

# A Global Village

IMPERIAL COLLEGE'S INTERNATIONAL AFFAIRS JOURNAL



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The next IUHPE World Conference, organized by the Thai Health Promotion Foundation, will take place in 2013 in Pattaya, Thailand. The proposed theme for the Conference is "All for Health: Partnership and Reorientation of All Sectors for Health Promotion".

Please refer to website of IUHPE for more details: [www.iuhpe.org](http://www.iuhpe.org)

# Foreword

## Living Life Forwards, Understanding Life Backwards

Our world is undergoing exceptional change and churn in its sociopolitical structure. Two countries, China and India, which had the largest economies in the world in the 16th century, look set to reclaim their places, while some European countries that once boasted great empires seem to be heading for a fall. In Africa, there are 15 countries which have sustained a greater than 5% annual economic growth rate for the last 10 years, and while some look set to stumble over the spikes in food and fuel prices, others are experiencing even greater growth due to simultaneous spikes in the prices of the commodities they produce.



These new dawns and frustrated hopes have profound consequences for peoples' lives. The grand hopes for humankind at the turn of the millennium – articulated in the 8 Millennium Development Goals – were revisited at a UN Summit this year and, with 10 years completed and only 5 years to go until judgement day, only the education goal looks likely to be met. Even the few successes in health, such as the net fall in global maternal mortality, only serve to highlight egregious global inequities: in 1990 Africa's share of total global maternal mortality was around 23%, while in 2010 it is more than half, as the continent falls behind, such that in rich countries 4 or 5 mothers die for every 100,000 births, while in the worst affected countries the death toll is more than 1,500.

The complexity of these development challenges was highlighted during a recent discussion in East Africa when a Minister of Agriculture described the remarkable increase in agricultural production that his food insecure country had achieved in the last few years, thanks to such technical advances as micro-irrigation, improved fertilizers and high yield seeds, but then he added that the human population had also increased “while we weren't watching”, and there is now little expectation that production can keep up with the country's 1 million new mouths each year. Finding solutions to the challenges that we face will need a much greater emphasis on synergy, on ensuring that making some things better does not make other things worse.

In this fast changing and complex world we do not have the luxury of waiting for things to happen before we take action: if we wait to 'live life backwards' it will be too late. As we discussed during the Global Village 20 October panel on the 'Global Food Crisis' and as is covered in several articles in the current edition, three of the main challenges that face us – population increase, food insecurity and climate change – are strongly inter-dependent, so they need multifactorial responses, and need intervention long before the problems become critical and perhaps irreversible. A good example of joined-up thinking is 'Home Grown School Feeding' (see page 42). Smallholder farmers in Africa (70% women) grow the food that feeds children in schools: the schools provide a stable and predictable market, so the smallholders earn income, and the food overcomes hunger and ensures that the children stay in school and are able to learn. This good idea – led by the Partnership for Child Development in DIDE at St Mary's - required expert inputs in agronomy, supply chain management, nutrition and education, but once developed is proving sustainable in countries as diverse and challenging as Cote d'Ivoire and Nigeria. The Imperial College mix of critical thinking, innovation, science and technological solutions is essential to the timely and effective responses that are needed to prove that Kierkegaard is only right some of the time.

*Prof. Donald Bundy*

Lead Specialist in Health and Education, The World Bank, Washington DC, USA

# Editor's Note

*'Many of the defining challenges of the 21st century – from climate change and food security, to poverty reduction and nuclear disarmament – have scientific dimensions. No one country will be able to solve these problems on its own. The tools, techniques and tactics of foreign policy need to adapt to a world of increasing scientific and technical complexity.'*

New Frontiers in Science Diplomacy, Royal Society 2010

Evolving towards a new focus on key areas where policy and politics meet science and technology, *A Global Village* has been rapidly establishing itself on campus and beyond over the past six months. Building on the momentum initiated by the publication of Issue 2, we have recently branched out into hosting events such as our lively 'Global Food Crisis' panel discussion with the World Food Programme in October last.

With just four years left until the Millennium Development Goals are due to be achieved in 2015, we ask in this issue: what progress has been made? Virtual 'Universal Coverage' of malaria nets in Africa is hailed as a success yet the prospects for continued affordable generic HIV drugs for the developing world seems to be bleak as the EU presses India to strengthen its patenting laws. On the energy and environment front, as the ongoing IPCC climate negotiations continue to top the global agenda, we ask: where do we go from here, and can carbon capture play an important role in transitional mitigation strategies? Posing as many questions as answers, our contributors tackle a wide range of pressing global issues – we hope you will engage with these challenges!

Last but by no means least, many thanks go to Prof. Albert Lee of the Centre for Health Education and Health Promotion at the Chinese University of Hong Kong for his enthusiasm and support of this project.

Neave

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# Making Progress On Climate Change

*Dr Simon Buckle* is Policy Director of the Grantham Institute for Climate Change at Imperial College London. He was previously a senior diplomat at the British Embassy in Paris responsible for taking forward UK policy on a diverse range of global issues such as climate change, science & innovation and energy.

**It's that time of the year again. Northern Europe gripped by unusually severe winter weather while international negotiators meet to tackle climate change. It's reminiscent of 2009, when political drama at Copenhagen was heightened by extreme winter weather and controversies over climate science. In retrospect, the 2009 weather was a regional anomaly in the second warmest winter in 130 years. But at the time it contributed to the "perfect storm" for climate science and policy. The current cold weather over Northern Europe is equally anomalous.**

None of last year's controversies weakened the key conclusions of the IPCC's Fourth Assessment Report, namely: (a) warming of the climate system is unequivocal and (b) most of the observed increase in global average temperatures since the mid-20<sup>th</sup> century is very likely due to man-made emissions. Climate change therefore remains one of the major policy challenges of the 21<sup>st</sup> century, and one with potential to amplify other major problems, such as development.

Why is effective mitigation action so difficult? I think there are two distinct but interlinked aspects of this problem: the first is economic and technological and the second strategic and political. Fossil fuels were the basis of the Industrial Revolution and remain central to the way of life in much of the world. Energy from fossil fuels has, excluding environmental costs, been cheap

and plentiful, encouraging inefficient energy systems, short-sighted planning and an ever expanding appetite for energy services. These features have now become hard-wired into so many economies that decarbonising our energy systems in the relatively short space of time available to avoid the risk of potentially large-scale change in the climate system has become extremely difficult, soon perhaps bordering on infeasible. It will also be costly, with recent modelling<sup>1</sup> suggesting costs of perhaps two or three percent of (discounted) GDP over the next century to achieve a 2°C target<sup>2</sup>.

## Carbon Budget

We now understand that it is the cumulative level of CO<sub>2</sub> emissions that is critical in determining the peak warming response of the climate system. In effect, we have a certain carbon budget for the next century corresponding to the particular level of global temperature change that we are willing to tolerate. The higher the temperature change we judge acceptable, the greater is the corresponding carbon budget, and vice versa.

The unused portion of the carbon budget corresponding to peak warming of 2°C has been estimated at around 1,800 billion tonnes of CO<sub>2</sub>, corresponding to about 60

<sup>1</sup> See the 2009 Stanford Energy Modelling Forum <http://emf.stanford.edu/>

<sup>2</sup> With reasonable assumptions about the climate sensitivity to CO<sub>2</sub> emissions

<sup>3</sup> Allen M. et al. (2009). Warming caused by cumulative carbon emissions towards the trillionth tonne. *Nature Letters*.

years of fossil fuel-related emissions at current levels<sup>3</sup>. This is an incredibly short period in which to transform the global energy system and of course neglects emissions from deforestation and land-use change, which make the situation even more challenging.

So there is a clear policy imperative to accelerate the demonstration and large-scale deployment of low-carbon technologies and negative emissions technologies that can suck CO<sub>2</sub> from the atmosphere. But the effectiveness of mitigation action by any single country or group of countries is dependent on the response to this by the rest of the world. Competitiveness and other concerns appear to have limited the extent of costly mitigation action in a world where mitigation effort is uneven.

Even if the developed economies reduced their greenhouse gas emissions virtually to zero by 2050, this would not in itself solve the climate problem. The International Energy Agency's Baseline scenario projects a massive increase of global energy-related CO<sub>2</sub> emissions from around 30 billion tonnes to 57 billion tonnes by 2050, over a third of which would be due to China and India alone. The

major developing economies cannot therefore continue carbon-intensive growth trajectories for much longer without increasing the risks of large-scale change.

### **The Right to Emit**

A globally agreed mitigation target creates a scarce resource – the right to continue to emit an amount of CO<sub>2</sub> into the atmosphere. To make such a target operational requires agreement on two things: the level of the global carbon budget and on how it is to be allocated amongst countries. This of course is the huge political stumbling block that has bedevilled climate negotiations. The Kyoto Protocol's top-down targets and timetables have proved completely ineffective as a response.

To overcome the inherent difficulty of negotiating effective mitigation targets within the UN process, there have been several efforts to establish complementary and alternative negotiation tracks, such as the US Major Economies Forum. It seems likely that mitigation negotiations in future will become much more like arms control negotiations, involving just the key emitting economies rather than all UN member states. Though the timescales over which the impacts of climate change unfold are much longer than the instantaneous damage from a nuclear exchange, each large emitter increasingly recognises

*We have a certain  
carbon budget  
corresponding to  
the level of global  
temperature  
change we are  
willing to tolerate*

*Passengers became stranded all over Europe as uncharacteristic freezing temperatures grounded planes*



that others' decisions can inflict serious harm, either in terms of climate impacts or through spillovers from the climate to the trade agenda, and that it will need to engage directly with them to manage these risks and safeguard national interests.

While there are clear incentives to negotiate, a successful outcome is not guaranteed. The trade-off between the short-term economic benefits of fossil-fuel use and the risks of long-term climate damages will differ between (and within) countries. If a particular large emitter turns out to be insulated from major climate impacts then the rest of the world will have difficulty in managing the consequences. The extent to which the green economy proves to be a real source of economic competitiveness will also be an important factor.

In such a negotiation process, emission reductions by one party will be carefully calibrated on the actions of others and will need to be underpinned by confidence building measures and effective verification – the latter

being one of the key US demands in UN negotiations. It is in this, rather than in setting top down targets and timetables, that the UNFCCC has a potentially unique contribution to make as a trusted clearinghouse for the collection, analysis and interpretation of national information on emissions and policies.

Where does this sort of process leave the poorest and most vulnerable? Potentially disenfranchised. They will struggle to influence the mitigation negotiations between the major emitters, who will in effect determine the level of risk and impacts faced by the rest of the world, much as the USSR and the US did during the Cold War. Will major emitters take sufficient action early enough to safeguard the

Small Island States and other vulnerable communities and countries? The omens are not good, though limiting damages for the most vulnerable is more likely the more exposed the major emitters are to climate impacts.

*Mitigation negotiations in future will become much more like arms control negotiations, involving just the key emitting economies*

*IPCC summits in Copenhagen and Cancun attempted to build a global consensus on climate change action*

Copenhagen 2009	Cancun 2010
<p>The 2009 Copenhagen summit was billed as the world's best chance to agree to a global climate deal to succeed the Kyoto Protocol but ended with a brief, nonbinding agreement rejected by a clutch of countries on a fractious final day</p>	<p>Hailed as a step in the right direction, delegates in Cancun struggled to agree on binding emissions targets yet made progress in many areas such as finance, adaptation and measures to stem deforestation in developing countries</p>
<b>Successes</b>	
<ul style="list-style-type: none"> <li>• A global first – 110 world leaders travelled to Copenhagen to pledge their support for the fight against climate change. In particular, China and India made voluntary commitments to mitigation action for the first time</li> <li>• Broad awareness of climate science and support for action; green growth was hailed as the economic model for the future</li> <li>• Increased public awareness</li> </ul>	<ul style="list-style-type: none"> <li>• A new Green Climate Fund to channel money from the West to developing nations and a framework for funding the reduction of deforestation by developing countries</li> <li>• The creation of structures for technology development and transfer</li> <li>• Formal recognition that current emissions pledges need to rise</li> </ul>
<b>Failures &amp; Disagreements</b>	
<ul style="list-style-type: none"> <li>• An inability to overcome concerns about sovereignty in the context of international law – countries agreed to co-operate, but not under the threat of legal sanction</li> <li>• No quantified aggregate target for emissions reduction such as the 50% by 2050 in early drafts</li> <li>• No verification of actions undertaken in the developing world unless they are paid for by the developed world</li> </ul>	<ul style="list-style-type: none"> <li>• No binding emissions cuts and no new mechanisms for negotiating deeper emission cuts</li> <li>• Deep disagreement over the future of the Kyoto Protocol and other potential carbon trading/limiting mechanisms</li> <li>• No decision on the legal status of any new global agreement</li> </ul>



A key challenge going forward will be to try to ensure there is effective and adequate linkage between the mitigation decisions determined by the major economies and the adaptation challenges faced by the less developed, more vulnerable countries, including the financial, technological and other assistance they require. Hence the continued calls for a successor to the Kyoto Protocol from developing economies, in order to tie in the rich economies to early mitigation action, despite the ineffectiveness of this approach hitherto. Nor are the difficult dilemmas limited to the poor.

