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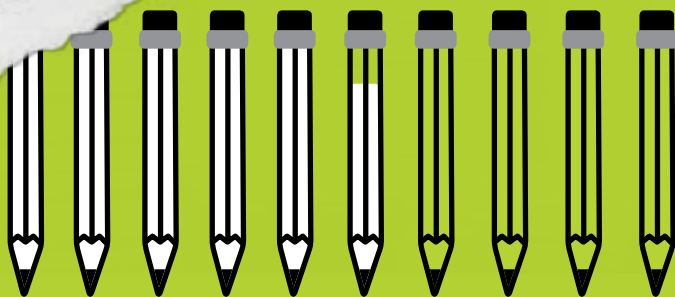
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From the Editors



As African economies such as Ghana and South Africa emerge onto the global stage, [Franca Hoffmann](#), on page 42, looks at the potential for foreign investment in this region. Is heavy infrastructural investment by the Chinese a sign of confidence that Africa can move beyond primary industry into the lucrative manufacturing sector, replacing an increasingly expensive Asia as a new hub of economic growth?

Neave O'Clery Editor In Chief

The war on drugs has become a bloody battlefield, with many political leaders now confessing defeat of existing drugs policies. What should be the new plan of attack? On page 21, [Ian Perrin](#) suggests that public health and socio-economic approaches could go a long way towards more comprehensive and effective anti-drugs strategies in the future.



Nazeeha Hasan Narcotics



The number of human beings without access to safe food remains stubbornly high. On page 14, [Prof. Tim Benton](#) highlights the dangers of an even greater food crisis precipitated our ever-growing global population – how can we meet the soaring demand for food in ways that are both environmentally and economically sustainable.

Claire Roseren Security and the BRICS

Negotiating adolescence is difficult in the best of circumstances, with huge changes occurring both mentally and physically. [Dr. Caroline Foster](#), on page 26, outlines and discusses the further challenges facing adolescents who have to juggle the trials of this troublesome phase along with the tricky management of HIV.



Georgia Lockwood-Estrin Adolescent Health

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Foreword

Knowledge Meets Power: How The BRICS Were Born

It's rare for an academic economist to create a new political grouping of nations. Rarer still for this to happen via a 16-page review paper. If there was ever a prize for an academic report to have directly influenced international policymaking, Jim O'Neill's paper from 2001¹ has got to be among the strongest contenders.

As Andrew Harmer and colleagues write on page 34, O'Neill, a former head of research at Goldman Sachs, created the BRIC acronym. He did so after working out that the collective GDP of Brazil, Russia, India and China was set to rise from 8 per cent of the world economy to 14 per cent within a decade, according to one scenario. O'Neill argued that these countries' rising share of global wealth production needed to be reflected at the highest forums of economic policymaking.

He called for the BRIC economies to be allowed into the Group of 7 industrialised nations, with the case for China being "overwhelming". He also suggested that Europe's representation on the G7 be reduced from four countries (France, Germany, Italy and the UK), down to just one, or two depending if the UK joined the single currency.

Academic papers that influence policy are almost always written in accessible if not entertaining language with a strong top-line. They also tend to have influential support in places that count. And yet in that regard, O'Neill's dreamy vision of redistributing global power has made little headway. We shouldn't be surprised. No country with a permanent seat at the top table is likely to give it up voluntarily.

But inside the BRIC countries it's a different story where O'Neill is a mix of rock star and prophet. His thoughts from 2001 spurred BRIC leaders to organise themselves into a group (later including South Africa) to rival the G7. BRICS leaders have since met annually four times since 2009 and this year's fifth summit takes place in Durban at the end of March.

As Harmer and colleagues write, it is too soon to say if the BRICS will start to act more as a power-bloc. They are still very tied into existing policymaking networks (whether bilateral or multilateral), and a recent attempt at creating a BRICS-funded development bank (like the World Bank) remains mired in political wrangling.

This is deeply ironic. It suggests that when it comes to their own money, BRICS leaders aren't really that confident in the investment potential of emerging markets. They could do worse than keep an eye on what's been happening at Goldman Sachs. In 2010 the bank put O'Neill in charge of asset management, responsible for \$800 billion of its clients money. And at the end of January the bank announced its most profitable quarter in three years.

Ehsan Masood

Editor of Research Fortnight and teaches International Science Policy on the Science Communication Master's Course at Imperial College London.

[1] O'Neill, J. (2001) The World Needs Better Economic BRICS. *Global Economics Paper No. 66; Goldman Sachs Economics Research.*



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Learning From Nature: Bio-Inspired Sensing For Security

Dr. Peter Biggins & Andrew Burton, Imperial College London



A dog's sense of smell is legendary. But our attempts at 'engineering' the canine olfaction system loses something in the process. Instead of mimicking nature by forcing a human-designed solution, do we need to adopt an holistic systems approach that retains naturally evolved characteristics?

Learning from nature seeks to develop bio-inspired sensing systems that may one day emulate the amazing sensitivity and specificity observed in the natural world. Nature's capabilities have evolved often for specific tasks, providing the organism with an advantage in its ability to survive and prosper in its environment. Naturally evolved capabilities cover a wide range of sensing functions including vision, temperature, hearing, touch, taste and smell; and for many such functions, the capabilities of natural systems are vastly greater than those achieved by current engineered solutions.

Since natural systems have developed specifically to detect the sort of entities that are of interest in chemical and biological defence, it is not surprising that they could be the source of inspiration for improved capability. In fact it is possible to conceive of a complete bio-inspired security system concept which is likely to be radically different from more conventional approaches.

Terrorist activity is not confined to conventional means of attack, and the use of chemical or biological agents is a real possibility, as was seen in the attack on the

Tokyo underground system in March 1995. With this increasing concern comes the need to provide ever more capable detection systems. The increased capability required does not just concern the ability to detect and recognise agents, but extends to many aspects of the whole system which may be required to operate outside conventional military environments.

Current engineered systems are produced in a totally different way from the process that leads to a natural biological system. In engineering, a specification is derived and a design developed to meet this specification. The designer will select materials and components that can meet the requirements in an efficient manner, and will also consider how the product will be manufactured in order to minimise the number of processes involved and the amount of waste energy and material produced.

In contrast, natural systems develop over long periods of time. What we observe is a system that has adapted to its environment to produce an optimised solution. However, the constraints that have driven this iterative 'design' process may be impossible to determine in any detail. Optimisation against one set of constraints can result in a lack of tolerance to new conditions, and this poses a challenge in assessing the suitability of a biologically inspired solution to an engineering problem. While there are undoubtedly difficulties in understanding why natural systems are constructed as they are, it is also true that natural systems possess elegant and effective designs from which inspiration can be drawn.

Natural systems have developed specifically to detect the sort of entities that are of interest in chemical and biological defence

In recent years there have been extraordinary advances made in biotechnology, and the technologies and techniques developed offer significant promise for sensing systems, especially for chemical and biological agent detection. A fundamental issue, however, is the ability of systems to operate in extreme environments rather than in a controlled laboratory.

The direct use of biological entities can seem attractive but brings the significant overhead of sample preparation, which can be important for the analysis of many agents. Samples have a limited lifetime which adds to the logistical burden associated with such detection schemes. Collection, concentration and purification are also critical steps for biological detection in practice, where agent levels can be low compared to a variable and sometimes high natural background material. Biological detection methods tend to rely on laboratory-based equipment which requires qualified personnel to operate it and which can take several hours to produce a result. Such long response times are unacceptable for field use.

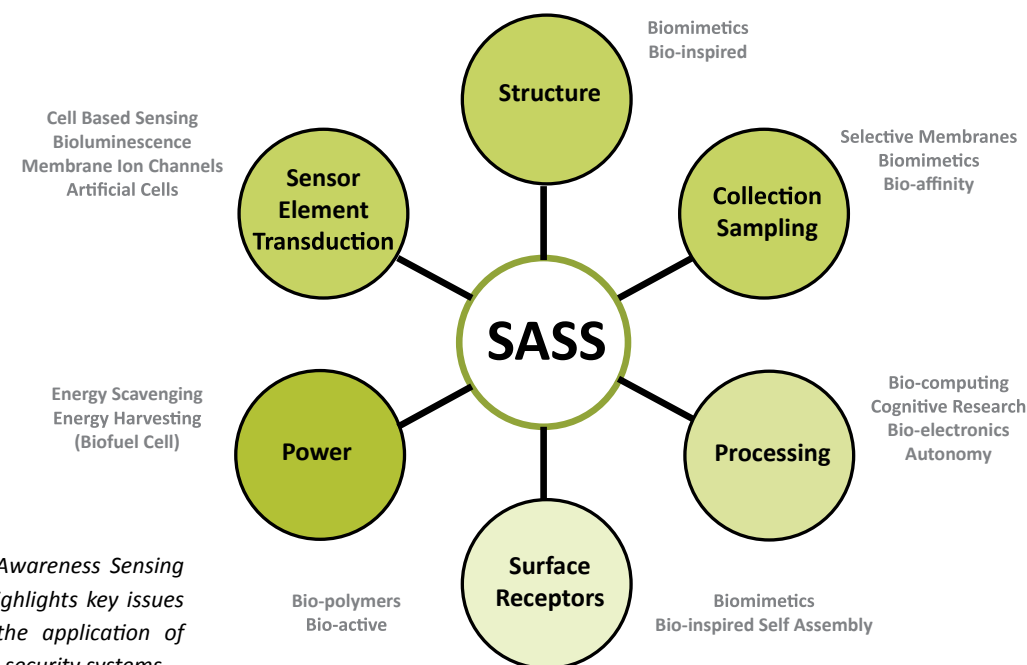
The challenge, then, is to capitalise on the extraordinary capabilities of natural systems and to develop techniques for the detection of bacteria, viruses and toxins in a form that can be employed for field use. These techniques need to be immune to background

material and provide rapid results, and they need to be part of an intelligent and autonomous system which requires minimum operator intervention or logistic support.

The Situational Awareness Sensing System

To help facilitate the application of biotechnology and bio-inspiration to sensors, a conceptual model can be developed to focus on key issues that need to be overcome. Whilst the model itself may never be fully realisable it can be used to generate a vision of what could be developed and also to assist in the identification of enabling technologies that are required. One such approach is the Situational Awareness Sensing System (SASS). It is not a design for a real system but rather a schematic of a concept to enable aspects of the overall system and its component parts to be explored.¹

There are six key parts to the system: (i) sampling/collection, (ii) structure, (iii) receptor surfaces, (iv) transduction, (v) processing and (vi) power. This concept is not aimed at a single component, such as a sensor, but leads naturally to the consideration of a whole system concept. The colour coding of the various components indicates our view of the maturity of a particular item. For example, there have been significant advances made in the science of surfaces and receptors (coded light green) while the issue of power, especially to enable extended



The Situational Awareness Sensing System (SASS) highlights key issues for facilitating the application of biotechnology to security systems.



autonomous operations, still requires major advances to be made (coded dark green).

A critical part of any sensing system is the ability to collect and sample target material. For substances dispersed in air, well-established techniques can be used to capture and concentrate aerosols into liquids. But these devices are cumbersome, require user interaction and are inefficient at collecting trace materials. In contrast, some organisms have evolved to collect material even when distributed in low concentrations. An example is the Australian Thorny Devil (*Moloch horridus*), which has the ability to move water through inter-scalar spaces on its skin surface from its feet to its mouth for drinking.² This ability seems to rely upon hinged joint walls which are covered by a complex arrangement of fractured surfaces with a large surface area. Semi-tubular joint channels and a jaw buccal cavity pumping mechanism work together to collect and transport drinking water harvested from infrequent rainfall. This enables the Thorny Devil to remove water from sand at just 3% concentration.

The physical structure of a SASS will need to protect and align components, regulate the internal environment and maybe also the physical aspects of locomotion. Natural systems can exhibit remarkable structural performance from materials with relatively low performance constituents. Bone, for example, has outstanding toughness which is at least partly explained by its structural hierarchy and the size scale of the bio-mineralisation.

Moving from the micro to the macro scale, it is possible that inspiration can be drawn from social structures such as a mound of termites (*Macrotermitinae*).³ The study of these mounds has shown that they are complex self-regulating structures and the way in which they are constructed and operate is the subject of current research. While there has been considerable work done in trying to understand the fundamental

mechanisms behind the properties of natural materials, much remains to be done to convert this knowledge into synthetic materials that can be commercially produced. The need for efficiency will encourage the concept of multi-functionality to combine functions with structure.

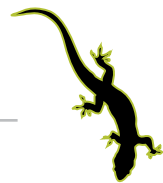
Surfaces and receptors are in essence an extension of the structure of a material, where the properties of surfaces and receptors are directly related to their structure down to the molecular level. Much has been learnt from nature in this area. There are a large number of existing bio-receptors including antibodies, enzymes, olfactory binding proteins, DNA/RNA probes, synthetic ligands and cell surface receptors. These biomolecules bind firmly or reversibly to a range of target ligands and are used for 'in vitro' applications in sensor and detector systems of exquisite sensitivity and remarkable specificity.

Assay systems, for example, have employed enzymes for some time. An example is the use of firefly (*Photinus pyralis*) luciferase in bioluminescent assay formats in which the degree of bioluminescence is based on the level of adenosine triphosphate (ATP) present within a bacterial cell. However, encouraging biological molecules to behave naturally while in an unnatural and hostile environment is a considerable challenge. For example, spacing, positioning and orienting antibodies and enzymes are critical for ensuring maximum functionality.

Considerable effort has also been undertaken to develop sensor transduction. These systems have been based upon a number of principles including optical, electromechanical, acoustic, piezoelectric, magnetic and mass spectrometric techniques. Although these are well established techniques, it may be possible to derive improved methods by studying nature. It is known that the detection of heat or infrared radiation is used by some animals to identify prey and to enhance their survival. An example is the Jewel Beetle (*Melano-phila*), which is reported to be capable of detecting forest fires from a distance of 50km. It is understood that infra-red radiation in the 2.5 – 4 μm wavelength region causes wax filaments in the front legs to swell and stimulate the nervous system.



The skin of the Australian Thorny Devil allows it to harvest and transport water from sand at just 3% concentration, demonstrated by blue-dyed water being transported over its skin surface (inset). This has inspired the development of novel sensing systems for collecting and sampling target materials.



- [1] Biggins, P.D.E, Hiltz J. & Kusterbeck, A. (2011) Bio-inspired Materials and Sensing Systems. Cambridge: Royal Society of Chemistry.
- [2] Sherbrooke, W.C. (1993) Rain-Drinking Behaviors of the Australian Thorny Devil. *J. Herpetol*, **27**, 270-275.
- [3] Feltell, D. Bai, L. & Soar, R. (2005) Bio-Inspired Emergent Construction. *Proc IEEE Swarm Intelligence Symposium*, 7-14.
- [4] Melhuish, C. Ieropoulos, I., Greenman, J. & Horsfield, I. (2006) Energetically Autonomous Robots: Food for Thought. *Auton. Robot* **21**(3), 187-198.

