Issue 4, Summer 2011

A Global Village

WHERE POLICY AND POLITICS MEET SCIENCE AND ENGINEERING

Health Care and the Economic Crisis: Can Technology Help?

Empowering Rural Rwanda with Energy Kiosks

Social Networks and Social Change

More than a Nudge: The Long Road to a Low Carbon Future

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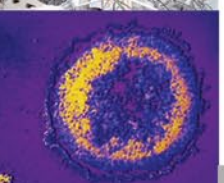

Imperial College London
School of Public Health

Global Health studies

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Global Health Short Course

27 June – 1 July 2011

Who should come?	The course is designed for (and with) medical students, but is open to all
What is the format?	Lectures, small groups, interactive workshops and films
What will it cover?	Globalisation, conflict, climate change, neglected tropical diseases, emerging epidemics, the role of pharma, international health care, working with the media and much more!
Who are the teachers?	Experts in global health, doctors who have worked overseas, guest speakers

Course Directors	Prof. Helen Ward & Prof. Alan Fenwick
Contact	Isobel Blake, imb02@imperial.ac.uk
Venue	St. Mary's Campus, Imperial College (near Paddington Station)
Registration Fee	£50
Website	www.imperial.ac.uk/schisto/courses

"When it comes to global health,
there is no 'them' ... only 'us'."

Global Health Council

Foreword

I am delighted to have been asked to introduce Issue 4 of *A Global Village* which includes a focus on the unprecedented and interlinked challenges of climate change and providing clean, secure and affordable energy services.

In a world where some 20 percent of the global population still lacks access to electricity, and where climate impacts are likely to fall hardest on the poor and most vulnerable, it is all too easy to feel discouraged by the apparent lack of progress and urgency in tackling these issues at a political level in the developed economies. The task of doing so has of course been hugely complicated by the financial crisis over the last few years and the more recent and tragic events in Japan.

Fatih Birol made clear in his recent talk at Imperial College (see interview on page 58) the huge challenge that the world faces in providing the energy required in developed and, increasingly, in developing countries and at the same time limiting our integrated carbon dioxide emissions to an amount that is consistent with a change in global temperature near 2°C. It is certainly hard to see how a credible global mitigation strategy can completely cast aside a major technology such as nuclear power without having a clear idea of how it would be replaced and at what human and financial cost. However, the damage to the reactors at Fukushima has rightly revived questions about the risks of nuclear power. It has also generated heavy demands on Imperial College nuclear expertise to interpret and advise on its implications. Important energy supply decisions have to be made relatively quickly, but they must be made in a considered manner.

One of the great pleasures in taking up my role as Director of the Grantham Institute at Imperial was to see the vast range of the work going on here and the amazing quality of the people, both researchers and students. The ability and enthusiasm of the Imperial College student body for making a better tomorrow shines though in so many areas. *A Global Village*, which builds much needed linkages between the fundamental science and engineering at Imperial College and the real-world policy challenges of development, health, energy and climate, is a wonderful example of this talent, commitment and energy.

The *A Global Village* team are to be congratulated on pulling together another high quality publication. This current issue includes thoughtful essays on the potential future role of biofuels (Andrew Purcell, page 54) and solar power (Alice Jensen, page 49), the geopolitics of gas pipelines in a crisis-stricken part of the world (Akhmed Tillayev, page 46) and a piece that examines the hugely important issue of electricity market reform and electricity networks in the UK (Nick Hughes, page 41), which as a member of the UK Climate Change Committee I will read with particular interest.

Prof. Sir Brian Hoskins
Director, Grantham Institute for Climate Change, Imperial College London

Editor's Note

2011 has so far been a year of calamitous change with uprisings across the Middle East and a devastating tsunami and ongoing nuclear crisis in Japan. It is against the backdrop of these events that our contributors tackle some of the most pressing issues that we face in global health, development, governance and energy security today.

The fourth issue of *A Global Village* sees a focus on the potential for IT in healthcare and the impending threat posed by antimicrobial resistance, and we look at the impact of social networks on social change and epidemiology. On the energy front, we ask: why has the so-called low-carbon transition stalled in the UK, and how might technologies such as solar power and biofuels play a part in a future global low-carbon energy mix? We also caught Dr. Fatih Birol, Chief Economist at the International Energy Agency, for an exclusive interview and asked him about the impact of rising oil prices on the global economy, and the critical role of the US and China in combating climate change.

The team at *A Global Village* has also been busy hosting events including a timely debate on the future of nuclear energy and a lively discussion on the role of intellectual property law in global health with panelists from academia, industry and government – see pages 60/61 for more.

Finally, many thanks go to Prof. Alan Fenwick OBE, Director of the Schistosomiasis Control Initiative, the Boston Consulting Group and the IC Trust for their support of this project – without you we would not be able do what we love to do!

Neave

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A Global Village

WHERE POLICY AND POLITICS MEET SCIENCE AND ENGINEERING

Submissions for October Issue

A Global Village focuses on key areas where politics and policy meet science and engineering from global health to climate change and energy, food security and development. Article lengths should be within the range 800-1800 words.

deadlines for issue 5

July 1st
short abstract/word count

August 1st
final deadline

Key Topics: The Right to Health, Food & Agriculture, Financial Markets & Risk

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Health Care and the Economic Crisis
Can Technology Help?

Agnes Becker, Institute of Global Health Innovation, Imperial College London

Countries around the world are struggling to reform their healthcare systems in the midst of immense cost constraints. Safe, effective and accessible technologies could drive down costs globally, and help put patients at the heart of healthcare.

Cutting Edge yet Accessible Technologies

Chronic diseases are the leading cause of mortality in the world, representing 60% of all deaths[1]. Patients require regular monitoring, a process that is both inconvenient to the patient and costly for health care systems. With demographic changes associated with ageing populations, most Western countries are increasingly faced with age-related diseases and the political and economic ramifications that these introduce. This has motivated the development of pervasive sensing technologies using miniaturised wireless, low-power, wearable biosensors for key physiological indices to address the resource and cost implications of serving populations with increasing life expectancy and improved survival of chronic illness. They are also used to promote safe independent living, limit complications and expedite safe discharge.

Western countries are increasingly faced with age-related diseases and the political and economic ramifications

Such devices are designed to be low cost, easy to use, yet technologically sophisticated to include context aware and autonomic sensing such that they are suitable for an untrained elderly population, often with decreasing perceptual and cognitive capabilities. The technical and design challenges faced by developed countries are, in fact, not dissimilar to those required for vital sign monitoring and point of care, lab-on-a-chip technologies in resource deprived countries where such services are not universally available. For once, there is a common ground for innovation where previously there was little incentive for manufacturers to develop devices solely for developing countries due to potential ethical issues surrounding differing standards and prohibitive engineering costs.

At Imperial College's Hamlyn Centre researchers are developing miniaturised sensors that could be used to remotely monitor patients with chronic and life-style related diseases. Packed with the latest technological advances, these sensors were designed to be used by elite athletes and those in resource poor countries alike. One example is the award winning e-AR sensor that is worn on a person's ear to measure balance, body posture, activity level, and heart rate. This information is then transmitted wirelessly to a computer or other device where it can be viewed by the patient's doctor or used by the patient to guide and manage the rehabilitation process. The e-AR sensor would allow health professionals to call patients into hospital when needed, rather than every few months for regular check-ups. Minimal hospital visits would give patients better quality care and cut costs for the health service provider.

This reliance on wireless technology echoes mobile technologies that have transformed commerce, healthcare and social lives across the world – mobile subscriptions

1 WHO Chronic Diseases. (March 2011). http://www.who.int/topics/chronic_diseases/en/

2 The Lancet (2006). WHO's patient-safety checklist for surgery.

3 Mytton O. T., Velazquez A., Banken R. et al. (2010). Introducing new technology safely. *Quality and Safety in Health Care*.

in Africa rose from 54 to almost 350 million between 2003 and 2008 – and heralded the establishment of a state-of-the-art communication infrastructure. This provides a unique opportunity to improve access to information by healthcare workers in these countries thus enabling safer and more effective care delivery.

Are Technologies Too Complicated?

Available technologies designed for industrialised markets are often inappropriately complex, and donations of these types of equipment to resource-poor countries can result in equipment left unused. The context within which a new technology is used, and the associated human errors that may result from its use, must be carefully assessed. Health workers globally must receive adequate training for new equipment.

Imperial College's surgical education team have developed an inflatable surgical theatre that can be used to train staff from entry-level health workers to consultant surgeons. The theatre can be used for surgical simulations that give effective training for the technological apparatus used in surgery as well as team-working and appropriate regulatory and management procedures. The portable theatre can easily be taken to hospitals for training sessions. In the UK, around 850,000 errors occur annually in hospitals, contributing towards 40,000 deaths[2]. In England and Wales, 27% of inhospital reports of patients' safety incidents were related to problems arising from medical devices or equipment[3]. Adequate training will result in fewer errors, thereby improving patient experience and cutting costs for the health care provider.

What about Resource-Poor Settings?

Inequality in access to technology and a general lack of appropriate technology designed for developing countries – with consideration of infrastructural gaps – is a problem. There is considerable need for safe, effective and accessible technologies that are tailored to the environment within which they will be used.

Point-of-care testing is an area where technology can have a significant impact in resource-poor countries. Imperial College's CD4 Initiative is working to produce a simple, low cost, point-of-care test to aid treatment decisions for those living with HIV/AIDS in resource-poor countries. HIV infects and kills cells CD4 T cells, which are essential for a healthy immune system. In the developed world newly diagnosed patients are not always put on medication straight away; rather, antiretroviral therapy (ART) is only started when the number CD4 T cells in the blood fall to less than 350 cells/mm^3, a threshold at which the patient is considered vulnerable to opportunistic infections. The traditional technology to count CD4 T cells is expensive and needs specialised

e-AR sensors developed by the Hamlyn Centre are worn on a patient's ear to measure balance, body posture and heart rate

laboratory and technical support that is beyond the scope of peripheral health centres in resource poor countries (where the majority of HIV patients access healthcare). Patients in developing countries must often travel many miles to their nearest HIV clinic and these may not offer CD4 counting. The decision to start life-saving ART is then based on whether the patient looks sick enough to start treatment. Alternatively, a blood sample is taken and sent to a centralised laboratory for testing. The patient will then have to come back to the clinic after four weeks to receive the result. Over 50% of patients do not return to collect their CD4 count results, perhaps because they are too ill to travel or partly due to distance from the clinic and an inability to afford transportation costs. These patients, many of whom will desperately need treatment, are effectively 'lost', potentially putting themselves and their community at risk. In addition, it is well established that patients who start treatment before demonstrably sick have better outcomes. The CD4 Initiative point-of-care test would offer an alternative scenario where patients could attend peripheral health centres and have an instant CD4 cell count (<30 minutes), ensuring sick patients are triaged for treatment immediately. These patients are then retained in the healthcare system and start ART before their immune system is severely damaged.

Over 50% of patients do not return to collect their CD4 count results

Technology can aid health research in remote rural areas, providing vital data and statistics to influence health policies. Developed at Imperial College's Infectious Disease Epidemiology department and Bioinformatics Support Service, EpiCollect is a smartphone app and web application that can collect data from anywhere across the globe using mobile phones (Android and iPhone)[4]. EpiCollect is being used across Africa for studies of animal and human health. For example, the monitoring and evaluation of chemotherapeutic agents for the treatment of schistosomiasis and by Maasai vets for animal disease surveillance[5].

Although EpiCollect uses mobile phones, a SIM card is not needed for the collection of data, making the devices cheap to use. Data, including photos, videos, sound

clips and bar code scans, are entered into the mobile device, and can then be sent via 3G or wireless networks to a central computer server to be further analysed. The technology is simple, easy to use and portable and the website allows anyone to set up their own data gathering projects[6]. Researchers conducting surveys are able to take the mobile phones to remote areas and upload data directly, thereby cutting administrative costs.

Power to the People

EpiCollect could also revolutionise health care by giving power to the citizen. It is already being used in citizen science data gathering projects aimed at getting members of the public to contribute biodiversity data, but could be adapted to conduct national health surveys quickly and easily while cutting administrative and organisational costs.

Safe, affordable and easy to use technology can improve patient care globally and at the same time cut healthcare costs

The Dr Darzi Wellnote iPhone app, developed by Imperial College's Centre for Health Policy, gives users the opportunity to rate hospitals and GP clinics, putting patients in the driving seat of improving healthcare and potentially cutting costs of expensive patient surveys.

Students tackle Global Health Challenges

A Global Village is a testament to Imperial College students' drive to tackle global challenges. Student initiative has resulted in technologies that are being used across the world to benefit quality of life and better people's health.

Lack of consistent electricity supply is a major factor hampering health care in many resource-poor settings. e.quinox, a charity set up by Imperial College engineering students, aims to bring sustainable electricity to rural areas. e.quinox have developed a portable battery pack that can be recharged using solar energy. In order to make the idea fully sustainable, local residents in each rural village staff the e.quinox energy kiosks. Villagers can use the kiosk to buy electrical equipment and recharge their batteries for a small fee. Already improving the quality of life of families in rural Rwanda, e.quinox's sustainable energy supply could one day be transferred to clinics and hospitals. See page 28 for more on the e.quinox project.

Collaboration between Imperial College's engineering students and the Royal College of Art's design students has resulted in mywater, a portable home desalination unit that produces safe drinking water. The students formed their company InProgress to develop mywater which aims to provide people who have access to salt water and fossil fuels for cooking the opportunity to produce a significant amount of their daily water needs using the wasted energy created by the cooking process. By selling mywater at a premium to yacht owners, InProgress will be able to launch the product at a cheaper price in resource-poor settings, such as coastal areas of Bangladesh where high salt levels in drinking water has been shown to cause hypertension in pregnant women.

In both cases, students have developed products that fit the environment in which they will be used; they are simple and do not require vast training. They have ensured their business model is sustainable and will benefit the local community.

Technology can Better Patient Care and Cut Costs

Safe, affordable and easy to use technology can improve patient care globally and at the same time cut healthcare costs: as mobile phones dominate global communications, patients and citizens will be able to influence their health service; portable technology and body sensors will allow patients to be at the heart of health care delivery in both resource rich and poor settings; and efficient, sustainable products will continue to help curb the causes of disease.

Institute of Global Health Innovation at Imperial College
www.imperial.ac.uk/global-health-innovation

Agnes Becker wrote this article as Communications Consultant for Imperial College's Institute of Global Health Innovation. With a BSc Hons Natural Sciences and an MSc Science Media Production Agnes has worked in science communication at the Science Museum, on science TV programmes for BBC, Channel 4 and National Geographic, and as a freelancer producing short films, illustrations and publications.

4 Aanensen D. M., Huntley D.M. et al. (2009). EpiCollect: Linking smartphones to web applications for epidemiology, ecology and community data collection. *PLoS ONE*.

5 London International Development Centre. (March 2011). http://www.lidc.org.uk/news_detail.php?news_id=98

6 EpiCollect. (March 2011). http://www.epicollect.net

Enabling E-Health

A Revolution for Informatics in Health Care

Simon Kennedy MD & Benjamin Berk, The Boston Consulting Group

Health care costs are growing at an unsustainable rate throughout much of the world. In response, many governments are taking steps to prod the health care industry to aggressively expand its use of IT. The potential long-term benefits to all parties, measured in cost savings and improved medical outcomes, will be vast. But the near- to intermediate-term disruption to the industry will be significant, translating into both costs and opportunities for industry players and the entire health-care ecosystem.

As a key part of their efforts to contain surging health-care costs and improve the quality of care, governments around the world have launched major initiatives to spur health care players to embrace IT. In the US, for example, the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act – a combination of regulations and financial incentives for health care providers (including $36 billion to propel the expanded use of electronic medical records) – became effective this year. China's government, which has committed to a massive $125 billion overhaul of that country's health-care system, has identified the expanded use of IT as an essential part of its campaign and has instituted measures to spur investment and compliance. Sweden is seeing the fruit of its investments in the development of patient-outcomes data registries and has committed additional funding to further the registries' coverage[1]. And the Kingdom of Saudi Arabia recently commissioned its first-ever e-health strategy.

Globally, health care costs are rising at an unsustainable rate, one that significantly exceeds both GDP growth and growth in household incomes

For the health care industry – which, despite being arguably the most information-intensive industry in the world, has been slow to join the digital revolution – the transition will be a sea change. The potential long-term benefits to all parties, measured by cost savings and improved medical outcomes, will be vast. But the near- to intermediate-term disruption to the industry will be significant, translating into both costs and opportunities for industry players and the entire health-care ecosystem.

Here we discuss factors driving the unprecedented investment in so-called health care informatics, the progress to date, and why the revolution is, we believe, sustainable.

An Industry Ripe for Change

First, it is important to understand that the health care industry, which represents approximately $5.5 trillion, or 8%, of the global economy, is itself made up of multiple industries. These can be grouped into the following categories:

- Innovative suppliers, or the biopharmaceutical and medical-devices companies that develop new diagnostics and treatments and invest tens of billions of dollars annually in R&D
- Payers, or the insurance companies, third-party administrators, government agencies, and large employers that pay for the vast majority of health care

[1] Larsson S., Lawyer P. & Silverstein M. (November 2010). From Concept to Reality: Putting Value-Based Health Care into Practice in Sweden. BCG White Paper.

- Providers, or the doctors, nurses, and other health-care professionals who provide care in hospitals, private offices, and other settings
- Other supporting infrastructure players, including medical-equipment companies, disease-management outsourcers, and pharmacy benefits managers
- In the US, for example, there are an estimated 5,795 hospitals (according to the American Hospital Association), 800,000 physicians (World Health Statistics 2010), 1,300 private health-insurance companies (America's Health Insurance Plans), and many thousands of smaller participants.

Globally, health care costs are rising at an unsustainable rate, one that significantly exceeds both GDP growth and growth in household incomes. According to Plunkett Research, the US health-care system, for example – by far the world's most expensive – now consumes about 18% of US GDP, with its costs having risen fully three times faster than economic growth over the past two decades. For most other countries, the problem is less severe but still significant, with health care costs for several major Western countries (such as France and the UK) consuming as much as 10% of GDP and rising at roughly twice the rate of economic growth.

Rapidly rising costs might be justifiable if they were accompanied by commensurate gains in efficiency or the quality of care. But that is the exception rather than the rule. Numerous studies have shown that higher spending does not necessarily translate into improved patient outcomes. And most countries' health-care systems are plagued by a considerable amount of waste. In the US, for example, an estimated $700 billion of the $2.5 trillion spent annually on health care is considered wasted, the result of overtreatment, fraud, abuse, and error.

