achieving the United Nation Sustainable Development Goals

Caption: Indoor cooking is a leading health risk
Source: Travel mania / Shutterstock.com

by Sidi Zakari Ibrahim

Summary
This article investigates challenges and identifies opportunities for reducing the environmental and health impact of household air pollution. The article shows that evidence-based decision making, education and awareness raising are necessary for the effectiveness of the interventions to keep pace with population growth, particularly in developing countries where the majority of households rely on solid fuels (coal and biomass) for cooking and heating. Moreover, mobile devices and interconnected technologies have been identified as new opportunities for citizen participation and for addressing challenges related to obtaining accurate, timely and reliable air pollution data, and in achieving the Global Goals related to the 2030 Agenda for Sustainable Development.

## Household energy use

In the 1980s and 1990s, the household energy needs of many cities in developing countries were met by burning wood. This situation ultimately shifted to Liquefied Petroleum Gas (LPG) and electricity as cities grew and modernised.[1] Urban social and economic inequalities, government policies, and the availability of wood resources are among the location-specific factors that appear to have accelerated or delayed urban energy transitions, and to have shaped the particular transition route that a city followed along the path to modern fuels utilisation.[1] As illustrated in figure 1, household energy and development are strongly linked, even in the 21st century.

## Environmental and health impact of household air pollution

Indoor Air Pollution (IAP) is mainly caused by inefficient solid fuel combustion from traditional technologies used for cooking, heating and lighting. Pollutants such as methane, polycyclic aromatic hydrocarbons and black carbon emitted by inefficient cook stoves also potentially contribute to climate change.[2] According to the World Health Organisation (WHO), IAP is the leading environmental cause of death and disability in the world and it has recently been renamed Household Air Pollution (HAP) '… to more fully capture the health-based risks associated with it'.[3]

In many low- and middle-income countries, women and young children are most often exposed to HAP due to the amount of time spent near the domestic hearth. Other members of the family (men and the elderly) and neighbours are also exposed. Nowadays, in these countries, many households still rely on kerosene lamps due to a lack of access to electricity or intermittence of the electricity supply. These lamps emit high levels of health-damaging pollutants and can cause accidents or fires.

Using crop waste, dung, wood, coal or charcoal for heating also contributes to household pollution, and burning waste represents a health risk in and around the home. Around 41% of households in the world - over 2.8 billion people - rely on solid fuels (coal and biomass) for cooking and heating.[4] The inhalation of pollutants from household smoke, particularly PM2.5 and Carbon Monoxide (CO) leads to respiratory infections like pneumonia. Indeed, pneumonia was considered the most common cause of mortality in children under five years of age[5] 'and one of the top five overall health risks in poor, developing countries, and the cause of twice as many deaths as malaria'.[6,7] Additional potential health impacts of household air pollution include tuberculosis, asthma, cataract, low birth weight and some cancers. These impacts depend on the duration of the exposure (short or long term) and the concentration of pollutants, which in most instances are considerably higher than the recommended limits set by the WHO. Low-income populations are most affected by 'traditional risks to health', which include indoor air pollution, undernutrition, unsafe water and sanitation (see figure 2).

### Awareness raising about HAP

The health impacts of HAP could readily be prevented by providing better education, modifying user behaviour and technical interventions related to better ventilation, adopting large-scale, efficient and low-emission cook stoves and fuels. In 2010, Leslie Cordes, the former UN Foundation's senior director for partnership development, highlighted the fact that 'awareness of the risk varies between countries, with some nations taking aggressive action while women in other areas are left unaware that their health problems are related to their cookstoves'.[6]

Despite the nature of this problem, Gordon et al.[5], mentioned that the HAP issue has been largely ignored or neglected by policy makers, and social scientists have only recently begun to pay closer attention to this issue and to test strategies for reducing HAP.[7] Another important fact is that poverty, a lack of education, and poor living conditions contribute to increasing household air pollution vulnerability.

### Clean cooking and SDGs

The 17 Sustainable Developement Goals (SDGs) of the United Nations 2030 Agenda for Sustainable Development were adopted by world leaders in September 2015. These global goals recognise the importance of strategies that build economic growth, and address a range of social needs while taking into account climate change and environmental protection. Promoting clean cooking is a key element for achieving several of the SDGs.

### ICT for awareness raising about HAP and SDGs in Niger

From 1 March to 3 March 2017, GYA member Sidi Zakari Ibrahim (Niger) organised a vocational training at Abdou Moumouni University (AMU), in partnership with the local representation of the African Virtual University and the international NGO Knowledge For Development Without Borders (KFDWB, based in Vienna, Austria). This training, entitled 'Harnessing the power of Mobile phone apps for Air Pollution Monitoring in Niger', aimed at empowering citizens to become agents of development so as to be able to continue educating peers in their communities about pressing global development issues such as air pollution (causes, effects, resources and prevention) and climate change.

Both the local partner and the remote trainer delivered the training via online cloud platform. This training fostered collaboration among the 31 trainees (policy makers, scientists, civil society representatives, business people, students, innovators, NGO representatives and media professionals) on transdisciplinary research projects related to SDGs 3, 5, 7, 11 and their interactions. The training also offered new opportunities and perspectives for the existing research projects on air quality monitoring, particularly in terms of accurate, timely and reliable air pollution data collection for low-cost sensors calibration, epidemiological, mathematical or statistical modelling purposes.

Furthermore, the Global Open Data Index methodology (used as a case study during the training) highlighted the challenges of air quality data collection at the country or major city levels, particularly for Particulate Matters (PM), Sulphur Oxides (SOx), Nitrogen Oxides (NOx), Carbon Monoxide (CO), Ozone ($O_3$) and Volatile Organic Compounds (VOCs). The trainees recommended pursuing awareness raising on the impacts of air pollution and partnerships for implementing mobile apps and low-cost sensors, which can effectively reduce the local data gaps related to SDGs indicator 11.6.2 (Annual mean levels of fine particulate matter (PM2.5 and PM10) in cities (population weighted)).

Photos and a video record of the 3-day training are available at https://goo.gl/85yAfK and https://youtube/nVV5d3Hi294, respectively.

Sidi Zakari Ibrahim also previously administrated an online survey (from February to March 2017) about household energy use in Niamey (the capital city of Niger) and the corresponding environmental and health impacts. This survey was disseminated to

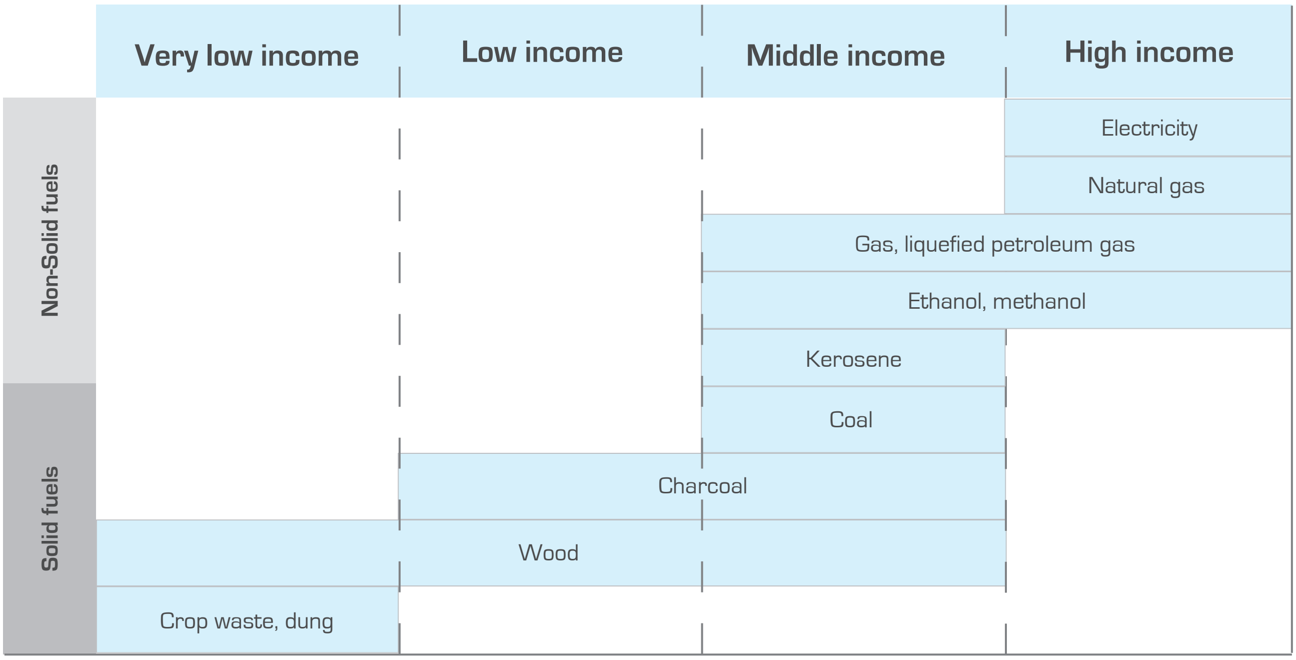


Figure 1: The energy ladder
Source: Adaptation from the World Health Organization.[8]