An important aspect of any sensing system is how information is processed. Bio-inspiration has been employed in the processing for detection systems: the use of neural networks is a good example. Developments in neuroscience are leading to an improved understanding of how the brain works which may lead to new techniques for sensor data processing. Some organisms appear to have relatively simple brains which are optimised for the efficient processing of sensory inputs. For example, research on the fruit fly (*Drosophila*) glomerulus using fluorescence imaging shows that different regions of the glomeruli respond to differing odours.



The rapidly evolving threats to security demand that we consider all possible means to counter them; bio-inspired approaches offer one possible route, making use of nature's own highly efficient design processes to protect itself

The SASS concept is more than just a biologically inspired sensor: it is a complete system possessing some degree of intelligence expressed in the decisions it makes about its environment and mission as well as the sensor inputs. In the context of a SASS, the algorithmic element must be able to exploit and extract information from bio-inspired sensors which are likely to have quite different characteristics when compared to conventional devices. For example, an imaging device inspired by an insect eye with multiple optical detectors must be matched with suitable signal or data processing algorithms to extract useful information from the device. In general biological devices are strongly non-linear (and non-Gaussian) and so will require non-linear algorithms to make good use of their outputs.

Finally, a key component of any deployed sensing system is access to a reliable low mass source of power and energy. For extended periods of operation the available energy is likely to be the critical parameter, but if the system has to move about in its environment then peak power may also be crucial. Whilst battery technology has advanced significantly in recent years, it still has relatively low endurance and the logistics burden imposed by battery usage is a growing problem especially for military operations. Potential alternatives are being investigated, for example

energy can be harvested from estuarine and marine sediments to power unattended sensing platforms in rivers or the ocean. Obtaining energy from tree sap or mammalian fluids has also been investigated. Energy might also be scavenged from the environment using solar, thermal, vibrational and other sources. Robotic systems that can be energy self sustaining are being developed in both land and water environments. A robotic system called Eco-Bot⁴ has been designed to power itself solely by converting unrefined insect biomass using on-board microbial fuel cells with oxygen cathodes.

Exploitation of Natural Systems

There is nothing particularly new about exploiting natural systems, and to some degree mankind has always done this, with many specific examples of where natural systems have been exploited for sensor applications. A good example is the use of caged canaries by miners to detect methane in coalmines.

Biologically inspired solutions, in contrast, seek to exploit underlying biological principles in synthetic systems. While this approach could provide a new range of possibilities, it is technically and intellectually challenging. The long-term potential for this approach is exciting, and is perhaps the key to overcoming some of the limitations described in exploiting biological systems in a SASS framework, and which could enable high performance devices to be made better suited to the constraints imposed by the conditions in which they must operate.

Demonstrations in response to operational requirements are needed to show that there are improvements to be exploited for significant gains in capability. The rapidly evolving threats to security demand that we consider all possible means to counter them; bio-inspired approaches offer one possible route, making use of nature's own highly efficient design processes to protect itself.

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Geo-Science Versus the Nuclear Industry: An Impending Showdown in Japan

Shigeyuki Koide, Freelance Science Journalist

The Japanese government and their domestic nuclear industry are facing a serious dilemma this winter. While geologists caution about the risk of active seismic faults beneath many of Japan's nuclear reactors, the electric power industry is pressing the need to restart nuclear power plants in order to supply stable electricity, mainly for industrial consumption.

This disagreement between the two communities of experts has, in turn, confused and frustrated the public, which now feels sceptical of both 'uncertain seismology' and 'unreliable nuclear engineering'.

Can Japan's new Prime Minister Shizo Abe address this crisis and secure the country's long-term energy strategy? What is the future for nuclear technology in Japan and around the world?

Japan's unprecedented earthquake of M.9.0 (on the Richter scale) of March 11, 2011, and the following Fukushima nuclear power plant accident, came as a shock not only to the Japanese public but also to many of the country's geologists and seismologists. The scientists forced to question their hitherto-established

standards for seismic risk control, agreeing that the risk of seismic faults must be re-evaluated at a basic level. The Japanese government also recently started a series of comprehensive assessments, collecting specific information about seismic faults surrounding major nuclear power plant sites. This, however, has resulted in a delay

in the resumption of operation of nuclear plants in the country for at least several months and potentially for much longer – posing a substantial challenge and cost for power-hungry industry currently relying on expensive imported energy.

Nuclear Power meets Geo-science in Japan

In 1963, Japan started producing electricity from nuclear power plants, just ten years after the US policy Atom for Peace was announced by President Eisenhower in 1953. The majority of Japanese people welcomed this decision, due in great part to the loss of access to traditional sources of energy, such as petroleum, as a result of defeat in World War II. Since then, Japan has continued to import and further develop nuclear technology, and today there are 54 nuclear power plants in Japan, which, until 2010, were supplying about 30% of the electricity in the country.

The unprecedented earthquake and subsequent tsunami in 2011 severely hit the east coast of Japan, including the Fukushima Daiichi nuclear power plants operated by the Tokyo Electric Power Company (TEPCO). TEPCO successfully stopped all of the nuclear reactors following the earthquake, but the lack of continuous water supply needed to cool down the power plants resulted in the

meltdown of nuclear fuel rods in the pressure vessel, while hydrogen gas explosions destroyed the reactor buildings. As a consequence 770,000 Tera Becquerel radioactive particles and compounds were scattered around the nuclear plants, corresponding to a radiation level 20 billion higher than the annual exposure

limit in the US, and about 110,000 people who were living within 30 km distance from the plants were forced to evacuate.

After the Fukushima accident, fearing similar or knock-on events, all nuclear reactors in Japan were ordered to stop their operation. Operators were instructed to install additional infrastructure to protect the reactors against tsunami and a self-generating electric system to cope with the sudden loss of external electric supply. Currently only two reactors – out of the existing 54 in Japan – are operating at the Oi nuclear power plant of Kansai Electric Power Co. in Fukui prefecture. These reactors resumed operation in July 2012.

While the nuclear industry was assessing the impact of Fukushima and reacting to public pressure to reform, the scientific community was forced to respond to the crisis. Many geo-scientists in Japan suffered public criticism for naively describing the disaster as “beyond expectation.” Despite many years of research, and the large amount of resources that Japan had invested in seismic research, no geologists or seismologists had predicted that a M 9.0 earthquake could or would occur in Japan or its coastal regions. Aside from Alaska and South America, geo-scientists

The prosecution of seven geo-scientists for manslaughter related to the underestimation seismologic risks and superficial reassuring of the population of L'Aquila may have encouraged Japanese scientists' post-Fukushima to 'play safe' in their assessment of risks

did not predict M.9.0 scale earthquakes anywhere in the world. In Japan itself, the maximum estimate was M.8.3. However, due to the exponential nature of the Richter scale, a M.9.0 earthquake actually indicates about 10 times greater energy than M.8.3.

The Seismological Society of Japan, the largest in the country, held a conference in May 2012 to discuss proposed new paradigms for seismological research. One major outcome was the revision of the definition of an active fault – this was vitally important as the Japanese government's safety guidelines prohibit the construction

of a nuclear plant directly above an active fault. Initially, in 1978, the guidelines determined that an active fault should show an evidence of seismic activity in the past 50,000 years, which was expanded to 120,000-130,000 years in 2006. At this conference, the Japanese seismologists revised the definition of the term ‘active’, expanding the previous referential range to a much longer timespan. This meant, however, that virtually the entire Japanese archipelago was now classified as an active fault.

In order to reassess possible earthquake risks at nuclear power plants in the country, the government launched the Nuclear Regulation Authority (NRA) in September 2012. The NRA's task was to investigate any potentially active faults located near to nuclear power plants, and to draw up new safety standards that regulate the conditions for restarting nuclear power plants. For the NRA to officially agree on reactivation of any nuclear reactor there must be an assurance that no active fault is found underneath the nuclear facility.

Since the geological studies by NRA experts started in November 2012, there has been growing concern about a suspected active fault located directly under the site of the Oi nuclear power plant. Mitsuhiisa Watanabe, Professor of Geomorphology at Toyo University and a member of the NRA's expert panel, believes that the risk of active faults has been intentionally underestimated by the scientists supporting Japan's nuclear industry. He insists that the Oi nuclear power plant should be suspended until the geological assessment of the NRA is complete.

It has been suggested, however, that related events abroad may have been influencing the

Japanese scientists. Following the 2009 L'Aquila earthquake in Italy that killed 309 people, the prosecution of seven geo-scientists for manslaughter related to the underestimation seismologic risks and superficial reassuring of the population of L'Aquila may have encouraged Japanese scientists' post-Fukushima to ‘play safe’ in their assessment of risks.

New Nuclear Safety Regulations

Pressure on Japanese scientists continued to grow, and in December 2012, a mere two months after the Italian verdict, the seismologists at the Japanese Nuclear

Regulation Authority substantially revised their definition of an active fault. According to the new definition, a fault is judged to be active if it has moved in the past 400,000 years. This revision resulted in a major shift in the nuclear safety regulations in Japan, severely limiting the areas that can accommodate nuclear power plants.

On December 10th, the Tsuruga nuclear power plant of Japan Atomic Power Co. (JAPC) in the Fukui prefecture was inspected by an expert panel of the NRA. There is a major active fault named Urazoko which lies about 250 meters from the nuclear reactor building. The panel focused on a fault fracture zone called ‘D-1’, which is located beneath the nuclear reactor building and is connected to the Urazoko fault. After inspecting test trenches and soil conditions for two days, the expert panel concluded that the D-1 fault is likely to be active or more accurately “cannot prove that the ‘D-1’ is inactive”. Consequently, Tsuruga, one of JAPC's major nuclear reactors, cannot be reactivated and may have to be scrapped.

Following Tsuruga, the NRA expert panel investigated the Higashidori nuclear power plant of Tohoku Electric Power Co. in the Aomori prefecture. Sure enough, they pointed out other active faults on the site of the nuclear plant. The NRA is now planning to investigate a total of seven nuclear power plant sites, where there are suspicious faults. The presence of these newly recognized ‘active’ faults may lead to an extended, large-scale suspension of nuclear electric supply in Japan.

JAPC responded to the NRA's decision on the Tsuruga nuclear plant stating that the NRA's conclusion is “based on too much speculation and lacks support from sufficient empirical data, and is therefore unacceptable”, announcing that the company would independently investigate the site to prove the inactivity of the D-1 fault.

Japan's Energy Future

Nuclear engineering requires the combined practices of many fields of science and technology such as civil engineering, earthquake engineering, architecture, and structural mechanics. Coordinating this effort, the Japanese Association for Earthquake Engineering (JAEE) has a membership of more than 1,000 researchers. However, not one expert from the JAEE was present on the NRA expert panel. In fact, following the ‘Fukushima Shock’ which drastically undermined public faith in the nuclear industry in Japan, researchers linked to the nuclear

industry were distanced from the NRA. As a result, the expert panel became dominated by ‘pure’ geologists, lacking engineers with practical knowledge.

In response, however, the nuclear industry points to the uncertainty inherent in seismology, and argues that the estimated risk of the newly defined ‘active’ faults is poorly substantiated. Katsuichiro Hijikata of the Japan Nuclear Safety Institute explains: “Risk assessment for nuclear facilities should not only focus on the existence of active faults on the site, but should also incorporate the frequency of seismic activity and potential physical impact of ground motion to the facilities. We need to approach this issue from various angles and discuss it in a more interdisciplinary manner.”

Japan has quite limited domestic energy resources. Energy has been, and will always be, at the heart of Japan's national security agenda. The country cannot afford to abandon its nuclear energy programme without addressing the challenges that accompany the alternatives, such as the potential increase in CO₂ emissions and high cost of importing natural gas. While a comprehensive review and revitalization of national energy strategy is urgently needed, the lapse in communication between geoscientists and nuclear engineers is today's most pressing roadblock.

However, a much-needed breakthrough may be possible. The new Prime Minister Shizo Abe and his cabinet are now aiming to bridge this divide and successfully communicate the uncertainty and risks of nuclear technology to the public. The short-term nuclear phase-out plan, which had been pushed through by the previous cabinet, is now likely to be replaced by a more realistic, long-term strategy to gradually introduce more sustainable energy options in place of nuclear energy such as the use of ‘smart grids’ that optimize efficiency by combining various sources of energy while monitoring and controlling the balance between the supply and consumption of electricity. Time will tell if Japan's tsunami has nudged it on a new path away from nuclear.

Shigeyuki Koide was Science Editor for the Yomiuri Shim-bun, one of the most popular broadsheets in Japan, and has subsequently committed his expertise to unravelling the details surrounding the Fukushima incident. He is a former visiting researcher at Imperial College London and now works as a freelance science journalist.

Can We Make Our Demand for Food Sustainable and Secure?

Prof. Tim Benton, Global Food Security Programme and University of Leeds



Demand for food is growing globally, with some estimates suggesting the need for 60% more food while using less land and less water in the face of a changing climate. Addressing over-consumption and waste are routes to reducing demand, but these probably won't balance the need to produce more food. To what extent can we increase food production in a way that is both sustainable and secure?

Food is something that everyone needs all the time. Given the ability to eat more than is good for us, many of us do. Much of the food stuffs we particularly like are also demanding to produce from energetic or environmental perspectives; beef, for example, converts plant nutrients to muscle at about a quarter the efficiency that chickens do.

Wanting to eat more, and more “expensive to produce” food, is entirely human: as people get richer they eat more and this has been a sustained trend throughout history. As, on average, the world is getting richer, the demand for food per person reflects this trend and is increasing. This, coupled with significant population growth, especially in sub-Saharan Africa and Asia, underlies the FAO's¹ estimate that global food demand will increase by 60% by 2050.

Food Demand is Outstripping Supply

We are experiencing the third spike in food prices in the last 5 years. Increasing food prices may not only lead to a rise in starvation and malnutrition disorders in the developing world, but can also undermine

Increasing food prices may not only lead to a rise in starvation and malnutrition disorders in the developing world, but can also undermine governance in the most fragile economies

governance in the most fragile economies. For instance, food price riots were a contributory fact in the civil unrest that sparked the ‘Arab Spring’.

Breakdown of social order has consequences that are felt far beyond the country in question, whether via an increased need for trade, or aid, or increasing migration rates, and results in knock-on effects on global order. Increasing food prices also enhances the disparity between the rich and the poor in any nation; leading to the potential for a variety of social ills as well as malnutrition and inability to access food.