Many of the problems that plague health care systems have a common thread: they are largely attributable to a lack of timely, accurate information, including clinical information about patients (such as past diagnostic images and lab results) and decision-support tools for physicians (such as information about potential adverse drug reactions). Improving the accuracy and timeliness of information across health care systems could considerably improve patient outcomes while materially reducing costs. For innovative suppliers, such as biopharmaceutical companies, access to larger, broader datasets and real-time data could translate into a range of benefits, including the following:

The lack of timely, accurate information translates into billions in wasted health-care spending

In the United States, $700 billion is wasted annually

Estimated waste ($billions)	Drivers	Potential information-based solutions
270	Overtreatment and non-guideline care	• Automated, real-time prompts encourage the use of less-expensive generic drugs • Real-time approvals for diagnostics and imaging help ensure conformance with care guidelines
140	Fraud and abuse	• Clinical data comparison across sites identifies duplicate billing
120	Administrative-system inefficiencies	• Clinical data in initial claim enables automated adjudication
90	Provide inefficiency and errors	• Timely access to discharge instructions targets support, avoiding readmissions • On-demand scheduling for equipment improves satisfaction and productivity
40	Lack of care coordination	• Real-time access to preexisting diagnostic data avoids duplicative testing • Instant access to medication list and alerts avoids adverse drug events
40	Preventable conditions and avoidable care	• At-home patient monitoring supports timely intervention, avoiding the need for hospitalization

Sources: Where Can $700 Billion in Waste Be Cut Annually from the U.S. Healthcare System?, Thomson Reuters White Paper, October 2009; BCG analysis.

- Powerful new ways to identify and recruit patients for clinical trials, dramatically speeding the time to trial completion
- New simulation tools, enabling elimination of some in vivo trials altogether
- An enhanced ability to track and target marketing efforts to prescription-drug users
- A stronger foundation for outcomes analysis and decision making
- A greater ability to monitor user outcomes and meet rising pharmacovigilance standards while also improving compliance and the return on investment (ROI) of health care spending on pharmaceuticals

For payers, the benefits of enhanced information flows are equally compelling and would including the following:

- Minimization of duplicative and unnecessary testing and diagnostic imaging
- Less fraud
- Improved ordering processes for prescriptions and lab tests, leading to a reduction in associated administrative costs and substantially reducing the tens of thousand of adverse drug interactions per year (and their associated medical expenses)

Providers have historically derived the least value among industry participants from improved information flows. This is because, in many systems, providers are paid via a fee-for-service, or flat-salary, model, which gives them little incentive to improve the quality of care or the management of outcomes. Instead, most providers have focused their efforts on measuring "inputs," such as procedures performed or visits. In many advanced economies, this structural issue, which translates into both direct costs and opportunity costs, is exacerbated when multiple providers treat a single patient, which increases the number of handoffs and the opportunities for communication failure.

Improving the accuracy and timeliness of information across health care systems could considerably improve patient outcomes while materially reducing costs

As the study and science of comparative effectiveness become more mature, however, more and more health-care systems are rethinking their practices and revamping their economics to give providers a stake in outcomes, not just inputs. Providers thus have increasing incentives to invest in outcomes-enhancing IT systems, which can deliver several advantages:

- A lower incidence of medical errors, leading to fewer adverse events and disputes and ultimately fewer demands on the health care system
- Increased "evidence-based" medical decision-making coupled with automated record generation, leading to lower billing costs through improvements in adjudication of reimbursements
- Better clinical-decision support, improving the quality of outcomes and reducing the very high number of errors currently occurring in many hospitals
- Greater empowerment of patients over their own care, and improved patient adherence to clinical recommendations

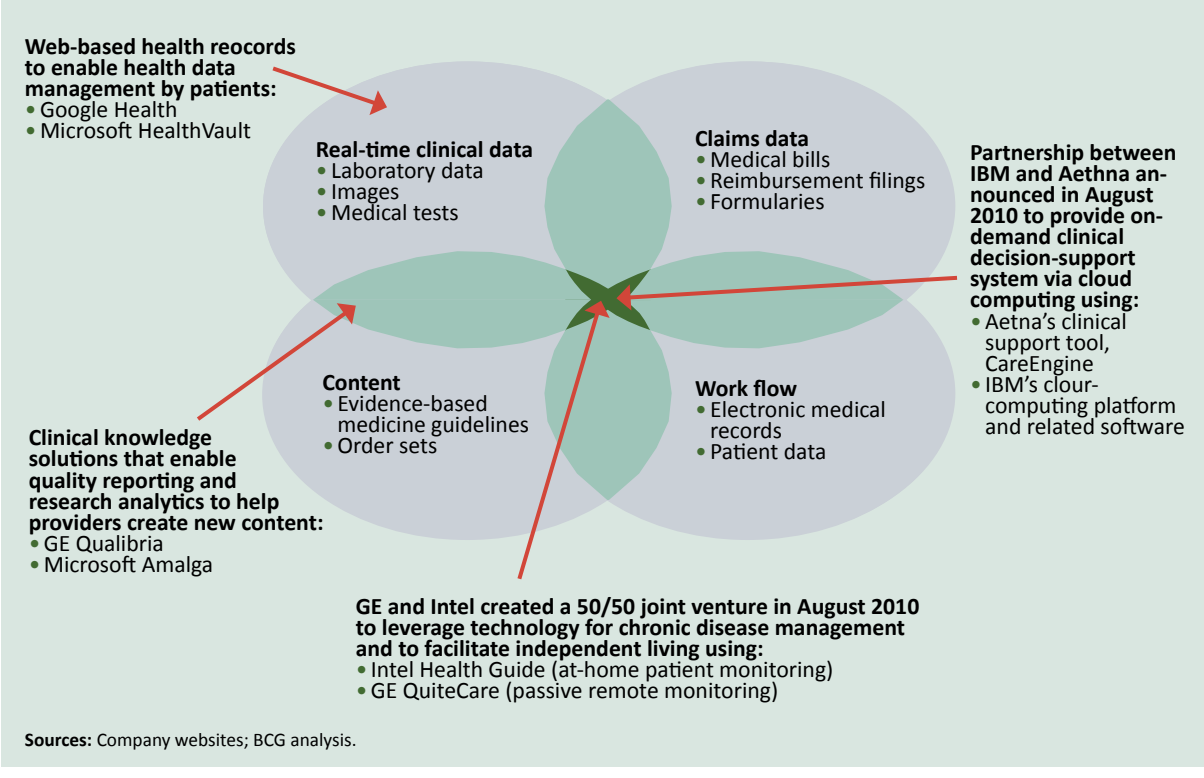
Given the number and range of potential benefits to all parties, including patients, any serious effort to control health care costs and improve outcomes must necessarily focus on information management – as governments and many industry participants are now doing.

IT Is the Key

Ongoing advances in health care informatics are allowing health care providers, payers, and other industry participants to access richer, more accurate data than they could in the past. These data include real-time clinical data (for example, electronic medical records and patient-outcome registries), real-time clinical workflows (such as clinical decision support and provider-ordering systems at the point of care), continuously updated content knowledge (including evidence-based guidelines), and real-time claims data (for encounter and prescription claims adjudication). And informatics will allow the industry to use the data in ways that could have a truly transformative effect on health care.

A case in point is the potential impact of data on the pursuit of value-based health care (VBHC), a concept introduced several years ago by Michael Porter and Elizabeth Teisberg[2]. VBHC is based on the

[2] Porter M. & Teisberg E. (2006). Redefining Health Care: Creating Value-Based Competition on Results. *Harvard Business Press*.



Industry participants are joining forces to advance, integrate, and leverage health care informatics

premise that the goal of any health-care reform should not be simply to lower costs, or to improve outcomes at any cost. Rather, it should be to maximize value divided by costs, with "value" defined as quality and measured on the basis of data such as hospital readmission rates or diabetes control.

This pursuit is, by definition, highly information-intensive. Health care providers and payers must be able to aggregate and analyse volumes of data to determine which treatment approaches are likely to yield the best, most cost-effective care. While this sets the bar very high in terms of implementation (given the size of the industry), a number of countries are already starting to build the infrastructure and processes necessary to support a value-based approach – with advances in health care informatics a key enabler.

Sweden is a prominent example. While it has not created a full-scale version of VBHC, the country has made great strides toward surmounting one of the largest challenges – obtaining timely and reliable data. Over the past several decades, the country's health-care sector, aided by the government, has developed a number of disease registries, which are vast repositories of data on outcomes for patients undergoing specific types of treatments, such as hip replacement surgery. The information gathered has helped providers identify value-based treatment protocols – procedures that have a much higher ROI and are safer – and adjust them to specific patient populations, enabling better, more cost-effective care while eliminating unnecessary and ineffective treatments. The success of the program to date is reflected in any number of metrics, including a recent study that found Sweden to have the best health-care outcomes in Europe – a noteworthy feat, given that the country's health-care costs as a percentage of GDP hover around the European average.

Further advances in health care informatics will enable new applications and solutions across the entire health-care value chain. A range of health care players, IT providers, institutions, and vendors are working both independently and collaboratively to push the envelope. Exciting examples include the Partnership to Advance Clinical electronic Research (PACeR), a coalition of medical research centres, pharmaceutical companies, and health information technology organizations (current members include Pfizer, Merck, and Johnson & Johnson) that seeks to dramatically improve the speed and

quality of clinical research necessary to develop new medicines; the Observational Medical Outcomes Partnership (OMOP), a public-private partnership among the US Food and Drug Administration, the US Foundation for the National Institutes of Health, and PhRMA (Pharmaceutical Research and Manufacturers of America, whose members include leading US research-based biotechnology and pharmaceutical companies that aim to improve the monitoring of drugs for safety by upgrading techniques for mining existing health-care databases); and a partnership between IBM and ActiveHealth Management, an Aetna subsidiary, that is working to support physicians' decision-making by leveraging cloud computing and advanced analytics to create detailed patient-health records.

Why Now Is Different for Health Care Informatics

Skeptics will point out that health care informatics has had several "false dawns" in the past and has failed to gain broad adoption. We believe, however, that the time is now for health care informatics to deliver on its promise. First, as noted, governments are "all in" in their commitment to advancing the use of IT in health care, making large investments and setting standards and regulations. Hence, there is a strong push that in the past has been lacking – along with a growing sense among industry participants that this is now inevitable.

Value-based health care is based on the premise that the goal of any health-care reform should ... be to maximize value divided by costs, with "value" defined as quality and measured on the basis of data such as hospital readmission rates or diabetes control

Second, there is increasing evidence of the value of health care informatics, making the case for broader adoption even more compelling. For example, some integrated health systems, where the payer is also the provider and thus has more incentive to invest in IT (examples include the US Department of Veterans Affairs and Kaiser Permanente), have made substantial investments over the last five to ten years to develop integrated computer systems. These investments are now generating returns through better, less expensive care.

Third, the adoption of electronic medical records is accelerating and is expected to reach 70 to 90% among health care providers within five years. And health information exchanges (HIEs), which aim to boost the quality and efficiency of patient care by mobilizing health care information electronically across organizations within a region, community, or hospital system, are multiplying quickly in both developed and developing countries. In the US, for example, there are more than 200 HIEs in development, including more than 70 that are already in operation. China's health-care reform initiative includes the development of nearly 350 "regional health information networks", more than 100 of which have already been launched.

Fourth, technology standards have reached a level of maturity and adoption that is beginning to allow the interoperability of systems across care settings. A host of standards – including Logical Observation Identifiers Names and Codes (LOINC), Digital Imaging and Communications in Medicine (DICOM), Health Level Seven International (HL7), and Systematized Nomenclature of Medicine – Clinical Terms (SNOMED CT) – are allowing for rich information interchange across care settings and are being used by regional health-information organizations, such as Indiana's HIE, to coordinate care across regions, with impressive results. Though much developmental work remains to be done, as standards are refined and become more commonplace, the ability to exchange, aggregate, and analyse health care data will increase dramatically.

Health care informatics will transform the health care industry – and far sooner than many realize. Industry participants – and those that help support them, including IT services providers – that have not yet moved should be working on the development of informatics strategies and thinking about investment decisions. Taking a wait-and-see approach is a losing bet.

Simon Kennedy MD is Senior Partner and Managing Director at the Boston office of The Boston Consulting Group. *Benjamin Berk* is Project Leader at the Chicago office.

Have We Truly Conquered River Blindness?

Dr. Poppy Lamberton, School of Public Health, Imperial College London

Seventy five percent of blindness worldwide is avoidable through prevention or treatment, with 90% of these avoidable cases occurring in developing countries. Human onchocerciasis, better known as River Blindness, is a parasitic disease caused by infection with the nematode (roundworm) *Onchocerca volvulus* and is the world's second-leading infectious cause of blindness. Thirty seven million people are infected with onchocerciasis worldwide. Calculations, which are likely to vastly under-represent the magnitude of the problem, indicate that 500,000 individuals have visual impairment and 270,000 are blind. It is estimated that over 130 million people are at risk of infection in West and Central Africa, and to a lesser extent Yemen and Latin America.

Mass chemotherapy combined with insecticidal spraying became the norm, OCP covering over 1.2 million km^2 and protecting 30 million people in eleven countries at its peak

The parasitic worms which cause onchocerciasis are transmitted to humans through the bite of *Simulium sp.* flies (black flies) which breed predominantly in fast flowing white water sections of rivers. Adult *O. volvulus* worms can live for up to fifteen years in the human body, with the males and females entwined in nodules within the subcutaneous tissue of the skin. After mating, the female worm releases up to 1000 embryos (known as microfilariae) per day into the surrounding tissue. If left untreated, the microfilariae can live for 1–2 years, migrating to many areas of the body and in particular the eye and skin lymphatic system. When these microfilariae die they cause an inflammatory response that can lead to severe skin rashes, lesions, intense itching, skin depigmentation and damage to the optic nerve leading to blindness. While the initial infection can be treated, the blindness, once occurred, is irreversible.

Onchocerciasis belongs to a group of diseases called Neglected Tropical Diseases (NTDs), so named because, although they affect vast numbers of people globally, research, control and treatment is grossly under-funded and under-resourced in comparison to the burden of the disease they bestow on afflicted populations.

A local man blinded by onchocerciasis is led by a child from his village in Ghana

Control History

Although still classified as an NTD, onchocerciasis has been the focus of several large-scale control efforts since the biology and life cycle of the disease was first understood. The Onchocerciasis Control Programme (OCP) operated in West Africa during the period 1974 to 1988, exclusively targeting black fly populations through mass larvicide spraying of the flies' breeding sites, in fast flowing rivers, from helicopters and aircrafts. In 1987, with the donation of Mectizan® (ivermectin) by Merck & Co., Inc., mass chemotherapy combined with insecticidal spraying became the norm, with the OCP covering over 1.2 million km^2 and protecting 30 million people in eleven countries at its peak. The OCP was a fantastic early example of multi-disciplinary collaboration involving the World Health Organization, the World Bank, the United Nations Development Programme and the UN Food and Agriculture Organization. Specifically, it clearly demonstrated the synergistic value that comes from countries and organisations working together in partnership, as well as the economic benefits and social development that results from investments made in a disease control programme in remote and neglected areas.

Ivermectin does not kill the adult worms and therefore must be administered regularly and consistently until transmission has been halted and the adult worm populations have naturally died out

Indeed, the OCP was deemed to be such a success that onchocerciasis was no longer considered a public health problem by the end of 2002, with approximately 600,000 cases of blindness prevented and 25 million hectares of land made safe for cultivation and resettlement. However, vast swathes of Africa remained untreated and onchocerciasis was still claiming the sight and disrupting the lives of hundreds of thousands of people each year.

Although Non Governmental Development Organizations (NGDOs) continued mass ivermectin distribution in various regions from 1989 to 1994, the OCP control zone had excluded almost 100 million people in areas of active transmission. In 1995 a second programme to combat the remaining burden of Africa's river blindness, named the African Programme for Onchocerciasis Control (APOC), was initiated. The APOC covered an additional nineteen countries and relied mainly upon Community-Directed Treatment with Ivermectin (CDTI). Such community treatment strategies empower local people to fight river blindness in their own villages, as well as relieving suffering and slowing transmission of the disease. The programme, which has been extended until 2015, intends to treat over 90 million people annually in 19 countries while protecting an at-risk population of 115 million and aiming to prevent over 40,000 cases of blindness every year.

Current Chemotherapy

Community-directed treatment with ivermectin is now the mainstay for onchocerciasis control throughout West Africa and is particularly effective because it only needs to be taken annually (the strategy in Africa) or biannually (in the Americas), needs no refrigeration, and has a wide margin of safety enabling drug administration to begin in communities with only minimal training of community health workers. CDTI has therefore played a major role in alleviating current and future onchocerciasis-related health risks as well as having a direct impact on transmission. The drug itself paralyses and kills the microfilariae, temporarily halting transmission. In addition it also reduces the fecundity of the adult females, reducing microfilarial output for a number of months after treatment. However, ivermectin does not kill the adult worms and therefore must be administered regularly and consistently until transmission has been halted and the adult worm populations have naturally died out. This seemingly huge task has been greatly facilitated by Merck's pledge to donate the drugs free of charge until onchocerciasis is eliminated. Long-term commitments, such as these, are essential elements for a programme's sustainability.

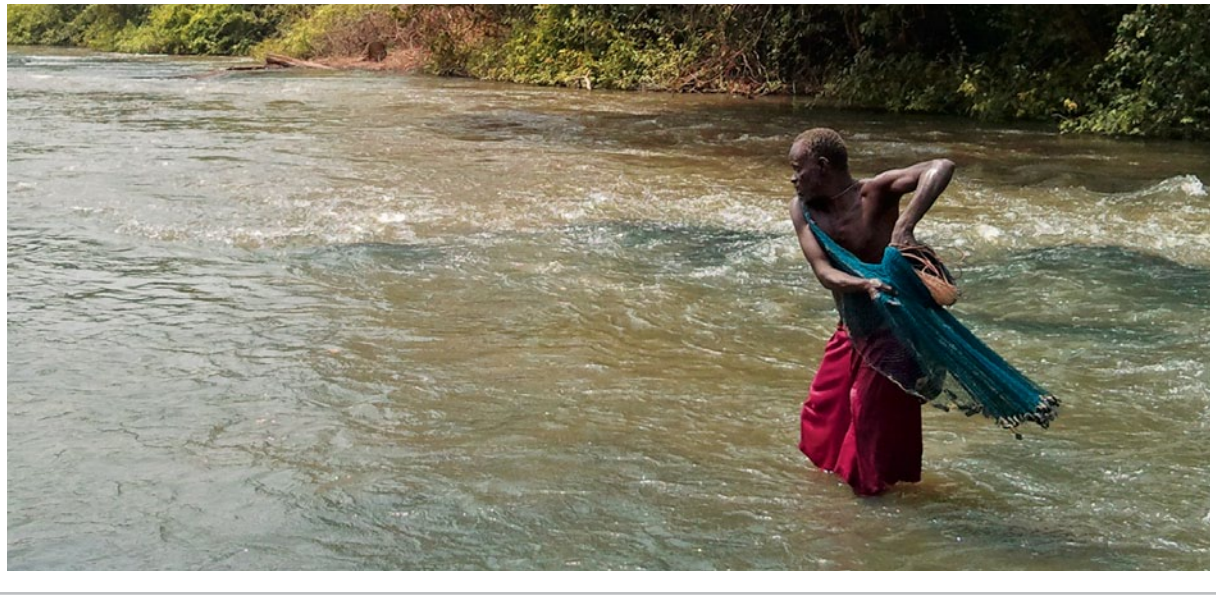
Success Stories and Future Fears

Although river blindness is still a very real and ongoing problem, there have been success stories. The island of Bioko in the Republic of Equatorial Guinea was the only island in the world to have endemic onchocerciasis. Control of onchocerciasis, using ivermectin, began in 1990 yielding clinical benefits but did not successfully interrupt transmission. It took sustained efforts to eliminate the endemic black fly vectors (which do not exist elsewhere in Africa; and in turn mainland vectors do not re-invade) using helicopters and ground-based applications of larvicide combined with a programme of ivermectin treatment to knock back transmission, which led to the successful elimination of transmission of the disease in 2005.