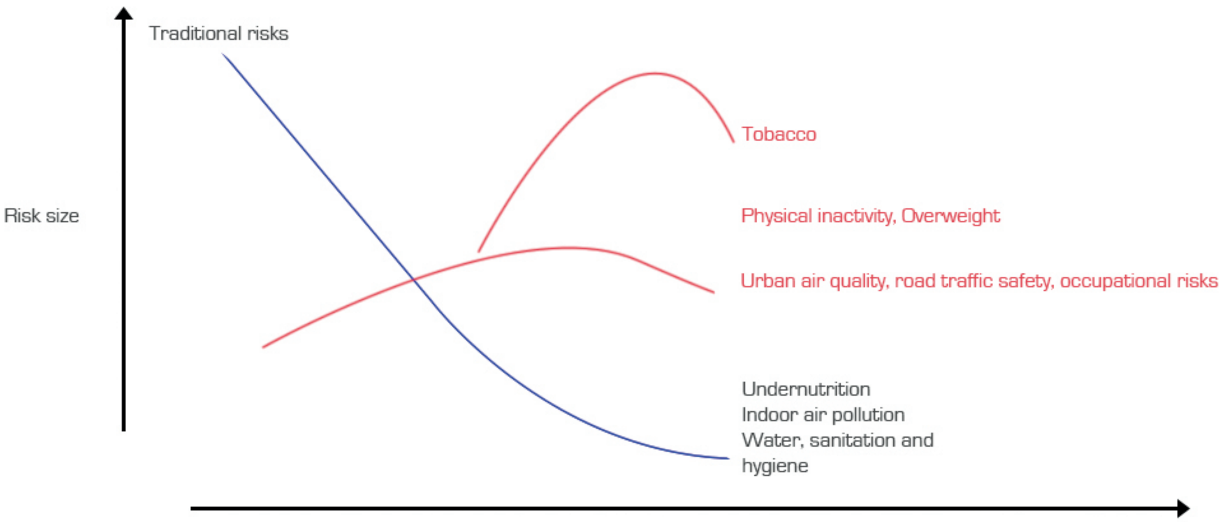


Figure 2: The risk transition
Source: Adaptation from the World Health Organization.[9]

bachelor's degree students enrolled in the ICT course at the Faculty of Sciences and Techniques (AMU). The majority of the students (n=337) filled out the survey, crowdsourced geo-located photos related to their living areas and provided feedback about the air pollution issue in urban areas. Questions were related to general knowledge about SDGs, prevention of diseases and premature deaths caused by HAP, policies and investments for reducing air pollution sources in urban, peri-urban and rural areas, key pollutants highlighted in the WHO guidelines for air quality, and the identification of clean and dirty cookstoves. The photos suggested that the majority of households in Niamey combine woodfuel and Gas or LPG for cooking.

The survey and a sample of the photos can be seen at the end of the following video in French: https://youtu.be/76EWKi583eA.

## Conclusion

This article highlighted the challenges and opportunities related to reducing the impacts of household air pollution in developing countries. Awareness raising, the promotion and dissemination of clean household energy solutions and improved cook stoves adapted to various cultural and socio-economic contexts are necessary for achieving several of the Sustainable Development Goals. Moreover, evidence-based decision making can be improved by harnessing the power of mobile devices and interconnected technologies in implementing participative household air pollution monitoring platforms, open data initiatives, and the World Health Organization indoor air quality guidelines related to household fuel combustion.

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## Free water

**by Anindita Bhadra (**India, GYA Member**)**

Some time ago I was attending the annual meeting of the Indian National Science Academy at the National Institute of Science Education and Research, Bhubaneswar. On the last day the meeting ended with lunch, and people dispersed from the venue gradually. I was among the last participants to leave, and as I sat in the lounge chatting with some of the other participants, I was struck by the dozens of water bottles that were strewn on the tables. Even worse, only a few were actually empty. The sight made me sad, angry and dejected.

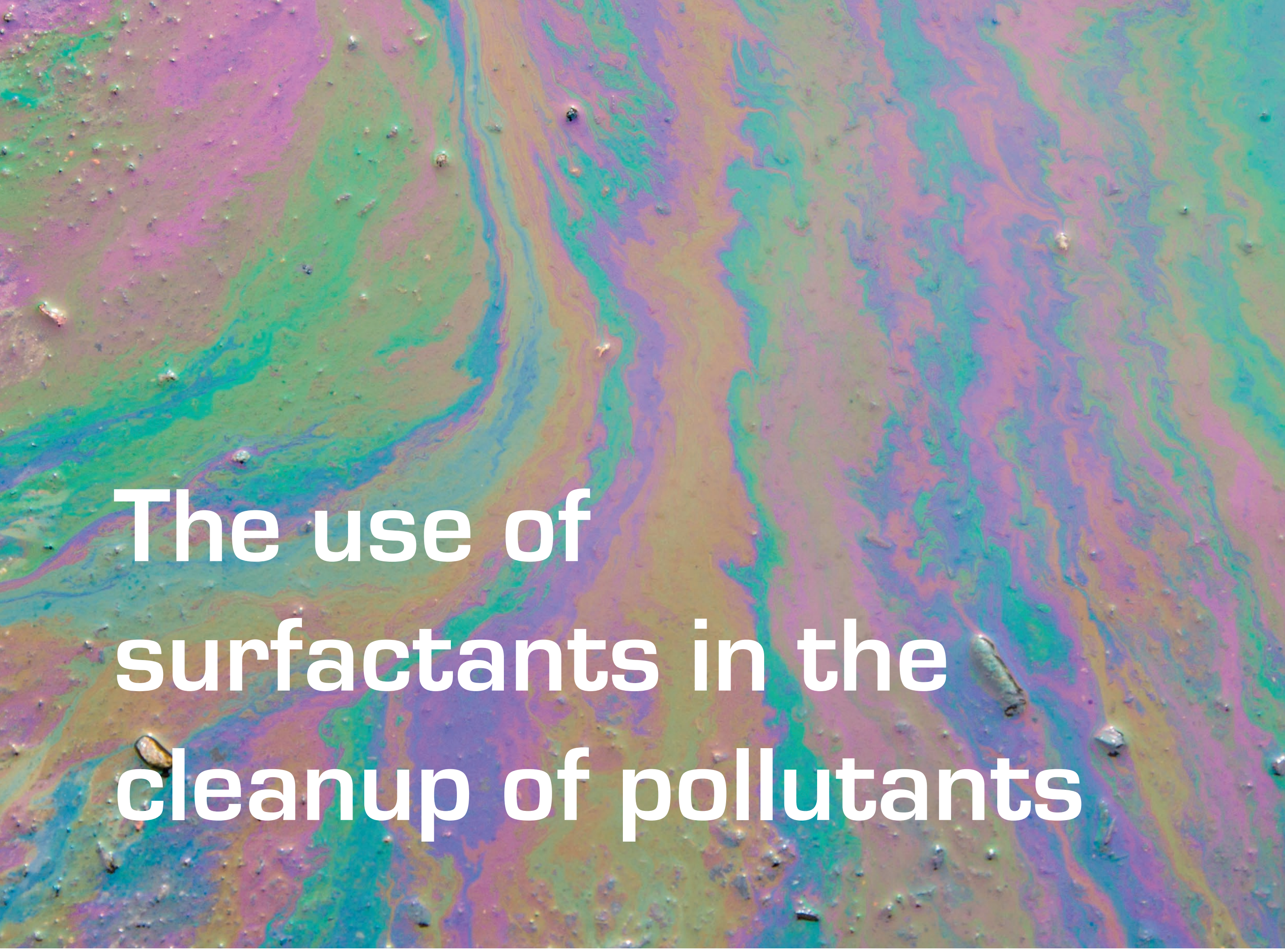
During this meeting, we, the Indian National Young Academy of Science (INYAS) had organized a symposium on food security and climate change. We discussed the future of our planet and potential remedial measures. We expressed concern over climate change and discussed the need to control our ecological footprint. Yet in this very same meeting we piled trash cans with plastic bottles, adding to the non-degradable waste of the world.

I think we have in some way accepted the inevitability of the use of plastic in our day-to-day lives. Plastic mineral water bottles are a constant source of irritation for me, but something that I can't do away with completely in today's lifestyle.

More than the plastic, I was upset about the amount of water that was wasted. We talk about water scarcity, we express concern over the crisis of drinking water that the world is facing, we hit like buttons and share messages spreading awareness about conserving water, and then we take a few sips from a bottle and leave it lying around and dump it in the trash can without a thought.

Is it too much to carry the bottle around and use up all the water that it carries? Do we do this when we actually BUY the bottle of water? Most often, we don't. But when we have free water available, we don't hesitate to waste this very precious resource, and we leave a trail of partially filled plastic bottles in our wake.

As I put my little bottle in my bag and prepared to leave the meeting venue, a senior professor came over and congratulated me for the excellent symposium that the young scientists had hosted. He said that it was great to see young people discuss these very relevant social issues, and said how we are the people who can bring in the required awareness. I glanced at the table strewn with the bottles and thought, "Whose awareness?"



# The use of surfactants in the cleanup of pollutants

**by Adewale Adewuyi**

Pollutants are substances that are capable of causing adverse effects when introduced into the environment; they may damage or have harmful effects on both living and non-living things. Pollutants can be found in air, water, or soil and ultimately end up in the food chain. Though by definition pollutants have negative effects, their primary intent sometimes may be positive. For instance, phosphate and nitrate fertilizers are meant to enrich soil fertility towards plant growth but when such fertilizers are washed off from the soil into water bodies, they become pollutants. The same goes for pesticides, crude oil from spillages, carbon dioxide emission and the release of heavy metals.

Cases of microbial pollution have also been established where disease-causing microorganisms have been found in water and air and other environmental media. Although a few of these pollutants are biodegradable, the non-degradable ones are persistent and their presence is of major concern. There are also situations where the degradation products of some of these degradable pollutants are themselves toxic. Efforts have been made to eliminate or mitigate the harm caused by pollutants, but most developed processes have at least one or more shortcoming, including inefficiency, high or inconsistent costs, or production of further toxic by-products. Over the years there have been a number of efforts to enhance the efficiency of such processes, and a search for new treatments that will be better than the presently established processes is ongoing.

One of several approaches used to address the issue of pollutants is the use of surfactants. Surfactants are capable of reducing interfacial tension between liquids or between solids and liquids. Such surfactants are generally referred to as detergents, emulsifiers, and dispersants with both domestic and industrial applications. Several types of surfactants have been produced with different properties that play vital roles in the kind of application they find. Although the presence of some of these surfactants in the environment may be worrisome, a few of them have been identified as safe and with the potential of improving pollution control either as an enhancer or an alternative remediation method. Surfactant functions are due to their unique chemical structure, which has a functional relationship with its extent of remediation.