For example, what strategy should the EU adopt? If it makes additional unilateral emissions reductions, in the context of a fixed carbon budget, might they be pocketed by others with no global mitigation benefit either for the EU or the most vulnerable? Or is the EU's best strategy to accelerate the transition to a low-carbon economy because, in the long run, that's the only sort of economy there will be and the solutions it develops will be needed by others?

*Is the EU's best strategy to accelerate the transition to a low-carbon economy because, in the long run, that's the only sort of economy there will be?*

The outlook is extremely challenging, but not hopeless. Ambitious mitigation targets that limit global mean temperature increase to 2°C remain (just) within reach and appear affordable at a few percent of global GDP. But they require systemic transformation of energy and economic systems in an extremely short timescale by historical standards. At the international level, we are seeing the start of a new and arguably more realistic approach that potentially will include all the major emitters, developed and emerging. But success is by no means assured, whether measured in terms of the extent of global mean temperature change or of limiting the impacts on the poorest and most vulnerable. The success of UN efforts will ultimately be measured by the degree to which they are able both to support effective mitigation negotiations among the major emitting economies and influence the ethical contours and ambition of the broader global response to climate change.

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# Why Are We Interested In Carbon Capture And Storage?

*Dr Nicholas Florin* is a Grantham Institute for Climate Change Junior Research Fellow based in the Chemical Engineering Department. His research interests include the development of solid sorbents for CO<sub>2</sub> capture, and the integration of CO<sub>2</sub> capture systems in advanced energy and industrial systems.

**C**arbon Capture and Storage (CCS) technology enables capture and storage of CO<sub>2</sub> emitted by fossil-fuel power plants, and is expected to play an important role in the transitional phases towards a low-carbon economy.

However, there are still many obstacles to overcome before CCS may be rolled out for significant climate change mitigation. These include energy and cost efficiency, and plans for the assessment and management of the economic, health, legal and environmental issues associated with large-scale deployment of CCS.

The global challenge of achieving greenhouse gas emissions reductions necessary to mitigate climate change is enormous. This challenge is inextricably linked to how we produce and use energy, with far-reaching implications for every sector. Significant reductions must come from improvements in the efficiency of energy production and use, fuel substitution, increased use of renewable energy and increased use of nuclear power. These should be coupled to the rollout of carbon capture and storage (CCS) technologies applied to fossil-fuel power generation and energy-intensive industry. Emission reductions must also be coupled with behavioural and lifestyle changes in order to restrain demand in the developed world as the spread of electrification increases the demand in the rest of the world.

The energy sector accounts for the largest share of anthropogenic CO<sub>2</sub> emissions, mostly as a by-product of fossil fuel combustion (including coal, gas and liquid

fuels)<sup>1</sup>. The trajectory of global fossil fuel use and corresponding CO<sub>2</sub> emissions is characterised by an exponentially increasing trend – a direct consequence of the rising demand for energy which accompanied the industrial revolution in the West, a trend that is now sustained by the spread of industrialisation to the rest of the world – particularly China and India.

If the world continues to follow a path of intensive fossil fuel use, then CCS technology will be essential for achieving large-scale global CO<sub>2</sub> emissions reductions within the next 30–40 years. From an energy security perspective, CCS can play an important role by decoupling CO<sub>2</sub> emissions from fossil fuel usage, and allowing a more diverse range of fuels and energy supply lines to meet a demand that cannot be met in the near-term by renewable or nuclear energy.

From an economic standpoint, CCS can underpin a minimum-cost mitigation pathway. For example, according to the International Energy Agency (IEA) 'Blue Map scenario', to achieve a 50% global CO<sub>2</sub> reduction by 2050 – at lowest cost – about one fifth of the total reductions in CO<sub>2</sub> emissions is required from the application of CCS to power generation, industry and fuel transformation<sup>2</sup>.

<sup>1</sup> United Nations Framework Convention on Climate Change (2009). National greenhouse gas inventory data for the period 1990-2007. *UNFCCC Secretariat*.

<sup>2</sup> IEA (2010). *Energy Technology Perspective*.

<sup>3</sup> HM Treasury (2010). *Spending Review*.

**What is CCS?**

CCS, which is proposed as one part of the CO<sub>2</sub> mitigation strategy, refers to a broad suite of technologies developed to capture carbon dioxide (CO<sub>2</sub>) gas produced when fossil fuel (or biomass) is used in power stations and industry. This includes the equipment to capture and purify the CO<sub>2</sub> gas produced during combustion or gasification of fuel, the infrastructure for handling and transporting the pure CO<sub>2</sub>, and the technologies for injecting and storing it in deep geological formations.

A range of important CCS applications include CO<sub>2</sub> sourced from the use of coal, gas and biomass for power and industry; and storage in geological forms, such as saline aquifers and depleted oil and gas fields. There is significant potential for CCS to contribute to emissions reduction outside of the power sector; for example, according to the IEA Technologies Perspectives 2010, CCS applied to industrial emitters could represent 20% of the total amount of CO<sub>2</sub> captured using CCS technology in 2050<sup>2</sup>. The major industrial emitters are cement plants and oil refineries, which, after the power sector, are ranked 2nd and 3rd highest in terms of CO<sub>2</sub> emissions from stationary sources. Other major industrial contributors to global CO<sub>2</sub> emissions include the iron and steel, aluminium, and pulp and paper sectors. These sources represent large sources of CO<sub>2</sub> that are frequently difficult (or impossible) to decarbonise without fundamental and expensive changes to the underlying processes.

However, the different applications of CCS have various emission reduction outcomes. For example, a coal-to-liquid-fuel production plant with CCS will still result in CO<sub>2</sub> emissions to the atmosphere if the fuel is burnt in the transport sector where capture may not be economically viable. On the other hand, a coal-fired power plant with CCS that substitutes some coal with biomass could potentially result in negative emissions, assuming the emissions associated with cultivating and transporting the biomass is less than the amount absorbed from the atmosphere during its growth. Life cycle assessment is therefore crucially important to benchmark the different technology options in terms of cost, efficiency and net emission mitigation potential.

**Challenges Ahead**

All of the individual elements of CCS are in use today in the oil, gas and chemical processing sectors and there are more than a hundred sites worldwide where CO<sub>2</sub> is

injected underground. Most of these sites inject CO<sub>2</sub> into depleted oil reservoirs allowing more oil to be recovered and the cost of injection and storage to be off-set (enhanced oil recovery, EOR).

However, there are a number of major challenges facing the widespread implementation of these technologies. In particular, it is a challenge to integrate all the elements of CCS and scale-up for CO<sub>2</sub> capture from power plants and industry in the very near term, i.e. the next two decades. Closest to market technology for CO<sub>2</sub> capture (i.e. amine-based solvents) is very energy intensive which means that about 20% more fuel must be burned at the power station to produce the same amount of power and capture the CO<sub>2</sub>. Equally, the storage of giga-tonnes of CO<sub>2</sub> deep under ground raises new issues of liability and risk that

*CCS will be essential for achieving major emissions reductions with continued fossil fuel use*

remain unresolved. Suitable storage locations in depleted oil and gas reservoirs are not evenly distributed around the globe, and so much of the anthropogenic CO<sub>2</sub> is proposed to be

stored in deep saline aquifers; these locations are broadly distributed, but have less well characterised geology and do not offer the potential to generate revenue from enhanced hydrocarbon recovery.

The capital investment for new plant and operating costs for separating, compressing, transporting and storing the CO<sub>2</sub> will impose a considerable economic burden on the power sector, or industrial processes. Thus, CCS deployment in these sectors will only occur with policy and regulatory frameworks designed to provide an incentive for investment, or which introduce a penalty associated with emitting CO<sub>2</sub>. Currently, the lack of a defined cost for CO<sub>2</sub> emissions means that the commercial deployment of CCS is dependent on unique economic conditions, i.e., where the opportunity exists for EOR, or where specific policy and regulatory frameworks exist. The latter is exemplified by projects in Norway, where a CO<sub>2</sub> emission tax has led to the Sleipner and Snøhvit projects that inject and store CO<sub>2</sub> separated from natural gas in saline aquifers.

A number of governments, including the UK, are developing CCS policies. For example, the UK government's new Energy Act 2010 promotes the application of CCS to coal-fired power stations using post-combustion or oxy-fuel technology, with a commitment to provide funding towards up to four CCS demonstrators via the UK CCS

competition. Scottish Power's Longannet power station is the first project likely to be funded via the UK CCS competition, with the government promising £1 billion towards capital costs for capture and storage off-shore of 90% of the CO<sub>2</sub> produced from the equivalent of a 300 MWe generation capacity<sup>3</sup>. Recently, responding to recommendations from the UK Committee on Climate Change, the government's commitment to fund CCS demonstrators has been extended to include gas-CCS.

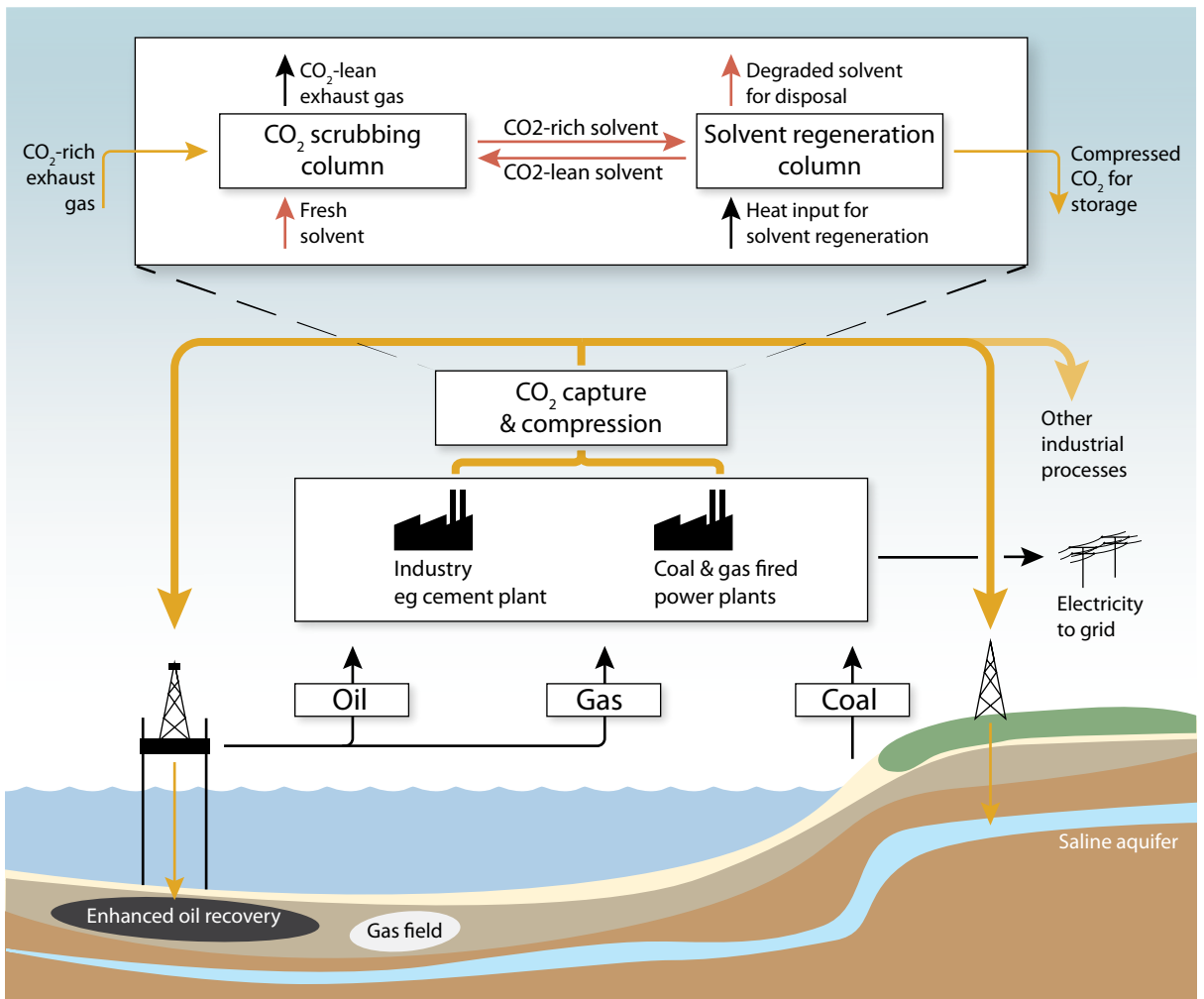
**A Transitional Technology**

CCS is a transitional technology, offering a near-term way of mitigating climate change consistent with continued extensive fossil fuel use, while progress is made towards establishing a truly sustainable low-carbon energy system in the medium to longer term. The costs of mitigation are expected to be considerably higher if CCS is not included in future low carbon energy technology portfolios. The deployment of CCS in countries with very large indigenous

fossil fuel reserves could also reinforce energy security, while not compromising climate mitigation goals. It is therefore extremely important to have early demonstration and deployment of this technology to test the system on a large scale and to iron out problems prior to its projected global rollout in the next couple of decades.

Legislative and policy clarity and consistency is needed, otherwise the large capital costs of the technology and long payback time will hold back investment in CCS. The general public are justifiably concerned about the potential risks of CO<sub>2</sub> storage, particularly near to populated areas. Research, consultation and dialogue will be needed to help make clear the potential risks and how these will be managed to address concerns.