The US Census Bureau estimates that there were nearly 50m people in the US who were food insecure in 2010. Thus, the demand-supply imbalance, accentuated by extreme weather events, is beginning to have significant consequences throughout the world.

A global aspiration to eat ‘westernised diets’ may not be attainable, and even if it is, it will not be sustainable. The World Wildlife Fund's 2012 Living Planet report² sug-

gests that “if everyone lived like an average resident of the USA, a total of four earths would be required to generate humanity's annual demand on nature”. A recent report on water from the Stockholm International Water Institute³, sets an upper limit of about 5% of meat in the average diet, purely due to water constraints, by mid-century.

As the world gets richer, more people can afford to eat like us, but equally, global resources are not available for the level of production that would be required. The

health drawbacks of the westernised diet are also becoming increasingly clear. Both factors suggest the need for a change in our expectations of what we can demand to eat.

By tackling waste, as well as consumption, we have a mechanism to reduce overall demand. At the moment, richer people tend to be wasteful of food, and, in the UK, we typically throw away about 20% of the food we buy.⁴ The more we can tackle waste and unsustainable consumption, the more we can relieve the pressure on increasing the global supply of food.

What is Stopping Us Growing More?

Managing waste and over-consumption will not fully counteract the growth in demand for food – partly because demand is growing faster than our ability to change the consumption and purchasing behaviour that drives the food system in its current configuration.

‘Growing more’ is not as straightforward as it has perhaps been in the past. Firstly, as a first approximation there is no more land available, perhaps even less. A map of the global land area under pasture or cultivation clearly shows that the majority of the available land area is used; the remainder is typically under rainforest. Converting rainforest to agricultural land would be the fastest way to accelerate climate change – not to mention the inestimable loss of biodiversity.

Secondly, competition for water is increasing, such that projections suggest that over 50% of the world's population will exist in areas where demand has outstripped supply by 2050. Already agricultural production drains about 70% of the world's available fresh water, and clearly societal and economic use of water (by industry)

exerts a growing demand. Thus, for many areas of the world, any increase in production to meet demand cannot rely on anything approaching a proportional increase in water use.

Thirdly, the considerable worldwide increase in production in recent decades has been underpinned by the use of a broad range of agro-chemicals, including synthetic fertiliser and pesticides. Both of these have negative environmental impacts, and in some areas, there is a growing societal pressure to reduce their use. Synthetic nitrogen fertiliser also requires significant energy to manufacture, contributing to agriculture's greenhouse gas (GHGs) footprint. And again, there is utmost need to address issues to minimise GHGs to prevent further climate change.

Farming is affected by the weather, not the climate, on a daily basis. Hansen et al⁵ show that the weather's variability is increasing much faster than the climatic mean is moving. The daily news is replete with reports of “once in 100 years” weather events occurring year after year. As weather has a particularly large impact on biology, the increasing frequency of extreme weather events is worrisome. For example, for many crop plants, a rise in temperature of 30% – especially around flowering – results in a significant drop in yield.

Thus, whatever the climatic mean, a few days of heat wave at 35 degrees can be catastrophic to yields. The past year has witnessed drought and extreme temperatures in both Eastern Europe and the mid-West; and, as part of the same overall climatic phenomenon. Northwestern Europe experienced a very wet summer, which had significant repercussions on local yields. Together, these northern hemispherical events impacted net agricultural production, leading to an increase in global food prices.



It may be most efficient to specialise the production of goods to areas where they grow best, rather than trying to produce everything everywhere.

Thus, whatever the future may hold for climate change, the impact of extreme weather events is already observable. We are witnessing a period where supply does not always meet demand, which contributes to increasing food price volatility.

Greening Agriculture: The Need for Sustainability

The recent history of agriculture has undervalued the natural capital that underpins our very existence. Thus, in addition to the constraints on production growth due to climate, water, land and resource availability, agriculture needs to become more sustainable. The environment provides a range of services that we value: soil biodiversity helps with soil fertility and carbon storage, vegetation and soils filter and clean water providing access to fresh water; insects pollinate crops, increasing yields, and others may be the natural enemies of pests and so on.

For example, recent work indicates that tropical forests provide a range of services to the local population: fuel, fibre, food, pollination of crops, prevention of soil erosion and ground water storage. It is also increasingly recognised that they release water into the atmosphere, along with organic molecules, and that, coupled with the surface texture and reflectance, help to stimulate cloud formation essential for rainfall onto nearby land.

Agricultural production needs to become more environmentally sustainable because, without doing so, the ability to grow and sustain production is threatened. This transition to sustainability will need to be driven by a range of innovations.

An important area for innovation will be increasing 'precision agriculture' which encourages smarter farming: applying fertiliser on those patches in the field which most require it, and only at times when it is necessary. New agricultural equipment and techniques will allow weeds to be sensed using cameras and sprayed, without the need for spraying the whole field. Proper management of soil will both enhance fertility and store carbon and water, useful in times of drought, with further prevention of erosion. Growing more with less will inevitably call for new varieties – whether from modern molecular biology – coupled with conventional breeding, or via GM technology.

- [1] World agriculture towards 2030/2050: The 2012 Revision (June 2012) ESA Working Paper No 12-03. *Food and Agriculture Organization of the United Nations.*
- [2] Living Planet Report: Biodiversity, Biocapacity and Better Choices (2012). *WWF.*
- [3] Stockholm International Water Institute report.
- [4] WRAP (2011) New estimates for household food and drink waste in the UK.
- [5] Hansen J., Sato M. & Ruedy R. (2012) Perception of Climate Change. *PNAS*, **109**, 14726-14727.

New ways of growing food – such as aquaponic systems in cities, and perhaps also artificial meat cultured from stem cells without using the organism – will inevitably be part of local solutions. What is not possible is cheap, plentiful, extensively grown food (such as from organic systems) for everyone, because there simply will not be enough land available to meet demand.

We also need to protect and enhance ecosystem services. A recent estimate suggests that small wasps provide £50 per hectare of pest protection services reducing the need for spraying for aphids. Pollination provides over £400m of benefit to the UK. By recognising these values, and the value of soils and water, rather than regarding them as 'free' and valueless, it makes economic sense to manage some patches of land to ensure that these services are maintained, for example, in agri-environment margins. By being smart about the placement and design of such margins, and with specific management of other non-cropped areas, it is possible to design a 'multifunctional landscape' that provides the services we require and produces the food we demand.

Smart agriculture then has a number of important components: at the landscape scale we need to exploit more efficient farming methods, producing both food and other ecosystem services. However, different landscapes will differ in the range of foods and services they can produce, and smart agriculture will increasingly require specialisation of land use: if the environmental cost is low, and the yield high, an area may be most efficiently used for production (and vice versa for ecosystem services).

In other words, producing food efficiently over a small area where the land is best suited would be more appropriate than doing it inefficiently over a larger area, which would mean increasing land pressure and undermining more ecosystem services.

Clearly, smart agriculture requires a shift in thinking, policy and governance, to prevent the market simply driving for production at all costs. This is possible, but it requires the recognition that land use decisions impact on more than the land in focus.

Can we Produce Enough Food Sustainably?

Yes but ...

First, we need to reduce demand in order to relieve pressure on land and natural resources. This requires each

of us to moderate our own demands for food, and decrease our waste. In turn, moderating demand requires a much better general understanding of what makes a nutritious diet and what can be sustainably produced.

Second, we need to be smarter about agricultural production and eco-system management. Should production rise without increasing the land area - and without doing it more sustainably – then this would call for greater efficiency in terms of our use of resources.

Third, we need to recognise that we live in a global world: many of the ingredients in our daily diet come from all round the world. Often, the transport component of the total carbon budget is relatively small – so eating local may not make sense on intrinsically sustainable grounds; in fact it may perhaps be most efficient to specialise production of goods to areas where they grow best, rather than trying to produce everything everywhere.

And fourth, we need to recognise that a global food market implies that the food we consume comes with environmental costs which may be paid anywhere in the world. We could turn the EU into a 'green and pleasant land', with low and extensive production and high environmental protection; but our demand for food would not decrease, so we would simply import more – paying others to carry the environmental burden we locally avoid. Furthermore, under-exploiting our very productive farmland will reduce global production, and increase global prices, which may impact most on the poorest people – here and abroad.

Thus, in our agricultural landscape, the stakeholders are not just our citizens, but also people in other parts of the world whose local land will be affected through market signals as we change our land use.

The challenge for us is to find the right balance between what we demand, what the environment needs, and what other people need from us (in terms of food imports and exports). This is not easy, but we are all global citizens, increasingly connected through the global food system.

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Bitcoins and the Silk Road: An Emerging Online Drug Market

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The Silk Road (SR) is an online illegal drug market where pseudonymous buyers and sellers can trade and transfer money via an online currency called Bitcoin. Buyers can also browse vendor pages, and place orders similar to any conventional e-commerce site – somewhat akin to shopping on Amazon. Operational and widely publicized since early 2011, it has been calculated that SR achieved an annual revenue of \$22m from 2011-2012¹.

The Silk Road owes its ideological and historical foundation to the now-obscure cypherpunk movement – a loose affiliation of cryptographic researchers and enthusiasts in the 80s and 90s who were interested in the relationship between cryptography and social and political change, and embraced secure self-regulation. Within this context, the Silk Road is described here as an innovative decentralized marketplace embodying the philosophical foundations of cypherpunk economic reasoning. Cypherpunk technology has begun to make waves in the murky black markets of online trading, but could it influence the mainstream?

'The state would leech into the veins and arteries of our new societies, gobbling up every relationship expressed or communicated, every web page read, every message sent and every thought googled, and then store this knowledge... But we discovered something. Our one hope against total domination. A hope that with courage, insight and solidarity we could use to resist. A strange property of the physical universe that we live in. The universe believes in encryption. It is easier to encrypt information than it is to decrypt it.'

Julian Assange and co-writers
*Cypherpunks: Freedom and the Future of the Internet*²

The cypherpunk paradigm can be summarized as replacing centralized systems of interactions, such as those operated by governments, with secure decentralized systems of voluntary interaction regulated by mathematics and economics. The cypherpunks developed many novel ideas and approaches to communication, economics, and politics, with achievements including the development of anonymous email remailers and helping to defeat USA export restrictions on cryptography (key to safe internet commerce outside the USA).

The ideal cypherpunk system is self-enforcing, self-regulating, and cannot be attacked directly by outsiders because they do not know where it is or how to affect it. Such systems ensure that communications are kept private from all third-parties, anonymity is guaranteed and there is no interference from external parties. Social mechanisms like reputation are replaced by formalized systems such as feedback and legal mechanisms like anti-fraud statutes superseded by mechanisms such as escrow or bonds (which can be fortified by cryptographic techniques such as multiple-party signatures). This type of decentralization is key to SR's success and ability to continue as an illegal online drug market place.

Bitcoins

Bitcoin is the online currency underlying SR. The fundamental challenge confronting any electronic currency is coping with the 'double-spend problem': when transactions conflict (e.g. spending twice the same unit of currency), which transaction takes priority? Double-spends are difficult to perform with non-electronic money since you cannot give a dollar bill to one person while simultaneously giving it to another, but can be done easily with electronic messages.



Centralization appears in many guises in currency systems: cryptographic pioneer David Chaum's own electronic currency could guarantee complete anonymity to anyone 'spending' a coin, solving the double-spend problem by ensuring that a double-spend leaks enough information such that anonymity evaporates. However, the maths only works with a central 'bank' that could be attacked and, due to this centralized point of failure, Chaum's system never took off.

If we avoid the problems of centralization and attempt to create a decentralized system, we face a different but equally challenging set of problems. Without centralization, in a distributed system in which no party has veto power (and any party can be anonymous or a mask for another party), how and who decides which of two conflicting transactions is the 'real' transaction? Must a distributed system simply allow double-spends, and thus be useless as currency? It turns out that the answer is no. The underappreciated genius of Bitcoin is that it considers the valid transaction to be simply the one that had the most computing power invested in producing it.

In the Bitcoin distributed system, there are many 'good' parties at work producing new transactions, and they will independently latch onto one of the two competing transactions produced by an attacker and incorporate it into future transactions; the amount of computing power necessary to out-invest those other parties quickly becomes too enormous for any one (potentially

fraudulent) entity to invest. Within hours, one transaction will be universal, and the other forgotten. Hence, Bitcoin is an acceptable cypherpunk currency: it is decentralized, parties participate out of self-interest, and it is economically infeasible to attack Bitcoin directly.

The Silk Road as Cyphernomicon's Black Markets

The design of SR evolved from cypherpunk designs for anonymous email: messages are swapped such that observers cannot tell the sender or destination of a message, and is heavily influenced by Timothy C. May's 1994 manifesto Cyphernomicon³. The Silk Road is an unregulated black marketplace which is accessed via Tor, a labyrinth of virtual tunnels originally developed by the U.S. Naval Research Laboratory, with the primary purpose of protecting government communications. SR is made up of pseudonymous entities, who communicate privately and securely via public-key cryptography to arrange purchases. It uses an escrow scheme for payment of vendors only on receipt of goods (see below). Buyers publicly rate their vendors who, in turn, are required to post the equivalent of bonds as surety before being allowed to sell their wares.

From an economic point of view, several measures serve to guarantee tight regulation of the market. The SR is paid as a percentage of transactions; hence, it is motivated to encourage as high a turnover as possible, and maintain the satisfaction of both buyers and sellers. Sellers are encouraged not to scam buyers because they will not gain access to their bitcoins in escrow and enough violations will forfeit their deposit held by SR. Buyers have limited incentive to scam sellers because their bitcoins are paid in advance and not held under their control; SR arbitrates disputes and more than a few bad transactions can lead to balances forfeited and blacklisting.

[1] Christin, N. (2012) Traveling the Silk Road: A Measurement Analysis of a Large Anonymous Online Marketplace. Working Paper, Carnegie Mellon INI/CyLab.
[2] Assange, J., Appelbaum, J., Muller-Maguhn, A. & Zimmermann, J. (2012) Cypherpunks: Freedom and the Future of the Internet. OR Books.
[3] May, T. C. (1994) The Cyphernomicon: Cypherpunks FAQ and More, Version 0.666. Cypherpunks.to.

Trust in an Anonymous World

Timothy May³ laid out the necessity of escrow for a marketplace which uses both pseudonymity and untraceable digital cash. On-line clearing suffers from the same danger implicit in all trades: Alice hands over the money, and then Bob verifies that it has cleared into his account but then fails to complete his end of the bargain. If the transaction is truly anonymous, and conducted via electronic cables, then of course Bob just hangs up his modem and the connection is broken. Alternatively, escrow agents that are untraceable but have established a digitally-signed presence and a good reputation for fairness act as mediators and hold payment until the goods are delivered.