Surfactants are sometimes used in the treatment of polluted water systems. Zhou and Lin (2013)[6] confirmed the use of an anionic surfactant as a promising technology to remediate chlorinated organic compounds in contaminated aquifers. These authors discovered that the presence of the surfactant, sodium dodecyl sulfonate, at a concentration below its critical micelle concentration was effective at enhancing the catalytic degradation of 1-(2-chlorobenzoyl)-3-(4-chlorophenyl) urea (an insect growth regulator and molt-inhibiting hormone insecticide) by nanoscale zerovalent iron. Vijayakumar and Saravanan (2015)[5] reported surfactants as a potential candidate for cleaning heavy metal pollution in the environment. Volkering et al. (1998)[4] also recorded the important role surfactants play in oil recovery and bioremediation of heavy crude oil. These authors attributed this ability to the water loving (hydrophilic) and water repelling (hydrophobic) capacity of surfactants, which makes them aggregate at the interface between substances of different polarity. However, the use of surfactants in this regard is considered environmentally safe due to their biodegradability, biocompatibility, specificity and availability. During oil spillage, surfactants have the potential to enhance the water solubility of oil hydrocarbons, making them more available for microbial uptake and as such making the oil readily available for microorganisms to act on. This characteristic of surfactants indicates their potential use for remediating crude oil spills. Xu et al. (2015)[2] also revealed the important role surfactants play in the treatment of waste-activated sludge, where the presence of surfactants played an active role in breaking down environmental pollutants.

Surfactants have also gained attention for their use as pollution treatment enhancers, where they act as adsorbent surface-modifying agents. Adsorbents used in pollution monitoring and control could be natural or synthetic in nature. The use of surfactants as a surface-modifying agent for zeolite and clay has also been shown to improve the cleaning capacity of zeolite and clay.[7, 8, 1, 3]
Although the mechanism by which the surfactant-modified adsorbent efficiently mops-up pollutants from polluted systems still needs to be resolved, the positive influence of surfactants on the removal or degradation of pollutants cannot be over-emphasized. As such, surfactants are promising agents for pollutant cleanup and also a possible enhancer of existing technologies.

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# Pieces on plastic

**by GYA Members**

I am constantly astonished at how much plastic surrounds me – it was a brilliant invention but now it is the cause of significant environmental consequences. If we all make a conscious effort to reduce our consumption, we can reduce our individual impact (e.g., not using take-away cups, buying in bulk, taking cloth bags to do the shopping, and avoiding plastic wrapped foods). But it's not easy to 'break-up' with plastic - it's everywhere. We need to use our collective buying power to push the big companies and our governments into taking plastic reduction seriously so we have plastic-free (or biodegradable) alternatives readily available.

*Anina Rich (Australia)*

### Plastic Packets and a Personal Experience

Two years ago, my family and I went to visit Sundarbans, the largest mangrove forest in the world and a UNESCO World Heritage Site in Bangladesh. While there, we were very upset to find plastic bottles and food packets strewn throughout the forest. So my family and I began picking up the bottles and packets nearby the entrance – just to make a little difference. After a while, the tour guide shouted and asked us to stop. He pointed out the army of monkeys following us who had learned to snatch chips and drinks from tourists. The guide warned that the monkeys would attack us because they thought we were carrying food. So we hid the packaging in our backpacks and ran back to a safe place. But since then, we have been very concerned about the long-term impact of pollution, its effects on the environment, as well as the natural balance of animals living in the forest.

*Nova Ahmed (Bangladesh)*

Plastics and their byproducts are littering cities and water bodies, which causes aesthetic issues and consequently health problems to humans and animals. Chemicals in plastics have the tendency to cause endocrine disruption in humans as well as aquatic organisms. Plastic waste comes in various sizes (micro-, meso- and mega-) that do not respect geographical boundaries due to their ability to be transported through waterways, and eventually to the sea. There is a need for concerted global effort to find a lasting solution.

*Marian Nkansah (Ghana)*

*Visuals: Created by Freepik, Adaption: Helena Ballasus*

Plastic hits at a giant weak spot in human thinking: we are generally very bad at weighing immediate benefits (such as quenched thirst) against long-term costs (such as waste bottles). The reason is that we tend to disregard long-term costs. When the costs are also geographically and socially distant, they bother us even less. This is how we end up with plastic in the Arctic. Better materials science and better legislation can treat the symptoms of plastic pollution, but treating the cause will require a new scientific understanding of convenience.

*Rob Jenkins (UK) Cognitive psychology*

The issue of plastic use and pollution boils down to personal, institutional and governmental intertemporal choice dynamics that do not necessarily normatively weigh long-term outcomes of our consumption behaviours.

*Fuat Balci (Turkey)*

Plastic pollution is an interesting case. The development of this polymer material heralded a new era of industry. Unfortunately, we quickly found ourselves surrounded by plastic waste, which is highly stable both chemically and environmentally, and can last hundreds of years with very little degradation. Recently, we have reached the point where the first products made of plastic are slowly starting to decompose. While we should be happy, no one could have expected that plastic decomposition would be partial and that plastic nanoparticles and fibres would become an even bigger issue than bulk plastic waste itself. Today, plastic fibres are found in 83% of the world's tap water. Most of the water treatment systems are not designed to deal with this issue, nor is our digestive system.

*Bart Kolodziejcyzk (Australia)*

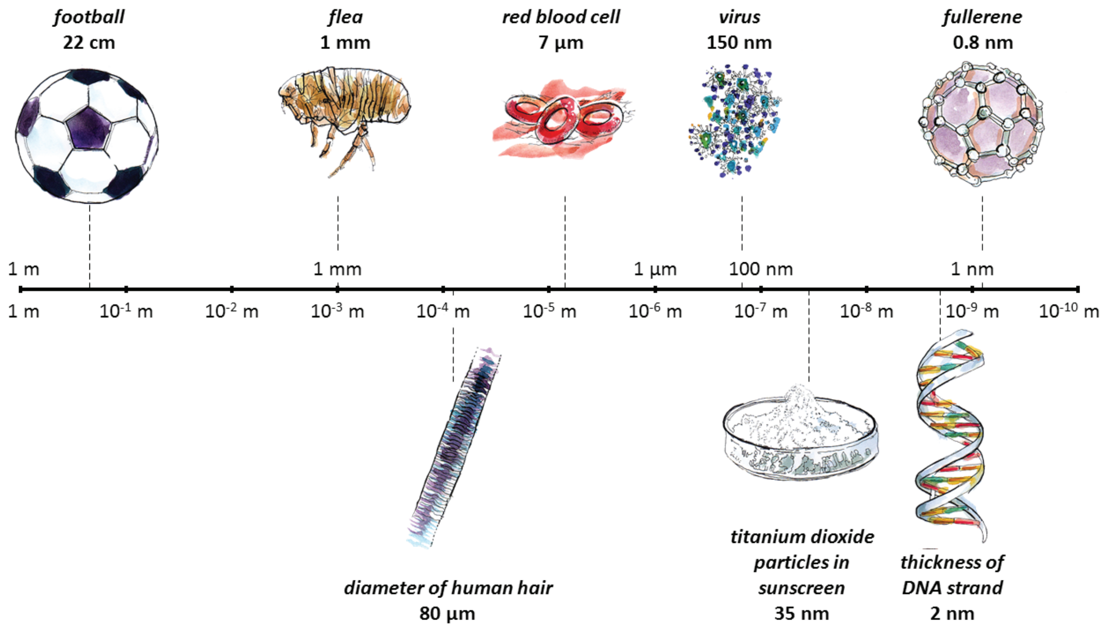
Studies have shown the significant levels of plastic in our ocean, literally choking marine life. Animals and fish are being found with plastic in their stomachs, which we in turn may also ingest. Additionally, micro plastic fibers - which we can't even see (from things like polyester clothing) are not being filtered out in our washing machines, but instead by filter feeders such as oysters and mussels, and again may be ingested by humans. We need strong policy to change the rapid production of cheap plastic in literally almost area of our lives, as well as to better capture waste before it pollutes the ocean. We need to recognize the true cost on the environment and public health of so much 'easy' plastic in our lives.

*Aysha Fleming (Australia)*

The Chinese government recently banned imports of millions of tonnes of plastic waste. This can be considered one of the very efficient actions to tackle the country's urgent environmental crisis. As the world's biggest market for household waste, the restriction seems to pose great challenges to large waste-exporting countries such as the United Kingdom. But this will also be a great opportunity for these countries to innovate their recycling systems.

*Desheng Wu (China)*

# What is nanowaste and why should we worry about it?



by Bart Kolodziejczyk

The Fourth Industrial Revolution is upon us. It represents a massive step forward and a big shift in all aspects of human life. However, like the three industrial revolutions that came before, it will also have by-products and problems to be overcome.

The Second Industrial Revolution brought mass production and cost reduction, but it also brought mass consumption and the problem of waste disposal and recycling. The Third Industrial Revolution, also called the electronic or digital revolution, gave us computers and telecommunication solutions, but the problem of electronic waste remains unsolved.

The Fourth Industrial Revolution is the era of human-computer interaction, smart systems equipped with advanced algorithms, small-scale rapid prototyping, and nanotechnology. The solutions and opportunities it presents seem to be unlimited. However, nanowaste and the issues associated with this new and not-yet-understood byproduct will escalate.

## Great things in small packages

One nanometre corresponds to one-billionth of a metre, or $10^{-9}$ m, as shown in the chart below. Tiny engineered materials often display different physical, chemical and optical properties than their bulk-scale counterparts. Gold is a great example of this phenomenon: bulk gold is a poor light absorber, but gold nanoparticles not only efficiently absorb light, they also facilitate certain chemical reactions (photo-catalyst) when stimulated by light.

In the past decade, the rapid growth of nanotechnology resulted in numerous new applications in the fields of electronics, medicine and food. The amount of investment and effort being dedicated to nanotechnology is simply astonishing. Some commercially available products already benefit from nanotechnology solutions. Indeed, it has been forecast that the global nanotechnology industry will grow to reach US$ 75.8 billion by 2020.