*This article is an excerpt from a briefing paper titled: 'Carbon capture technology: future fossil fuel use and mitigating climate change' recently published by the Grantham Institute for Climate Change, available at [www.imperial.ac.uk/climatechange](http://www.imperial.ac.uk/climatechange)*



# Dissolving CO<sub>2</sub>

## Amine-Based Absorption Technology

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**L**arge-scale commercial deployment of CCS presents a major challenge. The closest to market technology with several pilot plants worldwide is CO<sub>2</sub> capture with amine-based solvents. However, there exist major cost and technical challenges to be overcome, and environmental risks associated with amine emissions to be understood, before a sector-wide rollout of this technology is viable.

The UK government's recent announcement of a major capture and storage (CCS) demonstration programme is a promising indication that CCS is a high priority in the suite of CO<sub>2</sub> mitigation initiatives under consideration to meet the UK's reduction targets for CO<sub>2</sub> emissions. As a strategy for climate change mitigation, CCS is most cost-effective for large stationary sources of CO<sub>2</sub> such as fossil-fuel-fired power plants that account for roughly 80% of global CO<sub>2</sub> emissions from such facilities. Furthermore, this percentage is poised to increase in the future to service the emerging electrification of the transportation sector. However, there has been hitherto no CO<sub>2</sub> capture implementation at a large power plant of a scale of hundreds of megawatts although designs of such systems have been rigorously studied and proposed.

The key idea of amine-based absorption is to capture CO<sub>2</sub> from the exhaust flue gas streams of coal-fired power plants via the absorption of CO<sub>2</sub> into a liquid solvent to form a concentrated CO<sub>2</sub> stream that can be transported to a storage or sequestration site. Arguably the most attractive method amongst a diverse range of alternatives, amine-based CO<sub>2</sub> capture has a long history and

hence technical maturity. There are, however, major cost-related technical challenges to be overcome, and environmental impacts to be understood, before use of this absorption technology is widespread.

### Amine Solvents

In a modern coal-fired power plant using pulverized coal, the heat released as a result of combustion generates steam that drives a turbine generator, thus producing electricity. CO<sub>2</sub> is formed as part of the hot exhaust flue gas generated from the combustion process, which chiefly contains nitrogen with small amounts of water vapour and compounds formed from impurities in coal that include SO<sub>2</sub>, NO<sub>x</sub>, and particulate matter. The CO<sub>2</sub> is captured 'post-combustion' from the flue gas via chemical reaction with a liquid solvent – a process called absorption.

To date, most commercial carbon dioxide separation plants use monoethanolamine (MEA) solvent which was historically developed about 80 years ago to remove acidic impurities from natural gas. MEA is an organic base that reacts chemically with carbon dioxide, which is slightly acidic. Acidic gases, such as NO<sub>x</sub> and SO<sub>2</sub>, must be removed first as they will react with MEA, thus diminishing the amount of active MEA for carbon capture.

CO<sub>2</sub> removal via absorption takes place in a CO<sub>2</sub> scrubbing column. The flue gas is cleaned (or 'scrubbed') by forcing it to come into contact with MEA. This may be done in three ways: bubbling flue gas through the MEA solution, dispensing droplets of MEA solution in



the midst of flue gas, or blowing the flue gas over a thin film of MEA supported on a surface. Up to 90% of the CO<sub>2</sub> present is absorbed via this process. As the solvent is expensive, it is reclaimed in a solvent regeneration column by applying heat to the CO<sub>2</sub>-rich solvent solution for release (or 'stripping') of almost pure CO<sub>2</sub> molecules.

Applying high pressure then liquefies the removed CO<sub>2</sub>, making it easier and much less costly to transport than in gaseous form. The pressurised CO<sub>2</sub> is stored by various methods including injecting it deep underground for geological sequestration. The amine solution that is now low in CO<sub>2</sub> concentration is then recycled to the CO<sub>2</sub> scrubbing column and the cycle repeats.

#### **A Solution for CO<sub>2</sub> Mitigation?**

Absorption-based technology is attractive mainly because it is compatible with existing infrastructure for energy and power systems. As it removes carbon dioxide after combustion, this technology can be handled almost like a standalone unit that is easily incorporated into an existing power plant without major structural and technological modifications.

The technical operation of amine-based absorption is particularly simple compared to alternative existing technologies. Absorption takes place at ordinary temperature and pressure, thus presents a minimal energy demand. The chemistry of MEA renders it effective for dilute CO<sub>2</sub> streams, making it particularly suited for flue gas from coal combustion which typically contains about 10% - 12% CO<sub>2</sub> by volume.

For new plants, amine-based absorption technology can be integrated into the design of the plant and hot flue gas can be used to supply energy that runs the carbon-capture cycle. In particular, heat from the flue gas can be used to strip off CO<sub>2</sub> from solvent, thus reducing energy demand of the whole process.

#### **But...**

The capital and operating costs for absorption-based CO<sub>2</sub> capture technologies are substantial. Penalties are incurred from both the heat energy input required to reclaim the solvent and the energy required for the CO<sub>2</sub> compression and transport process. These costs may amount to a capture penalty of 8-9 percentage points

below the plant lower heating value (which is a property of a fuel, defined as the amount of heat released by combusting a specified quantity).

Furthermore, a sizeable amount of the solvent (0.35–2.0 kg) is consumed per ton of carbon dioxide captured, resulting in significant costs associated with solvent make-up to maintain the operation. These are in addition to costs associated with the transportation of exhaust gases and solvents.

#### **And the Environmental Cost?**

Much remains unknown about how much of the volatile amine solvent is emitted to the atmosphere and what happens to these emission compounds in the atmosphere. We are equally in the dark about whether the emission of amines and its degradation products are deposited close to their source. It is known that most of the molecules involved are soluble in water. Therefore it is possible that amine emissions will mix with rainwater and immediately enter the ecosystem.

A recent research article by a team of researchers at Imperial College London<sup>1</sup> attempts to shed some light on our current knowledge of the environmental impacts of the absorption-based technologies. Preliminary findings unfortunately indicate that many of the products formed as a result of the degradation of the amine solvent will be harmful to both human health and the environment, to the extent of being potentially carcinogenic. Active research on this is currently being undertaken to understand the health effects and also to look for a new solvent for carbon capture.

In summary, before alternative sustainable carbon-neutral energy sources are found, there is a pressing mandate for the global community to curtail carbon dioxide emissions from power plants, which collectively contribute overwhelmingly to carbon emissions. Absorption-based carbon capture technology with amine solvents may be an effective technology well suited for this purpose. However, lingering uncertainties surrounding the environmental and health impacts of this technology should be addressed quickly to ensure that we are fully confident of the capability of this technology as an intermediate solution to combat global climate change.

<sup>1</sup> Mac Dowell N. et al. (2010). An overview of CO<sub>2</sub> capture technologies. *Energy and Environmental Science*.

# Breathe

## Campaigning for Clean Air in London

*Simon Birkett* is Founder and Director of Clean Air in London which runs a cross-party campaign to achieve urgently and sustainably at least World Health Organisation recommended standards of air quality throughout London.

*'Unlimited and free access to clean air of an acceptable quality is a fundamental human necessity and right' and 'an unequal distribution of health risks over the population raises concerns of environmental justice and equity'*

WHO Europe, June 2004

**A**ir pollution in London is much worse than most of us have realised. It averages well over twice legal limits and WHO guidelines near our busiest streets. Furthermore, the Campaign for Clean Air in London has shown that air pollution has been responsible for thousands of undisclosed premature deaths in London and across the UK.

**Clean Air in London's (CAL's) mission is to achieve urgently and sustainably at least World Health Organisation (WHO) recommended standards of air quality throughout London. Its immediate priority is to see health-based air quality laws complied with in full each year up to the London 2012 Olympics (and thereafter).**

There are three main types of hazardous pollutants in ambient air:

- Particulate matter comprises very fine particles from dust, tyre and brake wear and black smoke from vehicles;
- Nitrogen dioxide (NO<sub>2</sub>) is formed in most combustion processes;
- Tropospheric ozone gas (O<sub>3</sub>) is a greenhouse gas also formed by combustion.

Sulphur dioxide (SO<sub>2</sub>) is no longer seen as a health risk in London.

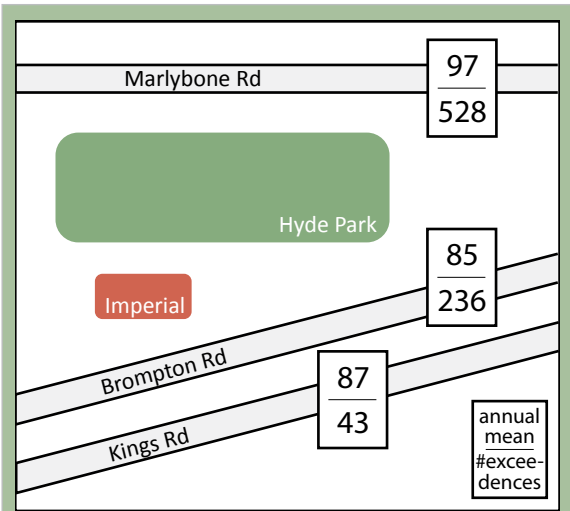
Concentrations of NO<sub>2</sub> are typically correlated with those of particulate matter (PM) although the latter is increased if there is greater local use of diesel-powered vehicles (predominantly trucks and commercial vehicles). PM is classified by diameter as ultrafine (PM<sub>1.0</sub>), fine (PM<sub>2.5</sub>), coarse (PM<sub>2.5-10</sub>) and PM<sub>10</sub> (with the last, for example, including particles up to 10 microns in diameter). The finest particulate matter is thought to be the most deadly since it travels furthest into the bloodstream and the body.

WHO guidelines typically include annual and short-term (hourly for NO<sub>2</sub> and daily for PM<sub>10</sub>) mean exposure levels to protect human health. There is no safe level for PM. European Union (EU) legal limits, based on WHO guidelines, for NO<sub>2</sub> exposure levels are set at annual and hourly legal limits of 40 µg/m<sup>3</sup> and 18 exceedences (number of hours for which limit is exceeded) respectively. Yet in the 2010 calendar year, annual mean concentrations of NO<sub>2</sub> in Brompton Road, Kings Road and Marylebone Road were over double these levels, see map.

Evidence from the summer smogs of 2003 and 2006 suggests that air quality will deteriorate as climate change causes warming unless additional mitigation action is taken that anticipates this rising trend.

### **Diesel Fumes**

The Mayor of London, Boris Johnson, has said that road transport was responsible for 79% of PM<sub>10</sub> emissions in central London and around 80% of PM<sub>2.5</sub> emissions



**While You Are Out Shopping**

In the 2010 calendar year, annual mean concentrations of NO<sub>2</sub> and hourly exceedences in Brompton Road, Kings Road and Marylebone Road were: 85 µg/m<sup>3</sup> and 236 exceedences; 87 µg/m<sup>3</sup> and 43 exceedences; and 97 µg/m<sup>3</sup> and 528 exceedences respectively compared to the annual and hourly EU legal limits of 40 µg/m<sup>3</sup> and 18 exceedences respectively.

in London as a whole in 2008 and 41% of emissions of oxides of nitrogen (NO<sub>x</sub>) in London as a whole in 2008.

Emissions from diesel engines are a particular problem. Empirical evidence published by the government suggests that, like for like, diesel engines for passenger cars may produce 17 times as much particulate matter and 83% more NO<sub>x</sub> emissions than petrol cars for a carbon dioxide reduction of 4% or less. Diesel vehicles with Pre-Euro 1 engines (1992 emissions standards) may produce more than five times as much particulate matter as diesel vehicles with Euro 4 engines (2005 standards).

The other main sources of harmful emissions include power stations, domestic natural gas, quarrying, construction and (outside London) agriculture. The proliferation of festival bonfires has also recently been recognised as a cause of more frequent air quality problems.

**Government Failings or ‘Cover-Up’**

CAL has shown that the previous government was responsible for one of the biggest public health failings or ‘cover-ups’ by a government in modern history.

For years we had been told there were 1,031 premature deaths due to air pollution in London in 2005 and some 12,000 to 24,000 per annum nationally. Research showed these estimates related to short-term exposure with the former due to PM<sub>10</sub> and the range comprising 8,100 from PM<sub>10</sub>, 3,500 from SO<sub>2</sub> and 700 to 12,500 from O<sub>3</sub>.

It was very odd though that the United States’ Environmental Protection Agency and others had published estimates attributable to long-term exposure to PM<sub>2.5</sub> while the UK had not. With much help, CAL calculated there were 3,460 such deaths in London and 35,000 nationally in 2005.

Parliament’s Environmental Audit Committee accepted these estimates saying: ‘Air quality must be given a higher priority for government. The Department for Environment, Food and Rural Affairs (DEFRA) must raise the profile of the issue by publicising the latest data on premature deaths more widely and making clear the benefits of improving air quality’. The Mayor of London and the new government have subsequently published estimates of 4,267 premature deaths in London and 29,000 nationally in 2008 attributable to long-term exposure to PM<sub>2.5</sub>.