Beyond the basic cryptographic and features of the site itself, SR embodies the cypherpunk dream of letting free-market forces operate to inform buyers, enabling them to find sellers with whom they can reach mutually acceptable agreements. For example, the psychedelic LSD is one of the more difficult purchases because there are a bewildering array of options and scammers are unusually common. The SR interface displays a similar review system to most centralized online e-commerce sites, including feedback information, overall reviews and LSD specific reviews. This allows anyone to carry out a simple and quick analysis of each vendor and, as with other online marketplaces, enables an elementary risk/benefit approach to be applied to the drug market, giving increasing power and choice to the previously constrained buyer. Will this lead to further illegal markets taking this more transparent approach?

The End of the Road?

The SR drug market has grown and thrived beyond all expectations, despite an extraordinary – and perhaps unprecedented – level of media coverage and transparency of operation. While SR maintains anonymity, to many users this is not a critical issue as they have little interest in the drugs law enforcement is most concerned with, such as heroin or cocaine. For many, the use of SR has become less about scoring drugs safely and more a statement of principle: they believe that they are capable of researching and evaluating drugs, and their associated risks, thus rejecting government regulation in this area.

SR exposes the scale of illicit drug use, providing a benchmark for understanding what estimates of the global black market really mean: if the Silk Road has

turnover of \$20m a year and the black market turnover is closer to \$100b a year, then the latter is equivalent to 5000 Silk Roads. By its use of public technology (even immature and hard to use technologies) and ordinary postal services, it demonstrates the infeasibility of the long-standing War on Drugs, which has arguably been a greater disaster than Prohibition.

The success of SR took many by surprise (including this author) who had assumed that it would quickly be shut down by law enforcement, fall victim to hackers seeking a lucrative payday, or at best devolve into a lemon market with a few overpriced goods. All three of these possibilities still exist: lengthy SR downtime in November 2012 fueled speculation that law enforcement had finally found a viable attack or that SR was suffering a Denial of Service (DoS) attack. SR's administrator stated that the downtime was due to 'a record' number of users; but if large numbers of legitimate users can accidentally take down the site, clearly a fully-fledged DoS attack is feasible. The real danger may be internal: that the community itself might be skewed towards scammers, and buyers will just give up and buy somewhere else. So far, it appears that the administrators have done a good job of maintaining the balance.

But supposing that SR continues to have an annual turnover of millions of dollars in drugs and other goods? The next development may be 'information markets': black markets for leaked data, whistleblowers, corporate espionage, or personal information such as credit card numbers. Existing 'carding forums' may be a market niche to usurp, as they have had problems with law enforcement infiltration and could benefit from increased security. Similarly, WikiLeaks has reportedly tried to auction off access to documents in its possession, and while the auctions failed, this may be due to defections and severe internal turmoil as opposed to flaws in the fundamental idea.

Cypherpunk technology appears to have built a sustainable framework for the operation of illegal online markets such as the Silk Road, but can it influence the development of platforms for e-commerce and trade more broadly? Researchers and digital entrepreneurs may benefit from taking a look back at these forgotten pioneers.

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The War on Drugs: Moving Towards a Public Health Approach

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The War on Drugs began in the early 1970s when President of the United States of America Richard Nixon proclaimed illicit drug abuse “public enemy number one.”¹ Multiple United Nations conventions in 1961, 1971, and 1988 also tried to address the problem by criminalizing the possession, use and manufacture of illicit drugs.² Policy makers argued that harsh law enforcement action against those involved in producing, distributing and using illegal drugs would decrease supply and demand of drugs such as cannabis, heroin and cocaine, and lead to a drug-free world.³

However, an increasing number of politicians, heads of state and influential policy makers from around the world are now declaring that the existing approach, which focuses heavily on the use of law enforcement and sanctions, has failed to prevent illicit drug use and supply, or curtail the wider socio-economic and health issues associated with taking them. It is argued that a change to the current paradigm is therefore needed sooner rather than later.

The 2011 report by the Global Commission on Drug Policy concluded that “vast expenditures on criminalization and repressive control measures directed at producers, traffickers and consumers of illegal drugs have clearly failed to effectively curtail supply or consumption”. On

- [1] Wood, E., Werb, D., Marshall, B. et al (2009) The War On Drugs: A Devastating Public-Policy Disaster. *The Lancet*, **373**(9668): 989-990.
- [2] Bewley-Taylor, D., 2003. Challenging the UN Drug Control Conventions: Problems and Possibilities. *International Journal of Drug Policy*, 14:159.
- [3] Report of the Global Commission on Drug Policy (June 2011) *Count The Costs*.
- [4] Ibid.
- [5] World Drug Report (2010) United Nations Office on Drugs and Crime.
- [6] The War on Drugs and HIV/AIDS How the Criminalization of Drug Use Fuels the Global Pandemic (June 2012) Report of the Global Commission on Drug Policy.
- [7] Rolles, S., Murkin, G., Powell, M. et al (June 2012) The Alternative World Drug Report: Counting The Costs of the War On Drugs. *Count the Costs*.

the demand side, UN estimates of annual drug consumption between 1998 and 2008 indicate that there was a 34.5% increase in the number of opiate users, a 27% increase in the number of cocaine users, and an 8.5% increase in the number of cannabis smokers.⁴ On the supply side, data from the United Nations Office on Drugs and Crime, indicate that the worldwide supply of illicit opiates such as heroin and opium has increased dramatically by more than 380% over the past three decades, from 1000 metric tons in 1980 to more than 4800 metric tons in 2010.⁵

Further evidence also suggests that despite the US budget for international supply reduction and counter-narcotics activities steadily increasing, the purity of cocaine has remained persistently high, while, during the same period, the purity- and inflation-adjusted price of cocaine in the US has concurrently dropped by more than 60%, suggesting that the overall supply of cocaine has overwhelmed law enforcement efforts.⁶

But the problem is more complicated than one of just supply and demand. There are a multitude of other indications that the War on Drugs has been a failure.

Counting the Cost of the War on Drugs

Enforcing the War on Drugs has been costly, with some estimates in the region of \$100billion each year.⁷ Given the current economic climate and global uncertainty, it has been argued that this money could be more effectively spent elsewhere and is diverting funds from other law enforcement needs.

Besides the economic cost, there has been a significant social cost. Stringent enforcement measures, especially those seen in recent years, have also led to a huge

increase in violence and death. Upon coming to power in 2006, the former President of Mexico Felipe Calderón embarked on an ambitious heavy-handed crackdown on the drug gangs and cartels operating in the country. During his six-year term as leader, an estimated 50,000 to 55,000 people were killed as a result of drug-related violence in Mexico alone.⁸

The War on Drugs and the heavy-handed enforcement measures aimed at curtailing both supply and demand have also had a very negative impact on other aspects of public health. As a result, there is increasing recognition that any new approach needs to avoid the harm that the War on Drugs has done to drug users.

The adverse health effects of drugs are well documented. However, as the Transform Drug Policy Foundation outlines in its series of publications on the War on Drugs, “Count the Costs”, the health risks that have emerged directly as a consequence of the War on Drugs are great, and are threatening public health and spreading disease. These risks are separate to the adverse health effects of the drugs themselves, and are caused by the punitive approach that criminalizes many users. Often, these users are some of the most vulnerable members of society. Criminalizing use also puts organized crime gangs in control of the industry – gangs that give no consideration for the health impacts of their trade.

Evidence suggests that the enforcement-led approach maximizes harm to users and encourages risky behaviours and using environments,⁹ and that, as a direct

There ... exists a strange paradox where on the one hand authorities ban the use of certain kinds of drugs, but allow the use of what some would consider to be more dangerous products

result of enforcement against possession of drug-injecting paraphernalia, needle sharing can become more common, therefore increasing the risk of blood-borne virus transmission.¹⁰

Helping Users via Harm Reduction Policies

The enforcement-based approach also creates obstacles to effective harm-reduction policies. Harm-reduction policies, as opposed to policies to reduce drug use itself, emerged in the 1980s as a non-judgmental approach to tackling the health risks around drug-taking. Measures such as needle exchanges and opioid substitution therapy arose in response to the risk of HIV transmission from intravenous injecting. Countries that have successfully implemented comprehensive harm reduction strategies from the onset of the HIV epidemic in the 1980s, such as the UK, Switzerland, Germany and Australia, have much lower prevalence of HIV among those who inject drugs, compared with those nations that have only partially introduced, or introduced late, harm-reduction strategies, such as the US, Portugal and France. Nations that have never implemented any national harm reduction strategies have extraordinarily high HIV prevalence among injectable-drug users, such as Thailand, where prevalence is well over 40%.¹¹

Harm reduction is considered a highly cost-effective mechanism for reducing the risks associated with drug use. However, it seems that obstacles to expanded provision are primarily driven by failure of politics rather than of resources,¹² and despite their becoming increasingly established, evidence suggests that the uptake of harm reduction strategies remains limited, especially in low- and middle-income countries.¹³

Owing to the fact that drug users are classified as criminals, some find themselves in prison, often with their drug dealers or members of the crime networks that supply their dealers. Treating users as criminals has proven to be counterproductive, as drugs are prevalent in prisons and many lack harm reduction strategies, and so incarceration usually does not reduce the negative health effects associated with use. High levels of drug use continue among those who are incarcerated, and also bring with it additional risks including initiation into high-risk drug using behaviours.¹⁴ Prison-based harm reduction programmes are only available in very few countries, with prison-based opioid substitution therapy

- [8] Archibold, R. & Cave, D. (2012) Candidates in Mexico Signal a New Tack in the Drug War. *The New York Times*, 10 June.
- [9] The War on Drugs: Threatening Public Health, Spreading Disease and Death (2011) *Count The Costs*.
- [10] Rhodes, T., Singer, M., Bourgois, P., Friedman S. & Strathdee, S. (2005) The Social Structural Production of HIV Risk Among Injecting Drug Users. *Social Science and Medicine*, 61 (5): 1026-1044.
- [11] Report of the Global Commission on Drug Policy (June 2011) *Count The Costs*.
- [12] Stimson, G., Cook, C., Bridge, J., et al (2010) Three Cents is Not Enough. *International Harm Reduction Association*.
- [13] Cook, C. (2010) The Global State of Harm Reduction: Key Issues for Broadening the Response. *International Harm Reduction Association*.
- [14] The War on Drugs: Threatening Public Health, Spreading Disease and Death (2011) *Count The Costs*.



A soldier searches a vehicle at the Juarez Avenue border crossing into the USA in Juarez, Mexico. More than 1600 people were killed in Juarez in 2008, making Juarez the most violent city in Mexico.



Police investigator at the scene of a shoot out believed to be part of on-going drug war in a slum in Juarez, Mexico.

only being available in fewer than 40 countries, and prison-based needle exchanges only available in one in ten countries,¹⁵ despite clear guidance on harm reduction strategies available from the World Health Organization, United Nations Office on Drugs and Crime and UNAIDS.¹⁶

Other impacts associated with the War on Drugs are that in many countries enforcement often has consequences for human rights and subsequently health harms, through torture, corporal punishment and in some extreme cases capital punishment. Global enforcement efforts also have significant negative repercussions on the medical use of opiates for pain control and palliative care, as restrictive policies and regulations have been imposed in order to control illicit diversion of drugs. However, this means that a highly significant number of people around the world, especially in low- and middle-income countries, have limited, if any, access to opiate medicines, which are a cheap and very effective source of pain relief.¹⁷

There also exists a strange paradox where on the one hand authorities ban the use of certain kinds of drugs, but allow the use of what some would consider to be more dangerous products. This further exacerbates the risks to public health, as people infer from the legal status that these substances are less harmful than the ones that are banned – an assumption that some experts say is wrong. The former British government drugs adviser and Imperial College academic Professor David Nutt put the issues in context when he stated in 2009 that,

statistically, alcohol and tobacco are more dangerous than LSD. So in short, the way in which we classify drugs also bears almost no relation to their relative degrees of harmfulness to health.

Other so-called ‘legal highs’ further add to the confusion as their classification as legal is wholly misleading. Just because they are legal, it does not mean that they are safe.¹⁸ They are simply drugs that have not made it onto the list of illegal substances. The existing system has some fundamental conceptual challenges and seems unable to keep up as more and more drugs are continuously added to the list of banned substances. As soon as a new drug or legal high is added to the list to make it more difficult for users to obtain, it is not long before another legal substance – either already existing or new – replaces it on the drug-taking scene. This does not benefit public health as there is potentially a new health risk in the form of the danger associated with every new drug that emerges on the

[15] Cook, C. (2010) The Global State of Harm Reduction: Key Issues for Broadening the Response. *International Harm Reduction Association*.

[16] HIV/AIDS Prevention, Care, Treatment and Support in Prison Settings: A Framework for an Effective National Response (2006) United Nations Office on Drugs and Crime, World Health Organization, UNAIDS.

[17] The War on Drugs: Threatening Public Health, Spreading Disease and Death (2011) *Count The Costs*.

[18] Legal Highs (2012) *NHS Choices*.

[19] ‘War on Drugs’ Has Failed, Say Latin American Leaders (2012) *The Guardian*. 7 April.

[20] U.S.-Colombia Trade Deal to Take Effect in May (2012) *CNN online*. 14 April.

[21] *Ibid*.

[22] Ken Clarke: Britain Plainly Losing War on Drugs (2012) *The Telegraph*. 3 July.

black market. Furthermore, it is often the case that little is known about its health effects initially, which poses a real challenge to emergency services and those developing treatment strategies.

Political Support for Change

Owing to the growing consensus that the existing approach has failed, there is increasing political will for a new approach, moving away from the costly enforcement-based model in order to address issues relating to gang-related violence, help reduce the huge amounts of money that are spent on law enforcement, and minimize the health risks for users.