## But there's a catch

Nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of the materials. Nanomaterials and nanotechnology-based products reach their lifespans like any other technology, but dealing with nanowaste is complicated. For a start, it's invisible to the naked eye, making it hard to track and monitor. Nanoparticles and nanowaste do not behave like regular bulk materials; they tend to be more chemically reactive and toxic than their ordinary bulk-

sized counterparts. This makes it hard to predict how the tiny particles will act under different conditions, and this unpredictability poses some very big questions.
Disposing of such chemically reactive materials without prior deactivation can lead to serious consequences for the environment and human health. Moreover, toxicity and other hazards related to nanomaterials and nanowaste are not yet completely understood. Unfortunately, not enough attention has been given to the evaluation of toxicity, as well as the health and environmental hazards related to the use of nanomaterials. The OECD recently published a series of five reports on nanomaterials and nanowaste that describe possible methods of disposal, hazard evaluation and recycling. Surprisingly, there are no policies or frameworks currently in place to tackle this growing issue.

## A new health hazard

Certain nanomaterials have already caused problems to human health and the environment. For example, asbestos, a naturally occurring mineral that was found to be useful as thermal insulation and building material, attracted wide attention in the last century. Asbestos belongs to a group of minerals that are made of thin needle-like fibres, each containing several nano-size crystal-fibrils. These nano-fibrils can be released into the environment and have been found to be a serious threat to human health when inhaled.

Silver is another great example of a material that can be potentially harmful when scaled down to nano size. Used primarily in jewellery, in its large scale it's not hazardous. However, silver nanoparticles are known for their great antibacterial properties. And if nano-silver is aggressive towards bacteria, what can it do to cells in our body? Studies show that silver nanoparticles, even at very low concentrations, have been found to kill beneficial soil microbes affecting naturally occurring symbiosis processes.

There have also been concerns raised regarding the titanium dioxide ($TiO_2$) nanoparticles widely used in cosmetics, sunscreens, paint and even vitamins. It has been shown that $TiO_2$ nanoparticles can break DNA and cause chromosomal damage as well as inflammation, which may lead to cancer. These are only a few of the numerous and potentially hazardous nanomaterials.
Many concerns related to this rapidly growing field remain without clear or definitive answers. For example, it is not known whether nanoparticles can pass through biological barriers such as skin, mucous membranes or cell membranes to inadvertently enter our bodies. Some studies show this to be a possibility. It is also unknown how nanoparticles behave once they enter the food chain. Indeed, do they circulate in the organism's system until they are naturally removed through the biological process, or do they remain and accumulate inside of the organism, causing problems and affecting natural processes?

## A call to action

In the next few years we will see the growth of nanotechnology. But there is a lack of clear standards and frameworks related to the use, disposal and recycling of nanomaterials and nanowaste. Scientific and research organizations, together with governments and environmental agencies, need to tackle the issue by performing more evaluations and developing uniform policies and effective practices.

Luckily, international and national organizations are starting to take note: the OECD, UNIDO, EPA and IUCN, as well as several national governments are already aware of the escalating issue and are trying to apply precautionary principles. It's also up to us, the public, to be responsible for understanding the risks of nanomaterials and to apply that knowledge to the products we buy.

*Notes:*
*An earlier version of this story originally appeared on Agenda, and can be accessed at:*
*https://www.weforum.org/agenda/2016/02/what-is-nanowaste-and-how-will-it-affect-us/*

*Image on the right: Nodules of Polystyrene under the microscope and in polarized light.*

***Bart Kolodziejzcyk** (USA) is a research fellow at Carnegie Mellon University.*
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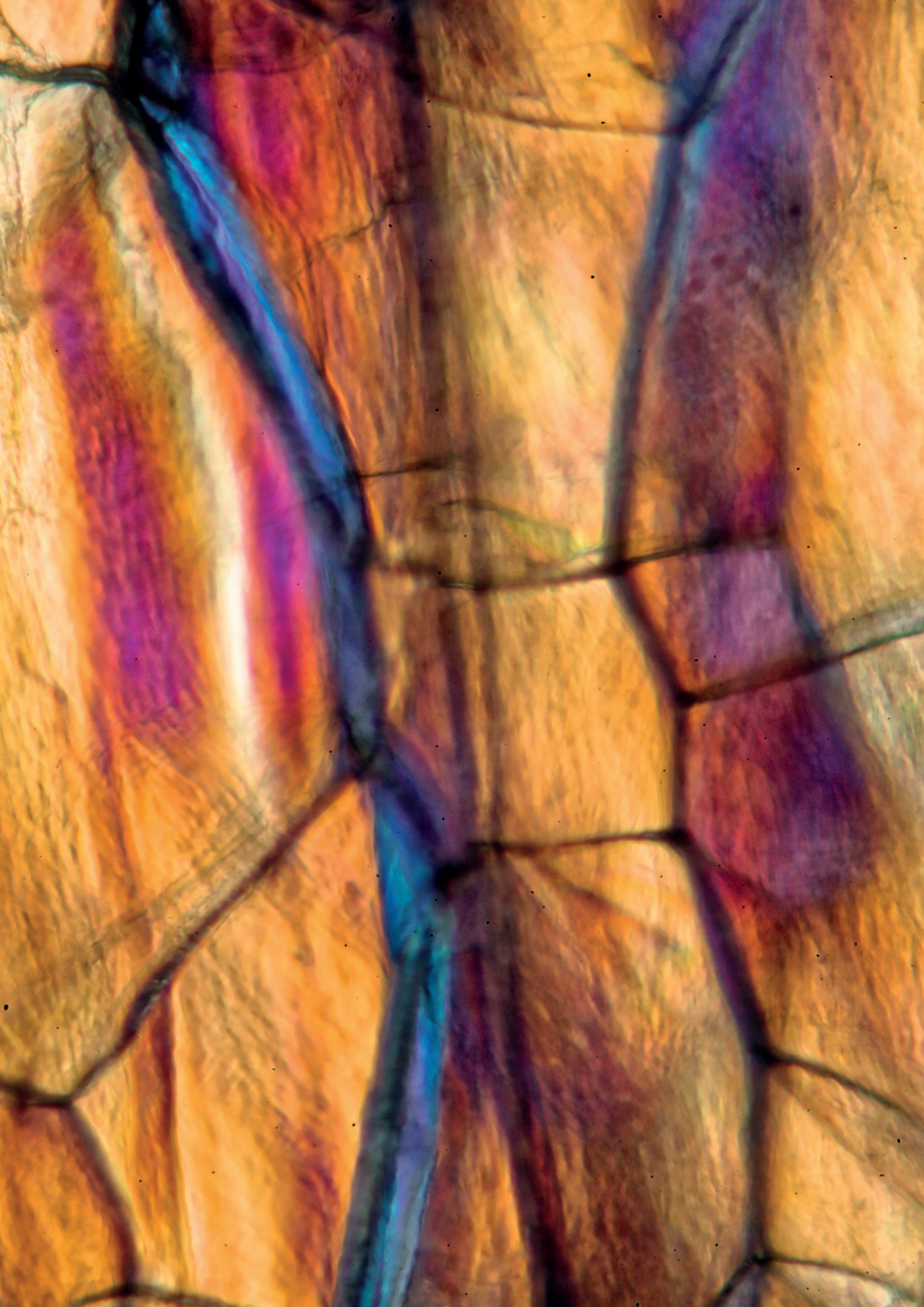

# Supporting displaced scholars through the At-Risk & Refugee Scholar Membership Initiative

Image : © Kit Chan

**by Teresa Stoepler, Karly Kehoe, Anina Rich, Eva Alisic, and Jan-Christoph Heilinger**

The scale of global migration today is unprecedented, with large numbers of people being forced to flee from their country of origin. Among this flow of people are highly trained scholars - scientists, medical researchers, historians, philosophers, and others - who now face uncertain futures and would benefit from a community of support. GYA members are well positioned to support these scholars to stay connected with research in ways that will enable them to help with the rebuilding of their countries in the future.

In his recent op-ed in *Science*,[1] Dr. Mohamed Hassan, former Executive Director of The World Academy of Sciences (TWAS), called on academies to reach out to refugee scientists. In December 2015, members of the GYA, the Royal Netherlands Academy of Arts and Sciences, and the Dutch Young Academy met to discuss how the integration of refugees could be facilitated in Europe. In alignment with the recommendations of that workshop,[2] and building on the subsequent success of the Royal Society of Edinburgh's Young Academy of Scotland At-Risk Academic and Refugee membership initiative,[3] the Global Young Academy has embarked on a flagship initiative to mentor at-risk and refugee scholars around the world and to offer them a potential path to GYA and National Young Academy (NYA) membership and other professional opportunities.

These scholars have the potential to make significant contributions if they are supported to continue their work. Historically, Nobel Prize winners, for example, have tended to include a high percentage of immigrants and refugees.[4] We know that scholars from different backgrounds provide unique and valuable perspectives. Indeed, diverse teams have been shown to produce higher quality research and more innovative ideas than uniform ones.[5] As members of a worldwide research community and as people committed to working for the benefit of society, it is essential that we support our at-risk colleagues.

Mentorship and the active inclusion of at-risk and refugee scholars in the GYA and NYAs are meaningful, and are concrete steps towards helping these individuals maintain scholarly connections, achieve professional recognition, and access opportunities. Indeed, including high-achieving at-risk scholars in our membership will increase diversity within the GYA and help us to deliver on an important part of our mission. Such a mentorship program is an essential part of the process of enabling at-risk and displaced scholars to start establishing new research relationships and to rebuild their professional lives. From the perspective of the GYA mentors, it also offers new opportunities for learning and the exchange of ideas with fellow scholars.

We are working with several partner organisations to identify vetted at-risk and displaced scholars for our initiative, including

The World Academy of Sciences (TWAS), the IIE Scholar Rescue Fund and Scholars At Risk. These organisations, in addition to the European Union's Joint Research Centre (JRC), the Alexander von Humboldt Philipp Schwartz Initiative, the Council for At-Risk Academics (Cara), and the Young Academy of Scotland (YAS), have played an advisory role and have provided support in the form of mentorship resources and program feedback.