Early predictions on how long ivermectin treatment would need to be continued to achieve the goal of removing onchocerciasis as a public health problem have not held up

On the mainland, however, things are, unsurprisingly, a lot more complex. Over a decade into the 21st century, with mass ivermectin treatment extending into its' 23rd year, high levels of onchocerciasis transmission and infection remain problematic for many West African countries. With the cessation of OCP vector control, early predictions on how long ivermectin treatment would need to be continued to achieve the goal of removing onchocerciasis as a public health problem have not held up and active transmission is still occurring in several areas with millions of people still at risk. Indeed reinvasion of the disease has occurred in many of the OCP areas and little is known about how many additional

Fishing near the white water black fly breeding sites which made him blind



treatments must be given in areas that have no current recorded infections, in either humans or vectors, to halt reinvasion.

Compounding problems associated with such questions, fears of drug resistance are starting to arise in a few hot spots across West Africa. A study of 2501 people in Ghana showed that the prevalence rate doubled between 2000 and 2005 despite treatment[1] suggesting that some parasite populations may be developing resistance to the drug. Should such resistance arise there are other drugs available to target specific non-responders; but additional complications exist with these other drugs (for example doxycycline) due to the fact that they need more prolonged treatment regimes.

Questions should be asked about what are the best methods to achieve global elimination of onchocerciasis and its associated morbidities?

Looking at NTDs in Niger in the last issue of *A Global Village* Anna Phillips highlighted that 'although treatment with drugs is excellent for morbidity control and maintaining low transmission rates of disease, it is not a sustainable means to eliminate such parasites forever.' In some more isolated river basins, with seasonal transmission and no re-invasion of infected flies from elsewhere, it has been reported that ivermectin alone can lead to interruption of transmission[2]. More generally, however, and if a reduced efficacy of ivermectin were confirmed, questions should be asked about what are the best methods to achieve global elimination of onchocerciasis and its associated morbidities[3]?

As with the control of all infectious diseases, care must be taken to take heed of early warning signs of drug resistance. Only if researchers, funders and programme managers do not turn a blind eye to such warnings can river blindness truly become an affliction of the past.

1 Osei-Atweneboana M.Y. et al. (2007). Prevalence and intensity of Onchocerca volvulus infection and efficacy of ivermectin in endemic communities in Ghana: a two-phase epidemiological study. *Lancet*.

2 Diawara L. et al. (2009). Feasibility of Onchocerciasis Elimination with Ivermectin Treatment in Endemic Foci in Africa: First Evidence from Studies in Mali and Senegal. *PLoS NTDs*.

3 Basáñez M.-G. et al. (2009). River Blindness: a success story under threat? *PLoS Medicine*.

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Antimicrobial Resistance

Overcoming this Emerging Threat

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Antimicrobial agents have been around for less than 100 years, however, they have revolutionised the treatment of infectious diseases. The mortality of many of these diseases has declined dramatically and the development of such drugs has been heralded as a major advance in medicine.

Unfortunately, an increase in antimicrobial resistance has meant that some of the medications that we use today are becoming less effective and many countries are now seeing an increase in the number of infections with resistant organisms such as Methicillin-resistant Staphylococcus aureus and Multi-drug-resistant TB. The WHO estimates that 440,000 cases of Multi-drug-resistant TB emerge each year causing roughly 150,000 deaths.

Recently antimicrobial resistance has been in the news after the Lancet published a paper showing that bacteria with the antimicrobial resistance gene NDM-1 have been found in the water supply in Delhi. This enzyme destroys carbapenems, a group of antibiotics used to treat difficult infections. The Health Protection Agency (HPA), which has monitored antimicrobial resistance for 30 years, has said it recorded 88 cases of bacteria with NDM-1 (New Delhi Meallo-beta-lactamose) in the UK. Most of the patients had been linked to India. This development is worrying news for governments and may prompt an increased focus on antimicrobial resistance.

Drug resistance causes harm and possible death to patients. Pathogens that are drug resistant are much harder to treat and so patients generally spend more time in hospital meaning that they are more likely to spread their infection to others. They are also likely to need more drugs that may have adverse side effects, leading to additional suffering for both the patient and their family. These factors also lead to an associated increase in the cost of healthcare; for example, patients with a drug resistant infection are often unaffected by oral medication and so need intravenous drugs, which are more expensive and have further costs associated with their use. Whilst this increased cost is a manageable issue in the UK, it can cause greater difficulties in developing countries, particularly as infectious diseases are often more prevalent in these regions.

Some doctors are predicting that in a few decades some easily treatable diseases will become impossible to treat. Among these include Tuberculosis and Malaria.

If drug resistance is not tackled comprehensively, the long-term implications will greatly affect healthcare in the future. Already some doctors are predicting that in a few decades some easily treatable diseases will become impossible to treat. Among these include Tuberculosis and Malaria. Even now, in some cases, doctors skip first line medications and go straight to costlier second line ones as they presume resistance.

In order to tackle this global problem, countries need to make a collaborative effort to combat this resistance, as antimicrobial resistance does not respect borders. Indeed, recently the WHO declared antimicrobial resistance the theme for World Health Day

2011. Solutions outlined include preventing the spread of infections, developing new medications and improving regulation of those currently in use.

The genes for antibiotic resistance develop and persist primarily due to the overuse of antibiotics. Generally, the greater the exposure to these drugs, the faster resistance develops. Antibiotic misuse must therefore be addressed in humans and in animals.

Doctors often act to minimise any risk of complaint even if it means exposing a patient to unnecessary medication

Misuse in Humans

In the USA in 1998, 80 million prescriptions for antibiotics were filled. In a lot of these cases patients did not actually have an infection that would have been helped by antibiotics. This overuse is due to both doctors and patients: increasingly well informed patients may demand antibiotics even when their medical condition does not warrant it. In addition, doctors are more willing to agree to patient demands due to a risk of litigation. In other words, doctors often act to minimise any risk of complaint even if it means exposing a patient to unnecessary medication. Examples of diseases that are over treated with antibiotics include colds and flus. In the UK doctors are unlikely to prescribe medication in these cases unless there are serious underlying medical conditions. However, in countries with less regulated health care systems, such as India, doctors are more likely to prescribe. In these cases, patients may wrongly believe that their doctor is taking their condition more seriously, whereas in fact this is not the reality.

Another area of concern is compliance. When doctors prescribe antibiotics, it is usually for a course that must be taken over a set period. It is important that patients take the whole course to ensure that the infection is completely treated. There is a big risk of patients stopping their medicine intake after a few days, when they are feeling better, but the antibiotic course has not been completed. This can lead to partially treated infections, and importantly, the pathogen has had enough exposure to an antimicrobial to develop resistance, but not enough for it to be killed. It is therefore integral to educate people of the need to complete antibiotic courses to stop the development of resistance.

What is Antimicrobial Resistance?

This describes the phenomenon whereby a microorganism develops the ability to survive in the presence of an antibiotic.

How does this happen?

The cause of antibiotic resistance is due to a genetic mutation in bacteria.

How can antibiotic resistance spread?

Genes can be transferred between bacteria (horizontal or vertical transmission) and so a gene for antibiotic resistance, which had evolved via natural selection, can be shared and spread.

The Biology behind Antibiotic Resistance:

Genetic changes help pathogens evade antibiotics by:

1. Producing an enzyme that deactivates antibiotics (e.g. β-lactamases produced to break down penicillins);
2. Altering the target site of the antibiotic (e.g. MRSA alter the penicillin target PBP);
3. Developing methods to remove the antibiotic;
4. Altering the metabolic pathway targeted by the antibiotic.

Misuse in Farming

Agricultural practices account for about 60% of antimicrobial use in America. This is equivalent to about 18,000 tonnes per year. Irresponsible use of antibiotics in farm animals is an important cause of bacterial resistance. Bacteria living in animals will develop resistance and can then pass it on to human bacteria. Importantly, antibiotics are used as feed additives to farm animals. This is to prevent rather than treat infection. Many health care professionals consider this an irresponsible use of the drugs.

In many countries, treatment of animals is poorly regulated. In the USA one study suggested that 90% of all veterinary drugs are administered without a professional veterinary consultation. It can also be the case that medications can be acquired without a prescription. Often inappro-

priate doses and combinations of medications are used. Diagnosis is also a problem. Due to modern intensive farming methods, farmers are pressured into keeping costs as low as possible and it has been reported that farmers will often not properly diagnose an illness, preferring to give antibiotics straight away, as laboratory tests are too expensive.

However, some farmers argue that antibiotics will keep livestock healthy and hence reduce the incidence of infections in humans who eat meat. This argument emphasises the importance of education for farmers about resistance, as well as the need for new regulations that are based on firm scientific fact to be bought into practice.

New Antimicrobial Development

New medications are being developed continuously, but most of these are for medical conditions such as Hypertension. Over the last decade or so there have been relatively few new antimicrobials. This is because antimicrobial drugs need to be toxic to pathogens, but not to human cells; this means that they must target sites that are unique to pathogens. There are relatively few suitable sites and hence drug development has been slow.

A key impediment is that drug development is an expensive process. Today a new drug will usually cost about a billion dollars to develop and test. Drugs usually go through many stages of testing and clinical trials to determine their side effects and efficacy. It therefore often takes several years before a medication is available for general use in hospitals. New drug development is often funded by the drug company's themselves; however, they may ignore research into antimicrobials as other therapeutic goals may be more lucrative. Therefore, extra funding from governments, specifically targeted at the development of antimicrobials is vital.

Some farmers argue that antibiotics will keep livestock healthy and hence reduce the incidence of infections in humans who eat meat

The WHO has recently released a six-point policy for antimicrobial resistance. Firstly, the global community must try to prevent infections in patients. This will involve improving hygiene and increasing the availability of vaccines. Furthermore, surveillance of resistance, coupled to increased laboratory capacity, is crucial.

How Can We Halt the Spread of Antimicrobial Resistance?

Surveillance

- Development of methods to document the spread of drug resistant infections.
- Standardisation of the way in which these pathogens are classified.
- Effective reporting of new strains to warn countries in close proximity.

Regulation of Antimicrobial Use

- Universal regulation of the use of antibiotics.
- Enforcing these regulations.

Development of New Drugs

- A united effort for development of new drugs with promise of adequate funding for the necessary research.

Prevention

- Good sanitation, nutrition and comprehensive vaccination programmes.

In addition, it is widely accepted that reducing the use of currently available antimicrobials is very important. This means a combined effort from the farming industry and the healthcare sector is needed. Finally, countries need to invest in the development of new drugs. While this will prove expensive and time consuming, the alternative of widespread antimicrobial resistance will be far worse.

The impact of antimicrobials in modern medicine has been unquestionable. However, if they are to remain an effective treatment for infections, action must be taken to reduce antimicrobial resistance. The WHO is leading the response to antimicrobial resistance by providing policy guidance, technical assistance and working to prevent the spread of infectious diseases. Singular interventions will have little impact, so the global community must work together in pursuit of this goal.

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The Media and Humanitarian Aid
In the Eyes of the Beholder

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Human history has seen no shortage of wars, famine and natural disasters. Reflecting on the aftermath of the recent catastrophes in Haiti and Pakistan, an interesting question emerges – why do some humanitarian aid appeals generate more media coverage and funds compared to others?

We are living during an information age. The power of the individual via social media platforms has become apparent and 24-hour news coverage is now standard. One cannot doubt the role, and the increasing influence, that the media plays in shaping our thoughts, perceptions and actions.

Some $1.6 billion was pledged to Haiti within 10 days of the quake amounting to a staggering $495 per person

The aid industry represents big money. With a budget of over $150 billion per year, distributed by over 200 bilateral and multilateral organisations[1], it is clear that attracting a piece of this pie is paramount for disaster response efforts. The majority of aid budgets don't come from public donations, but from governments and international aid agencies that have large strategic reserves for emergency relief: for example, in 2009 $100 billion was spent by national and international agencies whilst $50 billion was spent by NGOs and private organisations[1].

This article will explore the media's role in the international community's response to aid appeals from both a public and policy perspective. For the sake of illustration, we will compare and contrast the response to two recent natural disasters: the 2010 earthquake in Haiti and flooding of Pakistan.

2010: A Year of Disaster

2010 was a year struck by Mother Nature. The insurance company Swiss Re estimated that in 2010 alone, natural disasters claimed more than a quarter of a million lives and caused $222 billion of damage worldwide. The response to the two mega-crises in the year, the Haitian earthquake in January followed by the summer flooding in Pakistan, together ate 96% of the UN aid budget with Haiti receiving $3.5 billion and Pakistan receiving $2.4 billion in assistance[2].

Haiti's earthquake caused massive destruction on the small Caribbean island, one of the poorest countries in the northern hemisphere. The epicentre was 25km from the capital, Port-au-Prince, and more than 316,000 people – 3% of Haiti's population – died[3]. Furthermore, the proximity of the earthquake to the capital caused a near total collapse of the Haitian government and central infrastructure.

1 de Haan A. (2009). How the Aid Industry Works: An Introduction to International Development. *Kumarian Press*.

2 United Nations Office for the Coordination of Humanitarian Affairs (2010). Natural Disasters 2010: Summary of Contributions.

3 CBC News (12/01/2011). Haiti Raises Quake Death Toll on Anniversary.

4 Tarakzai S. (2011) Pakistan Battles Economic Pain Of Floods. *AFP*.

5 BBC (20/08/2010). UN Says Pakistan Urgently Needs More Aid Helicopters.

6 Oxfam Press Release (10/08/2010). Pakistan Floods: Mega Disaster Needs Mega Response.

7 Al Jazeera (15/08/2010). UN Chief: Pakistan Needs More Aid.

8 AFP. (10/08/2010). Pakistan Floods Worse Than 2004 Tsunami: UN.

The Pakistani floods that followed engulfed the country, submerging nearly one fifth of the land – an area the size of England. The total economic impact was estimated to exceed $43 billion[4] and the Pakistani government estimated that nearly 20 million people were affected by the floods and more than 1,600 lives were lost[5].

The Aid Response

The humanitarian response to the Haiti earthquake got off the ground quickly with harrowing pictures and updates broadcast hourly around the world. Some $1.6 billion was pledged to Haiti within 10 days of the quake amounting to a staggering $495 per person[6].

In contrast, the initial response from the international community and aid donors to the Pakistan appeal was sluggish. Oxfam was highly critical of the international community, stating that in the first 10 days of the appeal less than $134 million was pledged, which breaks down to just $3.20 per flood-affected person[6].

The UN Secretary General, Ban Ki-Moon, urged the international community to donate an initial $460 million in funds to Pakistan while on a fact-finding mission in the region: "in the past I have witnessed many natural disasters around the world, but nothing like this."[7] His words proved to be ineffective, and within a couple of weeks only 20% of requested funds had been received.

Such was the extent of impact of the floods that a few weeks into the disaster the spokesperson for the UN Office for the Coordination of Humanitarian Affairs (OCHA) claimed that "this disaster is worse than the 2004 tsunami, the 2005 Pakistan earthquake and the Haiti earthquake"[8]. Over 13.8 million people were directly affected by the disaster in Pakistan compared with 5 million for the South Asian tsunami and 1.5 million in Haiti.

So what was it about Haiti that prompted the international community to donate 80% of the requested funds within 10 days, yet not surpass 20% for Pakistan despite the flooding being acknowledged by the UN and other aid agencies as being the most serious disaster of the year?

The Media Response

The Haiti appeal enjoyed broad support around the world. A specialised television appeal featuring several prominent personalities and many of Hollywood's finest was broadcast to 83 million people worldwide raising $61 million in funds. The star-factor did not end there, as a music album titled 'Hope for Haiti' was released and

Life goes on in Pakistan: Images like these did not inspire an outpouring of donor generosity

Crisis in Haiti: Heart-wrenching images of quake survivors mobilised a global aid response

soon reached the top of the worldwide music charts including the UK and US. Later, another music single was released, featuring a plethora of industry stars such as Michael Jackson and Lionel Richie, and was launched at the opening ceremony of the Winter Olympics 2010. The micro-blogging site Twitter had Haiti as one of its 4th most popular global trend in the year 2010. People were seeing, hearing and tweeting about Haiti.

The tone of Pakistan appeal was far more reticent. Pakistan is widely seen as a troublesome and volatile hotspot due to its chequered history and association with terrorism and corruption. Indeed, the British Prime Minister, David Cameron, visited the region only a few weeks prior to the onset of the floods and rebuked the Pakistani government for failing to combat tolerance for terrorism. The President of Pakistan, Asif Ali Zardari, was also derided in the media, both at home and away, for his refusal to return home from a trip abroad. Public preconceptions, coupled to the slower-moving nature of the disaster and perhaps an element of media and public fatigue, contributed to a muted and ultimately unsuccessful campaign.

It has also been suggested that there may have been a perception that Pakistan is an emerging economy and should be better able to cope with the disaster than Haiti. Yet the per capita income in 2010 for both nations was comparable with $710 for Haiti[9] versus $1,067 for Pakistan[10].

We must ask, to what extent does the tone and scope of media coverage influence and dictate the outcome of a humanitarian appeal?

The Media and Aid

There was a significant contrast between the media response to Haiti and Pakistan. The mainstream support that the Haiti appeal generated added serious credibility to the large sums of money that were being sought. Despite a similarly chequered political history, the Haiti appeal relied on a positive portrayal of the resilient Haitians who had also suffered devastating tropical storms in both 2004 and 2008. The mobilisation of entertainment industry personalities enabled access to a broader donor base and bestowed a certain kind of legitimacy on the appeal.

Yet, in stark contrast to the Haiti appeal, few news agencies ran reports on the situation in Pakistan without mentioning issues surrounding terrorism and corruption in the region.

[9] IMF. Haiti: Gross Domestic Product per Capita, Current Prices (US dollars).

[10] IMF. Pakistan: Gross Domestic Product per Capita, Current Prices (US dollars).

[11] International Red Cross (2005). Humanitarian Media Coverage in the Digital Age, World Disasters Report 2005.

[12] Sheerin J. (21/08/2010). Who Cares About Pakistan? *BBC*.

The International Red Cross reported in 2005 that, "News judgment reflects established criteria. News must be new. Editors sort stories by death tolls." They go on to argue that disasters that cause considerable death or destruction in accessible places get more coverage. In a quest to provide news entertainment and chase ratings, they propose "it's understandable that sudden, dramatic disasters like volcanoes or tsunamis are intensely newsworthy, whereas long-drawn-out crises (which are difficult to describe, let alone film) are not."[11]

This insight seems to describe what we saw in Haiti and Pakistan. A sudden quake that provoked dramatic scenes of carnage and a high death toll in a very poor country ensured that the Haiti quake was immediately newsworthy. In contrast, the Pakistan disaster was a gradually unfolding catastrophe and the floods 'only' went on to claim the lives of 1,600 people.