However, national drugs policy and prevention strategies are contentious issues for politicians. The use of certain drugs has for many years been regarded as a criminal activity, and many politicians have been reluctant to change the existing approach because of endemic fears of potential backlash against altering the status quo. For politicians, being seen to be soft on drug users is often perceived as being soft on crime, something that could lose them votes. But Latin American States are leading the charge for a change to the current enforcement-based approach.¹⁹

Newly elected Mexican President Enrique Peña Nieto has pledged to make violence reduction a priority after his predecessor Felipe Calderón’s heavy-handed crackdown. Similarly, Colombian President Juan Manuel Santos called for a reassessment of existing counter-narcotic strategies and an examination of possible alternatives at the 2012 Summit of the Americas. “I think the time has come to simply analyze if what we are doing is the best we could be doing, or if we can find an alternative that would be more effective and less costly to society ... One extreme can be to put all users in prison. On the other extreme, legalization. In the middle there may be more practical policies, such as decriminalizing consumption but putting all the efforts into interdiction.”²⁰

At the same summit, the President of the United States of America Barack Obama stated: “I think it is entirely legitimate to have a conversation about whether the laws in place are doing more harm than good in certain places.” However, he did clarify his remarks by stating that the United States will not be embarking on the path of legalization.²¹ The past 12 months has also seen a significant shift in the debate in the UK. Speaking to the

Home Affairs Select Committee in July 2012, former Justice Secretary Ken Clarke said: “We have been engaged in the War on Drugs for the past 30 years. We are plainly losing it.”²²

Thus, as momentum for a change in approach gathers pace, it appears that the political will is now also present for alternatives to be considered; something that would have been almost inconceivable not even five years ago.

The Difficulty in Finding an Alternative

Ultimately, the evidence suggests that the War on Drugs has failed to limit supply and demand, it has cost billions of dollars per year to enforce and resulted in many thousands of deaths. It has failed to combat the social ills associated with drug use, and it has only served to exacerbate the health toll of drugs on drug users. As the Global Commission on Drug Policy concluded, it is becoming clear that the global drug problem is not a war that needs to be waged or won. Rather, it is a set of interlinked health and social challenges that need to be managed.

Politicians around the world are increasingly accepting that the time has come for a change. But finding a suitable alternative may be a tall order. Shifting away from the prohibition approach would no doubt reduce the burden for law enforcement agencies, and a move towards a new strategy focused around public health will no doubt reduce some health concerns associated with illicit drug use.

However, although the rhetoric of shifting towards a public health approach is straightforward, in reality it is much harder to implement, and whatever change takes place needs to do so without promoting the normalization of drug use. Should we move towards decriminalization of drug use while continuing to pursue drug-related organized crime, violence and intimidation, or should we lean towards a system of legalization and regulation of drugs? This decision will create a huge challenge for policy makers in the coming years, but at least this conversation is now underway at the highest levels and it appears that progress is being made toward a public health approach to managing drug use.

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Growing Up With HIV

Dr. Caroline Foster, Imperial College Healthcare NHS Trust

30 years after AIDS was first discovered, increasing numbers of children born with HIV in regions of the world with access to highly active antiretroviral therapy (HAART) are surviving childhood, entering adolescence and transitioning towards adult care. Hence perinatally acquired HIV (PaHIV) has become a chronic condition of childhood.

Improved survival due to HAART, high rates of uptake of antenatal HIV screening and successful interventions reducing mother-to-child transmission (MTCT) to less than 1%, has resulted in an aging European paediatric population of PaHIV patients, the average age in the UK being 14 years¹. However, worldwide an estimated 2.1 million children live with HIV, the vast majority infected during pregnancy, delivery or breastfeeding. Whilst HAART has markedly reduced HIV-associated mortality, in low and middle-income countries, only 23% of children requiring HAART had access to therapy in 2010². Without treatment more than 50% of infected African infants die before their second birthday, yet adults acquiring HIV horizontally with access to HAART have a near normal life expectancy.

This article concentrates on issues faced by adolescents growing up with HIV acquired at birth, yet young people are affected by this global epidemic disproportionately; more than 40% of the 2.7 million annual new infections occur in 16-24 year olds, the majority infected sexually². Navigating adolescence

with any chronic disease may be difficult, but to do so with a disease potentially transmissible to future partners and children is even harder and more complicated, and often compounded by the stigma and secrecy associated with HIV.

Antiretroviral Therapy

Adolescents with PaHIV have a varied antiretroviral history determined by treatment availability, the timing of their diagnosis and the rate of disease progression. Whilst around a quarter of infected children will present with symptoms within the first year of life, up to 10% will survive into adolescence with no or minimal symptoms and well maintained immune function – termed ‘long term nonprogressors’. Hence it is possible for adolescents born with HIV to become sexually active with the risk of onward transmission to partners whilst being unaware of their own status.

In the UK more than 90% of children diagnosed with HIV are followed prospectively in the Collaborative HIV Paediatric Study (CHIPS) until transfer to adult services at an average age of 17 years¹. In this UK cohort of more than 650 adolescents aged 10 years and over, at the last follow up two thirds were on antiretroviral therapy, three

- [1] Collaborative HIV Paediatric Study [online] Available at: <http://www.chipscohort.ac.uk/summary_data.asp> [Accessed 30 December 2012].
- [2] Key facts on global HIV epidemic and progress in 2010. WHO. [online] Available at: <http://www.who.int/hiv/pub/progress_report2011/global_facts/en/index1.html> [Accessed 30 December 2012].
- [3] Foster, C. Judd, A., Tookey, P. et al. (2009) Young People in the UK and Ireland with Perinatally Acquired HIV: the Paediatric Legacy for Adult Services. On behalf of CHIPS. *AIDS Patient Care STDs*. **23**(3):159-66.
- [4] Reisner, S.L., Mimiaga, M.J., Skeer, M., et al. (2009) A Review of HIV Antiretroviral Adherence and Intervention Studies Among HIV-Infected Youth. *Top HIV Med*. **17**(1):14-25.

quarters of whom had HIV viral loads of <400 copies/ml, and 18% were treatment naïve³. Nearly a third of the adolescent cohort had commenced treatment prior to 1998, in the era of mono/dual therapy and almost half of those who had received HAART had received the 3 main antiretroviral drug classes. Of the 166 adolescents with resistance assays available, 52% and 12% had evidence of dual- and triple-class HIV-1 associated resistance mutations respectively and 12% of the cohort had evidence of severe immunosuppression with CD4 counts <200 cells/uL³.

Higher HIV viral loads in early childhood, a lack of palatable paediatric formulations, limited data on antiretroviral pharmacokinetics in adolescence and the complexities of dosing dependent on changing weight during growth, all play a role in poorer virological response rates in paediatric populations when compared to adults. However response rates to first line therapy in paediatric populations have improved markedly over the last decade.

The management of adolescents with extensive antiretroviral experience and limited treatment options differs from those initiating therapy for the first time. Whilst naïve adolescents have once daily or even combined single pill options available, those who have developed resistance mutations have more limited options, typically twice daily regimens with higher pill burdens. Since virological failure and acquisition of resistance is most commonly due to poor adherence, the issue is further compounded by the need for more complex regimens.

Sticking With It

Issues of poor adherence and responsiveness to therapy, often worse during adolescence, play a prominent role in the complexities of disease management for young people. Conflicting data exists about the factors associated with adherence in adolescents, but mental health issues including depression, substance abuse including alcohol, and lack of wider disclosure of HIV status to family and friends have been associated with poorer adherence⁴.

A lack of randomised controlled trials of adherence interventions and small study numbers limit interpretation, but patient education and support with a treatment ‘buddy’, directly observed therapy and motivational interviewing have shown a positive impact, although sustainability after cessation of the intervention is less clear. Adherence patterns appear to be set early in treatment and predict long term virological and immunological control, and hence the time spent by the child’s family or

carer and the multidisciplinary team prior to the initiation of first line therapy is of great importance. In addition, medication fatigue occurs, so adherence messages need to be frequently repeated to prevent virological failure over time.

More recently, a pilot study using motivational interviewing with financial incentives linked to HIV virological response has shown some benefit in adherence in a small UK adolescent cohort with advanced disease and longstanding poor adherence⁵.

Toxic Therapy?

As this first population of young adults born with HIV transitions into adulthood, the long term effects of living with HIV and prolonged exposure to antiretroviral therapy throughout postnatal growth and development are becoming apparent. Data is accumulating regarding neurocognitive development and mental health, cardiovascular and bone toxicity, yet the long term outcomes remain uncertain⁶.

The impact of HIV on the developing brain results in a wide spectrum of disease from infantile HIV encephalopathy and hypertonic diplegia, through expressive speech delay in preschool children and increased requirements for educational support in school-aged children. Early data suggests higher rates of asymptomatic neurocognitive impairment with poorer executive functioning in college students living with PaHIV. Increased rates of behavioural disorders and psychiatric diagnoses, most frequently anxiety and depression, impact on quality of life and adherence.

Comparable to HIV infected adults, adolescents with PaHIV show higher rates of various conditions including dyslipidaemia, insulin resistance, thrombophilic abnormalities, inflammation and endothelial activation with growing concern regarding the potential for increased rates of cardiovascular disease in middle age⁶. In order to perform a careful long-term follow up of this unique

- [5] Foster, C. McDonald, S., Frize, G. et al. (2012) Financial Incentives and Motivational Interviewing for Adolescents with Advanced HIV Disease; A Pilot Service. *BHIVA*. April [P85].
- [6] Foster, C. & Fidler, S. (2011) Adolescents with Perinatally Acquired HIV-1 Infection. *European Infectious Diseases*. **B**(1):10-6.
- [7] Cohen, M.S., Chen, Y.Q., McCauley, M. et al. (2011) HPTN 052 Study Team. Prevention of HIV-1 infection with Early Antiretroviral Therapy. *N Engl J Med*. **365**(6):493-505.
- [8] Bundock, H., Tudor-Williams, G., McDonald, S. et al. (2011) Crossing the Divide: Transitional Care for Young Adults with HIV- Their Views. *AIDS Pt care & STDs*. **25**(8):465-73.

cohort, recruitment of 400 infected adolescents and 300 household age matched controls is currently underway in 'The UK and Ireland Adolescents and Adults Living with Perinatal HIV Cohort (AALPHI)' Study, with comparable observational cohort studies in the US and France.

Sexual and Reproductive Health

Teens with PaHIV are developing their sexual identity, negotiating relationships, becoming sexually active and in some cases even giving birth to the next generation. Hence, issues such as disclosure to sexual partners or other family members, and the risk of onward transmission to partners and future children are inevitably raised during the adolescent years. Discussions, started early, can prepare a young person for such situations and should cover negotiating relationships, disclosure and safe sex, routes and risk factors for HIV transmission, condom use, additional contraceptive choices and interactions with HAART, post exposure prophylaxis (PEP) and emergency contraception in the event of condom failure, and potential criminalisation of transmission.

As adolescents with PaHIV become sexually active they require on-going education, contraceptive options in addition to condoms 'doubling up', optimisation of Hepatitis B vaccination and an annual STI screen. This screen is particularly important as a concomitant STI can increase the risk of HIV transmission to partners.

Whilst an increased risk of cervical neoplasia is well recognised for women with horizontally acquired HIV infection, a lack of data for those with PaHIV makes recommendations for the onset and frequency of cervical screening difficult. Further, the impact of HPV vaccination, the optimal vaccine, and booster interval in this population is unknown. Recent cohort data from the UK and US suggest adolescents with PaHIV may have increased rates of cervical premalignant change, and therefore currently annual screening within a year of coitarche is recommended.

HAART treatment markedly reduces the risk of HIV transmission to partners and children⁷ and so teenagers should also be aware that they can have healthy uninfected children if they so choose. Reassuringly, so far rates of mother-to-child transmission of HIV (where the mother has PaHIV) are low, despite the extensive maternal antiretroviral history and complex perinatal case management⁶. Whilst no congenital abnormalities were reported for infants in the small PaHIV cohorts

described, no long-term data exists for this unique population, where the mothers have been exposed to HAART throughout pubertal development, and ongoing surveillance of these infants is required.

Teens Grow Into Adults

Over 400 UK adolescents with PaHIV already attend adult services¹. In chronic childhood diseases, planned transition programmes improve attendance, disease control, self management and patient and carer satisfaction. Data is emerging on the transition preferences of adolescents with PaHIV, with lack of confidence in negotiating adult services, stigma associated with HIV and fear of ending life-long patient/carer relationships identified as barriers to transition⁸.

Integrated paediatric and adult care in an age specific environment, increasing autonomy, patient-centred timing of transition and comprehensive management explanations are known to facilitate transition to adult care. There is little point in providing high level tertiary paediatric care if transition itself is not well managed, allowing children to become independent young adults, who are retained in medical services appropriate to their needs and are able to fulfil their potential within society.

In only two decades, HIV has become a chronic manageable condition. An 'AIDS Free Generation' is a theoretical possibility: HAART dramatically reduces transmission to sexual partners and infants. However, globally this requires enormous resources and increased access to treatment. Prevention of transmission would require greater than 90% adherence to HAART irrespective of the disease status, a goal yet to be achieved.

However the success of HAART means HIV infected children in the UK are growing into young adults and, whilst the future may be uncertain, this is a remarkable achievement to build upon. Lessons learnt in these small but evolving cohorts will hopefully improve the outcomes for the much larger numbers of children globally as access to treatment improves.

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At 17, Rafael is among the first generation of young people who have always lived with HIV.

What Do Menstruating Girls Need in Schools?

Seung Lee & Brad Kerner, Save the Children

Imagine attending a school without any toilets or drinking water. Imagine attending a school with a single latrine for all the students. Imagine that the latrine is smelly, with no toilet paper and the door no longer closes. Imagine attending one of these schools while you are sick from the flu or malaria or have diarrhea.

Imagine trying to attend classes in these schools while you have your menstrual period. Imagine your menstrual period is extremely painful. Imagine your reuse-able pad is soaked through but there is no running water to clean it, or that there is no trash bin for disposing your used pad. Imagine having your pad soaked through to your pants so you have to hide the stain with your book bag. And don't forget this happens every month.

Sadly, adolescent girls in the developing world do not have to imagine these situations. They experience it every year, even every month – if they manage to stay in school. Many are not able to stay in school after too many missed classes, too many embarrassing moments, too many failed tests, too many repeated grades and too many disappointments.

As 2015 approaches, analysis of the Millennium Development Goals (MDG) indicates that the education sector goal of universal education (MDG 2) will not be achieved by 2015. Tremendous progress with child school enrollment has been made, and the current global rate is at 89%; however it has plateaued since about 2004. Beyond enrollment in school, children need to complete their schooling to benefit from this access, however, in some regions such as Africa, 30% of children drop out before they complete their primary school education.¹ Equally enrollment parity

between girls and boys has not yet been achieved, although we are closer than ever before, and gender equity decreases at higher levels of schooling.

The reasons for low enrollment and incompleteness of education are numerous, but the health and nutrition status of the children are critical factors. According to the World Health Organisation (WHO), 272 million school days are lost each year due to diarrhea alone and about 400 million children in the developing world have worms that prevent them from learning.² These barriers to education are further exacerbated with puberty. Adolescence brings with it rapid biological changes including the development of reproductive capacity and changes in the sexual response system. Adolescence is also a critical time for cognitive changes that lead to the emergence of advanced mental capabilities, such as increased capacity for abstract thinking and empathy. It is also the time for major social-emotional changes as children transition into adults and shift from dependency to interdependency within their society.