GYA mentors applied to participate and were matched with mentees on the basis of current geographic location as well as broad disciplinary field. Currently, we have 14 mentorship pairs, with the mentees representing six countries (Syria, Yemen, Iraq, Iran, Turkey, and Ethiopia) and a range of disciplines, from literature and theatre to biochemistry and computer science. Most of the mentees are based at universities or research organisations throughout Europe, Asia, Australia, and North America, but in a few cases they are still seeking institutional affiliation or a stable work environment in their home countries. We have approximately 10 additional GYA members and alumni awaiting mentees.

Mentees interact regularly with their GYA mentors to receive assistance with CVs, applications for fellowships and jobs, gain access to mentor networks, and simply to get support from a friendly colleague. GYA mentors receive a handbook that outlines their roles and expectations, confidentiality policies, and information on additional external resources. The Co-Leads oversee the network of mentee-mentor pairs and liaise with partner organisations. Although GYA or NYA membership is not guaranteed to mentees, we will be working closely with the GYA Executive Committee and the Membership Selection Committee to reserve several membership places for the top talent within this mentorship group.

After an initial pilot and assessment phase, we plan to expand our program following the 2018 AGM, and we are working to raise funds for a workshop in 2019 where mentors and mentees can come together. We plan to document best practices as we learn from our own experiences and those of our partner organizations, and also to develop metrics to evaluate the initiative.

For more information about this initiative and the list of GYA Steering Group members, please visit our website, https://globalyoungacademy.net/activities/at-risk-and-refugee-membership-initiative/. We also encourage you to view the TWAS documentary film, Science in Exile, which features the GYA and the At-Risk and Refugee Scholar Initiative: https://twas.org/node/14265/. Finally, please reach out to Co-Leads Teresa Stoepler (teresa.stoepler@gmail.com) and Karly Kehoe (karly.kehoe@smu.ca) with any questions, ideas, resources, or to find out how to get involved! We welcome new members to the steering group as well as new mentors and mentees.

*__Teresa Stoepler__ (USA) is the Executive Director of the InterAcademy Partnership for Research. __Karly Kehoe__ (Canada) is the Canada Research Chair in Atlantic Canada Communities at Saint Mary's University in Nova Scotia, Canada. __Anina Rich__ (Australia) is co-director of the Perception in Action Research Centre (PARC) and heads the Synaesthesia@Macquarie research group. __Eva Alisic__ (Australia) is a senior research fellow at Monash University, Australia, where she leads the Trauma Recovery Lab. __Jan-Christoph Heilinger__ (Germany) is an assistant professor and Academic Director of the Ethics-Centre at the University of Munich, Germany.*
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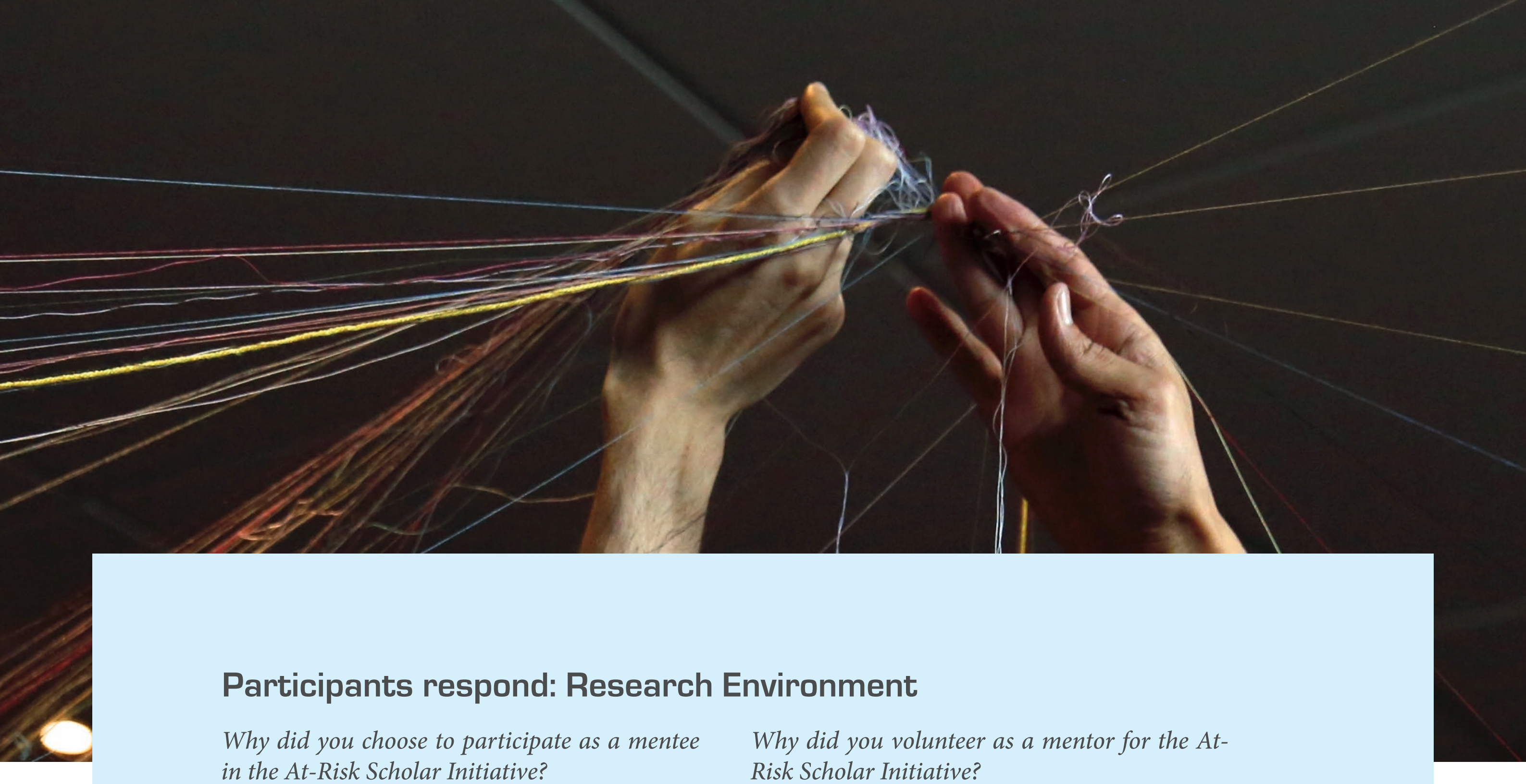

## Participants respond: Research Environment

*Why did you choose to participate as a mentee in the At-Risk Scholar Initiative?*

'It is great to talk to my mentor who has vast experience in his field. It makes me hopeful and inspired. Because of the different context in which scholars like me conducted their academic research, we need to be initiated in the new circumstance. GYA is one of the networks that is helpful for such initiation.' - Scholar from Iran

'It takes a lot of courage for a woman from the Middle East to gain independence. She has been taught to be dependent on the traditions and people surrounding her. When I first came to my new country I felt scared, lost and alone. I want to inspire others in similar situations . . . People in exile have a lot of skills and knowledge but they need the opportunity to use these skills to rebuild their lives in order to benefit their adopted communities. Finding one's place in a new community and culture is a core need for the reestablishment and development of any displaced professional. My mentor is an angel from heaven. She encourages and supports me. She always says "hat's why I am here".' - Scholar from Iraq

'GYA is working to expand the safety net for at risk/displaced academics. For these human resources, their creative scientific work is the only capital they have. Continuing their work means that they are still alive. They can then go back to rebuild their countries with rich knowledge.' - Scholar from Syria

*Why did you volunteer as a mentor for the At-Risk Scholar Initiative?*

'Academic systems are often difficult to navigate - there is the official side, but then there are also all the unwritten rules. I see it as an act of solidarity to support others, especially scholars at risk, in navigating these systems.' - Lisa Herzog, Germany

'Researchers are the backbone of a healthy, vibrant and pluralistic society. Scholars who have to leave their home and work due to conflict or persecution deserve our full support. I am proud to work with GYA to help mentor these scholars. My hope is that this effort will not only enable our colleagues to get back on their feet, but will also help me develop stronger bonds of collaboration across disciplines and enrich our understanding of various approaches, cultures and traditions.' - Muhammad Zaman, USA

'Rebuilding a disrupted academic career is not only about learning a new system of funding, job applications, and institutions. It's getting an institutional affiliation that will provide credibility, library access, and a whole host of practicalities we might take for granted. Our national Academics for Refugees network has already agreed to help develop research collaborations with displaced scholars, spreading the potential benefit from my mentee to others in Australia.' - Anina Rich, Australia

# First glimpses at the state of young scientists in Africa from the GloSYS Africa team

Image : © Eyescape corporate photography, 2015

**by Marie Neumann**

The Global State of Young Scientists (GloSYS) studies form a flagship project of the GYA, and aim to increase our understanding of how early career researchers across the globe are faring. As young scientists themselves, GYA members are in a unique position to investigate the challenges faced by early career researchers across the globe, and to use the information gathered through this project to affect change. Since the original GloSYS precursor study, the GloSYS studies have taken a regional focus, collecting internationally-comparable data on young scientists where little information on this topic exists. The GloSYS project utilizes the data collected to advocate for initiatives aimed at better supporting young scientists in their research and career development.

Over the last year, the GloSYS Africa team has been hard at work setting up the study and collecting data from early-career researchers in Africa and the diaspora about their experiences. In our mixed-methods study, we combine quantitative data obtained through an extensive survey with qualitative interview data in order to gain an understanding of the broader trends as well as the deeper context in which young scientists across disciplines and employment sectors carry out their work. Particular themes of interest in this study are mentoring, challenges faced, funding and infrastructure, gender, and mobility. The GloSYS Africa project is carried out in 14 African focal countries, but our survey was opened up to accept responses from young researchers in or from any country in Africa.