The discrepancies between the Haiti and Pakistan aid appeals provide much food for thought and highlight the critical role that the media plays in dictating the discourse surrounding aid

This phenomenon did not go unnoticed in the media. Several papers and news outlets commented on the lethargy of the aid community in responding to the Pakistan appeal. It was thought that the timing of the Pakistan floods proved to be a decisive factor.

Just Bad Timing?

In the midst of a global economic downturn and against the backdrop of government austerity measures, raising immense disaster funds was indeed a tall order. Furthermore, some of the reserves that might have gone to Pakistan were simply already spent in Haiti; for example, the $1.03 billion USAID budget of for disaster responses was already depleted by a third in response to the Haitian relief efforts[12].

However, despite the economic downturn, UNOCHA still managed to raise more money this year than in previous years, indicating that the health of the economy – at least for now – is not a reliable prognostic indicator for donor appeals. In order to combat potential future shortfalls, the UN has launched a $7.5 billion appeal for 2011 to better equip international aid agencies for disasters in the coming year.

It has also been argued, in the case of Pakistan, that there was an element of 'donor fatigue'. In an interview with the BBC, Dr. Marie Lall, a Pakistan expert at the Royal Institute of International Affairs said, "I think there is donor fatigue all around – the 2004 Indian Ocean tsunami, the 2008 Burmese Cyclone, the 2005 Pakistan earthquake, and this year's Haiti earthquake – it is getting too much; we are in a recession and people are short of money."[12]

We could also consider the possibility that the countless disasters and conflicts have led to so-called 'media fatigue'. With tens of hotspots around the world, from Sierra Leone to Cote D'Ivoire and Sudan, many long-running conflicts and crises have stretched the resources and attention of the world's media. The Red Cross notes, "Forgotten disasters are often chronic and diffuse, changing little day by day. Unlikely to qualify as news, such crises may feature as current affairs stories – especially on the websites of news organizations."[11]

The discrepancies between the Haiti and Pakistan aid appeals provide much food for thought and highlight the critical role that the media plays in dictating the discourse surrounding aid. It is clear that, in order for us to be able to rapidly mobilise the international aid community, governments, private sector and individual donors, we must pay greater attention to the public's perception of a disaster as it unfolds.

The media is no doubt aware that they have a huge responsibility to report the truth – as ambiguous and potholed as it may be. Aid agencies are all too aware that over or under exposure of events can adversely affect their funding streams. It is about striking a balance between accurate and truthful reporting and creating and promoting narratives that encourage donor generosity.

Understanding this dialogue is key to ensuring collaboration between news media, the entertainment industry and other associated media streams and aid agencies, so that we can be better prepared to garner support quickly from a wide array of donors when the next disaster strikes.

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Harvesting Water for Tanzania

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Raincatcher Imperial is an annual student-led project that aims to improve the standard of living in Tanzania through the provision of clean drinking water. According to Tanzania's Ministry of Water, it is estimated that 70% of the rural population have no access to safe water causing the deaths of 31,000 children due to diarrhoea each year in Tanzania alone. In remote regions even unclean water is in short supply as the dry season lasts for up to eight months of the year. Raincatcher Imperial attempts to alleviate this problem by constructing Rainwater Harvesting Systems (RHSs) for such communities.

Tanzania experiences a dry season of up to 8 months during which time there is little to no rainfall. In contrast, during the wet season, rainfall is heavy and flooding occurs. The total rainfall over the year is sufficient for the population's water needs but is very unevenly distributed and drought is common.

Rainwater harvesting is a viable means of providing clean drinking water to the local population, as it is a simple yet effective method of storing water for countries with seasonal rainfall patterns. Through the adoption of rainwater harvesting, excess rainfall can be stored in tanks during the wet season that may be rationed during the dry season. This allows the local population to have a constant supply of water all year round, and minimises the population's reliance on well water during the dry season that is not only dirtier than harvested rainwater but expensive as well.

Since its inaugural project, Raincatcher Imperial has been working closely with Caritas Tanzania, a Tanzanian-based NGO. Each year a number of sites in need of rainwater harvesting systems are identified by Caritas and presented to the team. The team then decides how many rainwater harvesting systems to build and where they should be built taking many factors into consideration including that of available funding. Other logistical factors such as accessibility to construction materials, the safety of the team and ease of travel are also taken into account.

Rainwater harvesting is a viable means of providing clean drinking water to the local population

Capturing the Rain

The rainwater harvesting systems that are constructed by Raincatcher Imperial are designed by a Tanzanian engineer specialising in rainwater harvesting systems in collaboration with specialists at Imperial College. A key feature of these rainwater harvesting systems includes a dome-shaped storage tank that takes advantage of the compressive strength of concrete. At the same time the dome shape minimises stress concentrations and reduces the risk of fracture in the tank. A ring beam has also been incorporated into the tanks to make them earthquake-resistant. The design has low labour and construction costs and is built underground with space considerations in mind.

When the first rains fall after the dry season, the rainwater is allowed to first run off the roof but not into the tank. This first flush system allows the initial rainfall to be used to clean the roof of dirt and debris. Once the roofs have been cleaned, the storage tank inlet pipe is then connected to the gutters of the roofs allowing water to be collected off the roofs of surrounding buildings and stored in the storage tank. The storage levels of the

tanks should be managed such that the tank is full at the end of the wet season. The water in the storage tank is then further pumped up into a water tower that is connected to a tap stand.

Water for Education

For the 2010 project the tap stand is located in a shed and can only be accessed by the matron and head girl of the school for which the RHS was built. This ensures that during the dry season the water in the tank can be properly calculated and rationed to ensure that water is being consumed from the storage tank at the appropriate rate. At the end of the dry season the tank is cleaned, inspected and the cycle repeats with the new wet season. During the team's time in Tanzania, locals will be trained to clean and inspect the tank.

Members of Raincatcher Imperial faced many challenges on the ground in Tanzania. One of the main challenges faced by teams over the years is the language barrier. Most Tanzanians speak rudimentary English and many team members have difficulty communicating. Although most team members attempt to overcome this barrier by learning basic Swahili before going to Tanzania, their extremely fundamental grasp of the language is appreciated although largely ineffectual. Another significant challenge lay in securing materials in Tanzania. In 2010, the team faced delays in construction when no cement was being supplied to the nearest large town.

Raincatcher Imperial has improved the quality of life of local communities. The availability of clean water at schools through the RHS has meant that parents are more likely to send their children to school thus reducing the chances of their children falling ill. The children spend more time at school, time which might in the past have been spent fetching water from potentially contaminated wells, and receive a better education and prospects. It has also allowed the school to accommodate more students in their dormitories.

A hole is born

Tanzania

The United Republic of Tanzania is a costal country in East Africa. Once a German colony, then under British control after the World War I, the modern Tanzania assumed its present form in 1964 after a merger between the mainland Tanganyika and the island of Zanzibar, which had become independent the previous year. Despite being a largely peaceful and stable country, today's Tanzania is one of world's poorest economies with annual per capita income of US $1500.

The weather in Tanzania is tropical and dry. The only rain seasons are from March to May and from November to December in the North, and November to May for the rest of the country. It is estimated that only 54% of Tanzanians have access to water supply, directly contributing to the low life expectancy of 56 years and rendering the death of 20,000 children under the age of five yearly due to diarrhoea.

Raincatcher Imperial boosted the local economy as all resources and materials for the construction of the tanks were purchased locally at a cost of approximately £12,000 per RHS. Local labour was also hired during the construction phase thus generating jobs for members of the local community.

Raincatcher Imperial strives to make a positive impact on the provision of clean water to the rural villages of Tanzania, and hopes to improve the quality of life for the people through the provision of environmentally sustainable and ethically sound RHSs. If you would like to know more about Raincatcher Imperial or would like to support our efforts in any way, please visit our website at www.rwh-tanzania.co.uk.

Timothy Thang is a 3rd year undergraduate in Mechanical Engineering at Imperial College London, helping with promotion and fundraising for the Raincatcher project.

Empowering Rural Rwanda with Energy Kiosks

Roger Liew, Electrical and Electronics Engineering & Var Hansen, Mechanical Engineering, Imperial College London

In September 2010 ten Imperial College students embarked on a humanitarian expedition to Rwanda to supply 400 rural households with electricity. Founded in 2008 by students of the Electrical and Electronic Engineering Department, e.quinox is now comprised of students from varied disciplines all working towards the same aim: to provide electricity that is cost-effective, sustainable and renewable to developing countries.

The Republic of Rwanda is a small landlocked country within Central Africa with a population of approximately ten million. Despite its temperate climate and friendly inhabitants, Rwanda is probably best known for one of the worst genocides in modern history.

In 1994 a plane carrying President Juvenal Habyarimana and his Burundian counterpart was shot down near Kigali International Airport. The assassination of the native Hutu president ignited simmering tribal tensions and there were violent mass killings of Tutsis and moderate Hutus by the Hutu ethnic group. It is believed that over 800,000 people died in 1994 alone.

Despite recent years of relative political stability under the Tutsi Royal Patriotic Front (RPF) with comparatively low corruption levels for the region and strong economic growth, infrastructural development has been slow and poverty remains widespread. Over 57% of the population lives below the poverty line and only 7% of Rwandans have access to the electricity grid.

In villages that do not have electricity all activity stops when the sun sets. Providing just a few extra hours of light each night means that children have more time for education, and housework can be carried out during the evening leaving more time for paid employment during the day. The Rwandan government has recognized the critical importance of electricity and is supportive of innovative solutions to provide power to those that do not have access to the grid.

e.quinox, a fully student-led initiative from Imperial College, has devised the concept of the 'Energy Kiosk' which revolves around a unique business model. The kiosk acts as a centralized power generation site, and simultaneously a platform for decentralized energy distribution, in the form of battery boxes.

Rural villagers join the scheme by paying a refundable deposit for a battery box. Thereafter customers pay a small monthly subscription fee for a fixed bundle of recharges on their battery boxes that they can use for lighting, mobile phone charging and low-power appliances. The continuous revenue stream generated not only helps to maintain the kiosks and the battery boxes, but also goes towards the salary of a dedicated shopkeeper.

Only 7% of Rwandans have access to the grid electricity

Financial sustainability, or lack thereof, is often a major stumbling block for humanitarian projects. e.quinox's social enterprise model ensures that the running costs of the kiosks can be covered by the income stream, and equipment will be well taken care of by customers and stakeholders alike. The aim of e.quinox is to provide a technical solution that has the possibility of yielding an income such that local entrepreneurs can start their own kiosks and possibly, down the line, governments, NGOs and companies can roll out a similar idea on a larger scale.

Electricity in a Box

The battery boxes act as a mobile artificial electricity grid. Physical connection of a house to the grid often comes only at great expense even for houses directly beneath the grid line. The first generation of battery boxes, created in 2009, had a 12V DC-output, which could be used only for light. However the team quickly realised that there was a great demand for mobile phone charging. The second generation of boxes were, therefore, modified to include an inverter that transforms the voltage to the standard 220V output. This provides the boxes with the flexibility to power any low-power device of the customers' choice.

Three kiosks have been installed thus far; two are powered by solar power and one by a grid connection. e.quinox aims to show that the system can be implemented using a variety of generation methods thus demonstrating that the kiosks can be implemented using the most effective resources of a particular community or environment.

Field Work

In September 2010 ten students traveled to Rwanda in order to implement three Energy Kiosk projects – two new kiosks in the Bugesera and Kamonyi districts and an upgrade for e.quinox's pilot project established in September 2009 in the Minazi district. The purpose of this expedition was to provide electricity and lighting to more than 400 households living in rural communities.

On the ground e.quinox received significant support from its local partners the Belgian Technical Cooperation (BTC) and the Kigali Institute of Technology (KIST). BTC, the Belgian development agency, has been in partnership with Rwanda since its independence in 1962. BTC works in conjunction with the Ministry of Infrastructure in Rwanda to implement various projects in the electricity and infrastructure sector. e.quinox's strategic partnership with BTC provided the students with an official platform from which to implement the project with support from the Ministry of Infrastructure and the relevant local authorities.

KIST is a reputable local university based in Rwanda's capital Kigali. A local chapter of e.quinox was set up at KIST to provide necessary logistical support and monitoring throughout the year, as students from Imperial College lack a constant presence in Rwanda. This bi-directional knowledge transfer, where KIST students provide critical local knowledge and language expertise and Imperial College students provide technical know-how of the kiosk's electrical system, has been a win-win arrangement for both parties.

Connected: e.quinox battery boxes bring light and power to isolated communities

In the field the team's work involved application of different engineering aspects taught at Imperial College. Photo-Voltaic (PV) panels and electrical control systems were carefully calculated and scaled to provide ample electricity generation for each kiosk, yet conform to electrical ratings of each individual circuit component. Mechanical work was also part and parcel of installations – PV panels were mounted on beams before being installed on roofs and plastic tubing protection was used to protect wires from the weather and human tampering. Unlike the developed world, construction resources in Rwanda are extremely scarce. Therefore the team faced many engineering decisions, which required resource optimization and tradeoffs, ensuring that the construction side of the project was challenging from both a practical and planning perspective.

Let's Talk Business

Applying a successful business model to each Energy Kiosk is crucial to the long-term sustainability of the system. Indeed, the most challenging issue remained how to successfully execute such a model in rural villages. On the consumer side, adopting the battery boxes (with the free LED lamp and robust lamp holder) has to be affordable and comparable to current prices paid for kerosene lamps. Furthermore, due to the fact that the primary industry in rural communities is subsistence agriculture, many villagers do not have cash reserves at their disposal for a battery box deposit.

Students have empowered local entrepreneurs with tools to break the poverty circle

The e.quinox team visited each of the villages with the local KIST students to get a feel for the energy consumption of a typical household. This information was coupled with statistical information gathered from the Ministry of Infrastructure and the BTC to determine the price of monthly subscription and the corresponding number of bundled recharges. Throughout the price formulation process students had to weigh and balance the financial requirements of running a kiosk and the fundamental humanitarian purpose of their Energy Kiosks. The business model was therefore not meant to yield the maximum income, but to optimize the overall financial and social utility of the project.

Students found, however, that financial projections on spreadsheets often manifested themselves differently in reality. Depending on a location's demographics and the Energy Kiosk's technical limitations, each Energy Kiosk has a slightly different implementation of the same business plan. For example, the first pilot kiosk in Minazi started with a pay per recharge pricing scheme, which meant that the boxes were not fully exploited, as many costumers kept the boxes for several weeks without recharging them. In September 2010, during the upgrade of Minazi, new boxes were introduced on a monthly subscription scheme. This provided a more predictable income stream and also ensured the battery boxes had sufficient utilization.

With support from the BTC, e.quinox has also established partnerships with local micro-financing banks. This allows each potential customer to take up short-term loans for the battery box's deposit. One encouraging result of this is that budding local entrepreneurs have taken up loans and battery boxes to operate their own barbershops, mobile phone charging stations and even bars that run at night with lights. By providing the financial infrastructure and the technical solution, students have empowered local entrepreneurs with tools to break the poverty circle.

Lighting Up the Future

The e.quinox initiative provides students with a real-life application of their technical knowledge and business acumen. As a humanitarian project, the focus on the application of a successful business model ensures long-term sustainability of the kiosks.

Humanitarian expeditions such as the one during September 2010 gave students an opportunity to discover how they can enrich and empower people, by bringing electricity, light and education to rural communities. e.quinox aims to implement more projects every summer with a hydro-powered Energy Kiosk planned in collaboration with Dartmouth University for summer 2011.

If these pilot Energy Kiosks projects prove financially sustainable in the long run, the eventual target is to allow governments and private companies to spin off more such kiosks potentially benefiting vast populations in developing countries currently without access to electricity.

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Networking Epidemics

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"The world's too small. Too connected."

Superman

Although it is online social networking sites like Myspace and Facebook that garner the majority of media attention these days, social networks themselves have always been a part of our lives. From the small hunter-gatherer communities of long ago to our present overlapping family, school, and work groups, humans arguably were and still are defined by their relationships to one another. While the extent to which those connections have evolved over time is debatable, a crucial difference in the modern world is how much quantitative data has been compiled. Even as privacy advocates grow increasingly concerned about data rights, it remains the case that such data could be a veritable gold mine for policy-makers working with phenomenon that spread via network effects.

Mapping of the network of social interactions could provide insights into both the path and rate of spread of a disease and provide potential tools for halting or interrupting that spread

One such phenomenon that is of considerable interest to public policy is the epidemic spread of disease, for obvious reasons. Traditional models of epidemics compartmentalise the population into broad categories – e.g. those who are susceptible to being infected, those who have already been infected, and those who have been infected and are now immune. However, these models assume that there is random mixing within the population; that is to say, an infected individual is equally likely to infect any member of the susceptible category. This is clearly a somewhat unnatural assumption; in the real world we are far more likely to transmit an infectious disease – for instance, swine flu – to people with whom we come into close contact. Thus, mapping of the network of social interactions could provide insights into both the path and rate of spread of a disease and provide potential tools for halting or interrupting that spread.

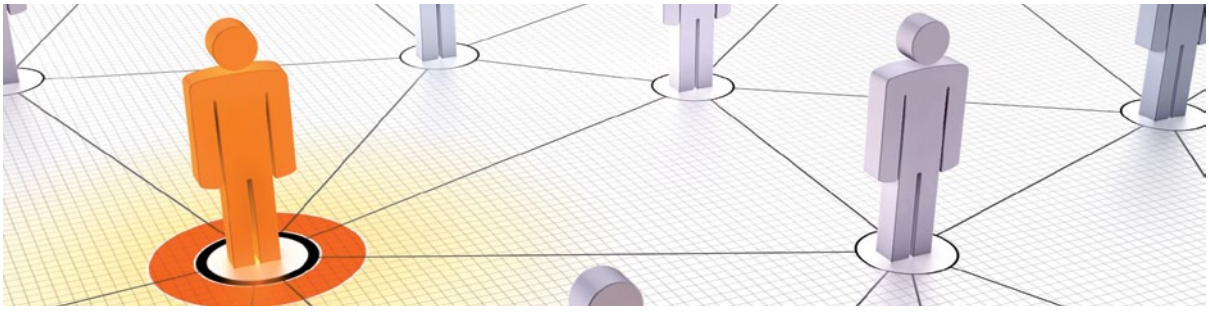
Thresholds

Human interaction networks are, however, extraordinarily complex and thus difficult to quantify accurately. Thus, although epidemic modelling historically has roots in the study of human diseases – with seminal work being conducted by Imperial College academics – let us first turn to an analogous but simpler problem: the spread of computer viruses for large networks (such as the Internet).

While different from biological systems in certain key respects, computers can also become infected by viruses (normally much to our dismay and detriment), spread the infection to connected computers, and then recover after a time (whether through anti-virus software or by a hard-disk format). What's more, the network topology – the structure of the connected computer network – is far better characterized.