To put the above numbers in context, compare them to the 230 people who died in London in the same period from road traffic accidents and the 617 people nationally annually who are estimated to have died prematurely from workplace related passive smoking before the legislation came into force. Each person dying prematurely due to poor air quality in London may do so up to nine years early.

During London’s summer smog episode in August 2003 there were a total of between 46 and 212 premature deaths from O<sub>3</sub> and 85 from PM<sub>10</sub>. London’s summer smog episode in July 2006 was likely to have resulted in a similar or greater number of premature deaths from O<sub>3</sub> and a slightly lower number for PM<sub>10</sub>. These numbers should be of great concern to those planning for the Olympic Games and Paralympic Games in 2012.

In summary, air pollution has been linked to cardiovascular and cardiopulmonary events as well as asthma, cancers and other health effects. Increasing obesity may make people more vulnerable to air pollution. The young and old are most vulnerable to poor air quality.

### Get on Your Bike

We need mitigation and adaptation to tackle air pollution whether poor air quality or climate change related. Mitigation means walking or cycling or using public transport rather than driving (particularly diesel vehicles) where possible to reduce air pollution for yourself and others. Adaptation includes walking or cycling down side streets rather than busy arterial roads.

Solutions are split into two main categories:

- **Non-traffic measures:** such as complying with the Best Practice Guidance on Demolition and Construction published jointly by the London Boroughs and the Mayor of London. Other measures needed include action to control the impact of biomass burning and micro-generation and the proliferation of festival bonfires; and
- **Traffic related measures:** which can be split further into fewer and smaller vehicles and cleaner vehicles. It is simplest to consider two overlapping circles: one for measures to reduce congestion and one to reduce harmful emissions.

Measures to reduce congestion include road pricing and those to reduce harmful emissions include low emission zones (LEZs). The former can reduce emissions since vehicles travelling at 20 mph are roughly half as polluting as those travelling at 5 mph. The latter can reduce congestion by excluding some vehicles. Germany, for example, had some 40 inner city LEZ's in place by the end of 2009 with Berlin saying its LEZ has been the single most successful measure to improve air quality in the

*CAL has shown the previous government was responsible for one of the biggest failings or 'cover-ups' by a government in modern history*

city. Measures to promote walking, cycling and the use of public transport clearly reduce both congestion and emissions.

CAL considers key solutions for London should include: the abatement of harmful emissions from buses and taxis; a Berlin style LEZ in inner London and around Heathrow; a boiler scrappage scheme; and a massive campaign to build public understanding of the dangers of poor air quality with advice on mitigation and adaptation. CAL is concerned that the Mayor's focus on buying hybrid buses may distract from the need to comply (cheaply) with air quality laws in the short-term (e.g. through the fitting of selective catalytic reduction devices

to buses) and put infrastructure in place for a sustainable long-term solution (e.g. electric vehicles).

It is clear that successive governments have continued to hope for some 'silver bullet' to solve air quality problems (e.g. technology solutions such as tighter emission standards for vehicles) while it is clear the cheapest and most successful solutions will require bold political action and behavioural change.

### Fresh Air in Sight?

The scale and urgency of the challenge requires radical and urgent action to reduce air pollution. But if we succeed, we will show the world (and London) how to tackle air pollution and sustainability issues more widely.

*'Boris bikes' are available at over 370 locations in London: is this the start of a 'cycling revolution'?*



# Changing Attitudes To Climate Change

Victoria Bignet is a final year BSc student in Biology at Imperial College London, with a strong interest in environmental issues and natural resource management.

*"Each passing day brings yet more evidence that we are now facing a planetary emergency – a crisis that threatens the survival of our civilization and the habitability of the Earth."*

Al Gore, 45<sup>th</sup> Vice President of the United States

**T**he publication of the Stern Review and the screening of Al Gore's *An Inconvenient Truth* in 2006 brought climate change to the forefront of public debate. The evidence seemed incontrovertible, and the consequences of continued CO<sub>2</sub> emissions shocking, yet five years later it seems that little has changed in terms of individual behaviour towards to the environment.

**While attitudes have evolved, there is evidence of an emerging so-called attitude-behaviour gap. Despite sustained media coverage, individual energy consumption continues to rise with no signs of abating. With complex carbon calculations to negotiate, and major personal sacrifice at stake, just how can an individual make a real difference?**

Few would deny the consequences of CO<sub>2</sub> emissions, or the existence of dramatic climate, yet a very small minority of us take significant action in our everyday lives to tackle the problem. It is as though we have become 'immune' to any moral requirement to take personal action; global warming is overwhelmingly reported on the news, yet our response is acutely underwhelming.

The central problem is that attitudes towards climate change and environmental issues, well intentioned as they may be, often fail to translate into lifestyle changes and actions at a personal level. This infamous attitude-behaviour gap is one of the greatest challenges facing the public climate change agenda.

## The Tragedy of the Commons

Most Europeans happily undertake environmental measures that require relatively little personal or financial effort such as waste separation. Yet polls indicate that these decisions are largely based on a cost-benefit analysis, where a quantifiable financial or personal cost of taking action is measured against a seemingly intangible and shared benefit to the environment<sup>1</sup>.

This is consistent with the success of energy saving light bulbs and fridges that will reduce power consumption and hence costs over the long term despite costing more initially. However, when it comes to voluntary carbon offset fees for air flights, that same energy-saving-light-bulb user is likely to balk. Even though everyone benefits, there is little financial motivation for flight passengers to pay the offset fees due to the small amount of personal gain.

Garrett Hardin highlighted this scenario in 1968, terming it the 'tragedy of the commons' – a dilemma arising from the situation in which multiple individuals, acting independently and rationally consulting their own self-interest, will

<sup>1</sup> McKie R. (Oct 2008). How the myth of food miles hurts the planet. *The Observer*.



ultimately deplete a shared limited resource even when it is clear that it is not in anyone's long-term interest for this to happen. This consideration of personal circumstances, against seemingly intangible benefits to the whole, is a leading factor behind the 'attitude-behaviour' gap.

### Complex Calculations

The truth is, in some areas, decreasing one's carbon footprint is very difficult. While walking or cycling instead of driving is a relatively straightforward calculation to make, buying low-carbon food is trickier than it may initially seem. While eating local produce has long been mooted as the 'green' option despite potential higher prices, recent analysis suggests that this is not always the case.

One example illustrating the complex relationships underlying food-miles involves the simple purchase of green beans. The fact is that often driving the extra miles to a place where 'home grown' beans are sold emits far more carbon than flying a pack of Kenyan green beans to the UK. Indeed when factors such as the non-use tractors, the use natural fertilisers and low-tech irrigation systems and the creation of employment in Kenya are taken into consideration, the prospect of 'local' beans seems almost indulgent. Hence, even though some carbon emissions are being negated through personal action, many are largely symbolic gestures.

### The Powers-That-Be

So where does the responsibility fall for promoting more sustainable consumer behaviour lie? It may be argued that it is the role of governments to formulate policy and regulation nudging us, the consumers, towards 'green' behaviour and choices. Many of these strategies include a form of environmental or carbon taxation. Simple

measures, such as a levy on plastic shopping bags, can have an immediate positive effect on the environment. For example, Ireland cut their use of bags by more than 90% during the first three months of the scheme and raised millions of Euros in revenue to be spent on environmental projects. Indeed today plastic bags are virtually unavailable in supermarkets across the nation; bringing bags has become the norm.

Sweden was one of the first nations to introduce widespread carbon taxes on energy in 1991. This made polluting more expensive and drove research into energy-efficient technology and renewable energy. The Swedish government also introduced a voluntary system for trading 'green certificates' encouraging consumers to increase the proportion of electricity they use that is generated from renewable sources.

More recent ambitious proposals include the introduction of a Personal Carbon Trading (PCT) scheme in the UK where every individual would be given a set allocation of carbon credits, which they could use to 'pay' for purchases like home energy usage and petrol. PCT attempts to highlight the connection between climate change and the individual by showing what is a fair amount of carbon for an individual use. Initially gaining political support, PCT was later 'shelved' due to concerns about the total extra reduction of carbon with respect to the costs of the scheme.

There are inherent challenges in associating individual action in climate change with the greater good, and complex carbon calculations involved in personal action. It seems that individual action will increasingly be coupled to government schemes to enable people to make informed choices. Those choices, however, remain ours to make.

*Roaming the receding ice: polar bears often symbolise the dangers of climate change in the media*



# The Imperfect Energy Markets

Mark Jennings is currently undertaking a PhD at Imperial College London's Civil Engineering Department, specifically looking at the role of optimizers in understanding the dynamics of retrofitting urban energy systems. He holds an MSc from Stanford University in Energy Engineering and a BE in Civil Engineering from the National University of Ireland, Galway.

*"The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value."*

Theodore Roosevelt, 1910

**N**atural resources are harnessed by humans all over the world in a variety of ways, often in the form of fuel and power for both essential and non-essential services. Yet, the price paid by consumers is below the natural market price, resulting in increased resource consumption. The consequences include depletion, national energy dependence and climate change.

The current situation stems from a pernicious underpricing of natural resources largely due to energy subsidies and negative externalities – when negative side effects of a process are borne by parties not directly involved in the process.

Natural resources consumed to provide heat and light have been traded for millennia. For instance, oil has been recorded as being used for illumination around 300 AD in Mesopotamia. Technological innovation over time has brought significant changes in the way energy is both generated and used, with major breakthroughs

coming during the industrial revolution. Since then, it has become easier to access and profit from reserves of natural assets such as coal, natural gas and oil. Today, energy is provided through a host of agents, including companies involved in the generation, transmission, distribution and sale of electricity to us, the consumers.

The price of an underlying asset, such as energy, must account for various costs. For an oil reservoir or coalmine, these costs may include wages of the labourers, profit of the investor for taking on the risk of accessing the asset, and the rent of the underlying land. Further costs may include the cost of transportation and maintenance of pipelines/wires. After taxation the product is sold then to the consumer. However, energy consumers of heat, electricity or transport fuel rarely pay this 'natural' price.

*Energy consumers of heat, electricity or transport fuel rarely pay the 'natural' price*

In a free market, an increase in demand for energy will result in an increase of supply; but over the short term, suppliers may not be able to produce it at a higher capacity, and thus the increase in demand results in higher prices.

## Subsidies

Evolution in the supply and demand of energy forms the basis of 'market forces'. As energy demand rises, the price of energy should rise in parallel as supply decreases, thus discouraging some consumers from

using energy and hence effectively putting a cap on the amount of energy traded. Subsidies, however, are deliberate market distortions that lower the price of energy thus quashing any cap.

Subsidies are inherent in the current market system to which most societies abide, and are particularly tied to the political economy of natural resources. These can be in the form of direct subsidies (e.g. cash transfers to producers or consumers) or indirect measures acting largely through the transfer of risk from upstream investors to the public – for example, via pass-through costs from the investor to the consumer or government backed insurance of risky projects. Some country specific cases include high-import taxes on bio-fuels imported into the US and direct transfers to state backed oil and gas monopolies in China. The twenty largest non-OECD countries gave to the energy sector an estimated \$310 billion in direct transfers in 2007.

*Subsidies are deliberate market distortions that lower the price of energy thus quashing any natural cap*

Regarded as a basic necessity in most societies, access to energy is a central issue for governments around the world. Populist subsidies are often in place for the most visible energy prices in a country, such as for petroleum in Venezuela or Iran, and for gas in Russia. Indirect subsidies also exist in states that interfere less directly in the energy sector, such as the feed-in-tariff in the UK for electricity production from solar photovoltaics and the biased subsidies for power-using farmers in India.

Regardless of the motive, what is clear is that once subsidies are introduced, they quickly become locked into political systems. Self-interested lobbies quickly form, investing both capital and political resources into maintaining high barriers to market entry through compounding regulations. Furthermore, consumers expect prices to remain low giving governments incentive to manipulate prices.

An example of this has been seen in the US coal markets. Governments typically receive rents from land

*The decommissioned Battersea Power Station: £200 billion will be invested in energy infrastructure over the next 20 years*





*A powerful US coal lobby: this winding wheel controlled cages to take men to and from the bottom of the mine*

they lease out to investors. There is an assumption underlying these rents that there exists a scarcity of land, but there is no such assumption for the natural resources that are obtained from this land. The US government tendered attractive mineral rights for coal at the end of the 19th century when the government feared a shortage of coal. This shortage of coal would have raised the prices and demand would have adjusted itself accordingly, yet with this new subsidy investors produced coal at below the natural rates. This system stayed in place even after there was clearly no shortage of coal prompted by the strong lobbying arm of the US coal sector<sup>1</sup>.

Subsidies underpin the global energy markets but certainly do not form a stable system. In principal, when demand for resource stock increases, the price for a stock will decrease. This decreasing price will allow more people to access the stock, and hence the

availability of a stock should decrease. A decreased stock will increase prices and demand for the resource should in turn decrease. This is where governments typically subsidise either upstream technologies or downstream costs to consumers, creating an unstable system where prices are kept artificially cheap, and as a result, overall energy consumption increases dramatically. This over-consumption has arguably led to three of the main strategic risks faced by our planet: resource depletion, energy security and climate change.