Yet most boys and girls are unprepared for these changes; some studies indicate that around 66%³ of girls know nothing about menstruation until they start their menses, which makes for not only a negative, but also a traumatic experience. The lack of knowledge and skills for menstrual management can be detrimental to school attendance, quality and enjoyment of learning for girls. According to UNICEF⁴ 1 in 10 school-age African girls 'do not attend school during menstruation, or drop out at puberty because of the lack of clean and private sanitation facilities in schools'. In another survey conducted by FAWE in Uganda, 94% of girls reported issues during menstruation and 61% indicated missing school during menstruation.⁵ According to Water Aid, "95% of girls in

Ghana sometimes miss school due to menses and 86% and 53% of girls in Garissa and Nairobi (respectively) in Kenya miss a day or more of school every two months. In Ethiopia 51% of girls miss between one and four days of school per month because of menses and 39% reported reduced performance".⁶

Girl Troubles

For girls, in particular, the impact of low school attainment and poor health and nutrition can have a magnified impact on the next generation. Malnourished girls become mothers who face high levels of maternal mortality, and bear low birth weight babies. In addition, the link between female educational attainment and lifetime health is unequivocal; a better educated girl takes better care of herself and as a woman, has healthier and fewer children.

Save the Children's experience in Ethiopia illustrates these health issues and provides evidence of what can be done to ensure adolescent girls stay in school. Girls in Ethiopia navigate puberty without proper information about the physical changes they can expect, without support from family members, without schools that have a "girl-friendly" water and sanitation infrastructure, and without information on feminine hygiene products. Ethiopian adolescents have limited access to sexual and reproductive sexual health information and services, and the sociocultural context perpetuates an environment in which these issues remain taboo to discuss with parents.

Within this context, Save the Children has been working in Ethiopia since 1998 to improve adolescents' sexual and reproductive health with comprehensive, multifaceted programs. More recently, the organisation began to pay particular attention to the needs of girls in their early adolescence who were making the critical transition from primary to junior secondary school. There is a particularly high dropout rate and declining school attendance at this

Many schools in Ethiopia have no bathrooms or latrines

[1] The Millennium Development Goals: Report 2010. United Nations, New York.
[2] Raising Clean Hands: Advancing Learning, Health and Participation through WASH in schools. A Joint Call to Action (2010). UNICEF.
[3] Mooijman, A., Snel, M., Ganguly, S. & Shordt, K. (2010) Strengthening Water, Sanitation and Hygiene in Schools A WASH Guidance Manual with a Focus on South Asia. IRC, the Netherlands.
[4] Sanitation: the challenge. (2005) UNICEF.
[5] Toolkit on Hygiene Sanitation & Water in Schools: Gender Roles and Impact (2005). World Bank.
[6] House, S., Mahon, T. & Cavill, S. (2012) Menstrual Hygiene Matters. A Resource for Improving Menstrual Hygiene Around the World. WaterAid.

stage. The Menstrual Hygiene Management (MHM) programme was designed to identify these issues via a qualitative study (including forty-nine girls, forty-seven parents, and fifty-two teachers). The results concluded that:

- Information on reproductive health is very limited – particularly on puberty, feminine hygiene, and menstruation. A few girls reported receiving some information on reproductive health and puberty from science and biology classes.
- Girls learned about feminine hygiene from peers and sometimes from elder sisters and mothers. Many experienced their first period on their own without prior information about the onset and nature of menstruation.
- Many girls were surprised or panicked by their first menstruation.
- Some girls described not wanting to go to school when menstruating because they felt they could not fully participate in school activities.
- Girls, teachers, and parents all agreed that girls' menstruation and related issues have an effect on school performance and attendance.
- Most of the girls use cotton or cloth from old dresses as sanitary protection materials and complain about their lack of comfort and inadequate protection quality. Only a few described having used commercially produced sanitary pads.
- Most girls, particularly those in rural areas, had never seen sanitary pads, although most had heard about them. Almost all girls were enthusiastic about learning about these alternative menstrual blood management products.
- While participants said they looked forward to the opportunity to use sanitary pads, they also expressed concern about sustained usage due to cost.
- Girls stated that school latrines have limited privacy and poor hygienic conditions. Teachers and girls also confirmed that there are no hand-washing facilities at the schools.

Girl-Friendly Schools

Based on these results, Save the Children developed a four-part programme using the School Health and Nutrition (SHN) programming framework. SHN addresses the critical health, hygiene and nutrition factors that keep children and adolescents out of school and reduce their ability to learn.

First, it created community dialogues and community spaces where mothers, teachers, community leaders, and girls could come together to talk about puberty and



Piloya Caroline displays a sanitary pad she handmade at Awere Primary School, Uganda, as part of a project aimed to help keep girls in school.

Essential SHN Program Elements	Examples in the MHM Program
Ensure equitable health-related school policies and support	<ul style="list-style-type: none"> • Creation of policies supporting girl’s right to education • Creation of code of conduct among teachers, parents and children to ensure safe schooling • Positive Gender Norm training for all school and community members to change gender stereotypes
Promote life-long healthy behaviors through skills-based and child-focused health (including HIV) education	<ul style="list-style-type: none"> • Key Life Skills e.g. analytical thinking and decision-making are learned and practiced in safe settings • Knowledge, attitudes, values and skills are developed through key themes: nutrition, general health, hygiene, HIV/AIDS prevention, reproductive health • Interactive teaching methods such as Child-to-Child
Increase access to safe and hygienic learning environment	<ul style="list-style-type: none"> • Latrines that are private as defined by the girls, with access to water and soap • Waste disposal including disposal of menstrual pads • Fencing/barriers to make the school safe if necessary
Increase access to health and nutrition services for school-age children	<ul style="list-style-type: none"> • Provision of HPV vaccination, deworming and malaria treatment, micronutrient (esp. iron) supplementation • Provision of sanitary napkins or other means of menstrual management • Getting to know health service providers/centers • Provision of First Aid Kits with painkillers and/or training of pain mitigation methods.

The four essential elements of the Menstrual Hygiene Management (MHM) program that fit with the School Health and Nutrition (SHN) framework.

menstruation in order to begin breaking down taboos that prevented discussion of these issues. The conversations helped families and teachers begin to understand the challenges that adolescent girls face in school when they are menstruating, and together are now finding ways to make communities and schools more girl-friendly. For example, once communities recognized that menstruation was not initiated by sex and that the girls needed assistance, the parents helped build better latrines and sought out local materials for sanitary pads.

Second, a school-based sexual education programme was developed to teach adolescent girls about puberty, menstruation, and menstrual hygiene. They linked this effort to a broader curriculum for very young adolescents in which girls also learned about the risks of early marriage and preventing pregnancy, coupled with other life-skill-building exercises, to help them negotiate a healthy adolescence. Teachers and girls’ peer leaders were trained to roll out this life-skills curriculum as an extracurricular learning opportunity.

Third, Save the Children collaborated with communities to improve the water and sanitation infrastructure within schools. Unfortunately, too many schools in Ethiopia have no bathrooms or latrines. Girls describe such an environment as being unsafe and undignified. The new latrines designed by the girls are separated from boys’ latrines and have doors that lock from the inside, as well as a place to dispose of menstrual hygiene materials.

Fourth, the girls were introduced to all the menstrual hygiene products available to them including both traditional and commercial products. Girls in the programme were provided with a three-month supply of sanitary napkins to help them understand the different methods of menstrual blood management.

The success of this multi-sector programme depends on effective partnerships between education, health, and other sectors, as well as with communities and with children and adolescents. Save the Children’s implementation approach is to create model programmes through strong partnerships with governments, local organizations and communities. The engagement of communities is especially critical when challenging current gender norms and addressing reproductive health issues. Mobilizing and educating parents and community leaders were necessary for the success of these projects and should be the first step in future efforts to address the needs of girls in and out of schools.

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The BRICS:

What is their Contribution to Global Health?

Dr. Andrew Harmer, Dr. Fodayinka Dania & Dr. Lesong Conteh, University of Edinburgh and Imperial College London

The BRIC countries, namely Brazil, Russia, India and China, have received a lot of attention since the acronym was coined by Jim O'Neil in 2001; he was, at the time, the Head of Global Economic Research at Goldman Sachs and he used it to refer to what he predicted would be the fastest growing emerging economies in the world. In 2006, the four countries met for the first time and adopted the acronym 'BRIC' in a bid to formalize their union and increase their stature. They held their first official summit in Russia in June 2009, debuting as a policy consultation and coordination group; and since then have shown interest in building a platform for cooperation on issues such as health, economics, science and technology. In 2010, South Africa was formally invited to join the BRIC countries by the president of China making the BRIC, the BRICS.

Since their emergence as a group, many commentators have championed the BRICS as good news for global health. However, this article seeks to explore whether it is right to assume that their economic accolades readily extend to the sphere of Global Health.

Over the last decade, while there have been a variety of groups of emerging countries making a mark on the global economic landscape, the BRICS seem to have made the most notable impact. Their economies grew at an average of 6% annually between 2000 and 2010, much faster than the growth of the Organisation for Economic Co-operation and Development (OECD) economies, which grew by an average of 2% annually during the same time period. Combined, the

BRICS account for 19% of nominal world Gross Domestic Product (GDP), with China, Brazil and India ranking among the top 10 economies in the world by nominal GDP. While there are signs of these phenomenal economic growth rates slowing, the BRICS continue to grow in political stature.

Individual BRICS countries are becoming more vocal and active in shaping, and indeed leading, global (read 'worldwide') health movements

As well as their overall economic development, the BRICS have increased their international development cooperation. In 2010 alone, they spent over US\$6 billion on foreign assistance to low- and middle-income countries (directed primarily towards health, education, infrastructure, information technology, agriculture, training and capacity building) and this foreign assistance grew steadily by an average of 16% annually (excluding Russia) between 2005 and 2010.¹

Although the foreign assistance spending of the BRICS is relatively small when compared to the foreign aid spending of other major donors such as the United States

- [1] Global Health Strategies initiatives (GHSi) (2012) Shifting Paradigm: How the BRICS Are Reshaping Global Health and Development.
- [2] WHO (2011) WHO Director-General addresses first meeting of BRICS health ministers.
- [3] Koplan, J., Bond, T., Merson, M., Reddy, K., Rodriguez, M., Sewankambo, N. & Wasserheit, J. (2009) Towards a Common Definition of Global Health. *Lancet*, **373**:1993-1995.
- [4] Bozorgmehr, K. (2010) Rethinking the 'Global' in Global Health: a Dialectic Approach. *Globalization and Health*, **6**:19.
- [5] Rowson, M., Willott, C., Hughes, R., Maini, A., Martin, S., Miranda, J., Pollit, V., Smith, A., Wake, R. & Yudkin, J. (2012) Conceptualising Global Health: Theoretical Issues and their Relevance for Teaching. *Globalization and Health*, **8**: 36.

Four Definitions of the word 'Global' in Global Health⁴:

- 1) Meaning 'worldwide', 'everywhere' and stand for a universally prevalent agent'.
- 2) Referring to 'issues that transcend national boundaries'.
- 3) Implying a 'holistic' denotation, referring to all and everything which impacts on health, ranging from biological, molecular levels to 'higher' (or other) levels by building complex 'assemblages'.
- 4) Encompassing the concept of 'supraterritoriality', which refers to 'social links between people located at points anywhere on earth, for example developments such as climate change or pandemics that envelop the planet at one place at one time; their causes and consequences cannot be divided and distributed between territorial units'.

(US\$30.7 billion in 2011) or OECD's thirty-four member countries (US\$133.5 billion collectively in 2011), it is still substantial and worthy of note. Moreover, with aid donations from the OECD countries to developing countries, known as Official Development Assistance, declining for the first time in 15 years and health spending cuts being made by most European governments due to financial constraints, the world seems to be looking to the BRICS as the next set of potential donors and health innovators.

During the first BRICS Health Ministers' meeting held in Beijing in 2011, the BRICS made a statement reiterating their firm commitment to strengthen dialogue and cooperation in the field of public health. At the summit Dr Margret Chan, the Director-General of the World Health Organization said "... BRICS represents a block of countries with a ... great potential to move global public health in the right direction ... towards reducing the current vast gaps in health outcomes and introducing greater fairness in the way the benefits of medical and scientific progress are distributed ...".²

It is important to note that while the BRICS may be building their profile as health donors, they continue to face significant domestic health challenges of their own. Two of the most prominent issues include the dominance of

non-communicable diseases compared to the burden of infectious diseases (apart from in South Africa) and their ageing populations.

Are the BRICS a Collective Force in Global Health?

The question then arises whether the BRICS, lauded for their economic achievements, qualify as global health champions?

To answer this question, what is meant by the term global health needs to be clarified. This requires understanding how the word 'global' differs from words that are commonly conflated with 'global' such as 'international' and 'public'. Our analysis of the BRICS reveals that the label 'global health' continues to be attached indiscriminately to what are really either public/national or international health issues. The reader is provided with two useful analyses that should set them on the right track. The first is a framework that distinguishes between global, international and public health (see box above).³ The second is a highly nuanced analysis of the different ways that the word 'global' is used to describe global health,⁴ which is itself subject to a favourable critique by Rowson et al (2012) (see table overleaf).⁵

So, are the BRICS a collective force in global health? Well, as argued above, it depends on what is meant by global. Examples from the literature that describe the BRICS countries' influence as global include Brazil's leading role in the negotiations that led to the Framework Convention on Tobacco Control; India, Brazil and South Africa's involvement in issues around access to anti-retroviral drugs, resistance to the dominant intellectual property rights regime and support for generic drug manufacture; India's support for low cost service

- [6] Harmer, A., Missoni, E., Tediosi, F. & Xiao, Y. (under review) BRICS Without Straw? A Systematic Literature Review of Newly Emerging Economies' Influence in Global Health.
- [7] Dania, F. (2012) 'The BRICS and Global Health', MPH Dissertation, Imperial College London.
- [8] Joint Communiqué of the BRICS Member States on Health, Geneva, May 2012.
- [9] Mawdsley, E. (2012) From Recipients to Donors: Emerging Powers and the New Development Landscape. London: Zed Books.
- [10] Scholte, J. A. (2005) Globalization: A Critical Introduction. Basingstoke/New York: Palgrave Macmillan.

delivery and ‘frugal innovation’ such as that pioneered by the Aravind eye hospital; and China’s international medical teams. But to what extent are these ‘global’ interventions or actions?