Scientists at Carnegie Mellon University were able to use a nonlinear dynamical systems model to relate the connectivity of a network to whether or not an epidemic spreads or dies out[1]. They found that, given the

[1] Charkrabarti, D. et al. (2008). Epidemic Thresholds in Real Networks. *ACM Transactions on Information and System Security*.



complete network of connections between computer systems, it is possible to derive an epidemic threshold for the virus below which the epidemic dies out exponentially[2]. In tackling such virus spread, identification of critical nodes, or computers, for 'immunization' is key: immunizing a particular computer rewires the network and, if chosen correctly, may stop the spread of infection.

One can compute the change in the epidemic threshold before and after immunization to determine if the node was effectively chosen to stop the spread of the infection. Ideally, if anti-viral resources ('vaccines' in the biological disease case) are limited, one wishes to immunize only those computers that result in a rewired network with a minimized epidemic threshold.

By constructing a similar 'contact network' for human disease transmission, it would theoretically be possible to make similar recommendations for vaccination regimes. Often, when a new epidemic is sweeping through a community, vaccine supplies are limited and policy-makers are forced to make unpalatable choices about where efforts should be directed. Network science could one day be used to advise authorities on the optimal allocation of available resources.

Identification of critical nodes, or computers, for 'immunization' is key: immunizing a particular computer rewires the network and, if chosen correctly, may stop the spread of infection

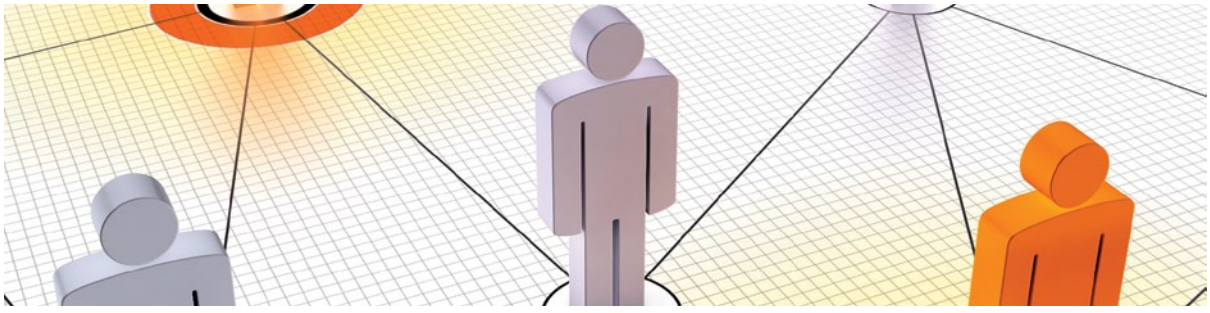
Building the Network

Unfortunately, it is somewhat more difficult to generate similar network maps for human diseases. Despite the staggering amount of data available from Facebook, limitations persist[3]. Scientists must first characterize the types of interactions that contribute to increased transmission rates. In some cases, e.g. for HIV-AIDS, it is well known what sorts of interactions should 'count' in constructing the network. However, for many other diseases, it is unclear a priori the types of contact that are linked to transmission rates. Human interactions are also ephemeral in nature such that any network of interactions is constantly evolving.

Over the past few decades researchers have been working on just that: figuring out what sorts of interactions make up a contact network – this is done largely by making copious observations during instances of outbreak of disease. This type of data is almost always imperfect, but statistical inference may permit insight into modes of transmission. For instance, in a study by the Pennsylvania H1N1 working group (composed of researchers from Imperial College and the US Centres for Disease Control and Prevention), researchers examined the rates of swine flu transmission in relation to different features of primary (grade) school life[4]. While it was impossible to pinpoint directly how particular children were infected, after constructing social networks corresponding to the interaction patterns of the school children, the team could determine accurate probabilities

[2] More precisely, we encode the connectivity of the network into an adjacency matrix A, which specifies which computers are connected to one another for purposes of viral transmission. The epidemic threshold is then the inverse of the dominant eigenvalue of A, easily computable even for extremely large matrices using numerical techniques.

[3] It is possible to get interesting results even in the absence of a known contact network. For example, because of the friendship paradox ('your friends have more friends than you do'), the named friends of randomly selected people tend to become infected earlier in an epidemic than the randomly selected people themselves, which provides an early-detection mechanism.
Christakis, N.A. & Fowler, J.H. (2010). Social Network Sensors for Early Detection of Contagious Outbreaks. *PLoS ONE*.



of transmission as correlated with a number of different factors. Unsurprisingly, sex-related mixing patterns played a role – it was hypothesized that because children of the same sex in a class tend to play together, there is an increased likelihood of transmitting disease to one another. However, contrary to what may be popular belief, sitting next to an infected individual in the classroom did not significantly increase the probability of infection.

Although still a far cry from the extent to which we understand the spread of computer viruses, data of this sort continues to be compiled. As epidemiological modelling continues to advance, it will likely one day be possible to accurately map human disease transmission networks and make policy recommendations such as the one highlighted in the last section.

Although currently of largely academic interest, it is only a matter of time before social networks become an essential tool for government strategy in epidemiology and beyond

Brave New World

Of course, while the behaviour of infected computer systems might be in agreement with some models of disease epidemic propagation, such models do not take into account the vagaries of human nature. Unfortunately, while the humanities and social sciences have much of value to say about the human condition, and often advise what people or indeed policy-makers ought to do (whether from a moral, philosophical, or economic perspective), seldom are those fields quantitatively perfectly predictive of actual actions.

One obvious solution would be to ask actual human beings to inhabit the role of agents in an 'epidemic' game online. Perhaps an unusual approach, there are plausible advantages to characterizing behaviour in a simulation involving actual people despite that the fact that one's risk analysis changes considerably when one's own life – as opposed to one's game avatar's life – is at stake! This isn't a hypothetical; in late 2005, a glitch in the popular online game World of Warcraft resulted in the so-called 'Corrupted Blood incident', during which players' characters could be infected by a deadly 'disease'. Players invest hundreds of hours, monthly subscription fees, and significant portions of their social lives into the game; the virtual epidemic was able to provoke a wide range of responses from players, from flight to more sparsely populated areas to some characters trying to help others. Several epidemiologists have attempted to draw insight from these events, mapping them onto potential behaviour of people in real life epidemic disease scenarios[5].

As our online and offline worlds slowly merge, it is not altogether surprising that we should look from one to the other for insight and prediction. Although currently of largely academic interest, it is only a matter of time before social networks become an essential tool for government strategy in epidemiology and beyond, playing a role not only in dissemination of information, but also in policy and action.

4 Cauchemez, S. et al. (2011). Role of social networks in shaping disease transmission during a community outbreak of 2009 H1N1 pandemic influenza. *Proc. Natl. Acad. Sci*.

5 Lofgren, E.T. and Fefferman, N.H. (2007). The untapped potential of virtual game worlds to shed light on real world epidemics. *The Lancet Infectious Diseases*.

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What exactly is Global Leadership?

William Wong, 3become1

2011 has begun with two great disruptions, the Arab World uprising and the systemic impact of the natural catastrophe that hit Japan.

The sweeping changes in North Africa and the Middle East not only sent the price of crude oil well above $100 a barrel, fuelling further inflationary pressures from across Europe to China, but will have longer-term implications on the fragile balance of power between Israel and the rest in the region. The uncertain equilibrium in governance ahead poses a direct threat to global energy security, whilst the upheaval unfolding moment by moment is rewriting an entrenched social order in a manner that was hitherto unimaginable.

Challenges in our global village demand global solutions, calling upon global leadership. Right?

Just when some pundits argued that Libya is a classic example of why the West should wean itself off its dependence on oil, the earthquake in Japan turned cause and effect analyses on their heads. Whilst we could adapt and mitigate against the devastating impacts of earthquakes and tsunamis, the threat of a nuclear meltdown in north-eastern Japan immediately reignited the debate on how 'clean' nuclear energy is within the agenda of low-carbon economies and climate change. Energy security vs. human security.

Challenges in our global village demand global solutions, calling upon global leadership. Right?

Welcome to the global age of anxiety and paradox, chaotic complexity and exponential change. Whatever your views on globalisation, it is very likely we see more of President Obama on our television and electronic device screens than our parents and neighbours put together. What has happened with Obama's messianic campaign slogan of 'YES WE CAN"? Two years on, why are we still hearing 'Yes we can, but not yet'?

Thinking of the familiar charismatic and transformative 'revolutionaries' in history: Gandhi, Martin Luther King or Mother Teresa, each held a bold and singular vision for a better future, followed by consistent commitment to their chosen cause.

What Does Leadership Mean to You?

A good metaphor may be others choose to follow you out of free will. Gandhi famously said, "Be the change you wish to see in the world". Businesses, organisations, communities and wider societies are after all aggregates of individuals, so leadership begins with the self. Peter Drucker's 'Managing Oneself' is packed with timeless insights, but management is not leadership. Leadership and management are complementary and interdependent. Warren Bennis goes even further to say "Managers do things right. Leaders do the right thing."

Self-Leadership

Talent is overrated. Intellectual firepower aplenty. Leaders need to zoom in and zoom out. Spatial awareness is in short supply but emotional intelligence could be developed. Before embarking on grand visions, mission, strategies, policies and processes, knowing yourself is key. Isn't this common sense? But common sense is far from being common.

There is the tried and tested psychometric testing, and strengths identifier tools that help you understand your personality and those who work with you better. But no customised template could help you with the much bigger and fundamental questions of "Who are you?" and "What is your purpose in life?" Most people would cringe at soul-searching. Yet we often look and forget to see, hear but fail to listen. Perhaps, "Who do you want to become, or what is your best potential self?" are more pertinent questions.

Leaders need to zoom in and zoom out

Awareness is the beginning of change, self or global. Awareness begins with curiosity. Curiosity stimulates an open mind, an open heart, and an open will. This in turn encourages continuous and lifelong learning. Keeping abreast of what is happening is no longer enough, but how and why it is happening, why now, and what that means for the future. Information may be abundant, but it is original insight that is critical to progress. Yet the answers you seek depend on the quality of questions you ask. Are you asking the relevant questions? There are many right answers.

Passion is infectious and is key to leading effectively. It underpins your core values and what drives you. But passion alone does little. It is a bridge to engaging with others who may have a totally different worldview from yours. True engagement is based on active listening and understanding; a genuine empathy for differences and diversity comes from within.

Dealing with the unknown is part and parcel to leadership. Doing nothing is fine as a strategic choice, rather than a reflection of decision-making inertia. Taking calculated risks towards the uncertain requires courage, and even more so when galvanising support and momentum from a wide range of competing stakeholders. In times of immense change, it is not blind bravery but rather tactical resilience addressing the delicate balance between power and accountability that wins hearts and minds.

Oprah Winfrey, the most powerful woman in the world?

Barack Obama, has he lived up to his promises?

You may have to cross the bridge as it is built. What are your top five leadership behaviours?

Community Leadership

Feel free to swap 'community' with business, cultural, organisational, social or political. Increasingly, you need to be able to navigate complexity and embrace diversity. Economic cycles and public sector reforms have led to the conventional boundaries separating the public, private and third sectors becoming more blurred. Deep-rooted cultures and distinctive working practices in each sector often could be at odds with top-down policy initiatives, causing friction through a carousel of restructuring exercises that often prove counterproductive.

Perhaps innovation through partnerships is easier said than done. Interdisciplinary and cross-sectoral collaboration remains the exception rather than norm. It is more of an art than science to weave the three sectors together seamlessly, and explore the spaces in between.

We have a long way to go when glass ceilings in prominent corporate boardroom and senior executive appointments remain a hot topic at the centenary of the International Women's Day. Besides gender diversity, there is a wide range of further complex issues to be tackled such as cultural and ethnic divisions, social and class structures, discrimination in the areas of disability and sexuality.

Great leaders understand followership. So, why should anyone be led by you?

Global Leadership

There is an important distinction to be made between global and international leadership. The latter infers a domestic counterpoint, as one sees at any major international airport. Increasing physical and social mobility challenges the concept of home and abroad. Global indicates a state of mind where the world is indeed one village, despite all its diversity.

Our 24/7 news feed has shifted the perception of what is global, national and local. Despite the underlying interdependence between complex factors and forces shaping our daily lives, most people are not natural-born globalists. If anything, more and more are rejecting the banal homogeneity of globalisation, reverting to a stronger national, regional or local identity. Yet, the

borderless world of Internet communications, social media and capital flows directly challenges the established order of nation states and trade blocs.

To be a true global leader, you need to be genuinely interested in the world as a whole, systemically; and at the same time understand that many competing silos remain in force. For any given situation, you need to grasp all of its political-economic-social-technological-legal-environmental (PESTLE) implications. These must be distilled into what could potentially fuse or divide cultures. To help others decipher ever-changing complexities and realities, you need to articulate all of the above in plain language highlighting opportunities and threats. But opportunities and threats are relative to your personal or organisational strengths and weaknesses at any one point (SWOT). Hence, we have come full circle back to knowing yourself, and the people you lead.

Self-awareness and intellectual prowess alone would not change the world. You have to able to build broad-based and shifting alliances to mobilise and create new resources towards latent and unexpected demands. There will be times when no strength of diplomacy or charisma can win you backing and followership. Will you go against conventional wisdom to do the right thing?

It may be heroic to drive a moral crusade, but knowing when to step down is scarce and undervalued. Mikhail Gorbachev and F. W. de Klerk have respectively been instrumental in changing the future of Europe and South Africa irreversibly. Both made history by gracefully getting out of its way.

Knowing when to step down is scarce and undervalued

What would be your global leadership legacy?

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Social Networks and Social Change

Andrew Burton & Prof. Chris Hankin, Institute for Security Science and Technology, Imperial College London

A few years ago we began to hear how social networking internet sites were being used to advertise spontaneous gatherings and social events. More recently, from the streets of London to the towns of North Africa and the Middle East, social networks have played a prominent role in the democratic and revolutionary process. For example, a reported 24,000 students signed up to a nationwide Facebook page for the November demonstrations against education cuts in the UK, and the use of Facebook and Twitter helped the rapid spread of action during the Egyptian revolution that led to the eventual downfall of President Hosni Mubarak[1]. These examples have shown that social networks can be a technical catalyst for social change. They move content, control and dissemination of information away from government agencies and broadcasters into the hands of the populace at large.

Once data is posted to a social network it takes on a life of its own

In the defence and security sector we refer to these as 'game changers' – ubiquitous technology utilised in a completely new or unforeseen way. Examples include the organisation of demonstrations (e.g. using live Google map based updates as well as anti-kettling applications such as Sukey) and the use of cheap RF technologies (e.g. mobile phones) for remote IED detonation. Recent history has shown that for most internet-related technologies the genie is out of the bottle. Rather than focus on the political aspects, this article will review some recent European work on mobile social networks and look at what can be learnt from the analysis of such networks, both in terms of improved business processes and understanding of social dynamics.

For the first part, we draw on a recent report by the European Network and Information Security Agency (ENISA), an EU Agency which gives advice and acts as a switchboard for information and good practices in network and information security[2]. According to their own website, Facebook has 200 million active users who access the site through their mobile devices; and they are typically twice as active as non-mobile users[3].

The major concerns related to mobile social networks identified by ENISA include: identity theft (by a 'man-in-the-middle' attack, intercepting information on its way to its intended destination or stolen mobile devices); the distribution of various types of malware; data leakage, misuse and reputational risk (once data is posted to a social network it takes on a life of its own, is difficult to entirely eradicate and, moreover, if users federate information from different networks, data from social and business networks can become inextricably linked); and, finally, personal security resulting from position tracking, which, while having some benign applications, is a particular threat to the security and privacy of mobile users.

It is estimated that 2% of the world's population has been victim to identity theft: the latest figures for the UK suggest that over 1.8 million people have been affected

1 See www.facebook.com/Thawret2011 and @egyptianuprise

2 European Network and Information Security Agency. (2011). http://www.enisa.europa.eu/

3 Facebook Statistics. (March 2011). http://www.facebook.com/press/info.php?statistics

4 http://www.identitytheft.org.uk/

5 http://www.getsafeonline.org/

at a cost of £2.7 billion[4]. Whilst some of these threats are present in traditional social networks, mobile access adds a new dimension, particularly because the mobile device effectively becomes a valuable and vulnerable database. ENISA recognise that there are technical safeguards against some of these vulnerabilities but, quite rightly, they argue that raising awareness and empowering individuals through legislation is an important first line of defence. An example of the behavioural safeguards that are recommended can be found at the UK's Get Safe Online website[5].

Raising awareness and empowering individuals through legislation is an important first line of defence

From a legal perspective, the main protection comes on a European level from Data Protection legislation (Directive 95/46/EC) (see fact-box on next page). In the UK however, the responsibility for overseeing data protection (enshrined in the Data Protection Act 1998) falls to the Information Commissioner's Office[6]. It is clear that the legislation does apply to social networking site providers, even when the providers are not based in the EU.

The situation of users of social networking sites is less clear: private profiles could be argued to be exempt under the so-called 'household exemption' where users process data 'in the course of a purely personal or household activity'. However, users who choose to make their account accessible to the public do fall under both the Act and the EC Directive. Even in the case of private profiles, the situation is not entirely clear-cut, as exemplified by the celebrated case of Mrs. Bodil Lindqvist who set up a networking site for 18 colleagues in the Swedish parish of Alseda, and was found to be in breach of the EC Directive (given in a 2003 ruling: ECJ Case C-101/01) because she included personal information on the site.

From a more benign perspective, understanding the structure of a social network in a firm or region gives insight into the innovation process. The Innovation and Entrepreneurship group in the Imperial College Business School has done groundbreaking research in this area. By studying the interactions, such as co-authorship or co-investigation in projects, it is possible to gain significant insight into the innovation process. Members of the Business School have used these techniques to advise large companies on how to improve their processes and their competitive position. Recent studies have focussed on the role of geographic proximity in promoting competitiveness and innovation in technology clusters.

At the Institute for Security Science and Technology[7] we are interested in the analysis of social network structures to enhance aspects of social behaviour and also to better understand the dynamics of such organisations. There are a number of groups in the Faculties of Natural Sciences and in Engineering contributing to this work, adopting a variety of different techniques. Bayesian statistics provides the basis for predicting missing (i.e. hidden) links or nodes in a network. Bayesian techniques also provide the basis for spotting anomalous interactions within the network – this involves an analysis of traffic between connections in the network and observation of how that changes over time. On the other hand,

6 http://www.ico.gov.uk/

7 http://www.imperial.ac.uk/securityinstitute/

8 http://www2.imperial.ac.uk/securityinstitute/agora/elgg/

Across the European Union, data protection is based on eight principles (Directive 95/46/EC) that require information to be:

1. Fairly and lawfully processed;
2. Processed for specified purposes;
3. Adequate, relevant and not excessive;
4. Accurate and up-to-date;
5. Not kept for longer than necessary;
6. Processed in line with individuals' rights;
7. Secure;
8. Not transferred outside the European Economic Area without adequate protection.

techniques from optimisation and linear programming provide the basis for identifying critical nodes in a network – these are the nodes which might need to be more heavily protected, if physical entities or, for people, who might be identified as key leaders in a social group. Notions from the theory of Markov processes have recently contributed insights into assessing the quality of clusters in a network – this provides a basis for identifying sub-communities in a network and understanding how such groups evolve over time, perhaps as a response to external stimuli. Identifying the members of a social network and collecting information about the interactions for such a network relies on extracting data from distributed sources – this is the domain of Data Mining. The Department of Computing at Imperial College has a very strong multi-disciplinary activity in this area.