### *Cities of the developed world consume resources daily far beyond indigenous supply levels*

**1. Resource Depletion:** There is currently great debate surrounding the amount of proved reserves of natural resources, and also the sum of the total resource base. Regardless of who you believe, societies are using more resources and at an enormous rate, greater than at any point in human history. Whilst resources such as coal and natural gas may not run-out any time soon, there are very disconcerting trends for both oil<sup>2</sup> and water<sup>3</sup>.

<sup>1</sup> Victor D. (2009). The Politics of Fossil-Fuel Subsidies. *Global Subsidies Initiative*.

<sup>2</sup> Farrell A. E. et al. (2006). Risks of the oil transition. *Environmental Research Letters*.



**2. Energy Insecurity:** Sovereign nations are becoming increasingly concerned about their strategic energy supply lines. In particular, cities of the developed world consume resources daily far beyond indignant supply levels. As China and India rise, pressure on energy supply is set to continue a steep upward trend.

**3. Climate Change:** The earth is currently experiencing an increase in global average temperature due to an overabundance of greenhouse gases (GHG) in the atmosphere, which absorb outgoing infrared radiation from the earth and radiate this heat back in all directions in the area surrounding the gas particles. The science is not settled but there are established components that have led to the robust conclusion that human are causing a rapid warming of the troposphere, which is leading to many potentially dangerous feedback processes.

### Negative Externalities

Another innate flaw of energy markets is that of negative externalities. These occur when costs of a negative side effect are not shouldered by any of the parties directly involved in the process of creating those side effects. This usually causes overproduction and overconsumption, as the perpetrators do not have to pay for the indirect consequences of their actions<sup>4</sup>. For example, a coal power plant releases huge amounts of CO<sub>2</sub>, as well as sulphur dioxide, SO<sub>2</sub>, which contribute to climate change and acid rain respectively. Yet the release of such gases has a large environmental cost that is not borne by the producer of energy, and is not paid for by the consumer. That is to say, while energy has a certain price to it, this price does not include the cost to the environment, or the cost of measures it would take to clean up the environment. Thus negative externalities further contribute to energy prices being far lower than the 'true cost'.

Only recently have there been widespread efforts made to 'internalise' such externalities within the price of the good or service, as via government legislation – e.g. a carbon tax on some goods – or through voluntary

options, such as paying to offset one's carbon emissions for a flight.

### Distortion

For any kind of market, free or centrally planned, ideally a state should provide appropriate legislation to tackle harmful distortions. A number of solutions to market distortions have been offered by a variety of authors and institutions and are focused on the provision of another subsidy or tax (such as the Clean Development Mechanism, Cap and Trade regulations or a Carbon Tax). These regulatory instruments have seen varying results where they have been implemented so far but are generally based on the assumption that embedded subsidies for fossil fuels remain.

A nation has multiple further options to tackle this issue. For example, a government could slowly phase out subsidies for the suppliers of energy; thereby putting pressure on suppliers and consumers alike to become more efficient and thus less wasteful of energy; or it could issue emission quotas or special taxes to reduce the net production of energy. Solutions must be tailored to each sector, as different stakeholders are involved, yet it is certainly possible that subsidies can be phased out, and externalities internalised within an appropriate time frame.

In summary, while some subsidies may be justified – such as providing electricity to satisfy the basic needs of developing nations or to aid the development of expensive new green technologies – in every case subsidies represent a distortion of a free market. The majority of subsidies, particularly in the developed world, tend to lead to excessive and sometimes wasteful usage of energy. Subsidies that may have been well justified in the past are still in place many decades later. Although there are many other factors contributing to climate change and the waste of resources, the issue of underpriced energy and its subsequent over-use are key challenges that need to be addressed.

<sup>3</sup> McKinsey & Company (2009). Charting Our Water Future: Economic frameworks to inform decision-making.

<sup>4</sup> Harris R. G. et al. (1983). Public Regulation of Marketing Activity: Part I, Institutional Typologies of Market Failure. *Journal of Macromarketing*.



# Can Global Wealth Lead To Global Health?

*Prof Albert Lee* is Professor of Public Health and Primary Care at The Chinese University of Hong Kong, Adjunct Professor of Applied Health Science at Indiana University, US, and Visiting Professor of International Health Development at Brighton University, UK. He is WHO Temporary Advisor on Healthy Cities, School Health and Health Promotion.

**G**lobal Health or International Health has become a trendy term and many academic centres have evolved around this 'Global' theme. Is it the emergence of new infectious diseases such as SARS, or the re-emergence of old infectious diseases such as Avian Flu (H5N1) and Swine Flu (H1N1) that drives this global action on health? Should global health focus on the provision of medical aid to low-income countries? And finally, is the training of health care workers in low-income countries a priority area, as it helps to build the capacity of health care systems to respond to various health challenges more effectively and efficiently?

There is no doubt that such initiatives are essential components of global health, and in fact, they have been ongoing for decades with support for developing countries coming from developed countries. However, we still witness major disparities in health standards across the continents. More worryingly, developing countries of either high or low mortality rates nonetheless show the 'double health burden' of traditional and modern health risks<sup>1</sup>. The latter set of health risks manifest themselves in diseases including hypertension, high cholesterol, obesity, and problems arising from alcohol and tobacco; the former burden covers traditional risks such as malnutrition, iron deficiency, unsafe water and poor sanitation and hygiene conditions.

There is a tendency for people to think that economic growth alone would result in an improvement in health standards, and that a global health strategy should emphasize economic development leading to rapid urbanisation. Yet does global wealth really lead to better global health? Although countries with high economic growth have shown improvement of health in terms of infant mortality, maternal mortality and longevity, a rapid rise of non-communicable diseases – such as hypertension and diabetes – has been observed in these countries. A review of countries/regions with rapid urbanisation and economic development such as mainland China and Taiwan shows that the prevalence of chronic illnesses is rising at an alarming rate.

## Closely Packed Spaces

We have witnessed tremendous growth of the global economy since World War II, but a parallel improvement of global health was not observed. For example, the detrimental effects of urbanisation on health have been underestimated. Without doubt, urbanisation creates opportunities for better housing and living conditions, access to safe water and good sanitation, more employment opportunities, access to health and community service and recreational facilities. However, unplanned and uncontrolled urbanisation can strain health services, damage the environment and exacerbate poverty and inequality.

## Outbreak

A recent WHO report in 2009 entitled 'City and Public Health Crisis' points out that urbanisation would enhance the spread of disease in today's world. In a city

an outbreak could soon become an epidemic, and with better road, rail and air links to other cities, such an epidemic would soon become a pandemic. In high-rise buildings with multiple apartments and with floor levels linked by elevators, infections are likely to spread faster than down a residential street with a row of separate single-family homes. The 2003 outbreak of SARS in Hong Kong is a striking example, where within just two months there were over 1,800 patients across a dozen countries in Asia, Europe and North America. A similar example was the H1N1 virus, where the first case identified on 23 April 2009 in Mexico spread very quickly to many cities in USA. Within nine weeks, all six WHO regions of the world were affected. It is now impossible to say that any particular part of a city is safe. As such, the inherent nature of a city makes it susceptible to epidemics.

There is less emphasis on the impact of globalization on non-communicable diseases and mental health in low-income countries. Most vulnerable individuals with mental disorders are poor and living with disabling conditions. Rapid economic growth and urbanisation, changes of family structure, loss of neighbourhood relationships, and lack of time for communication and interpersonal interactions exposes vulnerable individuals to mental distress. This effectively reduces the size of the productive workforce, an issue to be tackled by the WHO Mental Health Global Action Program.

There is also a tendency to over-emphasize the importance of subsidized or free health care services for low-income countries as a key strategy in the resolution of

## *The detrimental effects of urbanisation on health have been underestimated*

health issues – ignoring the local culture and social context, the inequitable distribution of health, as well as the system of governance. In an editorial in the British Medical Journal, the then Editor, Dr. Richard Smith, pointed out that global public health should reorientate services, strengthening public health within both developed and developing societies as a joint endeavour, and advocated a resilient system of global governance for health.

The protection and improvement of global health requires prioritizing health across all public policy agendas, along with developing a system of governance for putting such policies into practice. The European Commission has stated three core objectives for promotion of healthier and safer citizens, and these objectives could serve as the framework for an effective global health policy<sup>2</sup>:

- To protect citizens from risks and threats that are beyond the control of individual and cannot be effectively tackled alone, e.g. unsafe commercial practice, unsafe products.
- To enhance the ability of citizens to take better decisions about their health.
- To mainstream health and consumer policy objectives across all policies putting health on the agenda.

### **Health Promoting Setting**

Global health needs investment in social systems, particularly for vulnerable groups within a society. It should move away from investing predominately in health care systems alone, to investment in health generally. The concept of 'Health Promoting Setting' has emerged as

*Shanghai, the most populous city in China, was threatened by the 2003 SARS outbreak*



an effective public health intervention for global health strategy. The promotion of health is organised around settings such as schools, communities and workplaces, which provide the 'social structures' to reach the defined population in the context of their daily lives<sup>3</sup>. Thus, the Health Promoting Setting approach is an ecological model of health improvement, in which health is determined by a complex interaction of environmental, organisational, and personal factors. It has become a global movement for health improvement and the International Union for Health Promotion and Education has established a Global Working Group in this field. This approach would facilitate healthy urbanisation as a process of conscious and judicious coordination of urban management practices, so that it can produce health benefits, strengthen social solidarity, and ensure efficient and sustainable ways of meeting basic needs of community life.

Targeting schools as a Health Promoting Setting has been shown to be particularly effective in reducing behaviours leading to health risks. One recent study in Hong Kong used the model of a 'Healthy School' for the prevention of childhood obesity with an integrated approach. This entailed a comprehensive needs assessment, improved school eating policies and eating environment, training of teachers, parents and student ambassadors, the increased involvement of family and community with school, along with a comprehensive nutrition education programme and the active participation of students. The data analysis of students' questionnaires showed a statistically significant improvement in nutrition knowledge – 58.7% students received a pass at baseline vs 73% at the post assessment. Longitudinal comparison showed significantly higher proportions of students reported that they were consuming adequate amount of fruits (18.4% vs 23.1%) and vegetables (24% vs 34.6%). The weighed lunch surveillance showed an overall significant increase of 63.3% in vegetable consumption at lunchtime by the students. The consumption of high fat and high sugar snacks by the students at the longitudinal comparison was reduced, and significant improvements of parents' knowledge and consumption of fruits and vegetables were also observed. Developing countries also use schools as a setting for health promotion. For example, in Laos schools work with the local religious leader, the local education authority and local nurses to implement

*An outbreak could soon become an epidemic, and such an epidemic would soon become a pandemic*

healthy school initiatives for health improvement of students such as mental health and helminthes control.

A sustained combination of visionary leadership and governance at the municipal level, strong inter-sectoral cooperation at the programmatic level, and active community participation is needed to achieve a healthy form of urbanisation. A society must ensure the value of health, and keep it high on the global political agenda.

### **Collective Action**

Global health needs a strong global response and international collective action. During the Mayors' Summit of 4th Global Conference of Alliance of Healthy Cities in October 2010 in Gangnam-su, Seoul, Korea, the Gangnam Declaration of Health City reaffirmed the commitment of leaders of cities, towns, communities, non-government organizations, private sectors and academia to the development of 'Healthy Cities' so as to address the social determinants of health and reduction of health inequity. This also empowers people's capacity in personal health improvement, and enhances health care services – particularly preventive services to vulnerable population groups.

The term wealth refers to not just economic capital, but also includes three other forms of capital: social, natural and human capital. This is why an improved global economic situation would not solve the major problems facing health issues alone. Global health initiatives need to invest in improving health through Setting Approaches where people live, study, work and play. A comprehensive range of sectors within society is involved, rather than sole reliance on health care systems. Thus, global health can truly lead to global wealth only if we recognise the importance of contributions from non-health sectors to population health, and don't rely solely on the WHO as the only international organization for the promotion of global health. This will lead to the creation of a healthy community with high levels of social, ecological, human and economic 'capital', a combination of which may be regarded as 'community capital' bringing wealth to the society.

- 1 WHO (2002). Health Report: Reducing risks and promoting healthy life.
- 2 Kickbusch I. (2005). The Health society: Importance of the new policy proposal by the EU Commission on Health and Consumer Affairs. *Health Promotion International*.
- 3 Green L.W. et al. (2000). The Settings Approach to Health Promotion. *Setting for Health Promotion: Linking Theory and Practice*.

# Reframing Support For Development

*Matti Navellou* is the UK Activation Coordinator for The Global Poverty Project – an educational organisation seeking to invigorate the global movement against extreme poverty by increasing the number and effectiveness of people taking action.

**E**xtrême poverty isn't a sexy subject. But it is one that affects 1.4 billion people today. The fact that 1.4 billion individuals, sharing our common humanity, with the same capacity as us to feel pain, hunger, love, and with the same aspirations and potential for greatness, currently live on less than \$1.25 a day and lack access to basic opportunities such as clean water, health-care, education and food can seem overwhelmingly disheartening.

Seeing starving kids on TV adverts is depressing. It's enough to make us want to switch off. It seems like nothing has changed since the days of Live Aid back in the early 1980s. But what if you knew that extreme poverty has halved since then, and that we could eradicate extreme poverty within a generation?