Drawing on Bozorgmehr’s four definitions of ‘global’, it seems to us that most of the examples of the BRICS so-called ‘global’ influence in health are actually international actions incorrectly relabelled as global; or are issues that simply cross national borders (typically infectious diseases); are issues that are global but in the limited sense that they are ‘worldwide’; or are described as global when really they are public health interventions, plain and simple. Very few commentaries on BRICS have identified the significance of their actions in terms of supra-territoriality.

A full answer to the question would also have to consider the extent to which the BRICS coordinate their efforts towards improving global health. True, each of the BRICS countries engages individually in bilateral, trilateral and multilateral efforts to improve health, although some members prefer one channel of assistance to another: Russia channels its development assistance almost exclusively through multilateral partnerships such as the Global Fund to Fight AIDS, Tuberculosis and Malaria, while China is less active in its multilateral or trilateral engagement, preferring traditional bi-lateral relations. Furthermore, individual BRICS countries are becoming more vocal and active in shaping, and indeed leading, global (read ‘worldwide’) health movements such as Universal Health Coverage or the support for generic drug production.

Little evidence is found in literature to support the assertion that the BRICS are influencing global health as a ‘block’

But what about the BRICS’ collective action for global health? Little evidence is found in literature to support the assertion that the BRICS are influencing global health as a ‘block’.^{6,7} Joint statements by all five of the BRICS are rare: there have been just two Health Ministers high-level meetings. More common are examples of two or more BRICS countries supporting specific health initiatives, and here the preferred channel of influence is multilateralism. The Global Polio Eradication Initiative (GPEI) is one example of a multilateral initiative and a global partnership for health that is supported by two BRICS countries: India and Russia. And in the context of reform of the World Health Organisation, BRICS Ministers of Health committed “to strengthen and legitimize the WHO as the coordinating authority in global health” through the principle of multilateralism.⁸

All of this is not to say that the various Summits and High Level Meetings of BRICS Political leaders or Communiqués issued by Ministers of Health are without meaning or import for global health. Such international fora – and we would emphasise that they are international agreements between states – do show political will for collective action. But it is one thing to commit to do something; quite another to actually put those commitments into action. Here we agree with a conclusion drawn by the authors of a recent Report on BRICS and Global Health: “The BRICS have declared health collaboration a priority, but they have not yet begun to work collectively to enhance the impact of their assistance programs”.¹

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Country Type	Global Health	International Health	Public Health
Geographical Reach	Focuses on issues that directly or indirectly affect health but that can transcend national boundaries	Focuses on health issues of countries other than one’s own, especially those of low-income and middle-income	Focuses on issues that affect the health of the population of a particular community or country
Level of Cooperation	Development and implementation of solutions often requires global cooperation	Development and implementation of solutions usually requires binational cooperation	Development and implementation of solutions does not usually require global cooperation
Access to Health	Health equity among nations and for all people is a major objective	Seeks to help people of other nations	Health equity within a nation or community is a major objective



India is one of the biggest producers of generic drugs and vaccines, which allows it to keep the cost of vaccines low.

In 1955 in Bandung, Indonesia, developing countries met for the first time to promote economic and cultural cooperation and to oppose colonial resurgence from either the US or the Soviet Union as the Cold War played out. The Bandung Conference, as it became known, is also credited as sowing the seeds for the Non-Aligned Movement (a movement that sought to radically shift the Western discourse of ‘development’). For many BRICS-watchers, the groups’ most significant contribution has been to re-frame development through a counter discourse that rejects Western notions of ‘aid’, promotes horizontal rather than vertical assistance, partnership, non-conditionality, and heavily promotes values such as equity. If the BRICS have collective influence in global health, then it is most likely to be found in this realm of ideas and discourse; extending into the health sphere a counter-discourse of health cooperation. But, as Mawdsley (2012)⁹ argues, the coherence amongst BRICS of a common discourse of health development should not be exaggerated.

Conclusion

Although there is limited evidence of the BRICS working as a team of five countries, there are examples of initiatives in which certain members do work together. The BRICS as individual countries have a history of contributing to health improvements of countries beyond their borders long before labels such as ‘Global Health’ and ‘BRICS’ were popularised. Their actions both directly

and indirectly have affected the health of populations in other low and middle income countries in areas such as infrastructure building, capacity building and health innovation. However, we find a tendency in much of the literature on BRICS and ‘global health’ to describe interventions by one or more of the BRICS countries as global when a more accurate term such as international would be appropriate.

While it might be a little premature to look to the BRICS collective as current global health champions, they appear to have ambitions of moving in this direction. How far their influence will extend into the supraterritorial sphere – i.e. enabling people to become physically, legally, culturally, and psychologically engaged with each other in ‘one world’¹⁰ – remains to be seen.

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China's Pro-Renewable Energy Approach

Dr. Judith Cherni, Imperial College London

Driven by an energy and carbon intensive economy and strong GDP growth, China boasts the second largest electricity industry in the world. However, its reliance on polluting coal also makes it the single largest emitter of greenhouse gases, particularly CO₂, while there are still areas without energy access. As part of its strategy to reduce emissions, promote economic growth, increase energy supply to rural areas and protect the environment, China has embarked on the vigorous development of renewable energy technologies. Here we consider the international, national and local challenges facing the energy industry in China, discussing policy and investment and, through a case study of the Yunnan Province, assessing both the degree of success in meeting these challenges and the untapped potential of renewable energy for development purposes.

Since the beginning of the industrial revolution CO₂ emissions have continued to rise and, at 30,649 million tonnes (Mt) in 2007, their level has more than doubled in the past 40 years¹. Since the early 1990s, Asia has been responsible for the greatest surge in fossil fuel production (3.2%/yr), particularly China and India. China's huge population and economy will remain dependent on fossil fuels, (predominantly coal) for more than 70% of its energy demands for at least the next twenty years, and hence will continue to emit huge levels of CO₂, a major greenhouse gas².

Reliance on coal for energy supply ... has caused environmental and health problems, including acid rain and air pollution

The path to universal electrification in China is not complete, and about 8 million individuals (i.e., the total population of Sweden or Austria), particularly in rural areas, still lacked electricity in 2009³. The Western regions of China have historically been neglected by central governments, and only recently electrification in rural areas like Yunnan has become a national priority.

Within the context of electricity market reforms, the Chinese authorities set objectives to significantly increase the share of renewable energy in the energy mix, reduce emissions and generate additional power to also supply areas where there is no energy access. This article identifies the broad spectrum of challenges facing China's energy sector and looks at the impact of this policy intervention on its development.

International, Regional and Domestic Challenges

In 2007, China overtook the US as the world's largest CO₂ emitter and, with emissions rising to 6,500 Mt, accounted for 22% of the global total⁴. The international challenge to reduce emissions in China is thus central to protect the global atmosphere and avoid further climate change.

Priding itself on having the second largest electricity industry in the world (after the USA), China's booming economy is immensely energy intensive, with energy production almost trebling in nine years. As a result, the formerly habitual blackouts, which lasted for years and seemed to jeopardize growth particularly in the coastal regions, are now largely a thing of the past. Reliance on coal for energy supply, however, has caused environmental and health problems, including acid rain and air pollution in numerous cities. The combination of continued

dependence on coal and strong economic growth is likely to result in additional land and water contamination for an already deteriorating environment. At the national level it is therefore vital to implement a strategy to reduce China's reliance on polluting coal plants.

Yet, despite more than three decades of electricity market reform, the country's huge energy industry has not managed to keep pace with demand even with an average annual growth rate of 8% installed capacity over the past decades⁵. Furthermore, while one should not underestimate China's achievement in providing universal electricity access to the bulk of the population, some 2.6 billion – mostly in rural areas – do not have access to clean energy for cooking. Regionally, China, India and Bangladesh account for more than half of those without clean energy for cooking.

Thus China urgently needs to increase energy supply, while reducing reliance on polluting coal. With these demands in mind, China aims to expand both its share of renewable energy (excluding hydroelectric) to 15% by 2020 and energy consumption from renewables to 4.5%⁶.

Policy Interventions and Incentives

One of the key challenges facing China is how to meet energy demands by drawing on its existing energy infrastructure and dual system of state and private ownership industry without further exacerbating environmental problems but prioritising affordable and effective power supply to its entire population and rapidly growing economy. Driven by the National Development and Reform Commission (NDRC), in 2005, the National Programme for Building a New Type of Rural Area was launched to eliminate rural poverty and, particularly so in the Western provinces, where farmers have depended on traditional firewood to generate basic energy. The provision of modern energy services was a key priority in this policy.

The Renewable Energy Promotion Law, which came into effect in January 2006, provided a single coherent framework for the development of renewable energy within China's electricity system. Designed to address the barriers to renewable energy and facilitate the growth of the industry, this legislation is the first strategy of its kind in China. The Chinese government also included a commitment to the construction of off-grid renewable power systems in areas not covered by the grid, and to

establishing a renewable energy development fund to support projects in remote rural areas and outlying islands (such projects may qualify for preferential loans and tax benefits). Further, in 2007 the Government launched specific Energy Programmes in four provinces, including Yunnan⁷.

Inaugurated in 1953, a Five Year Plan (FYP) is the body of policy and strategies drawn up by the Chinese government in order to achieve social and economic development objectives. The goals of energy sustainability and a low carbon economy were included in the 12th FYP (1011-15). Despite the fact that coal is recognized as the dominant energy source, state policy explicitly aims at a 17% reduction in CO₂ emissions by 2015⁸ and establishes that energy from non-fossil fuel must reach and stay above 11% of total power generated by 2015. It forecasts that China will generate 91 GW additional capacity yearly between 2010 and 2015⁹.

The policy and market incentives written into the 12th Five Year Plan and Renewable Energy Promotion Law send a powerful message to the international community about how vitally important achieving CO₂ reductions, increasing energy supply and promoting renewable technologies are for the Chinese government. Should these objectives be attained, the 11% renewable energy target set in the 12th FYP could be exceeded. Making these goals a reality within the country's 'dual public-private economy', however, is the real challenge for policy-makers and researchers.

What has the impact been so far of this commitment to the development of renewable, and rural, energy sources in China?

Investment in Renewable Energy

Conditions within China's energy sector have fundamentally changed due to the transition to electricity liberalisation and the policy incentives for renewable energy.

- [1] World Development Indicators (2010), World Bank, US.
- [2] Watts, J. (2009) China Puts its Faith in Solar Power with Huge Renewable Energy Investment. The Guardian. 26th May.
- [3] Energy Development: Access to Electricity (2011) World Energy Outlook, International Energy Agency.
- [4] Greenhouse Gas Emissions (2010) United Nations Statistics Division, Environmental Indicators.
- [5] Yeoh, B. & Rajaraman, R. (2004) Electricity in China: The Latest Reforms. The Electricity Journal, 60-69.
- [6] Measuring Progress Towards Energy for All. Power to the People? (2012) World Energy Outlook, Chapter 18, IEA International Energy Agency.
- [7] Yunnan Rural Energy Working Station (2007) Interview in Yunnan, personal communication.



Reliance on coal for energy supply has caused environmental and health problems, including acid rain and air pollution in cities.

Decommissioning of the country's old and polluting energy plants has become a priority as China adopts new standards and invests in new, more efficient technologies and systems via a process known as 'leapfrogging'. This latter term describes when, in essence, developing countries advance rapidly by adopting modern, more efficient technologies and systems without first using older less efficient systems which may still be in use elsewhere.

To meet some of its energy targets, China has significantly increased its investment in renewable energy technologies – through state-owned enterprises, financial mechanisms and tax incentives – with an estimated

US\$1.54 trillion earmarked for clean energy projects over the next 15 years. The China Investment Corporation is a US\$300 billion-asset-holding state owned wealth fund which invests heavily in national clean-energy companies and foreign operators with projects in China. Similarly, the state China Energy Conservation Investment Corporation funds energy conservation, pollution control and renewable energy projects in the private sector. As a result, the renewable energy market is growing at an average 15.5% per year⁸.

Against a backdrop of a 6.6% decline globally in such investment in 2008, China invested almost twice as much as the United States in clean energy¹⁰, becoming the world's leading manufacturer of photovoltaic (PV) panels – although a very high percentage of production is destined for overseas markets (e.g. 95% of the total produced were exported in 2009)².

Renewable Energy in Rural areas

A study was undertaken in Yunnan Province, as part of a DELPHE research project (Development Partnerships in Higher Education; British Council and UK DFID,

2007-2011) in which Imperial College is a partner. Semi-structured interviews with local policy-makers, and household surveys, were conducted and analyzed using the multi-criteria tool SURE-Decision Making System. Designed by an international research team and coordinated by Imperial College, SURE-DSS software aims to address the gap in energy development by suggesting initiatives that are both technologically appropriate and sustainable in the long-term by matching local resources to needs^{11,12}. The tool, piloted in other developing regions, had not been used in East Asia before.

The study revealed that the Energy Programme in Yunnan brought mostly grid-connected electricity to rural towns with only minor expansion of off-grid energy projects, particularly biogas and improved cooking stoves. By 2006, 1.7 million rural households had access to biogas, yet the use of firewood remains high in Yunnan: 53% of households generate energy directly from the burning of crop stalks and firewood⁷. Such heavy reliance contributes to extensive local deforestation, respiratory health problems and long hours expended – especially by women – collecting firewood.

The 50-household survey in the rural town of Yule, in Yunnan's western region of Lijiang, found that, 32% of the households were dissatisfied with the energy service (blackouts, cost), and that 62, 54 and 52% of the households were dissatisfied with healthcare, water access and education in their village – a sign that grid connection may be inadequate in terms of alleviating poverty.

The results of SURE-DSS indicate that there is considerable scope for further expansion of renewable energy technologies in Yule. Given that farmers in the region rear cattle and domestic animals, rolling out biogas installation seems feasible. However, investing almost exclusively in biogas technology, as the government has been doing, is rather limited: other small-scale renewable technologies, such as solar, could be appropriate for the region.

Renewable Energy for Development?

Despite policy intervention, renewable energy generation remains low in China with the share of wind, solar and biogas at just over 3.26% of total electricity

production by 2010⁸. Renewable energy resources in China, particularly wind and hydropower, are abundant but significantly under-utilised at present and hence a major increase in the share of renewable energy in the country's generation mix could play an important role in both moving China towards a cleaner electricity system and helping to reduce emissions.

It is nonetheless questionable whether promotion of renewable energy alone will achieve the substantial reduction in CO₂ emissions required from China. It could be expected that further renewable installations will be required to replace existing polluting generation sources as well as reducing the carbon and energy reliance of current technologies.

It is likely that China's NDRC confident and forceful approach may result in their exceeding the 15% target share of renewable energy. Indeed reaching a 20% share would represent a direct challenge to Europe's (who share a 20% goal), and particularly the UK's claims to world leadership in the field – despite the fact that China continues to be heavily reliant on fossil fuels to satisfy its energy needs.