The Institute has identified Social Network Analysis (SNA) as one of its priority areas. We intend to build a coalition of people working on different aspects of this problem. We have already seen that new work in measuring the quality of clusters can be used as an optimisation criterion in fast community detection algorithms. We also expect other major algorithmic advances from combining other techniques such as those described above. If you would like to contribute to this activity or follow the work please visit the Institute website and join our on-line forum, the Agora[8].

Prof. Chris Hankin is Director of the Institute for Security Science and Technology and a head of the Theory Section in the Department of Computing at Imperial College London.
Andrew Burton is the Programme Manager in the Institute for Security Science and Technology at Imperial College London.

A spring of discontent: News of unrest and protest spread like wildfire online

More than a Nudge: The Long Road to a Low Carbon Future

Nick Hughes, Centre for Environmental Policy, Imperial College London

As world crude oil prices reached a two and a half year high in early March, causing financial pain for motorists and fuel users, Labour called for the government to abandon the increase in fuel duty planned for the forthcoming budget. Despite being touted as an environmental tax necessary to put us on the route towards a low-carbon future, an increase in fuel duty during a time of recession and high oil prices was never going to be politically popular.

In the budget announced on the 23rd March, the government not only cancelled the planned fuel duty increase, but actually reduced duty by 1p from its pre-budget level. A 'fair fuel stabiliser' was announced through which future oil price rises will be cushioned by a drop in duty paid for by a levy on North Sea oil and gas production. If oil prices should fall, duty will again rise and the oil and gas levy will fall in proportion.

Can we expect the low carbon transition to take off in the near future?

Thus ran the latest chapter in the chequered history of a tax constantly on the verge of an identity crisis. Is it a regressive incursion into the budgets of those dependent on fuel for their livelihoods or a necessary pro-environmental tax designed to make us greener and more efficient?

Fuel duty is periodically justified as an environmental tax, designed to have the long term effect of shifting energy consumption away from fossil fuels towards lower carbon alternatives – indeed Ed Balls, now shadow chancellor, explicitly argued for the tax in this way while Labour were in government.

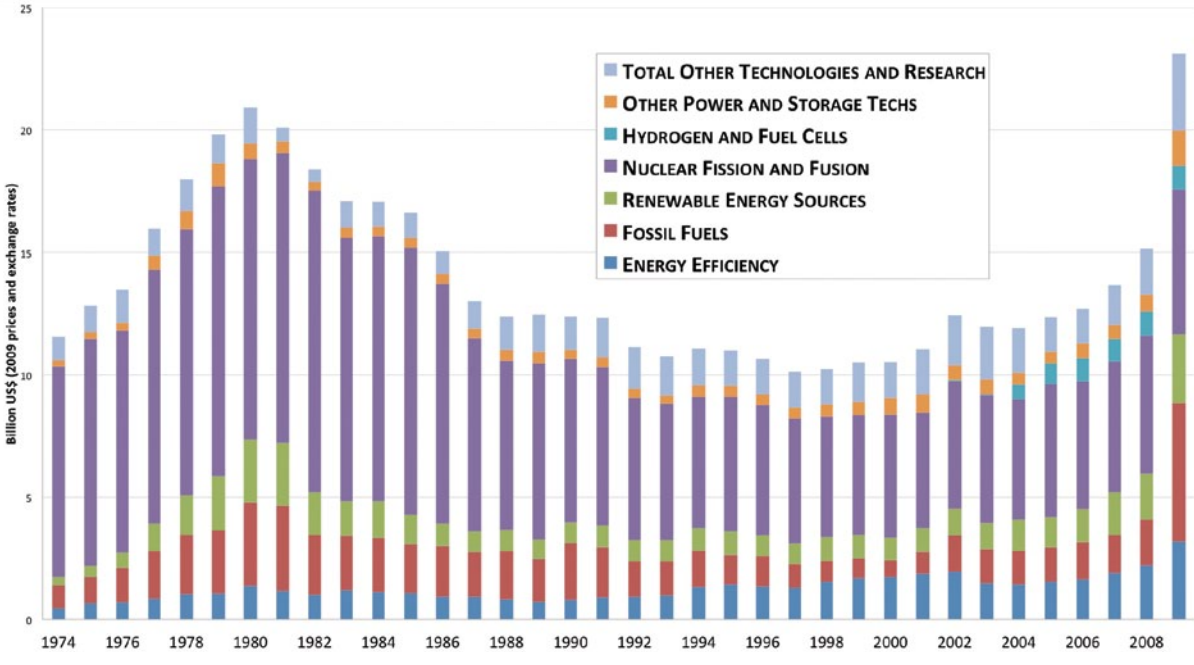
Chris Huhne, current Secretary of State for Energy and Climate Change, also recently encouraged us to take the long view, emphasising that higher fossil prices represent a golden opportunity for catalysing a low carbon transition. Drawing on work by government economists, Huhne argued that when oil prices exceed $100 a barrel UK, consumers would become overall winners as a result of having kicked the fossil fuel habit[1].

However, in the short term when oil prices rise, politicians, whether in opposition or in government, struggle to uphold economic theory.

Kicking the Fossil Fuel Habit

With current prices of Brent Crude already nudging $120 a barrel, can we expect the low carbon transition to take off in the near future? If Huhne's analysis is correct, do we even need taxes and other unpopular policies? Surely energy companies will simply deliver investment in low carbon technologies as a rational reaction to the inevitable upward march of fossil fuel prices.

Unfortunately it's not quite so simple. Although oil prices have indeed been following an upward trend since the late 1990s, they remain volatile and unpredictable. Neither companies nor governments have been prompted to make sustained and significant investments in renewable technologies on the basis of certainty in the continuing rise in oil prices. Although the oil shocks of the 1970s did briefly stimulate a significant increase in investment in government research, development and demonstration (RD&D) spend on renewable energy technologies, this spending level declined through the 1980s and 90s and remained at less



Estimated Energy Technology RD&D spend in IEA countries (Source: IEA (2011) R&D Statistics.)

than 10% of total energy RD&D spend into the 2000s (see figure above); this was despite further notable oil price spikes in 1990 and 2000.

In more recent years government spend on low carbon RD&D has increased modestly – most notably in 2009 due in large part to one-off stimulus spending following the financial crisis. However, the IEA still notes a funding gap of $40-90 billion between the current annual low-carbon RD&D spend and the level required to catalyse a major low carbon transition[2].

Neither companies nor governments have been prompted to make sustained and significant investments in renewable technologies on the basis of certainty in the continuing rise in oil prices

Apart from government funding, much of this gap needs to be filled by private sector investment. However, major energy companies remain slow to invest heavily in non-fossil energy. BP, for example, which some years ago rebranded itself as 'Beyond Petroleum', estimates that it has spent $4 billion in low carbon technology development since 2005[3] – a small figure in comparison to the total $80 bn it has invested during the last five years, most notably in exploration for oil and gas from unconventional sources such as Canadian tar sands[4].

For companies that are already in the oil business there is significant reluctance inhibiting the development of alternative technologies due to the fact that they have a natural preference for continuing to invest in areas where they have already amassed considerable technical expertise. Rather than encouraging such companies to make a major switch to developing renewable technologies, higher oil prices are far more likely to be seen as improving the business case for the exploration of more expensive and hitherto uneconomic, unconventional sources of oil, such as tar sands, oil shale, and sub-arctic sources. Many of these will be even more carbon intensive and environmentally damaging than conventional sources.

1 Huhne C. (2011). A blueprint for our energy future. Speech to CentreForum, 3rd March 2011.

2 IEA (2010). Global Gaps in Clean Energy RD&D.

3 BP (2011). Sustainable Energy – Sustainable Business.

4 BP (2011). The Energy Mix.

A comprehensive shift towards low carbon sources of energy requires the development and rollout of a diverse range of technologies. Such products have a time lag between investment and reward – they require extended periods of R&D and the establishment of new production facilities and supply chains before any serious return on the initial investment can be recouped. In order to justify such long-term investments, companies need to have some confidence in the likely existence of a future market for their products at the end of the process. A transition to a low carbon economy is unlikely to occur on the basis of a series of short term and inherently unpredictable oil price spikes and while the large energy players continue to demonstrate a huge reluctance to move away from traditional oil and its derivatives.

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A Low Carbon Revolution in the UK?

With dwindling domestic oil and gas supplies and a declining conventional manufacturing base, the UK has much to gain from a low carbon transition. As well as having the potential to be at the forefront of offshore wind- and marine-generated power, UK based companies are among the world leaders in developing innovative low carbon transport technologies. Modec, for example, is a company that produces electric delivery vans for Tesco from its plant in Coventry. Smith Electric Vehicles, based in Tyneside, is the world's largest manufacturer of electric vehicles.

However, at present these are small companies operating in restricted markets. The extent to which these trailblazers will step in to reinvigorate our declining industrial sectors, thus spurring a new low carbon industrial revolution, depends on confidence that there is a sustainable future market for low carbon products in the UK. The periodic panic which courses through the veins of the country in response to an oil price spike is no basis for such confidence.

A Role for Government?

What role should government play in creating a sustained demand for low carbon technologies? This very question is being grappled with at the moment as the

FedEx-ing us to the future: An electric-powered delivery truck navigates a wind-farm in the US

When it all goes wrong: The BP rig explosion caused catastrophic environmental damage in the Gulf of Mexico

government considers how to reform the electricity markets. Since privatisation in 1987, the UK electricity market structure has encouraged the construction of flexible, low capital cost gas powered plants, but has provided insufficient incentive for the construction of high capital low carbon generation plants such as renewables and nuclear. A clearer signal of the future price available for low carbon electricity would greatly encourage low carbon investment.

An unwillingness to create long term certainty for potential low carbon investors via measures such as fuel duty risks missing out on an opportunity to stimulate a low carbon transition

Amongst measures proposed by the UK's Department for Energy and Climate Change (DECC) to improve this market structure is a low carbon 'feed in tariff' based on a 'contract for difference'. The government will 'top up' the market price received by low carbon generators to an agreed tariff level, thus creating greater long-term certainty around the revenue stream available for low carbon projects.

In its consultation document on the electricity market reform, the government is trying to balance on the one hand its acknowledgement of the need to intervene in markets which are clearly not delivering important public goods, with on the other hand a deeply ingrained trepidation that intervening too deeply in such markets stifles innovation by private actors.

However, increased government intervention is not necessarily synonymous with an inefficient and unwieldy delivery of services in comparison to what is achievable by an untrammelled private sector.

The early years of the electricity supply industry in the UK were characterised by huge numbers of private firms competing to provide specific loads with dedicated power stations via their own distribution systems. The result was a system that was incredibly inefficient due to the fact that power stations and distribution networks were operated with extremely low load factors. The situation changed in 1926 when the government established a Central Electricity Board (CEB) to bring greater coordination to the industry. The CEB began work on a new

5 Hannah, L. (1979). Electricity Before Nationalisation. *Palgrave Macmillan*.

6 Barder et al. (2005). Making Markets for Vaccines. *Center for Global Development*.

7 Nature (2011). Pneumococcal vaccine rolls out in developing world.

132kV interconnected system – the forerunner to the National Grid – and presented a clear signal to the industry: if they built a large scale plant of high enough efficiency, it would be connected to this new network.

This signal of a clear future demand overcame the major stumbling block for companies considering investing in larger, more efficient plants – that due to the number of other small competing companies building small power stations very quickly, there could never be sufficient confidence in future demand to justify a large power station[5]. The actions of the CEB had the effect of creating a new market – a future demand that generators could be certain of – and as a result investment and innovation was stimulated.

It is clear that, while it is often the case that private sector competition is a factor that contributes to innovation, there are also situations where the combined effect of the motivations of the various private sector actors results in a lack of innovation due to an aversion to risk. In such situations government action to coordinate the development of secure future demand for certain kinds of products can be the stimulus that an industry needs in order to take off.

A similar principle is at work in the pharmaceutical industry in the form of 'advance market commitments' (AMCs), which could significantly accelerate the development, by private sector companies, of critical vaccines for developing countries[6]. Indeed, a pioneering AMC for a pneumococcal vaccine is already proving successful as the newly developed vaccine will be rolled out in Kenya at the same time as in developed countries – an impressive contrast to the 15-20 year delay which typically precedes roll-out in the developing world[7].

Importantly, none of these cases involves 'picking winners' – the government itself attempting to decide which particular type of technology fits the bill. The government simply expresses the demand for a kind of service – be it a more efficient power plant, a low carbon power plant, or a new vaccine – and leaves it to the private sector to provide the innovation. The key thing is that private actors are able to justify RD&D investment because they know that if they produce a product that meets the specifications, they are guaranteed a market.

A Secure Price for Carbon

And what about fuel duty, the tax embroiled in a perennial identity crisis? Repeated government decisions to slash it as a short-term response to oil price spikes and wider economic conditions inevitably undermine any government rhetoric about the need for long-term price signals and the macro-economic benefits of making a low carbon transition. An unwillingness to create long term certainty for potential low carbon investors via measures such as fuel duty risks missing out on an opportunity to stimulate a low carbon transition, as a result of which we would all be much better off as oil prices continue on their erratic, but inexorably upward progress. However, the government's 'fair fuel stabiliser' could be used as a mechanism not only to insulate UK consumers from the vicissitudes of the global oil price, but also to create greater long-term certainty for potential investors in low carbon technologies in the UK.

Essentially, if duty can be reduced at times of high oil price, it can also be raised if the oil price falls. The level of duty could be managed to ensure that the price of fuel at the pump retains a steady, upward, but crucially predictable trajectory. Like the feed in tariff proposed in the electricity markets, this mechanism could provide investors with that much needed clear signal about the future viability of a certain technology – except instead of guaranteeing a revenue stream for the low carbon option, it would guarantee the fuel cost of the high carbon option. If this trajectory were set out clearly several years in advance it would enable, for example, developers of low carbon transport technology such as electric vehicles to calculate the year in which their products would be cost competitive with vehicles running on fossil fuels. On a broader scale, this would create the kind of certainty required to enable small, innovative, and currently niche, companies to significantly scale up operations thus helping us to reduce our dependency on oil and creating jobs in the process.

The level of duty could be managed to ensure that the price of fuel at the pump retains a steady, upward, but crucially predictable trajectory

Nick Hughes is a PhD student at the Centre for Environmental Policy at Imperial College London, where he is studying the evolution of low carbon electricity networks in the UK.

Geopolitical and Security Risks of the TAPI Pipeline

Akhmed Tillayev, University Technology Petronas, Malaysia

In December 2010, Ashgabat – the capital of Turkmenistan – welcomed a quadrilateral summit that brought together the President of Turkmenistan Kurbanguli Berdimuhamedov, Pakistani President Zardari, Afghan President Hamid Karzai, and the Minister of Oil and Natural Gas of India, Murli Deora. The intergovernmental agreement signed during this summit laid the foundation for the construction of the TAPI (Turkmenistan-Afghanistan-Pakistan-India) pipeline.

The proposed TAPI pipeline project has major geopolitical significance. Spanning a region wracked by political and economic tensions, the pipeline represents an opportunity to improve relations between participating states. Furthermore, all four participating countries will benefit from the project. For India and Pakistan in particular, the TAPI pipeline will enhance and diversify their vital energy supply lines and open up further competition in the Central Asian gas markets. However, significant concerns remain surrounding the long-term security of the pipeline particularly along the proposed trans-Afghanistan route.

The TAPI Pipeline is a natural gas pipeline that will transport natural gas over 1,700 km from Turkmenistan through Afghanistan and into Pakistan and India. In this way, the pipeline will provide 33 billion cubic meters of Turkmen gas to South Asian markets. Of this, 14 billion cubic meters will be delivered to Pakistan, the same to India, and the rest will cover the needs of Afghanistan. The estimated cost of the pipeline is around $4 billion and is expected to be largely financed by the US-backed Asian Development Bank.

Energy Equals Influence

The TAPI pipeline project will have significant geopolitical impact on the broader Asian continent; extending as far north as Russia, east to China and south to India and Pakistan.

Turkmenistan's dependence on Russian imports, however, has meant that Moscow is in a unique position to dictate the price of Turkmen gas and project influence on the region

Land-locked Turkmenistan is one of five Central Asian states that became independent in 1991 when the Soviet Union broke up, and it possesses the fourth largest reserves of natural gas in the world. It strongly depends on sales of piped natural gas and as such the TAPI pipeline project is of great importance in diversification of its currently limited export routes. Furthermore, 90% of the state's revenue is based on this export of energy resources, primarily to Russia due to a lack of alternatives. Turkmenistan's dependence on Russian imports, however, has meant that Moscow is in a unique position to dictate the price of Turkmen gas and project influence on the region. An opening up of supply routes, with a parallel expansion of it's customer base, would enable price the rise of Turkmen gas to rise and thus increase revenue.

Afghanistan in turn expects the pipeline to generate large transit fees with projected revenue reaching $300 millions representing one third of the total Afghan

[1] Foster J. (2010). Afghanistan, the TAPI Pipeline, and Energy Geopolitics. *Journal of Energy Security*.

budget[1]. Furthermore, the TAPI pipeline could cover Afghanistan's gas needs that are vital for maintenance and development of the country's industry and infrastructure. The pipeline would also reduce their dependence on Iran; in December 2010, Iran imposed a fuel blockade on Afghanistan arguing that the fuel was destined for US and NATO forces. However, the likely significant costs to Afghanistan in securing the pipeline have not been taken into consideration and remain a potential impasse (see below).

From a political point of view, the construction of the TAPI pipeline will likely affect the delicate equilibrium between the geopolitical and energy interests of big players in the region such as Russia, India, China and the US.

The construction of the TAPI pipeline will likely affect the delicate equilibrium between the geopolitical and energy interests of big players in the region

Russia considers the project to be threat to its dominance in the Central Asian energy market and fears it will affect Russian gas giant Gazprom's revenues. Furthermore, for Russia, which is one of the main importers of Turkmen gas, the implementation of the TAPI pipeline distribution network is likely to decrease Moscow's status and influence in the region.

For India and Pakistan in particular, the TAPI pipeline would enhance and diversify their vital energy supply lines and open up competition in the Central Asian gas markets which would be beneficial for their booming economies. Periodic flare-ups of long-term tensions between them, however, threaten to compromise cooperation in the future. In the case of China, which considers the Central Asian gas as one of the main sources to meet its increasing energy demand, the emergence of a new player in the Central Asian region may provoke concerns in Beijing. However, China is currently encouraging development of the western parts of the country in an effort to match the economic growth of Chinese eastern provinces and has expressed interest in participating in pipeline projects in the region.

Resisting Iranian and Russian influence in the region, the US and EU support the TAPI project as a counter proposal to an alternative Iranian-Pakistan pipeline. TAPI would

Nato is training ex-Tabilan soldiers to take over security in Afghanistan, will they be ready to protect the pipeline?

bypass Russia and link to the planned Nabucco pipeline through Turkey providing a secure gas supply for European markets.