Six years ago, 16 million people signed on to MAKE-POVERTYHISTORY getting behind the vision that seeing an end to extreme poverty was achievable. Yet, since then, momentum has stalled. People today feel powerless. They ask, "What has really changed since then? How can I make a difference?" They feel powerless because they don't know what happened next. They don't know what happened after their white arm-bands faded to yellow, and the Live8 concert tents had been packed up. This is the story of what can happen next and what we can do to move our understanding beyond starving children and sell-out concerts.

## *Guilt-inducing images of starving kids undermine longer-term support*

### What Happened Next

In early 2010, leaders from NGOs and charities working on poverty in the UK were drawn together to talk about building support for development – to try and bridge the gap between public sympathy and effective public action in relation to extreme poverty, and ask why, out of the 16 million who'd signed up to MAKE-POVERTYHISTORY, only a small percentage were still actively involved in trying to put an end to poverty.

Research conducted by the Development Education Association (DEA) shows that real understanding of global poverty in the UK is very limited. Perceptions of aid and charity are dominated by the 'Live Aid Legacy' which perpetuates a patronising, almost colonial vision of magnanimous Western powers handing out aid to grateful developing countries. We desperately need to move beyond this, to an understanding of development which addresses and appreciates its complexity, and is based on a vision of a common humanity and interdependence.

Vicky, one of our supporters, managed to capture the public's frustration with these issues when she said: "I'd love to help, but I'm confronted by the same images of starving children every year and am fed up of feeling guilty. I have no idea where my donations have gone or what progress has been made in this area. Why should I keep giving if it seems like nothing has changed? I just don't feel like there is anything practical I can do to help."



Vicky's response highlights a number of issues: a lack of access to information on progress that has been made in international development; fatigue and apathy at the use of images of victimization by charities to elicit feelings of guilt for the purpose of increasing donations; and, finally, frustration about the little information available regarding what people can do to help beyond giving money.

Surely this points to a flagrant gap in the NGO sector in the UK? Why does the public not have access to this information? How can they turn existing sympathy into action when there is no increase in educational awareness of these issues?

### Why the Guilt?

DFID have run public attitude surveys for over a decade and a recent report, *Public Attitudes Towards Development*, shows that the percentage of individuals that are very concerned about extreme poverty is currently at 21%, the lowest since 1999, after which levels of engagement have either been static or falling.

Falling support has led to a fundraising paradox for charities. Donations during the recession have fallen for some charities by up to fifteen percent, leading to intense pressure on fundraising departments to meet targets. Yet guilt-inducing images of starving kids, although a great fundraiser, undermine longer-term support and perpetuate a perverse and restrictive representation of

aid. 'Charity fatigue' inevitably creeps in – these images become trapped in a frame of "aid" in the public mind, where aid becomes permanently linked with donations and guilt.

According to a recent paper by Bond, the UK membership organization for NGOs working in international development, most people interpret 'aid' as 'donations to charities in response to disasters' severely undermining the complex and multi-faceted nature of aid work. This points to an urgent need to shift the public understanding of 'aid' to something that includes an understanding of the progress that has been made in reaching aid targets.

### Where are the Success Stories?

The irony of this situation is that great progress has been made in reducing extreme poverty and in reaching the Millennium Development Goal targets agreed upon in 2000. NGOs know that, for example, aid invested in educating women, infrastructure, microloans, free trade and export oriented growth work in helping reach these targets.

We know that maternal deaths through childbirth have decreased by about 35% since 1980. We know that whereas in 1982, 52% of the world's population was living in extreme poverty, that figure is down to 25% today. Yet, instead of being aware of this positive change, the general public hears about corruption, insurmountable natural disasters and the ongoing spread of HIV.

*Moving towards positive images of success stories in combating poverty: a local tailor in Ghana*





What we don't hear about are the success stories. We don't hear the fact that something as simple as building toilets for girls in schools in Western Tanzania can increase female attendance by 30%. That Rwanda, one of the world's poorest countries, has had national health insurance for 11 years now, covering 92 percent of the nation at premiums of \$2 a year enabling life expectancy to rise from 48 to 52 in spite of the ongoing spread of AIDS. That over the last 50 years South Korea has transformed from an aid recipient country to a bustling aid donor due to investment in education and infrastructure. That extreme poverty has dropped from 49% to 30% in Ghana thanks to policies implemented in 1992 that promoted economic growth and poverty alleviation through investment in infrastructure.

Around the world, during the past 50 years, we have seen a clear pattern of falling infant mortality, rising literacy, rising incomes, rising life expectancy and a falling number of people living in extreme poverty. These are the stories that should be at the forefront of public awareness.

#### **What is the GPP Doing to Challenge This?**

For the last year, the Global Poverty Project (GPP), in partnership with other UK NGOs, has been raising awareness of these issues, trying to shift British public attitudes towards development into a positive belief that practical actions can be taken by each and every one of us in our daily lives to contribute to putting an end to extreme poverty.

We have been travelling across the UK delivering an awareness-raising presentation called 1.4 Billion Reasons, named after the 1.4 billion people currently living on less than \$1.25 a day. 1.4 Billion Reasons takes people through the issues surrounding extreme poverty, answering people's questions on corruption, aid efficacy, trade barriers and the Millennium Development Goals. It gives people hope about what can be done: hope that is supported by facts on progress already made in the fight against extreme poverty.

We believe that education on issues of poverty and positive communication around the progress that has been made in poverty-reduction can kick-start deeper reflection and action on these issues. There are evidently still important challenges and barriers to be overcome in this fight but we can change attitudes by informing people

about what is achievable and the progress that is being made. Earlier this year, we got a call from Nestle because two children, no older than 12, had independently decided to write to the company, after seeing 1.4 Billion Reasons at their school, to ask what the company were doing to ensure their supply chains were ethical. This is progress.

No action towards ending extreme poverty is too small. Small demonstrations of a change in attitudes can and will develop into something powerful, a political force that will make politicians, governments and policy-makers finally feel the weight and urgency of this movement, this wave of change is about to break.

*Rwanda has had national health insurance for 11 years now, covering 92% of the nation at premiums of \$2 a year enabling life expectancy to rise from 48 to 52*

As this wave travels, carrying ever more people in its path, we move closer to ending extreme poverty within a generation. This wave of change in attitudes towards poverty has already started.

It is the same wave that prompts Bill and Melinda Gates to call themselves "impatient optimists" when it comes to progress in international development, and that only a year ago, made Cadbury become Fair-trade certified.

#### **No Longer 'Their' Problem - It Is Our Problem**

In the words of TV presenter Denise Robertson, at one of our presentations: "Technological advance has made it impossible to stay, eyes shut, in our own little world ... We can see what is happening to our fellow human beings. Global poverty is no longer 'their' problem. It is our problem." Denise's words bring us back to the notion of a shared humanity. Irrespective of where we live, the clothes on our backs, the cash in our pockets or food in our bellies, we all share one thing: the ability to feel hope and pain, to love and to laugh.

Through small steps each and every one of us can make the vision of a world without extreme poverty within a generation a reality. In a time of lack of trust in governments, why not place trust in ourselves to make the right ethical choices, and use our own voices to change policy. Let's reach a stage where politicians may not be elected without a clear, cohesive national plan for tackling extreme poverty. It may seem like we are a long way off, but given the passion and dedication we've witnessed on these issues, we may just be on the right track.

# Tackling Malnutrition: The First 1,000 Days

## A Critical Window of Opportunity for Action

*Tanya Green* works for the Human Development Department, UK Department for International Development (DFID).

**T**he first of the UN Millennium Development Goals is to eradicate extreme hunger and poverty. A third of all children under the age of 5 worldwide (195 million) are chronically malnourished<sup>1</sup> and 80% of these children live in just 24 countries, mostly in South Asia and sub-Saharan Africa.

The effect of chronic malnutrition is stunted growth. The immediate causes of malnutrition are inadequate diet and disease, but the underlying long-term causes are complex and multifaceted: relating to poverty, inequality, health and sanitation, socio-cultural, political and economic factors.

Malnutrition damages cognitive and physical development and weakens the immune system, leading to greater susceptibility to disease. In a series on nutrition, the Lancet<sup>2</sup> undertook a review of the evidence of the impact of malnutrition and found that if not tackled within the first 24 months of a child's life, the condition leads to irreversible damage – affecting educational achievements, future earnings and overall

life chances. Therefore, the time from conception to a child's second birthday provides a critical window of opportunity to improve the nutritional status of children.

The UK Government focuses on tackling malnutrition in children and pregnant women from conception to a child's second birthday. Firstly, we recognise the need to tackle the immediate causes of poor diet and disease via direct nutrition interventions; for example vitamin A and mineral supplementation, which, if scaled up, could reduce chronic malnutrition by one-third. Secondly, we also need to tackle the other two-thirds of the problem by programmes in agriculture, social protection (e.g. cash transfers), water, and sanitation to deliver greater nutritional impacts.

We also want to mobilise the international community to work together more effectively to tackle malnutrition. We are currently reviewing all of our aid programmes, and the scale of our plans on nutrition will be announced next year. Crucially, we are also investing in research so that we will have a better understanding about what measures work; particularly about how indirect nutrition interventions work.

Direct Nutrition Interventions	Indirect Nutrition Interventions
<ul style="list-style-type: none"> <li>• Promotion of breastfeeding</li> <li>• Use of zinc in management of diarrhoea</li> <li>• Vitamin A fortification</li> <li>• Universal salt iodisation</li> <li>• Iron fortification</li> <li>• Hygiene promotion</li> <li>• Treatment of severe acute malnutrition</li> </ul>	<ul style="list-style-type: none"> <li>• Road programmes linking marginalised communities to health services and markets with cheaper food</li> <li>• Public works programmes to provide a living wage</li> <li>• Investment in livestock to enable families to start small businesses, to provide milk for young children or money to buy a quality diet</li> <li>• Water and sanitation programmes to prevent diarrhoea and other infections which exacerbate malnutrition</li> </ul>

### Growing International Momentum: Was 2010 the Tipping Point?

Over the last two years, after the Lancet series and the 2007-2008 food-price crisis, there has been growing momentum for co-ordinated international action. There is now broad international consensus about what needs to be done to accelerate the scaling up of nutrition programmes in countries with high levels of malnutrition. 2010 has seen the launch of a global initiative: Scaling Up Nutrition (SUN) to expand programmes in countries in a coordinated way. A SUN “Framework for Action and Roadmap” was developed by a collection of agencies led by the UN Special Representative on Food Security and Nutrition, and endorsed by more than 100 organisations and institutions from governments, UN agencies, academia, private sector, NGOs and civil society groups.

At the UN Millennium Development Goal Summit in September, major international figures such as Hillary Clinton, the US Secretary of State, Micheál Martin, the Minister for Foreign Affairs of Ireland and Andrew Mitchell, the UK Secretary of State for International Development, along with others gave the issue of nutrition more prominence than it has been given before; all supported the SUN Roadmap launched by the UN Secretary-General Ban Ki-moon. Hillary Clinton launched a campaign called a “1000 days” to focus international attention on this critical window of opportunity in which to have an impact on children’s nutritional health. Seven international donors: Canada, France, Ireland, the Bill and Melinda Gates Foundation, UK, US and the World Bank, committed to work together effectively and to support countries to scale up nutrition. So far Bangladesh, Nepal, Ghana, Malawi and Uganda have come forward to scale up and we hope more countries will follow soon.

### The Year Ahead

The next nine months will be crucial to continue to build on the momentum and to start delivering results. What is clear is that tackling malnutrition in the first 1000 days from conception to a child’s second birthday is central to the UK’s approach, and it is shared by a coalition of other organisations working towards achieving the first Millennium Development Goal.



*Rosani (left) is 16cm shorter than Sonam (right) – The chance of Rosani being naturally this height is less than 3 in 100*

### About DFID

The Department for International Development (DFID) was set up in 1997 making fighting world poverty its top priority. It marked a turning point for Britain’s aid programme, which until then had mainly involved economic development.

Today, DFID works to combat extreme poverty, working with governments of developing countries as well as charities, businesses and international bodies, including the World Bank, UN agencies and the European Commission.

Among its key objectives, DFID set out to make global development a national priority and promote it to audiences in the UK and overseas, while fostering a new ‘aid relationship’ with governments of developing countries.

In 2008/09 DFID provided £5.5 billion of aid to poorer countries, increasing to £7.8 billion by 2010/11. By 2013, the equivalent of 0.7% of the UK’s gross national income will be dedicated to development assistance.

<sup>1</sup> Malnutrition covers over- and under-nutrition, but in this article we refer only to undernutrition

<sup>2</sup> The Lancet (2008). The Lancet’s Series on Maternal and Child Undernutrition (data from 2005).

# The End Of The Line For Affordable HIV Drugs?

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India has been dubbed ‘the pharmacy of the developing world’ because of measures that prevent patenting and promote competition between generic drug producers, resulting in affordable drug prices for the developing world.

However, India’s ability to produce these affordable medicines is in jeopardy. A new trade agreement between the EU and India may lead to stringent patent laws, resulting in a serious threat to the lives of hundreds of thousands of HIV patients in the developing world.