It is clear that China's renewable energy policy and market incentives highlight the Government's desire to address the serious local, national and international challenges it faces in the energy and domestic development sector. Although a definite step in the right direction, more may be done in terms of adopting low carbon intensive technologies and expanding installation of clean energy to achieve meaningful emissions cuts in China.

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State policy explicitly aims at a 17% reduction in CO₂ emissions by 2015 and establishes that energy from non-fossil fuel must reach and stay above 11% of total power generated by 2015

[8] An Overview of China's Renewable Energy Market (2011) China Briefing Magazine and Daily News Services. 16th June.

[9] APCO Worldwide (2010) China's 12th Five-Year Plan: How It Actually Works and What's in Store for the Next Five Years.

[10] Fielding, R. (2010) Pew Report: China Overtakes US. The Guardian. 25th March.

[11] Cherni, J. A., Dyer, I., Henao, F., Jaramillo, P., Smith R. & Olalde Font, R. (2007) Energy Supply for Sustainable Rural Livelihoods. A Multi-Criteria Decision-Support System. Energy Policy, 35, 1493-1504.

[12] Henao, F., Cherni, J. A., Jaramillo, P. & Dyer, I. (2012) A Multicriteria Approach to Sustainable Energy Supply for the Rural Poor. European Journal of Operational Research 218(3): 801-809.

Investing in Africa

Will Africa follow in the Footsteps of China?

Franca Hoffmann, Imperial College London

According to the International Monetary Fund, seven of the ten fastest growing economies over the next five years will be in Africa, a figure which is starting to capture the attention of both private and institutional investors. The Chinese, who have heavily invested in the continent over the past decade, appear to be planning to stay for the long-haul. Is this a sign of confidence that Africa will emerge as a legitimate force in the global economy?

Emerging markets was a term originally coined in 1981 by the Investment Manager and World Bank Economist Antoine van Agtmael to lift the negative connotation attached to the expression 'Third World Country'. As one of the first investors to recognise the financial potential of developing countries, his idea for a 'Third World Equity Fund' was instantly met with scepticism from leading investment managers. "Racking my brain, at last I came up with a term that sounded more positive and invigorating: emerging markets. 'Third world' suggested stagnation; 'emerging markets' suggested progress, uplift and dynamism."¹

Originally, emerging markets were defined as economies with low-to-middle per capita income. Today, some of these countries such as Singapore, Taiwan and South Korea, known as Asian Tiger states, could be considered to have emerged and are now highly developed economies. These have been closely followed by the BRIC economies who have experienced unprecedented growth over the past decade, with China on a path to overtaking the USA as the next economic superpower.

Given their generally high growth rates, 'emerging' as a description for this group of countries may still be adequate in the classical sense of the word, but perhaps

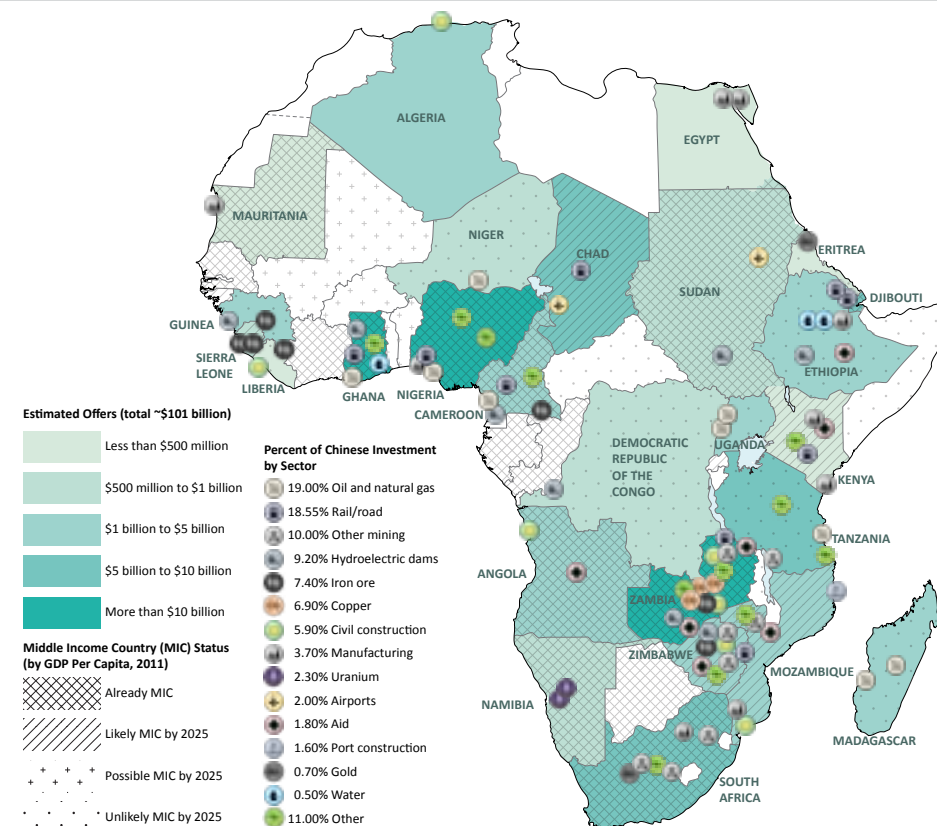
today's true investment opportunities lie at a new frontier - Africa. Wolfgang Fengler, the World Bank's Lead Economist in the Nairobi office is positive, "It is very possible that several African countries will follow in the footsteps of the BRICs and reach similar levels of income."

Sustainable Investment

With a total population of more than one billion spread over 54 nations, and rich natural resources distributed across 12 million square miles, Africa has always attracted more adventurous investors – but can it lure the mainstream?² Rajiv Jain, fund manager at Virtus, an asset management company, is not convinced, "You cannot put serious money to work in these economies."

With an average growth rate of 6%² (excluding South Africa, which represents a third of Africa's economy), GDP growth in the African region is substantially above the rest of the world, and the debt-to-GDP ratio is low as a consequence of debt forgiveness offered to African nations in the early 2000s. The comparably strong performance of emerging market funds during the recent global economic crisis highlighted the advantages of clever niche investment and, in general, higher volatility of African financial instruments can be offset by diversification as Africa's markets are little correlated with other

- [1] van Agtmael, A. (2007) *The Emerging Markets Century: How a New Breed of World-Class Companies Is Overtaking the World*. Simon and Schuster, pg 5. *Free Press*.
- [2] Fengler, W. (2009) Kenya Can ... End Poverty [online] Available at: <<https://blogs.worldbank.org/african/team/wolfgang-fengler>> [Accessed 1 January 2013].
- [3] Chinese Investment Offers in Africa [online] Available at: <<http://www.stratfor.com/image/chinese-investment-offers-africa>> [Accessed 1 January 2013].
- [4] Fongler, W. & Devarajan, S., (October 2012) Is Africa's Recent Economic Growth Sustainable? Institut Français des Relations Internationales. [online] Available at: <<http://www.ifri.org/index.php?page=contribution-detail&id=7349>>.
- [5] Virnich, B. (2010) *Der afrikanische Patient. Wunderheiler China?* WDR.



Chinese investment offers in Africa since 2010.^{3,4}

global markets. Investors are becoming more aware of the profits to be made, but there is a lingering reluctance to invest in the region.

According to Wolfgang Fongler, the reason African financial markets and their expanding public companies are still relatively unknown and under-invested is that the base is still too small. "Africa has yet to reach critical economic mass on most accounts. No country except Nigeria has a population of above 100 million. As a result, doing business in Africa is only interesting if companies can tap into larger regional markets. This is why regional integration is so important."

There is a well-established route via which more developed states indirectly invest in Africa. Development aid, however, is often criticized for being ineffective and an easy target for corrupt officials. Could Foreign Direct Investment (FDI) become a sustainable and bidirectional complement to traditional development aid? Wolfgang Fongler urges policy-makers to think of development aid not just in terms of money, but as a tool to generate knowledge transfer and international learning.

"As more African countries are reaching Middle Income Status, the role of aid to Africa will fundamentally change – or it becomes irrelevant." In fact, in many African countries FDI already has a larger volume than aid, with the main investor being China.

The Chinese in Africa

A highway across the African continent, from Cairo to Cape Town, was once the dream of colonial rulers. Today, this highway is being built by China. In fact, in many African countries still lacking modern road and transport links, the Chinese have seized an opportunity to drive infrastructural development, and currently hold more than 50 % of public contracts in Africa.⁵

With extensive investment in infrastructure, roads, railways, ports and airports all across the African continent, China is unblocking major bottlenecks to growth. The rehabilitated 840-mile Benguela railway line, for example, now connects Angola's Atlantic coast with the Democratic Republic of Congo and Zambia, and bilateral trade between China and Africa reached \$160 billion in 2011, up from just \$9 billion in 2000.⁶ Whether interpreted



In 2012, Zambia won the inaugural match 1-0 against Ghana at the Levy Mwanawasa Stadium, one of 52 stadiums around Africa built by Chinese contractors. Zambian reaction to the Chinese presence has been largely positive due to job creation and infrastructural development.

as disguised neo-colonialism to secure Africa's vast reserves of natural resources, or shrewd business strategy, Chinese investment has become a significant catalyst for economic development in Africa. Can Africa drive a transformation similar to the Chinese success story?

In fact, in the early 1980s most of Africa was still richer than China. Only 30 years ago, China was mainly considered to be a source of cheap labour for the developed world, however, with huge success in the manufacturing industry and consequent growth, China, is becoming increasingly expensive. Today, "Africa has a great opportunity to enter the segments Asia is leaving behind and take off," argues Wolfgang Fengler.

The key to China's success in Africa is strategic long-term planning - in contrast to Western portfolio investors who tend to flee as soon as difficulties arise. An example

of the Chinese business model is their presence in the Republic of Zambia. As the world's largest copper consumer, China needs copper almost as much as it needs oil and Zambia, with its rich copper resources, is one of China's most important partners in the region. Step by step, Chinese entrepreneurs have bought nearly all existing Zambian loss-making copper mines, investing more than 1 billion dollars.

However, working conditions and cultural conflicts regularly make the headlines. Imposition of the Chinese one child policy in many Zambian copper mines, for example, has evoked a lot of criticism. "Health insurance coverage is only provided for the first child. As a Zambian, my culture allows me to have many children. We are Africans, and this should be respected," criticises a Zambian copper mine worker.⁵

Yet overall, the reaction to the Chinese presence in the country is positive due to the jobs created and significant impact of the infrastructural development. Li Qiangmin, Chinese Ambassador to Zambia, sees their strategy as a win-win model. "Our experience with foreign investment as a developing country in the past has influenced

our policy in Africa. Moreover, our economy experiences enormous growth. We are looking for outlet markets and raw materials in Africa."⁵

Trade, not Aid

Besides Zambia, another major recipient of Chinese investment is Kenya. Hoping to copy the efficiency of Chinese companies in Africa, Wahome Gakuru, director of Kenya's 25-year economic plan, Vision 2030, sees great potential in outsourcing Kenya's infrastructure. "From China we want a transfer of skills: how to build roads, bridges, teaching discipline," he said.⁷

In November 2012, three Chinese companies successfully completed a Kenyan superhighway linking Nairobi with the city of Thika. The road, 8 lanes wide, is the biggest of its kind in East Africa.⁸ Helmut Reisen, lead economist at the Organisation for Economic Co-operation and Development (OECD), says "Africa presents at the moment a division of labour that can only displease the West. China is responsible for promising economic projects and cooperation, while the West takes care of humanitarian and social projects."⁵

Despite fifty years of development aid, sustainable growth has not been generated but rather a dangerous dependence on donor countries has developed, explains Kenyan economist James Shikwati. "When politicians draw sustenance from donors, they have to give account to the World Bank, the IMF and the international donor community, and they tend to pay less attention to the desires of their own people." Only time will tell whether the alternative Chinese approach to investment reverses this trend towards more independent and sustainable economic governance.

Changing Demographics

Growth in Africa is driven by its demographics. "Development is ultimately about people. If people live longer, and closer together, countries can benefit from a demographic and geographic dividend. They are then more likely to have higher incomes which is spent on fewer children. With a better upbringing, these children then have better opportunities than their parents. This creates a virtuous economic cycle which we are currently observing in most of Asia", explains Fengler. If Africa

manages this demographic transition well, it can expect to see in the next 30 years what Asia experienced in the last 30 years.

However, Africa's challenges are well documented. Lack of liquidity, insufficient infrastructure, healthcare, political and social instability as well as corruption are just some of the major roadblocks that hinder development; African countries have yet to transform their economies as the BRICs have done. "The best example is the weakness in manufacturing. As long as African countries don't produce industrial goods for the global market on a global scale, they will remain behind the BRICs," predicts Fengler.

The Chinese have seized an opportunity to drive infrastructural development, and currently hold more than 50% of public contracts in Africa

Furthermore, while most African countries are expected to have reached middle-income status by 2025, these statistics often disguise wide discrepancies as the benefits of accelerated growth are often concentrated in the hands of a few. Fengler warns of misconceptions, "If a country becomes a middle-income country due to a sudden discovery of natural resources it often does not change anything! The realities of the average and poor person remain dismal and sometimes natural resource discoveries make their lives even harder, especially if these new resources are not managed well as in Congo or in Gabon."

Nevertheless, Fengler sees Africa on the rise. "The continent has a great opportunity to benefit from a combination of several big trends: The demographics are favourable, urbanization creates new economic dynamism and technology has also empowered the poor in a remarkable way.

"Now comes the hard part: economic transformation has yet to happen and will depend on countries tackling their deep-rooted governance issues", says Fengler, "Only then Africa will be able to claim this century."

Franca Hoffmann is currently studying at Imperial College London for her MSc Mathematics. She has previously spent a summer in Ghana with MISE, offering voluntary mathematics programmes to children. For this article, commissioned for LIMUN 2013, she interviewed *Wolfgang Fengler*, the World Bank's Lead Economist in the Nairobi office of the World Bank.

[6] Eigen, P. (2012) Is China Good or Bad for Africa? *CNN World News*. 29 October. [online] Available at: <<http://globalpublicsquare.blogs.cnn.com/>> [Accessed 1 January 2013].

[7] China Building Solid Road to Kenya Relations (2007) [online] Available at: <http://news.xinhuanet.com//2007-10/11/content_6862740.htm> [Accessed 1 January 2013].

[8] Will Kenyan Superhighway Also Benefit China? (2011) [online]. Available at: <<http://www.npr.org/>> [Accessed 1 January 2013].



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