A New Silk Road?

The key security risk in realization of the TAPI project is the pipeline's precarious route. The Afghan and Pakistani portion of the route is politically unstable and partially under Taliban control or passing through tribal areas that have a history of independence from central and foreign powers. Securing the pipeline would not only need additional security and military measures but there would also need to be cooperation between these groups. As the existing ISAF and Afghan forces are not likely to meet these security concerns, NATO would likely be called upon to support Afghanistan in protecting the pipeline. However, since the pipeline project is set to last at least 50 years, it could auger a very long commitment in Afghanistan, perhaps too severe a price to pay for the Afghans.

The Afghan and Pakistani portion of the route is politically unstable and partially under Taliban control

Despite the economic and geopolitical significance of the TAPI pipeline project, major security concerns remain. Instability in Afghanistan renders the Afghan route unappealing and off-putting for investors. Furthermore, the TAPI agreement, which was adopted in Ashgabat in December 2010, does not stipulate the responsibilities of the parties to ensure security of the gas transportation through Afghanistan and Pakistan. In conclusion, while there are clear benefits for Turkmenistan and the region from the TAPI project, significant concerns surrounding security cast doubt on the viability of this project in its current format.

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Solar Power: Lighting up the Future

Alice Rolandini Jensen, Chemistry, Imperial College London

Solar energy is a free, clean and abundant source of renewable energy. However, there are a number of issues that must be overcome in order to ensure that solar power becomes a key technology in driving the low-carbon transition. Energy markets have long been dominated by fossil fuels, and today solar power cannot compete on cost. Production costs remain high and technical advancements must be made in order to drive down costs and achieve high solar energy conversion efficiencies in devices. Despite the relatively low overall contribution of solar technologies to the energy mix today, solar energy capacity has grown by a staggering 30% per annum in the last decade as a result of government policies and increased investment in these technologies.

A single statement may sum up the potential for solar energy: more solar energy reaches the surface of the earth in one hour, than that which is anthropogenically consumed in one year. If this is true, why is it that the solar contribution to the total energy consumed globally is currently a fraction of a percent[1]? With such a huge capacity, why does solar power not contribute more significantly to global energy production? What are the barriers to solar power becoming a key energy source of the future?

There are a number of alternative ways of generating energy from renewable sources, such as wind and wave power, hydroelectricity and biomass. The direct conversion of solar energy to electricity is normally performed employing photovoltaic devices (PV). Solar PV technology has the advantage that it can be installed in most environments and can be designed to blend into the surrounding architecture. Photovoltaics can be used as singular modules to produce small amounts of electricity to power specific devices or be connected to the national grid. They can also be used in to create Solar Power Plants, consisting of large arrays of modules producing electricity to power hundreds of homes. Despite high initial setup costs, due to expensive materials and manufacturing processes (land costs can also be an important factor), PV devices provide a free source of electricity for up to 25 years and require little maintenance. Wind turbines share similar advantages but are often large and unsightly, whereas the application of wave power and hydroelectricity has the disadvantage of being site specific.

PV devices provide a free source of electricity for up to 25 years and require little maintenance

More energy is produced in regions of high insolation (a measure of solar radiation energy) yet PV devices are also effective in countries that receive less sunlight. This is highlighted by the fact that currently Germany has the largest PV capacity in the world. The main disadvantage of solar PV is that electricity is not produced during the night and solar-electrical conversion efficiencies are significantly diminished in cloudy conditions, thus a complementary power source is generally required.

Solar-electrical conversion efficiency is defined as the ratio of the electric power produced by a photovoltaic device to the power of the sunlight incident on

[1] Renewable energy policy network for the 21st centuary, Ren21 (2010). Renewables 2010, Global Status Report.

the device. A typical crystalline silicon device has solar-electricity conversion efficiency of approx. 15%. This may seem low but compared to the sunlight-biomass conversion efficiency in photosynthesising plants it is significantly more efficient. Although the efficiencies of the conversion of sunlight to biomass in plants can vary dramatically between species, typically they do not exceed 5%. In just a few decades humans have surpassed this, with record efficiencies of some PV devices exceeding 40%[2]. Australia has high levels of insolation and, if much of the landmass were covered in devices of 15% conversion efficiency, over 2000 times the country's energy demands could be produced. It is thus evident that efficiency is not the main factor preventing solar power from becoming a viable alternative energy source.

The most significant issue encountered when considering solar power is cost. However, when compared to the 1990's, solar photovoltaic systems are now over 60% cheaper

Over 90% of solar cells currently produced worldwide are made from silicon crystals[3]. These provide the most economical and reliable source of solar PV power and dominate the PV market. Nevertheless, solar power is expensive when compared to energy derived from other sources. In 2006, electricity derived from solar energy cost \$0.35 $[kWhr]^{-1}$, whereas that from fossil fuels had significantly lower costs of \$0.02-0.05 $[kWhr]^{-1}$ [4].

So, the most significant issue encountered when considering solar power is cost. However, when compared to the 1990's, solar photovoltaic systems are now over 60% cheaper and the estimated average cost of solar energy in 2010 was approximately \$0.29 $[kWhr]^{-1}$ in northern Europe and is as low as \$0.12 $[kWhr]^{-1}$ in the Middle East[5].

In order to enhance the potential of solar power and to enable its wider use, these costs must be further reduced. There is a global consensus that this can be achieved through extensive research and development of photovoltaic technologies. Governmental organizations, such

Mirrors to heaven: these solar panels in North Africa could one day power Europe

as the United States National Renewable Energy Laboratory (NREL) and the European Renewable Energy Research Centres Agency (EUREC Agency) have been set up in order to achieve this goal.

The European Commission Mission

The European Commission stated in 2009 that it aims to increase the use of solar energy within the European renewable mix. This strategy stems from an effort not only to reduce the environmental impact of energy production and consumption but also to improve security of Europe's energy supplies.

A key component of this strategy is to maintain a European lead in solar RD&D. Photovoltaics are a key aspect of this plan as, not only are they safe, clean, robust and efficient, but they are highly scalable and easy to introduce and implement on a large scale. Thus far, the Commission has widely supported the development of solar photovoltaic technologies in order to produce cheaper more efficient PV devices. Thin-film, organic and dye sensitised solar cells are currently undergoing extensive research and development. These devices require less semiconductor material and can be produced via cheap roll-to-roll manufacturing techniques, providing attractive less expensive alternatives to crystalline silicon based devices.

Solar power could provide energy for more than a billion people in 2020 and sustain 26% of global energy needs by 2040

On the implementation side, a 2007 Commission White Paper set a target of 3,000 MW of photovoltaic capacity to be installed by 2010. This target was easily surpassed and by the end of 2010 the cumulative installed capacity of PV in the EU was over 28,000 MW[6]. This is an energy output level that equals the electricity consumption of around 10 million households in Europe. The European Photovoltaic Industry Association (EPIA) stated that they believe solar power could provide energy for more than a billion people in 2020 and sustain 26% of global energy needs by 2040.

Percentage of Solar Capacity in 2009

Germany	47%
Spain	16%
Japan	13%
US	6%
Italy	5%
South Korea	3%
Other EU	7%
Other world	4%

Solar goes Global

Non-EU countries have a lot of potential for growth of the solar power sector in the coming years. Last year the rest of the world increased capacity by an estimated 3,000 MW, with Japan making the largest contribution

How Do We Harmess the Sun?

Photovoltaic Devices (PV)

Conversion of light into electrical power via the photoelectric effect. Although electricity is not produced at night or in dark conditions, electricity can be stored in batteries or contribute to the national grid.

Heat Engines

Solar energy is converted to thermal energy. This technique is employed in Concentrated Solar Power (CSP) plants where lenses or mirrors and tracking systems focus sunlight into a small beam. The concentrated heat is then used as a heat source for a conventional power plant. An advantage over PV is that if sufficient hot fluid is stored in containers, the generators can run all night.

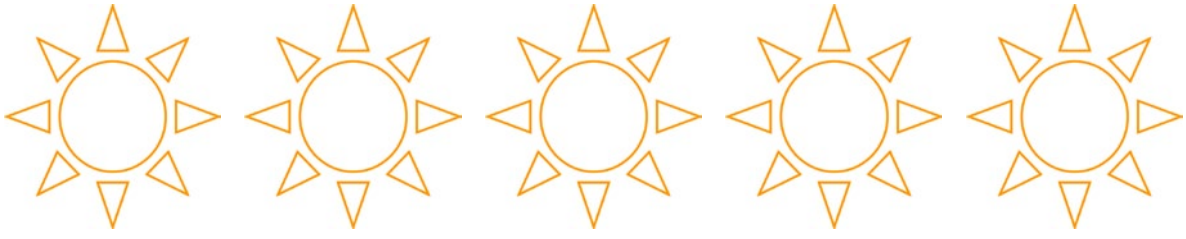
2 King, R. et al (12-16 March 2000). Metamorphic Concentrator Solar Cells with Over 40% Conversion Efficiency. *4th International Conference on Solar Concentrators (ICSC-4), El Escorial, Spain.*

3 del Canizo, C., del Coso, C. & Sinke, W. C. (2008). Crystalline Silicon Solar Module Technology: Towards the 1 Euro Per Watt-Peak Goal.

4 Lewis, N. S. & Nocera, D. G. (2006). Powering the planet: Chemical challenges in solar energy utilization. *Proceedings of the National Academy of Sciences of the United States of America*.

5 EPIA report (2011). Solar Generation 6: Solar Photovoltaic electricity empowering the world.

6 EPIA press release (2010). Solar Photovoltaics: 2010 a record year in all respects.



of 1,000 MW. The USA and China also increased their capacities by 700-800 MW and 400-600 MW respectively. Other emerging solar enthusiasts include Canada, Australia, India and South Korea, all of which increased their PV capacity by 50 MW or more in 2010[5].

Despite Europe's attempts to dominate the PV market, non-EU countries such as China and India have also invested large amounts in development of new technologies. With ready supplies of raw materials and cheaper labour costs, PV systems from these countries compete directly with those produced in the EU. Such price pressure will inevitably contribute to pushing prices down as the technology evolves.

Despite Europe's attempts to dominate the PV market, non-EU countries such as China and India have also invested large amounts in development of new technologies.

Benefits of Solar Energy

- Free energy from the Sun
- No harmful emissions or gasses produced
- No noise pollution
- Safe
- Module lifetimes of approximately 25 years
- Systems can be recycled and the materials reused
- Easy to install with minimal maintenance requirements
- Solar panels can be incorporated into the architecture of a building
- Power can be generated in many environments including in remote areas that are not connected to the energy grid
- In under three years of use, a PV system will produce enough energy to recoup that used in their production (this time is steadily decreasing as technology improves)

PV technologies produce most energy when implemented in areas of high insolation. The Sahara desert is one such area that could provide energy for both North Africa and Europe, and reduce dependence of these countries on fossil fuels from Russia and the Middle East. The Desertec Industrial Initiative (DII) aims to provide 15% of Europe's electricity by 2050 or earlier via power lines stretching across the desert and Mediterranean Sea. This project aims to use CSP technology rather than PV as generators can run overnight (see fact-box). Coastal wind power could be used to support a PV network exploiting strong North African summer winds when Europe's winds are weak. Despite the attraction of these proposals, there are political and ethical concerns surrounding European exploitation of African resources and political instability in many North African countries.

Solar Incentives

Feed-in tariffs (FiTs) are implemented by a number of countries worldwide including Germany, the US and the UK. A feed-in tariff is a policy designed to encourage both individuals and businesses to utilise renewable energy sources. Under this scheme, regional and national electric grid utilities are obliged to take the energy produced by renewable energy sources that are privately owned and pay the owner a premium pre-arranged price for it. FiTs offer the guaranteed purchase of energy from renewable sources on long-term contracts that are typically in the range of 15-25 years. Alternative incentives for promoting the deployment of renewable energy generation include initial investment and operational support in the form of tax exemptions and reductions, grants and subsidies, which may be used in combination.

Sketch of possible infrastructure for a sustainable supply of power to Europe, the Middle East and North Africa (EU-MENA)

Solar at Imperial

Imperial College has a large stake in research into improving solar power generation. Groups aiming at developing and improving device efficiency and production costs can be found in a number of departments, from chemistry and physics, to materials and engineering. The new Doctoral Training Centre (DTC), established in 2009, provides an excellent platform for interdepartmental interdisciplinary research. In particular, a number of Plastic Electronic DTC positions span chemistry, physics and materials and focus on researching nanomaterial devices such as dye-sensitised, quantum dot and organic photovoltaics. These technologies use relatively small amounts of semiconductor materials and may be manufactured by roll-to-roll printable techniques that can drive down costs dramatically. The main problem currently encountered with these devices is that their solar-electrical conversion efficiencies are generally relatively low and do not rival those of silicon based devices.

PV technologies produce most energy when implemented in areas of high insolation. The Sahara desert is one such area that could provide energy for both North Africa and Europe, and reduce dependence of these countries on fossil fuels from Russia and the Middle East.

This article has explored the current position of solar technologies and the challenges that must be overcome if they are to play a significant role in future energy supply. Although currently more expensive than fossil fuels, research and development is decreasing the production costs of PV panels dramatically each year. With a global consensus that there is a future in solar power, both to combat climate change and to reduce reliance on fossil fuels, governments worldwide are offering incentives to stimulate innovation and deployment. Within the past decade global solar capacity has increased year on year, with 2010 being a record-breaking year in the number of new PV installations. Let's hope this trend is set to continue.

Alice Rolandini Jensen is a postgraduate researcher Imperial College Department of Chemistry where she is investigating electrolytes in dye sensitised solar cells.

Biofuels: Not just 'Food vs Fuel', but 'Drink vs Drive' too

Andrew Purcell, Imperial College London

During the past few years, biofuels have gained much attention as a potential source of renewable energy in the pursuit of climate change mitigation and reduction of GHG emissions. In 2008, biofuels provided 1.8% of the world's transport fuel in anticipation of continuing growth. Yet, the rapid increase in agricultural and food prices leading to the 2008 global food crisis, partially fuelled by the use of grains and oilseeds for the production of ethanol and biodiesel, has raised concerns regarding the ethical implications of diverting agricultural land and crops to energy production. There are further concerns that a vast increase in agricultural cultivation could have environmental implications that would paradoxically have a negative impact on any attempt to reduce GHG emissions.

So is the reality of this 'green' technology that it is simply fraught with too many drawbacks – both social and environmental – to make it a desirable future energy solution?

With the current wave of protests sweeping the oil-rich regions of North Africa and the Middle East, Brent crude oil prices have risen to well over $100 per barrel. This has led to increasing speculation that biofuels and other currently expensive renewable energy sources may be back on the agenda. Biofuels have become very attractive in the past few years due to the relative abundance of feedstocks, their easy utilisation in combustion engines for transportation and also due to compatibility with the existing fuel distribution infrastructure providing a new end market for agricultural commodities. Biofuels are believed to have the potential to substantially decrease GHG emissions, however, several factors may limit this effort. Any calculation of a reduction in GHG emissions due to biofuel production must take into account not only the alternative fossil fuel consumption but also input fossil fuel consumed during biomass cultivation and any GHG released due to clearing of land with high carbon storage value. Depending on the biofuel type and production pathway, biofuels can have estimated net GHG savings of up to 80% compared to fossil fuels. Indeed, the total CO_2 emissions from 10% of the global diesel and gasoline consumption during 2030 were estimated at 0.84 Gt CO_2, of which biofuels could substitute 0.17 to 0.76 Gt CO_2 (20-90%). However, the annual CO_2 emissions from direct land conversion alone are estimated to be in the range of 0.75 to 1.83 Gt CO_2[1] thus having a substantial impact on any perceived CO_2 reduction.

The larger the area dedicated to biofuel crops, the less land that remains for growing food crops

Food Crops vs. Fuel Crops

The land needed to grow energy crops competes with land used for food and wood production. In the case of bioethanol, there is direct competition between food and fuel, as the corn from which the ethanol is obtained is also a staple food for much of the world's population.

1 United Nations Environment Programme, UNEP (2009). Assessing Biofuels.

2 Naeem, S. & Li, S. (1997). Biodiversity enhances ecosystem reliability. *Nature*.

3 Yachi, S. & Loreau, M. (1999). Biodiversity and ecosystem productivity in a fluctuating environment: The insurance hypothesis. *Proceedings of the National Academy of Sciences of the United States of America*.

We saw in 2008 that the price of oilseeds went up 94% compared with 2007 and wheat prices increased by 126% in the period January-April 2008, as compared to the same period in 2007[1] leading to a global food crisis.

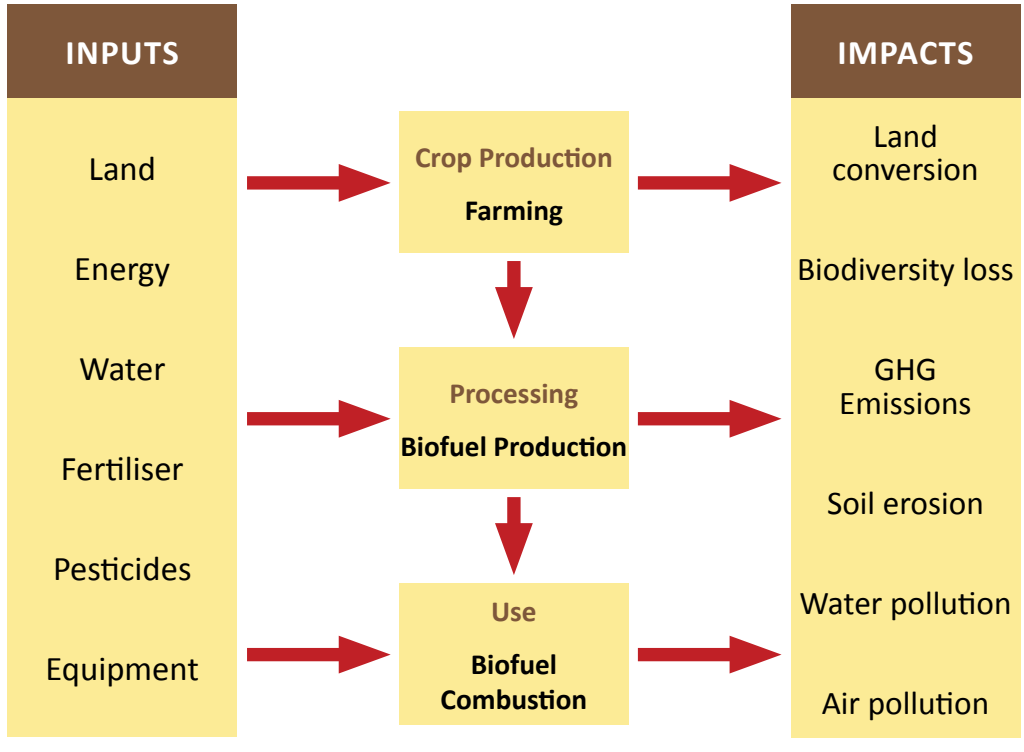
Biofuels can still drive up food prices even when the plants in question aren't those usually consumed by either humans or cattle. As biofuels in general face higher costs compared to fossil fuels, governments have largely supported biofuel development with mechanisms such as subsidies, tariffs and tax exemptions. These incentives and benefits were the main driver of development of energy farming and the biofuel industry. However, there's a risk that too many farmers choose to produce biofuels rather than food. Quite simply: the larger the area dedicated to biofuel crops, the less land that remains for growing food crops. The global land use for the production of fuel crops covered about 2% (36 Mha) of the global cropland in 2008[1]. Even with more land cleared for farming, there is a limit to the amount of land that can sustainably and profitably be cultivated. With the global population expected to reach 9 billion by 2050, there is already great pressure on available agricultural land to produce enough food to sustain our rapidly growing numbers.