Just like any other commercially available product, pharmaceuticals are subject to intellectual property rights (IPRs) that grant patent-holders the exclusive right to commercially exploit the product under consideration during a defined period of time. They can fight patent infringement (production, import/export and use of the product) through legal means.

While IPRs are necessary to sustain incentive for further pharmaceutical innovation they also reduce the affordability of drugs and can form a barrier to improving health in developing countries. Due to the weakness or complete absence of public health systems in many developing countries, patients are often obliged to pay the full price for their medications. Yet for these people, paying the market price is often not an option and generic

medicines may be their only treatment choice. The central case for restricting their access to medicine is the argument that a particular drug is the property of the pharmaceutical company that developed it.

As one of the world’s fastest growing economies, India is often referred to as an Innovative Developing Country (IDC); a term also applied to countries such as Brazil and Russia that are deemed ‘technologically proficient’. Nevertheless, the protection of IRPs in India and other IDCs has been questioned in recent years. In the past, the Western world has criticized India’s ‘sub-standard’ patent laws, stating that India is ‘unfriendly to business’. Meanwhile, India has also been dubbed ‘the pharmacy of the developing world’ because of measures that prevent patenting and promote competition between generic drug producers, resulting in affordable drug prices for the developing world. However, India is in serious danger of no longer being capable of manufacturing these drugs.

The European Commission (EC) is currently negotiating a number of bilateral trade agreements between the European Union (EU) and various countries in Asia and Latin America as part of the ‘Global Europe’ strategy. These agreements aim to improve the trade of various different products between countries. One particular agreement, the EU-India Free Trade Agreement (FTA), is currently being finalized and will allow a jump in bilateral trade from \$90 billion to \$130 billion. With negotiations ongoing since 2007, the EU announced in December 2010

*India has been dubbed ‘the pharmacy of the developing world’*

that the agreement would go ahead in 2011 despite serious concerns regarding its affect on access of essential medicine by developing countries.

The EU-India FTA may lead to stringent patent laws, resulting in a serious threat to the lives of hundreds of thousands of HIV patients in the developing world. For example, Médecins Sans Frontières (MSF) buys 80% of their HIV antiretroviral medications (ARVs) from India for treatment programs that allow people infected with HIV to live normal lives, care for their children, contribute to the economy and live to an old age.

### Molecules and Money

Modern drug development starts from high-throughput screening of a diverse range of chemicals, mostly chemicals present in natural products, to find compounds that can effectively inhibit the disease concerned at the molecular level. The molecule is then modified chemically to become a more biologically potent compound. After that, this 'lead' is subjected to animal testing to test the effect of the potential drug candidate *in vivo* and will then go through three phases of subsequently larger clinical trials in humans prior to regulatory approval of the product.

From the pharmaceutical industry's perspective, there is a substantial cost involved in developing a product with

the total expenditure on research and development (R&D) reaching \$95.2 Billion in 2009. Ultimately very few molecules reach the market, and hence the R&D cost per successful molecule is extremely high. Also, while the market for branded drugs in the poorest economies such as Chad or the Central African Republic may be tiny, many emerging markets such as China or India have rapidly growing middle classes that offer substantial profits to the industry.

### Patenting Power

ARV drugs are usually patent-protected. Originally, these patents can only be applied within a country where the patent is registered, not internationally. However, members of the World Trade Organization (WTO) are required to adhere to certain multilateral trade agreements, such as the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement, which was signed in 1995 and governs patent law across the globe. It was the first consensus statement of its kind that concerned IPR Law, and is still probably the most comprehensive document in the international trading system today that relates to IPR.

Under TRIPS, patents for any new, useful and non-obvious product, including essential medications such as ARVs, are protected for at least 20 years in all WTO member states after registration. Exact meanings of whether an

*Patenting power: the EU-India FTA is likely to inhibit generic drug production in India*





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invention is 'new', 'useful', and 'non-obvious' are not explained with precision in TRIPS. Instead, those criteria are subjected to the interpretation of individual countries.

After TRIPS was signed, countries were allowed to override patents in times of national emergency, and for public non-commercial use. This is achieved through compulsory licensing, which is granted by the government of the country in question that allows the manufacture, sale or use patented technology in the jurisdiction of that country.

### **Doha: Supporting the Right to Public Health**

The flexibilities inherent in TRIPS could have had a huge impact on public health, but were rarely used during the first few years after it was adopted because countries feared it would negatively impact on their trade with other countries. This called for the flexibilities to be formalised, which was achieved with the signing of the Doha Declaration in 2001. The Doha Declaration states that TRIPS should be treated in a way that was 'supportive of WTO members' right to public health and, in particular, to promote access to medicines for all'.

It was widely believed that the signing of the Doha Declaration would put an end to the battle for affordable medicines in developing countries. It allowed IDCs, which already had domestic pharmaceutical manufacturing industries, to proceed with the production of generic drugs.

Unfortunately the Doha Declaration had little impact on drug production in less economically developed countries that need essential medications, largely because they lack a domestic pharmaceutical manufacturing industry and hence rely on generic drugs manufactured in countries like India. Dependent on the importation of generic medicine from IDCs, they couldn't benefit from the Doha Declaration and had no control of the patents governing the manufacture of their drugs.

This problem was further compounded by the fact that countries with more advanced drug manufacturing capabilities were able to exert compulsory licenses only in times of national, not international, emergency. The WTO hoped to solve this problem with the August 30 2003 Decision, which allows manufacturing countries to

issue compulsory licenses to export drugs to countries that are unable to produce them, even if the drug remains patent-protected for use in the country where they are produced.

### **Drug Seizures**

The problems faced by Indian generic producers continue even after they obtain permission under Indian Law to manufacture a drug. Exporting drugs to locations like sub-Saharan Africa and Latin America is highly complex. Since 2008, there have been various seizures of generic drugs in European ports. For example, a shipment of anti-high blood pressure drugs that had been produced in India was seized in a Dutch port while en route to Brazil. Although the drug was not under patent protection in either Brazil or India, it was patent-protected in the Netherlands. A similar event occurred when a shipment of ARVs bound for Nigeria was seized in the Netherlands. The drugs were eventually sent back to India, meaning that thousands of HIV patients were forced to go without their medication. It is unsurprising that these events have frustrated aid organisations, health ministries of developing countries, generic drug producers, and above all, the patients for whom the drugs are made.

To make the matter even worse, India has strengthened its IPR legislation in the last few years. When TRIPS was signed in 1995, WTO member countries whose patent laws did not meet the TRIPS Agreement requirements were granted a ten-year adjustment period. One such country was India. As of 2005, India's laws regarding patent protection conform to TRIPS. Any drug invented prior to 1995 will remain non-patentable in India, and any company that was already legally manufacturing a drug prior to 2005 will be allowed to continue to do so. However, newer drugs, including heat-stable and second line ARVs, will likely not be available generically from India unless granted a compulsory license.

### **Keep the Drugs Flowing**

These problems look set to continue or worsen with the signing of the EU-India FTA. Médecins Sans Frontières (MSF) has highlighted two key areas of risk: data exclusivity and excessively broad enforcement measures. One of the terms of the FTA that the EC is pushing for is the introduction of a period of data exclusivity (DE) in India.

*Exact meanings of whether an invention is 'new', 'useful', and 'non-obvious' are not explained with precision in TRIPS*



Médecins Sans Frontières buys 80% of their HIV antiretroviral medications from India

In principle, if a generic manufacturer can use the data generated by the innovator, they only have to demonstrate that their drug is equivalent to the original. DE prevents government from approving the manufacture of generic drugs based on clinical trial data from the inventor and bars generic producers from accessing the original clinical trial data. Repeating clinical trials are lengthy and prohibitively expensive. It is also deemed unethical to repeat clinical trials for a drug that has already been shown to be effective because it would be necessary to withhold these drugs from control groups. Effectively this measure would delay the launch of a generic drug by up to ten years.

Furthermore, the treaty may prevent access to generic medicines during patent disputes. Presently, if an innovator challenges a generic manufacturer in court production in India continues until the dispute is resolved. Under the new terms it may need to be halted, further limiting access to essential medicines.

*Newer drugs, including heat-stable and second line ARVs, will likely not be available generically from India*

The pharmaceutical industry, as one of the most profitable industries in the world, together with governments of developed countries, needs to take responsibility for the change it is capable of making. Meanwhile, the EC must not succumb to pressure from the pharmaceutical sector and ensure that the flow of affordable medicines is not blocked while negotiating trade agreements. The EC Commissioner, Karel de Gucht, has reassured those concerned that the agreement will be worded in such a way that access to medicines is not impeded. Nevertheless, it remains to be seen how committed the EC is to ensuring this.

It is essential that generic drug production be allowed to continue in India. In addition to this, the EU-India FTA must not contain IP constraints that are more restrictive than TRIPS, and EC customs regulations must change so that seizures of generic drugs can be avoided, allowing the unrestricted delivery of life-saving medicines to the developing world.

# Thalassemia

## Pakistan's Fight to Eradicate this Condition

Zoha Shaikh studies Medicine at Imperial College London and is a member of Medsin's Global Health Forum.

**T**halassemia is a genetic disease of the blood where patients cannot make enough red blood cells and require life-long extensive treatment including regular blood transfusions. With a prevalence

of 5%, and with over 8 million carriers nationally, the burden of Thalassemia is high in Pakistan.

In a country where healthcare is a business and government hospitals are scarce, the poor often have nowhere to go. Yet changes are afoot. Public awareness campaigns to prevent the birth of babies with this disorder, coupled with aggressive genetic screening programmes, aim to tackle the spread of this disease.

Thalassemia may be characterized by the inability of the body to produce an adequate amount of haemoglobin in red blood cells. Thalassemia comes in two forms: minor and major. Whilst the first form results in mild anaemia, little treatment is needed and complications rarely arise. The latter form, however, results in severe anaemia and patients require lifelong intensive medical care. This problem occurs when two people with thalassemia have children – each child has a 25% chance of developing thalassemia major. The treatment and management of this condition is a huge financial and psychological burden on both the patient and family.

*Pre-nuptial blood screening allows potential partners to assess their chances of having a child with thalassemia.*

With over 100,000 thalassemia patients in Pakistan – with about eight million carriers – the complex and lifelong treatment for thalassemia patients presents a major healthcare challenge to this developing nation. Blood transfusion costs alone are in the region of £1000-

1500 per child per year – and that is before other medical and travel costs have been included. State of the art life-prolonging treatment is out of reach for up to 95% of patients and life expectancy can be as low as 15-20 years.

In a country like Pakistan, where children with thalassemia are refused registration in even private hospitals, prevention is a necessity.

### Prevention is Better than Cure

Prevention may take several forms:

1. Pre-nuptial blood screening allows potential partners to assess their chances of having a child with thalassemia.
2. Blood tests for potential parents (already married).
3. Pre-natal blood tests during weeks 18-20 of pregnancy.

In countries ranging from Iran and Saudi Arabia to Cyprus, pre-nuptial screening for certain diseases is compulsory and mandated by religious authorities. The success of prevention in these countries is evident. In Iran, a national thalassemia-screening programme led to a drop in new cases from 1200 to just 70 over a 5-year period<sup>1</sup>. Furthermore, they estimated that the ratio of cost of

<sup>1</sup> Samavat A. et al. (2004). Iranian national thalassaemia screening programme. *British Medical Journal*.

treatment to prevention of thalassemia is 10:1 – that is, the cost of treatment is 10 times the cost of prevention.

In the UK, there is an emphasis on educating people through the media, and then offering help and advice when asked. This is particularly the case with respect to genetic diseases. While the ethical implications of compulsory pre-nuptial screening programmes are likely to be questioned here, their impact in countries where they have been implemented is conclusive – they work.

The current campaign for prevention of thalassemia in Pakistan targets these areas:

- Raising awareness of the disease
- Educating the population about genetic diseases
- Stressing the importance of screening carriers
- Providing genetic counselling for carrier parents

Thalassemia Societies across the country are working on these aims. Securing support from influential individuals including doctors, politicians and businessmen has furthered their cause. However, to completely eradicate the disease and achieve results such as those seen in Iran, a coordinated government-led effort to provide a national screening and prevention programme is needed.

### The Hand that Stirs the Pot

Thalassemia was brought to the forefront of Pakistani politics when a bill was drafted in Parliament to make pre-nuptial screening compulsory. Contrary to expectations, it was patient groups who were the driving force behind political change, supported by Pakistani MNAs and doctors, as well as British MPs including Dave Anderson.

The law, which has already been implemented in several provinces, does not ban couples from getting married if they find out they are both, for example, thalassemia minor carriers; it does however, give them the advantage of knowing what the future might hold for them and any child they might have.