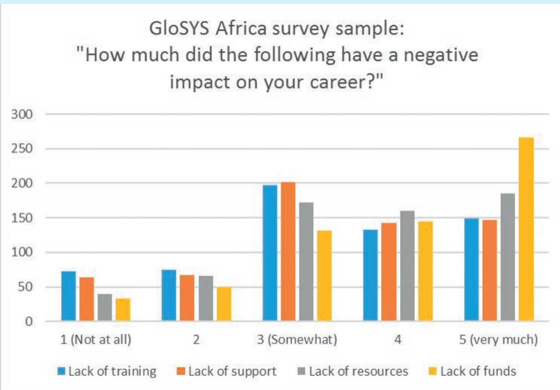


Figure 1: Negative impacts on career GloSYS Africa

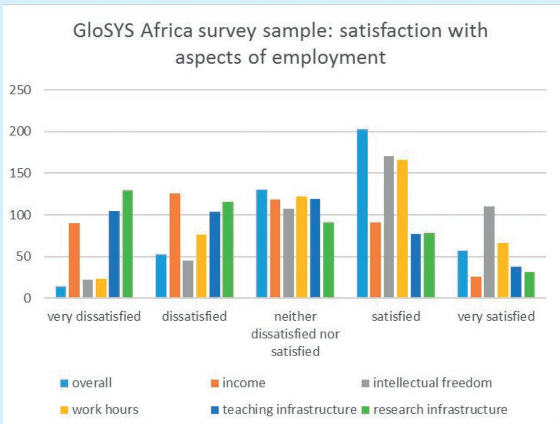


Figure 2: Satisfaction with employment GloSYS Africa

As we went to press, it was too early to present detailed findings or make any generalisable claims about our survey results. However, our preliminary analysis hints at some important themes to pay attention to as we move forward with data collection. Importantly, most of the young scientists in our sample seem to be quite satisfied with their careers. Those of our respondents who are currently employed (n=445 at the time of the writing of this article) seem to be quite happy with their careers overall (light blue bar in figure 1). These respondents are most *dissatisfied* with their jobs when it comes to their incomes (orange bar), and teaching and research infrastructures (dark blue and green bars, respectively). These findings are corroborated in the responses of to a question on the survey about how much various experiences have impacted the careers of our survey respondents (n=664; figure 2). In our sample, a lack of training (blue bar), lack of support (orange bar), lack of resources (grey bar), and lack of funds (yellow bar) are consistently reported as being major challenges.

While these findings may not be entirely surprising, they provide us with systematic evidence of the challenges faced by young African scientists across countries and disciplines. Upon the completion of the survey phase (planned for the end of May), we will work on teasing out differences in these trends across countries and employment sectors. An important contextual piece will be provided by the roughly 80 hours of interview data we are collecting with young African scientists. The GloSYS Africa project is set to be completed by the end of the year.

*Marie Neumann is a GYA Office Researcher.*

# Looking back: Creating the vision of the GYA


Caption:
*The sun sets outside the Dalian World Expo Center during the The World Economic Forum Annual Meeting of the New Champions in Dalian, China. 09/09/09.*

Image : © World Economic Forum (www.weforum.org/Adam Nadel)

**by Koen Vermeir**

Every serious academy needs its history and its historians. Indeed, Thomas Sprat published *History of the Royal Society of London* in 1667, less than 7 years after the Royal Society was founded. With the move of the GYA headquarters from Berlin to Halle (Saale) in the summer of 2016, the recent retirement of the first founding members, and key changes in the composition of the Office team, the GYA is entering a new phase. Another milestone will be marked by the 10th anniversary meeting of the GYA in Halle from 29 April to 3 May 2019, which will include members as well as alumni. It therefore seems a good time to take stock, reflect on the past, and project towards the future. This article seeks to document the founding and early development of the GYA, based on archival sources, published documents and interviews with founding members.

The origins of the GYA can be traced back to events organized by The InterAcademy Panel on International Issues (IAP) at the 2008 and 2009 'Summer Davos' meetings of the World Economic Forum (WEF). These 'Annual Meetings of the New Champions', aimed at young global leaders and technology pioneers, are held alternately in the north-eastern Chinese cities of Tianjin and Dalian. In 2008, 43 young scientists were preselected by IAP and the national academies of science to participate in the WEF conference in Tianjin, described by Howard Alper as an unsurpassed opportunity for eminent young scientists from around the world 'to showcase their knowledge and expertise, and to explore the worlds of economics, finance and politics with equally accomplished peers in other fields.' On Friday 26 September 2008, IAP organized two sessions, one on 'managing science for a better world' and another on the 'role of frontier science in shaping society', but the main goal of the initiative was clearly to foster contacts between science and business. Indeed, IAP gave special rewards to young scientists who teamed up with an entrepreneur and the report of the event, published in *Science*, was titled: 'An International Plan to Hatch Scientist-Entrepreneurs'.[1]

The young scientists did not so much discover the businessmen at the meeting, but rather each other. They found out that they had lots of energy, and they felt that together they even had the power and the ability to change things. During long evenings in the bar, plans were made to improve the world, even if they struggled to give these plans a concrete form. In the end, this energy was channeled in the form of a statement, 'Passion for Science - Passion for a Better World', signed by 40 participants of the IAP Young Scientists pilot initiative, which starts as follows: 'As young scientists from all five continents we are passionate about science, and we are passionate about science contributing to a better world. We wish to enhance the contribution that we can make to science and that science can make to society.' The statement identifies three areas that are crucial for young scientists: creating a supportive research environment for young scientists; removing obstacles and promoting collaboration and interdisciplinary research and training programs; and contributing to a better world, especially by developing a robust science culture at all levels of society. Ideas of a Global Young Academy were already germinating, and the report highlights the positive effects that had resulted from the establishment of 'Young Academies of Sciences'.

In 2009, the IAP and the WEF organized a 2nd IAP Conference of Young Scientists as part of the WEF's 'Annual Meeting of the New Champions 2009', this time in Dalian, China, from 10-13 September 2009. Of the 49 young scientists who attended, 42 were new participants and 7 who had attended the 2008 meeting acted as mentors. There were again awards for young scientists teaming up with the business community, and IAP organized two formal workshops: one on Science Education to Create the Innovators of the Future, and one on Research Priorities and Government/Business/Academia Partnerships to Address Societal Needs through Innovation. Especially the informal discussions and late evenings in the bar were formative, however, and the mentors carried over the energy and ideas of the 2008 meeting to the new class of young scientists. There was again an attempt to channel this energy into concrete results. James Tickner describes that some conclusions and recommendations were formulated in a closing session on the final morning. One of them was a call for 'The formation of a Global Young Scientists Forum, to promote international links and raise issues of particular concern to young scientists with national Science Academies and Governments'.[2]

After the Dalian meeting, discussions continued over Facebook and other media, and the idea of establishing a *Global Young Scientists Academy* took shape in the next few weeks. This GYSA would provide 'a voice to Young Scientists in international issues at the interface of science and society'.[3]
The project manuscript lists the over-arching aims of such a GYSA as follows:

- To advance interdisciplinary research.
- To encourage the exchange of information and ideas between science and society (including with policy makers, businesses, students, the general public, and others).
- To advise on general or science policy, especially as related to the interests of young or early career scientists.
- To support collaboration and scientific exchange, especially between young scientists from developing and developed countries.
- To catalyse the formation of national young scientist academies.
- To support and coordinate activities amongst national young scientist academies.

The concrete action plan of the project manuscript lists the preparation of a letter to communicate the plan, the organisation of a workshop, the establishment of a virtual community, and finally, writing a letter to *Science* magazine. The latter would contain the outcome of the Dalian meeting, maybe in a form resembling the Tianjin Statement, arguing the need for a global community of young scientists. The project initiative would be more successful than expected, however, because by the time the letter to *Science* magazine was written, the *Global Young Academy* was already in existence.

Gregory Weiss and Tilman Brück took the helm of this new initiative and they enlisted the support of the IAP. On 6 November 2009, an invitation was sent out from the IAP headquarters to the Member Academies, to 'Participate in a Workshop on Founding National Young Scientist Academies and the *Global Young Scientists Academy* (GYSA)'. The letter was signed on behalf of the IAP by Howard Alper, and by Weiss and Brück as the Workshop Organizing Committee Co-Chairs. The invitation set out the vision of a *Global Young Scientists Academy* and repeated the aims from the project manuscript as listed above. It was stated that the workshop would gather together members from senior national academies of science, distinguished young scientists, members of the WEF young scientists community and mentors from IAP. The letter called for applications by 1 December 2009, but on 3 December, the deadline was extended by one week to ensure that 'as many countries as possible be represented at the workshop.'

The workshop, which took place from 14 to 16 February 2010 at the Aquino Hotel Conference Center in Berlin, Germany, and hosted by the German 'Junge Akademie' (itself founded in 2000) and sponsored by the IAP and the Leopoldina, would be the founding meeting of the GYA.[4] During the meeting, 40 young scholars from 28 countries succeeded in drafting a constitution and agreed on a name: the *Global Young Academy* was officially launched on February 16, 2010. The first GYA Executive Committee (EC), Co-Chaired by Nitsara Karoonuthaisiri (Thailand) and Gregory Weiss (USA), was elected.[5] This EC, with Rees Kassen, Paul Nampala, Bernard Slippers, Kassymkhan Rapparov,

Amal Amin, James Tickner, Yael Hanin and Tilman Brück, would play a crucial role in shaping the GYA. The scientists also prepared a regional issues position paper and drafted a blueprint for creating national young academies. The founding membership of the GYA was constituted of the 2008 Tianjin and 2009 Dalian Young Scientists, together with the new participants at the Berlin workshop. The new GYA membership self-organized into Working Groups, focusing on issues critical to young scientists, and it was agreed that these Working Groups would carry out the core business of the GYA.

Although the aims of the GYA were reformulated in different documents, there are also clear continuities. The drafts of the GYA constitution – characterising the GYA by the following keywords: International, Independent, Science-based, Excellence, Impact – also still resonate with the original Tianjin Statement. In the first GYA funding application of 22 March 2010, called 'Leveraging young scientists', the aims of the GYA are summarised as follows:

- Provide a voice for young scientists around the world.
- Promote science as a career of choice for young people.
- Narrow the gap between science in the developed and developing world.
- Encourage novel approaches to solve scientific problems of international significance.
- Promote inter-disciplinary, international and intergenerational scientific dialog.