The End of Biodiversity

Clearing of land for biofuel crops can be a major driver for deforestation causing environmental degradation and loss of biodiversity. Furthermore, crop plantations tend to absorb significantly less carbon dioxide than forests. In fact, destroying forests to make way for biofuels leads to a destabilization of the ecosystem and, due to decreased productivity, may lead to an increase in the net release of carbon dioxide. One particular case for concern is the increase in palm oil cultivation in South East Asia leading to a clearing of the rainforest there. About two thirds of the current expansion of palm oil plantations results from deforestation while only one third is based on existing agricultural land. Moreover, a quarter of these converted areas contained peat soil with a high carbon content thus releasing CO_2 when drained for oil palms. By 2030, the total rainforest area of Indonesia is projected to have decreased by 29% in comparison to 2005 levels[1].

About 118 to 508 Mha would be required to provide 10% of the global transport fuel demand with first generation biofuels in 2030 – it is estimated that this would equal 8% to 36% of current cropland, including permanent cultures. Increased biofuel production is therefore

Food vs fueL: Corn-crops provide ethanol which is used for motor-fuel



General biofuel pathway with inputs and environmental impacts

expected to have a significant impact on biological diversity in the coming decades, mostly as a result of habitat loss, increased invasive species and nutrient pollution. Studies of the 'Insurance Hypothesis', or the effect of environmental fluctuations on ecosystems and biodiversity, have shown that diverse plant ecosystems will tend to photosynthesise at a greater rate than ecosystems with fewer species present.

The idea behind the 'Insurance Hypothesis' is simple: when different species are present, they are able to fulfil a variety of different ecological niches within a given ecosystem. By contrast, with monocultures, all of the individual plants are competing for the same resources held within one specific ecological niche. Consequently, the overall rate of photosynthesis in biodiverse ecosystems tends to be much higher than that of monocultures, which means biodiverse ecosystems, usually natural ones, are much better at helping us tackle climate change.

Destroying forests to make way for biofuels leads to a destabilization of the ecosystem and, due to decreased productivity, may lead to an increase in the net release of carbon dioxide

In addition, monocultures are much more susceptible to disease than biodiverse ecosystems; plant viruses are usually specific in attacking a particular species, genus, or family of plants. Consequently, it is possible for one viral strain to destroy an entire monoculture plantation of biofuel crops, thus reducing the photosynthesis rate of this area of land to zero. In stark contrast to this, should a virus destroy any

[4] US Department of Energy. Production of Biofuels from Biomass http://www.science.energy.gov/sbir/solicitations/FY%202009/18.EE.Biomass.htm

given type of plant within a biodiverse ecosystem, the gap created will quickly be filled by the other plant species present. Thus, the clearance of forests, in order to make way for biofuel crop plantations, is not only detrimental in terms of the animal species lost, for whom this forest was their habitat, but it can also cause a net increase in atmospheric carbon dioxide levels over time.

Further ecological concerns include excessive use of pesticides as well as overexploitation of water resources. Whilst nitrogen fertiliser is in relatively abundant supply, its increased usage will inevitably lead to an intensification of problems such as eutrophication and soil acidification and degradation. Furthermore, of particular concern is the increased water usage which widespread biofuel production may entail. Agricultural activities already use around 70% of the global freshwater supply and, with the proportion of the world's population living in water-stressed areas set to rise to two thirds by 2025, this is of significant concern. Furthermore, many of the processes involved in farming biofuel crops produce a substantial amount of carbon dioxide. This is not only in terms of the carbon dioxide produced by farming machinery, but also the carbon dioxide emitted through the process of distributing the biofuels produced throughout the world, both overseas and overland.

Ecological concerns include excessive use of pesticides as well as overexploitation of water resources

Is Algae the Answer?

However, there are developments on the horizon that could make biofuels a much more appealing proposition. One solution would be to use degraded, marginal, or abandoned land for biofuel production. In addition, certain crops, such as switchgrass, may even restore productivity of degraded land. There are woody and herbaceous non-food crops, such as *Miscanthus*, which have low maintenance costs and can easily be combusted to produce relatively large amounts of energy. Whilst these crops do not directly drive up food prices, as they are not usually crops we would consider edible; they still suffer from many of the issues detailed in this article. More promising, perhaps, is the prospect of using biofuels produced from algae, which experiments have shown can produce up to fifty times more energy per hectare than some land crops[4]. In addition, significant levels of funding are currently being directed towards researching organisms that may be genetically modified to secrete hydrocarbons. Furthermore, developments in cellulosic ethanol production techniques have recently been a cause for measured optimism. These second and third generation biofuels require significantly less water per gallon of fuel produced and tend to avoid the more severe land-usage problems associated with traditional biofuels.

Thus, whilst biofuels may contribute to the future energy mix, there are many concerns regarding their social, environmental and ecological cost. Hence, as rising oil prices ignite the debate on biofuels once again, we must think carefully before commiting ourselves to further investment in this technology. Perhaps economic measures may be put in place to help us reduce the effect of biofuel crops on world food prices, but the environmental issues are somewhat more difficult to tackle. Of particular concern is land usage, and associated costs due to a decrease in biodiversity. Indeed, calculating and modelling future biodiversity for the next couple of decades has shown that GHG reductions from biofuel production would often not be enough to compensate for the biodiversity losses from increased land use conversion[1].

So, perhaps it is time to finally abandon the idea of using hydrocarbons as fuels, whether these are obtained from oil, gas, or biological sources. Instead, ought we not start turning our attention to developing transport infrastructure powered solely by electrical means? If so, the next question to be answered is: what are the relative roles for renewable sources such as wind and solar power in generating this electricity? And what role, if any, will nuclear energy play?

Andrew Purcell is a postgraduate MSc Science Communication student and editor of I, Science magazine.

Exclusive Interview with Dr. Fatih Birol

Chief Economist at the International Energy Agency

Neave O'Clery & Sumana Chaturvedula

20 January 2010

Dr. Fatih Birol is Chief Economist at the International Energy Agency, with overall responsibility for the organisation's economic analysis of energy and climate change policy. He oversees the annual World Energy Outlook, the flagship publication of the IEA, and is recognised as the most authoritative source for energy analysis and projections. He was recently named by Forbes Magazine as the world's fourth most powerful person in terms of influence on the world's energy scene. Prior to joining the IEA in 1995, Dr. Birol worked for six years at the Organisation of the Petroleum Exporting Countries (OPEC) in Vienna. A Turkish citizen, Dr. Birol was born in Ankara in 1958. He earned a BSc degree in power engineering from the Technical University of Istanbul and he received his MSc and PhD in energy economics from the Technical University of Vienna.

Neave O'Clery **and** ***Sumana Chaturvedula*** **met Dr. Birol during a recent visit to Imperial College for an event hosted by the Grantham Institute for Climate Change, and asked him about the impact of rising oil prices on the global economy, the effect of subsidies on fuel demand and the crucial role of the US and China in combating climate change.**

Can you tell us about the trend towards increasing oil prices and the repercussions for the global economy?

Brent oil prices today cost a $100 and, as such, I believe it is a risk for the global economy. First of all, it is a risk for OECD countries, and industrialised countries, such as Europe and Japan and the United States, because they are now in the process of recovery. The economy is still very fragile and with higher prices we see a weakening of the trade balance, because they have to import more and they have to pay more. Secondly, there will be more pressure on the inflation. In many countries, including the UK, inflation numbers are going up so these are the first countries that will be heavily affected. But more importantly, at least for me, it is the developing countries in Africa, Asia and Latin America that will be much more seriously affected. And according to our calculations, if oil prices remain around $100 – where they are now – about one percentage point of the GDP will be used in order to compensate for their oil import bill increase, and that is bad news.

In 2020, a 20% or 30% reduction for Europe is equal to two weeks of emissions of China ... when I put it in a global context, it is peanuts

The third group of countries is the oil producing countries, the oil exporters in the Middle East and elsewhere, and I believe it is also not good news for them as well. It may be seen that for the oil producers the higher the price the better it is for them, but if the economies of their main clients in court are crushed or weakened, namely the European countries, or United States, then they will need less energy for their economic activities. They will drive less, they will use less energy and so on, therefore they will need to import less oil from the oil exporting countries, so at the end of the day this may not be good news for them as well. So one should think twice about what one is opting or wishing for. To sum up, I think the prices are too high now, and they may go even higher and as such this is not good news for the global economy, or for anyone on this planet.

Many have argued that subsidies for fuels are driving prices down. What do you feel about the impact of subsidies on the global market within the context of consumer demand and climate change?

There are, as we have discussed in our World Energy Outlook report, huge subsidies for fossil fuels, oil, gas and coal, mainly in the developing countries. And these subsidies provide incentive for the people to use more energy and to use energy in a wasteful manner. If something is cheap, whatever we have at home, we use it less carefully compared to something that is more expensive; everything, when we use a shampoo, when we use a perfume, when we use whatever, it is always like that. And therefore (energy) is artificially (cheap), and global energy demand goes (up). This is not good news for energy efficiency and, since most of the subsidies are for fossil fuels, it leads to increase in carbon dioxide emissions, which is bad news for climate change.

Some countries say that we have these subsidies in order to protect the poor, and we looked into that and we have seen that 85% of the subsidies go to medium and high-income levels, because they are the ones who use more energy. Only 15% is used by poor segments of the population, and so it may not be a bad idea to phase out the subsidies in general and to provide assistance for the poor in different ways, rather than just subsidising energy prices. The poor should be helped, but perhaps through different channels than subsidising fossil fuel energies.

You say in your World Energy Outlook report that combined the US and China will need to be responsible for 50% of abatement in carbon dioxide emissions for the 450ppm goal to be reached. What exactly do they need to do in the near future (to achieve this), and is there the political will? Do you believe they will manage to reach these targets?

Now, there is no single government in the world who doesn't want to find a solution to the climate change problem. However, the issue is, everybody thinks that the other one should do more than they themselves; this is the problem. There are some countries that are very willing to reduce the CO_2 emissions, such as European countries. In Europe, for example, there is a discussion about whether or not CO_2 emissions should be cut by 20% or 30%. I find this discussion on one hand very important – philosophically and morally very important – but when I put it in a global context, it is peanuts. The

Dr. Fatih Birol

difference between, in 2020, a 20% or 30% reduction for Europe is equal to two weeks of emissions of China, which is nothing. So therefore we should look at which countries can change the game. And I see two countries here, namely the United Stated and China. But, I know that both of these countries have serious considerations about which way they should go and how they should reduce emissions, but I can tell you that if our goal is to limit temperature increase by two degrees Celsius, without China and the United States making major efforts we have no chance whatsoever, (no matter what) happens in the other countries.

How do you see the future of nuclear power playing a role in the energy mix in the short to medium term?

I think nuclear power should play an important role in the global energy mix, as it generates electricity at low cost, doesn't emit carbon dioxide emissions and (supports) energy security by diversifying the energy mix. But I see significant challenges, especially in the OECD countries, to see a major breakthrough for nuclear energy.

Is the Future Nuclear?

Panel Discussion Hosted by *A Global Village* on 17 February 2011

Nuclear power has long been touted as a viable alternative energy source and has seen a domestic resurgence in recent times as the UK faces major challenges to meet GHG emissions targets and move towards a low-carbon electricity society. With approximately 15-20% of the UK's electricity generated by nuclear power, the government has begun building new power stations to sustain and build-up capacity over the next 20 years.

There has also been resurgence in nuclear-plant-building globally as the energy needs of China and India continue to grow exponentially. However, there are many long-standing legitimate security and environmental concerns surrounding radioactive waste-disposal and potential accidents, as highlighted by recent events in Japan - this was, as they say, a timely discussion.

This event focused on the role of nuclear power in a future low-carbon energy mix. We particularly looked at the strategy of China and the US, given that they are responsible for 50% of GHG emissions, in diversifying their energy sources. Many of the safety concerns regarding nuclear waste, proliferation and public perception were discussed, and waste disposal was highlighted as major issue to be resolved. The potential security risks associated with building nuclear power plants in politically less stable countries were deliberated, with the threat of accidents, proliferation and terrorism were also high on the agenda.

With an audience dominated by post-graduates and young researchers from energy-related disciplines, the debate closed with a poll asking attendees whether they were for or against a strong role for nuclear power in the future. A resounding 3:1 voted in favour, yet one must wonder – would the poll result have been different if held after the tsunami?

Prof. Jim Skea OBE
Professor of Sustainable Energy, Research Director of *UK Energy Research Centre*

Prof. Gordon MacKerron
Director of *Sussex Energy Group*, Former Chair of UK Committee on Radioactive Waste Management

Neil Hirst
Senior Policy Fellow in Energy Mitigation and Climate Change, *Grantham Institute for Climate Change*

Neave O'Clery (chair)
PhD Student in Mathematics at Imperial College, Editor in Chief of *A Global Village*

Big Pharma & Global Health
The Role of Intellectual Property

Panel Discussion Hosted by *A Global Village* on 7 March 2011

These are exciting times in the field of access to medicines. Under pressure to open up patenting of drugs for supply of medicines to the developing world, and with generic pharmaceutical manufacturers in India under threat due to the new EU-India Free Trade Agreement, various pharmaceutical companies have begun negotiations to join the UNITAID Medicines Patent Pool. Against this backdrop of change, the team at A Global Village decided that an event to raise awareness of these issues would be particularly timely.

Professor Alan Fenwick, Professor of Tropical Parasitology and the Director of the Schistosomiasis Control Initiative chaired the debate with panellists from wide range of backgrounds including representatives of GSK, the Mectizan Donation Program, DFID, and the Stop AIDS Campaign at the UK Consortium for AIDS and International Development. The event was fully booked, and attendees included Mun-Keat Looi of the Wellcome Trust Blog and Emily Ward, co-chair of the student campaign group PharmAware.

The discussion focused on whether or not intellectual property rights were in conflict with global health. The role of the proposed patent pool, drug donation programmes and tiered pricing were prominent themes, as were the role of government in regulating the pharmaceutical industry and the other challenges involved in improving access to medicines. Discussion also delved into the consequences of the current patent system, and why certain health areas needed particular attention regarding new diagnostics and therapies, such as neglected tropical diseases.

An animated discussion with lots of audience participation took place, and it was great to see such an interest in the translational issues that occur when health-related innovations go from bench top to bedside.

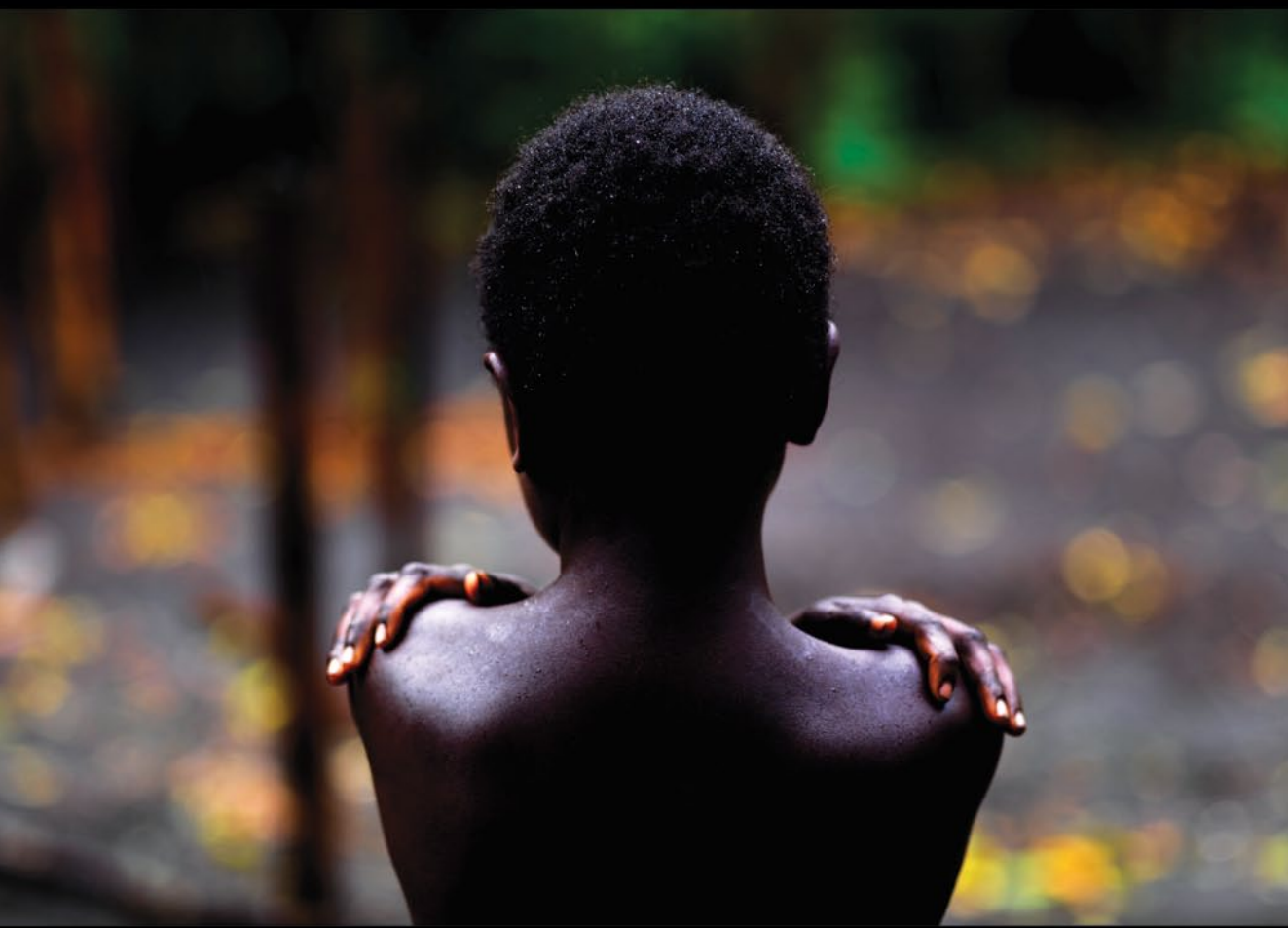
Prof. Alan Fenwick OBE (chair), Director of the *Schistosomiasis Control Initiative at Imperial College*

Jon Pender
Vice President, Government Affairs
GlaxoSmithKline

Dr. Adrian Hopkins
Director, *Mectizan Donation Program*

Diarmaid McDonald
StopAIDS Coordinator
UK Consortium on AIDS & Intl. Development

Saul Walker
Senior Policy Advisor, *Dept. for Intl. Development UK*



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