Reading about the passion and vision of the founding members is invigorating, but the new EC also needed to get to the practical business of running a new organization. They wanted to announce the GYA widely, and drafts for a *Science* editorial were shared immediately after the founding meeting in Berlin. The Co-Chairs felt they needed a website to increase visibility before the editorial was published, but they did not yet have the tools or the funding to do so, so they asked the IAP for an advance on their funding request. In the end, however, the Co-Chairs would pay for the website from their own pockets (later reimbursed by IAP funding). The *Science* editorial was slated to run 2 April 2010, but so many things needed to be set up and decided, and there were the inevitable glitches, as with the initial idea for a logo, finalized on 26 March (see figure 3). The 'grobal' is probably a typo, even if it occurs in two logos, and it may also have been a misguided attempt to suggest growth. The image is also less than successful, as 2D depictions of the Earth can only show one side of the globe. These archival images of logo designs (figures 3 and 4) are especially striking, not so much to illustrate the practical decisions that had to be taken, but because they also illustrate that other choices could have been taken, that the development of the GYA could have followed alternative paths.

The *Science* editorial 'Empowering Young Scientists' appeared on time and garnered a lot of interest, controversy and support.[6] The GYA had come a long way: from an idea to partner young scientists with business, the young scientists had self-organized into a global community. Against the original expectations, the GYA also became independent of the IAP, making true the aspiration of autonomy for young scientists that was at the core of the GYA vision. Finally, although the founding members were all selected by the IAP or other academies, in late 2010 the GYA started to select its own members, and at the first Global Young Academy General Assembly (originally planned to take place in Alexandria but held in Berlin due to the political unrest in Egypt), 32 new members from 23 countries were inducted, forming the first cohort of GYA members as they are selected today.

This story of the coming into being of a new entity exerts its own fascination. But it is not just fascinating: this story still shapes the GYA as it is today, and it is important to know these origins if we want to think about the future. The *History of the*


*Figure 3: Logo design for the GYA, file date stamp 26 March 2010.* Image: *© GYA archives.*


*Figure 4: Alterative logo design for the GYA, file date stamp 26 March 2010.* Image: *© GYA archives.*

*GYA* Working Group is driving this research, which is fundamental to the GYA itself. Crucial questions are at stake, such as: What are academies for, and how have the goals of the GYA evolved since its initial founding? What makes the GYA special within the current international research and policy landscape? What is the role of GYA members and leadership, and how is this evolving to tackle financial and policy requirements and accountabilities? What does it mean to provide a voice for young scientists? How do we promote science as a career for young people, and how can we help making young scientists autonomous? Lastly, what impact has the GYA had within and beyond research? These are some of the questions that we need to pose again and again while we continue to shape and implement the GYA vision.

***Author's note:*** *I have not provided references to all the documents that I have consulted, but rather only those that I quote from. The GYA archives are far from complete, and with this article I would like to call on members and alumni to send their GYA-related documents and correspondence to the GYA Office: info@globalyoungacademy.net.*

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At right: From then until now. Group photo at the GYA's 2017 AGM in Aviemore, Inverness-shire, Scotland. Photo by: Stewart Grant

# Creative insight

**Rob Jenkins interviews Dennis Sherwood of Silver Bullet**

**by Rob Jenkins**

Dennis Sherwood is a creativity and innovation consultant. His international clients include financial institutions (e.g. The World Bank), government organisations (e.g. The European Commission and The European Parliament), and charities (e.g. World Vision and Street Child Africa). In 2001, Dennis founded the Silver Bullet Machine Manufacturing Company, with a view to conferring on client organisations the ability to solve problems, to generate and implement new ideas, and to grasp opportunities reliably and repeatedly. GYA Member Rob Jenkins interviewed Dennis.

*We hear a lot these days about `creativity on demand´. What is your view on its impact?*

One plausible side-effect is that it will increase our powers of empathy. Crossing disciplinary boundaries exercises and strengthens our ability to see an issue from multiple points of view. And that in turn helps us to engage people with whom we disagree; to make progress on issues that tend to divide us. How do we reconcile opposing value systems? How do we tackle global inequality? These are among the most important problems of our time.

*You spend a lot of time talking to people about creativity. What do you mean by creativity? Are we talking about artistic talent?*

I'm very much influenced by Arthur Koestler's insight that, fundamentally, creativity is the formation of 'interesting' patterns from *pre-existing components*. Before I read his book *The Act of Creation*, I had thought that creativity was a natural gift with which the fortunate few are born - and that the rest of us have to do without; that creativity is that sudden 'light-bulb' moment; that creativity is an act of true, solo, originality. And all the other books I had read on creativity had all implied some form of 'magic'. So Koestler's recognition that creativity is all about forming new patterns from things that *already exist* was a real surprise. But the more I read Koestler's examples, and the more I thought about it, the more I was impressed with Koestler's truth. Neither Beethoven nor the Beatles invented musical notes, but they surely crafted wonderful, and wonderfully different, patterns from the same, pre-existing, tones. Mondrian did not invent red or white paint, but he made some beautiful patterns. And when Newton referred to 'standing on the shoulders of giants', he was explicitly acknowledging his debt to his predecessors such as Brahe, Kepler, Galileo, Descartes and Horrocks - all of whom provided some critical 'pre-existing components' which Newton finally assembled into his laws of motion and gravitation. This goes far, far beyond 'artistic talent' - I believe creativity is a vital human characteristic, and is essential in all aspects of human life, from politics to physics, from art to my own behaviour. And my response to the question 'what is the most powerful example of creativity you can cite?' is not 'Einstein's theory of general relativity', nor 'Adam Smith's invisible hand', nor da Vinci's *Mona Lisa*, nor Stravinsky's *Rite of Spring*. It's when I (or you!) change my (or your) mind, for good reason.

*How is this view of creativity related to knowledge generation or discovery?*

Drawing once more on Koestler, I'm convinced that creativity is totally knowledge-based. You can't form new, interesting patterns from pre-existing components if you don't know what those components are. So knowledge is the raw material for creativity, and the more knowledge you have, the more opportunities you have to be creative. Or, to draw on Newton, to stand on the shoulders of giants, you have to meet the giants first, and get to know them well. But there is a catch. Knowledge certainly is essential, but there is something else that you need if you want to use that knowledge creatively. To be creative, you must also be willing to 'let go', to allow your current knowledge to be challenged, and perhaps discarded. You cannot be 'in love' with your own ideas, and you must allow yourself to 'unlearn'. Knowledge and challenge lead to discovery - which is of course not a new idea at all: Fichte got there first, more than 200 years ago, with his trio 'thesis, antithesis, synthesis' (and it was Fichte, before Hegel!).

*In a sense, there's a balance between order and chaos. It reminds me of cultural tensions between the sciences and the arts. How much overlap do you see between science and art? How much overlap should we want?*

To me, there is no fundamental difference in the process of creativity as applied to the arts, or to science, or to any other aspect of human endeavour: an engineer can be wonderfully creative in solving a technical problem as can a health care worker in dealing sensitively with a distressed patient. Once again, I think Koestler has provided some remarkable insights. The Act of Creation explores the nature of creativity in relation to the arts, notably literature, poetry and drama; to science; and also to humour. His conclusion is that the process of creativity is the same in all contexts, based on combining different pre-existing components together (Koestler calls this 'bisociation'). What is different is the emotional stance of those involved. Great art is hugely emotionally engaging: when you read a great book, you want the heroine to fall in love with the hero, and you become the characters. The author explicitly seeks to achieve this emotional appeal. Science, in contrast, is emotionally neutral; whilst a necessary condition for humour to work is for the reader or observer to be emotionally disengaged – when the fat man slips on the banana skin, most of us laugh at the sight of the pompous made foolish: we wouldn't laugh if we worried about the broken leg.

*You describe this process of engineering collisions between remote ideas. How do we know which ideas are worth connecting? Or is the 'hit rate' high enough that random collisions pay off over time? Is this process of connecting remote ideas always creative, or can it be destructive or dangerous?*

Yes, 'bisociation' is indeed, as you correctly state, all about 'engineering collisions between remote ideas': that's exactly what, for example, Picasso did when he created Les Desmoiselles d'Avignon. But I don't think it is at all random. Earlier I referred to the formation of 'interesting' patterns, not just 'any-old' patterns. What we are seeking is a new pattern in which the whole is genuinely greater than the sum of its parts. There's a technical term for this – 'emergence'. The goal is therefore to discover truly 'emergent' patterns, where the nature of that emergence depends on context: in visual art, it is perceived beauty, or perhaps shock; in literature, it is emotional involvement; in science it is a deeper explanatory power, or public utility (such as a solution to the plastic pollution problem); in public service, it is, for example, the design of social systems which are more fair across the entire population.

*New ideas bring with them a mixture of opportunities and risks. How do we manage that dynamic?*

Indeed so. Not all ideas are 'good' - and in fact many, if not most, are bad. I play a game with my son, based on my 'rule of thumb' that only about 1 idea in 100 is worth pursuing. So when I say to him 'I've just had a great idea', he will reply 'Mmm. That's number 56. You have 44 to go!'. Creativity - having ideas - is only one part of the overall picture. Yes, you have to have ideas to start with, but once you've had them, you need to think about them, refine them, develop them - and indeed discard them if they are not good. This is all about what I call 'wise evaluation' - how to judge whether an idea is strong or weak, often on very limited evidence. In my experience, 'wise evaluation' is more difficult than having the ideas in the first place. Very often the 'rule' for evaluation is 'I like the idea'

or ‘I like the person who suggested the idea’. These, at a human level, are very understandable... but... whether or not I like the idea, or the person who suggested it, is not a valid judgement of the idea itself.

*It’s harder to manage risks when the consequences play out over long timescales because uncertainty is generally higher. How do we make progress on problems with a long-term character - problems like pollution or climate change?*

Yes, you are absolutely right. And not only do the consequences play out over longer timescales, they also extend over broader geographies too. Today’s key problems – of which pollution and climate change are two significant examples – aren’t local, but global. The best solutions require a truly joined-up approach, across national and political boundaries. So maybe this is something that GYA can truly contribute towards: to act as a global, energetic, enthusiastic and hugely intelligent and committed community to generate great ideas to solve the ‘wicked’ problems; to provide insight and wisdom in evaluating those ideas; and to form an influential lobby group to get things done!

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## Dmitry Alexeev (Russia)

*Scientist + bioinformatics*

A bioinformatics scientist with over 15 years of experience, he has been a lab head for over 5 years and written more than 50 scientific papers. Winner of the 2015 Moscow Government Prize to Young Scientists for his outstanding contribution to the development of microbiome research technologies. Current CEO of Knomics, based in Moscow.

## Abdalhadi Alijla (Lebanon)

*Palestinian + Swedish academic and writer*

An associate researcher at Varieties of Democracy Institute at Gothenburg University, Sweden, and the Regional Manager of the Gulf. He is also the Director of the Institute for Middle East Studies, Canada (IMESC). In 2010, he was a visiting researcher at ICCROM in Rome, Italy. He was also selected as a junior scientist at the 30th Alternative Noble Prize.

## Shalini Subash Arya (India)

*Food scientist + technologist*

Having witnessed an increasing number of malnourished children, as well as people affected by diabetes and cardiovascular disease in India, she develops diabetic- and heart-friendly foods using resources that are locally available. She has been recognised by various international and national organisations for her significant contributions.

## Michael Backes (Namibia)

*Lecturer + astrophysics*

Senior lecturer and head of the Namibian research group working on the H.E.S.S. telescopes at the University of Namibia, he was also appointed extraordinary senior lecturer at the Centre for Space Research, North-West University (South Africa). His interests lie in understanding the highest-energetic emissions from active galaxies.

## Sezgin Bakirdere (Turkey)

*Researcher + analytical chemistry*

His research has mostly focused on metal speciation, hydride generation systems, cold vapor metal determination, SQT atom trap systems, food analysis, wastewater treatment, and chromatography. In addition to receiving national and international academic awards, he was selected as an associated member of the Turkish Academy of Science in 2015.

## Rigers Bakiu (Albania)

*Molecular biologist + aquatic science researcher*

His research focuses on marine aquaculture, applied biotechnologies on aquaculture, and artisanal fisheries statistics. In April 2017, he won the Most Successful Young Scientist 2016 Prize from the Albanian National Academy of Sciences. Current Head of the Section about Technical and Natural Sciences, Albanian Young Academy.

## Christopher Paul Barrington-Leigh (Canada)

*Associate professor + physicist*

His recent research is focused on empirical and quantitative assessments of human well-being, measured through subjective reports, and their implications for policy. He was originally trained in upper atmospheric and space plasma physics at MIT, Stanford, and UC Berkeley, before studying Economics at the University of British Columbia.

## Suraj Bhattarai (Nepal)

*Physician, infectious diseases + tropical medicine*

His research interests are in infectious diseases, particularly vaccine-preventable and emerging infections. He works closely with the Nepal Academy of Science & Technology, IAP and other global networks to facilitate the development of science, research and public health in resource-poor communities.

## Krishanu Biswas (India)

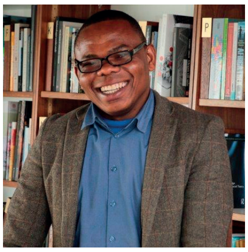
*Professor + metallurgy*

He has made significant contributions towards understanding several important scientific and technological aspects of metallurgy and materials engineering. His recent research activities involve sintering of high entropy alloys, nanomaterials, nanocrystalline, ionic nanoparticles, and graphene. He also teaches extensively on a variety of subjects.

## Patrick Cobbinah (Ghana)

*Geographer + urban and regional planning*

His background is in human geography and includes broad experience in urban and regional planning. He is a member of the Ghana Institute of Planners, a visiting scholar at the Stellenbosch Institute for Advanced Study (STIAS) at Stellenbosch University, Cape Town South Africa, and a University of Michigan African Presidential Scholar (UMAPS).



## John Kuumuori Ganle (Ghana)

*Lecturer + health and development*

His current research interests are in sexual and reproductive health, maternal and child health, gender and health, gender and development, and population and development. He is a recipient of a one-year USAID Systems for Health Innovations Grant and a three-year Iso Lomso Fellowship Award for Exceptional Early Career African Researchers by the Stellenbosch Institute for Advanced Study, among others.

## Roula Inglesi-Lotz (South Africa)

*Energy economist + macroeconomy*

Her research focuses on the interlinkages between energy, the environment, and the macroeconomy. She is the founder and president of the South African Association for Energy Economics (SAAEE), and was awarded the Distinguished Young Woman Researcher in the Humanities and Social Sciences category at the 2017 Women in Science Awards by the South African Department of Science and Technology.

## Ali Jahanshahi (Netherlands)

*Assistant professor + medical physiology*

In 2007, he received his Master's degree in medical physiology at Tarbiat Modares University, Tehran, Iran. In December 2008, he was awarded with a Marie Curie Fellowship to carry out his PhD studies at Maastricht University. Currently an assistant professor at the department of Neurosurgery, Maastricht University Medical Center.

## Malan Ketcha Armand Kablan (Côte d'Ivoire)

*Environmental scientist + human security specialist*

He has a Master's Degree in climate change and human security, and a Master's Degree in environmental science. His research interests include urban land use/cover change, climate change adaptation and mitigation, disaster risk management and reduction, water, sanitation and environmental pollution, as well as sustainable development.

## Monika Kedra (Poland)

*Oceanographer + marine ecologist*

An associated professor at the Institute of Oceanology Polish Academy of Sciences, her scientific interests focus on the assessment of climate change impacts on marine ecosystem functioning and resilience. She is particularly interested in the biodiversity of marine communities at the sea floor, population dynamics, food webs and carbon cycling.

## Seda Keskin Avci (Turkey)

*Chemical + biological engineer*

An associate professor of chemical and biological engineering at Koç University, her research is on molecular modelling of new generation nanoporous materials for energy applications such as gas storage and separation. Her research group performs atomically-detailed simulations of metal organic frameworks for various gas separations.

## Stefan Kohler (Germany)

*Economist + medical doctor*

Stefan is a research associate in global health at the Institute of Public Health at Heidelberg University. His research focuses on strengthening health systems and evaluating the impact of population health programmes on health, economic and social outcomes.

## Sergey Kostyrko (Russia)

*Associate professor + thermodynamics*

His research area covers the different aspects of mechanics and thermodynamics of thin film materials, such as the effect of surface and interface properties on the mechanical behaviour of film coatings, morphological patterns formation due to surface and volume diffusion, and multiscale modelling of layered composites.

## Junpeng Li (China)

*Sociologist + convergence and divergence*

He investigates ideological convergence and divergence in contemporary China, and the social forces behind people's political orientations. He is also working on intellectuals' engagement with politics throughout Chinese history. His multidisciplinary research has been published in journals in sociology as well as in political science, *inter alia*.

## Sandra Lopez-Verges (Panama)

*Virologist + immunologist*

Her research focus is on the virus-human host interaction as she tries to understand the role of innate immunity in viral diseases. Currently, arboviruses are her main focus. She participates in scientific associations and a new movement of young scientists in Panama that are involved in science communication.

## Abhijit Majumder (India)

*Assistant professor + chemical engineering*

An assistant professor in the Department of Chemical Engineering, IIT Bombay and Wellcome Trust-DBT India Alliance Early Career Fellow. He has published in many internationally reputed journals including *Science* and received multiple awards for his research, including the TR35 Young Investigators India awarded by MIT Technology Review.

## Elhadidy Mohamed (Egypt)

*Microbiologist + food-borne pathogens*

Currently an associate professor of Microbiology at Mansoura University and an adjunct faculty member at Zewail City for science and technology. He investigates the molecular characterisation of different genetic markers that play a role in virulence potential, antimicrobial resistance and transmission of food-borne pathogens to humans.

## Stefania Mondello (Italy)

*Physician + critical care*

She has extensive experience in clinical neurotrauma, biomarker research and statistical analysis methods. Her research focuses on the use and clinical validation of novel biochemical markers of brain injury to assist in patient management, and to improve diagnostic classification, clinical decision-making and inform a rational approach to personalised clinical interventions.

## Sarah Morales (Canada)

*Assistant professor + indigenous legal traditions*

Her research centres on indigenous legal traditions, specifically the traditions of the Coast Salish people, Aboriginal law and human rights. She is committed to the recognition and reconciliation of indigenous legal traditions with common law and civil law traditions in Canada. Her research has resulted in the creation of policies and procedures that reflect the laws and legal orders of the communities who utilise them.

### Dalal Najib (United States)

*Science policy + space engineering*

Senior program officer at the Development, Security and Cooperation in the Policy and Global Affairs Division of the U.S. National Academies of Sciences, Engineering and Medicine, working mainly on international development and capacity-building through science and technology.

### Chioma Daisy Onyige (Nigeria)

*Criminologist + environmental sociologist*

Her research interests include gender and crime, women and conflict, gender and climate change and environmental sociology. Her current research examines the criminal exploitation of women and children through human trafficking from Africa to Europe.

### Camila Ortolan Fernandes de Oliveira Cervone (Brazil) *Consultant + biology*

PhD candidate at the State University of Campinas and a consultant to the PROMOB-e project, a technical cooperation project executed by the Brazilian Government in partnership with the German government through the German international cooperation agency, GIZ. She has worked as a consultant to various international organizations.

### Ignacio Palomo (Spain)

*Researcher + human-nature interaction*

He is interested in human-nature interactions in social-ecological systems, the impacts of climate change in mountains and how society responds and adapts to them. A postdoctoral researcher at the Basque Centre for Climate Change, he is also a fellow of the Intergovernmental Science-Policy Platform on biodiversity and ecosystem services.

### Fatin Aliah Phang (Malaysia)

*Researcher + STEM education*

Her research area is in STEM education, with a focus on problem-solving, metacognition, qualitative research methodology and the nature of knowledge. She is the Chair of the Science Education Working Group of the Young Scientists Network - Academy of Sciences Malaysia.

### Flávia Ferreira Pires (Brazil)

*Social anthropologist + child development*

She is dedicated to understanding the everyday lives of children from their own perspectives and the macro structures that outline their existence. She is the mother of two very young girls aged two and four years old, who inspire her positive attitude towards the betterment of science in society given its social and individual transformation power.