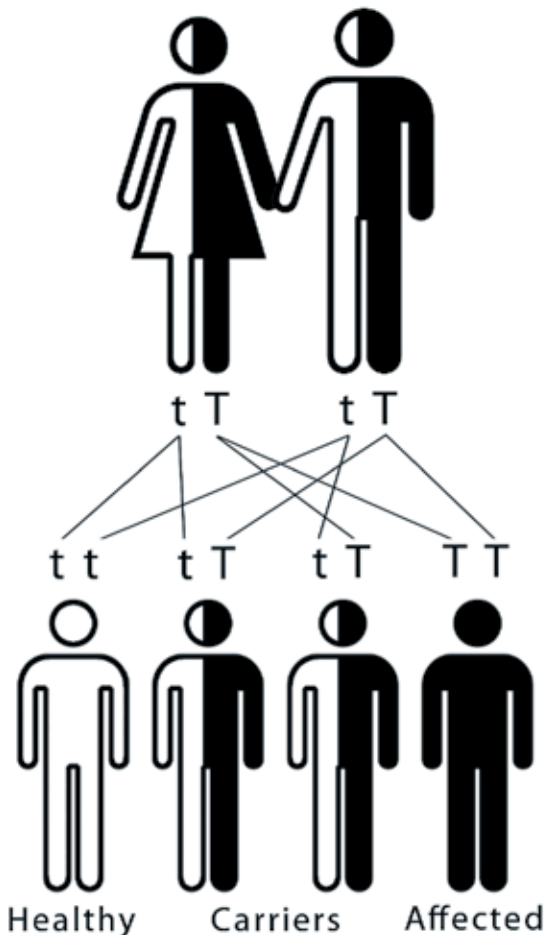
It is evident that thalassemia is a problem around the world, yet many countries have been successful in driving rates of the disease down. In the UK, adequate treatment is available to help a child with thalassemia survive; however, in a country like Pakistan which has limited resources and expensive health-care, life expectancy is very low. While improved access to treatment is needed in the short-term, radical genetic screening programmes may be the key to a long-term decline in cases.

### The Kashif Iqbal Thalassemia Care Centre

The Iqbal family suffered a hugely traumatising experience when they spent much of the 1980s and 1990s travelling the world looking for treatment for their son, Kashif Iqbal, a boy born with Thalassemia Major. Their aim now is to ensure that no other family has to go through the same ordeal.

The Kashif Iqbal Thalassemia Care Centre (KITCC) in Karachi, Pakistan provides free care for all who need it. Yet with just 1100 patients registered in a network of 20 Thalassemia societies across the country, this is but a drop in the ocean.

Donations finance the daily running of the KITCC – and your help is needed. Please visit [www.kashifiqbal.org](http://www.kashifiqbal.org) for more details.



*When two carriers of thalassemia have a child, there is a 1 in 4 chance (25%) their child will have thalassemia*

# Developing Vaccines For A Developing World

Dr Francesco Berlanda Scorza is currently completing a Marie Curie Fellowship at the Centre of Molecular Microbiology and Infection at Imperial College London. Before coming to Imperial, he worked at the Novartis Vaccine Institute for Global Health in Siena, Italy.

**S**ince vaccines arrived onto the world stage, we have been able to eliminate or reduce the effects of diseases like smallpox and polio, saving countless lives in the process and facilitating the acceleration of international development efforts. It is believed that the introduction of vaccines in developing countries will make a considerable contribution to the achievement of the Millennium Development Goals. Nevertheless, significant challenges remain in the design and implementation of vaccines for the developing world with many factors at play such as military conflict, limited healthcare infrastructure and socioeconomic issues. From the perspective of vaccine provision, the main goals are to improve vaccine coverage, efficacy and delivery.

Currently, in terms of infectious diseases, the three big killers in developing countries are known to be HIV/AIDS, Tuberculosis and Malaria. But if children below five years of age are considered, the picture changes substantially. Of the 20 countries in the world with the highest child mortality under 5 years of age, 19 are in Africa (the exception being Afghanistan). About a third of total child mortalities in Africa are due to neonatal causes (26%) with another third due to diarrheal diseases and pneumonia (together accounting for 37%). The remaining third is mostly represented by Malaria (18%) followed by all other causes, such as HIV/AIDS (6%) and Measles (5%). This area is where vaccines can have a major impact.

Despite being among the most cost-effective public health interventions, vaccines are not achieving their full potential. In developing countries, children are more likely to die from vaccine-preventable diseases than in developed countries. There are 25 million children in the world who need vaccinating against life-threatening diseases, but factors like poverty, conflict, corruption and inadequate infrastructure prevent this from happening.

Vaccines might be divided into three classes: vaccines yet to be developed (HIV/AIDS, malaria, TB and others), under-utilized (human papillomavirus, cholera, typhoid, haemophilus influenza, rubella, japanese encephalitis, Influenza, yellow fever and others) and implemented vaccines (rotavirus, pneumococcal, measles, polio, tetanus, pertussis, diphtheria and others).

A huge amount of funding has been fed into finding vaccines for the first group. A malaria vaccine is currently undergoing clinical trials yet it is unknown when, and indeed if, it will be broadly available. Promising data exists also for HIV and TB vaccines, although they are far from the production line. However, much success has been seen from campaigns to develop and distribute vaccines for the latter group.

## Quite Simply, It Works

One example is the Rotavirus vaccine introduced by the Global Alliance for Vaccines and Immunisation (GAVI), a

*'Big pharma' have been shown to be adept at helping societies in need, particularly when they get credit for it*



non-profit organisation that supplies the poorest countries of the world with vaccines. Rotavirus is one of the most common causes of diarrheal disease and accounts for 500,000 paediatric deaths each year worldwide. GAVI support for the rotavirus vaccine became available in 2007. In January 2009, four countries - Bolivia, Guyana, Honduras, Nicaragua - were approved for GAVI funding, which led to a surge in vaccinations against the virus in those countries. This was soon followed by a fall in the number of mortalities caused by the virus.

Polio is another disease often referred to in the context of successful vaccination programmes. The disease is now endemic at an all-time low in four countries - Nigeria, India, Pakistan and Afghanistan - and we are now in the so-called 'final mile' for eradicating this disease globally, a target achieved before only by the eradication of smallpox. This is the result of the efforts of organizations such as the Rotary Foundation and the Bill and Melinda Gates foundation.

This mass immunisation campaign required a considerable amount of investment and aid, including the participation of over 20 million volunteers. Nevertheless, efforts are often hindered by prevailing political climates. One such instance of this is the Democratic Republic of Congo (DRC). In late 2010, the UN called for a ceasefire in DRC in response to a sudden rise in polio cases so that vaccinations could be carried out without the further risk of loss of lives. This is just one of many complications faced by vaccine programmes when operating in troubled regions.

### Joining Forces

As with any development programme operating in low-income countries, finance is a central issue. The main actors in financing vaccine development and distribution are global health partnerships between the private and public sectors, known as 'Public-Private Partnerships' (PPPs). PPPs represent the best hope for long-term solutions concerning public health in developing countries.

One such PPP is between the Bill and Melinda Gates Foundation and GAVI. The Gates foundation announced at the 2010 World economic forum a funding of \$10 billion over the next 10 years – after investing \$4.5 billion over the last ten years – and announced that vaccines will be their number one priority. The Foundation is a founding partner of the GAVI Alliance that, in partnership with several governments, has immunised 250 million children over the last 10 years, preventing 5 million deaths.

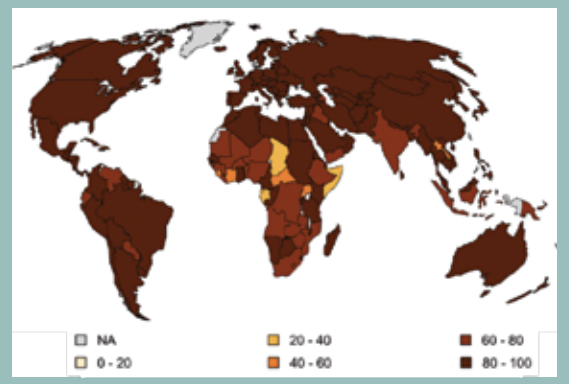
Furthermore, The Global Fund donors have committed another \$11.7 billion over the next three years. Global Fund has already provided antiretroviral treatment to 2.8 million people and TB treatment to 7 million just to name a few achievements. Other main contributors are the United Nations Foundation, the World Bank, the European Commission, humanitarian and nongovernmental organizations and corporate partners. Some donor governments, as part of the MDGs, committed to reaching the long-standing target of 0.7% of gross national income by 2015 (the European Union has recently reaffirmed its commitment to the 0.7% aid targets).

In the private sector, pharmaceutical companies are increasingly involved in aid for neglected diseases prompted by pressure to demonstrate corporate responsibility and the need to expand into developing markets. There are now many examples of support given by companies in the field of neglected diseases in terms of drug donation (with collaboration such as the Schistosomiasis Control Initiative at Imperial College), bed nets for Malaria, and vaccines.

'Big pharma' have been shown to be adept at helping societies in need, particularly when they get credit for it. On this basis, the Access to Medicine index was created with the aim of improving transparency and ranking

### The Global Polio Eradication Initiative

Polio is a severe infectious disease. There is no cure, but there are safe and effective vaccines. The Polio vaccine, given multiple times, almost always protects a child for life. The map shows the immunization coverage rate worldwide (% of target population that has been vaccinated with third dose of vaccine). Today, polio has been eliminated from most of the world and only four countries remain endemic. The aim is to completely eradicate the disease from the planet.



the world's largest pharmaceutical companies on their efforts to increase access to medicine for societies in need. Companies are assessed on the clarity and comprehensiveness of their access to medicine management systems, policies, research, pricing, distribution, donation and philanthropy. The ranking is based on 106 indicators that measure activities across four strategic and seven technical areas and results are published for the general public and for stakeholders. GSK, Merck and Novartis are at the top the list, with other large multinationals following closely behind. The goal is to improve transparency of existing efforts and stimulate future involvement by promoting sustainable support for the provision of access to medicine for developing countries.

Academic institutions also play a key role in this process, in particular in policy development, regulatory and ethics for global health. As Professor Lord Ara Darzi, Chairman of the Institute of Global Health Innovation at Imperial College, recently underlined, major advances in technologies and medicines need implementation strategies and policies to make an impact.

One recent example of that is the cholera outbreak in the post-earthquake Haiti. The risk of an epidemic was known but there was no capacity for an immunisation campaign. Although countries such as Russia offered the vaccine to Haiti, there was no ability to distribute it. In the end, most deaths were due to lack of capacity to provide simple but prompt rehydration therapies to infected children.

Two keys to success in the implementation of effective vaccine programmes in developing countries have been

identified. First is through international collaboration and partnership with companies who have expertise in vaccine manufacturing. Second is national capacity building in the country of interest. This includes local involvement of the community, development of regulatory and ethical frameworks, scientific infrastructure, clinical trials and laboratory expertise. An increasing number of examples support the feasibility of such approaches.

In 2009, Rwanda, with contributions from GAVI and UNICEF, became the first low income country in the world to integrate the pneumococcal vaccine into routine immunisation programmes. Vaccination levels have reached over 90% – a value fully comparable to developed countries – and the country is on track to reach the MDG on reducing child mortality.

**'Anyone Who Hears About Vaccines' Success History, They Want to Get Involved'**

In conclusion, medical practice has shown that vaccines work and are cost effective. While ten years ago immunization rates were decreasing, now we are again seeing a rise in immunisation and vaccine coverage. For basic vaccinations such as the DTP3 (third dose of diphtheria, tetanus, pertussis) in the poorest countries the rate of immunisation has reached 79% – the highest on record in history.

With ongoing global co-operation and sustained effort, rates of vaccine-preventable infectious diseases in developing countries have the potential to change dramatically in the near future. To quote Bill Gates: 'Anyone who hears about vaccines' success history, they want to get involved'.

*In 2010 a UN-mediated ceasefire was called in the Congo for the purpose of administering much-needed vaccinations*



# Building Toilets And Trust In El Salvador

*Francesca O'Hanlon* is a fourth year Civil and Environmental Engineering student at Imperial College London. She was joint team leader of the 2010 El Salvador Project. *Alison Ahearn* is Faculty of Engineering Tutor for Student-led Projects.

**E**l Salvador, a small but densely populated Central American country, was home to one of the most infamous civil wars in history. During the period 1980-1992 some 75,000 Salvadorians died with the war setting the development of El Salvador back 20 years. Currently, 37.2% of the population lives below the poverty line and only 59% have access to safe drinking water.

In the aftermath of the civil war, and a succession of violent earthquakes that hit El Salvador in 2001, students at the Department of Civil Engineering at Imperial College decided to team up with local NGOs to help carry out reconstruction work. In July 2010, thirteen students undertook a six-week construction project focusing on water provision and sanitation in rural San Simon, yet were challenged by unexpected hostility and mistrust from the local population. History helps explain why.

In 1970, the export of coffee contributed to 95% of El Salvador's national income. However, only 2% of the population profited from this lucrative trade. The unequal distribution of wealth led to national unrest. Violent protests became an all-too-frequent occurrence. In 1979, in response to the lack of action taken by the government to reduce the vast wealth divide, five main guerrilla groups united to form the left-wing political party FMLN.

In the midst of the Cold War, the United States, guided by its desire to combat leftist governments, came out in support of the government. Ronald Reagan, the

then-president of the United States, televised the following statement in 1984: 'San Salvador is closer to Texas, than Texas is to Washington D.C. Central America is at our doorstep and it has become a stage for bold attempts from the Soviet Union and Cuba to install communism by force throughout our hemisphere'. The Reagan administration viewed the Salvadoran military government as a potential barrier against the spread of communism. As the result, at the height of the civil war, US funding to the military government, including the infamous death squads, reached \$1.5 million a day.

The level of devastation after the civil war was unfathomable. By the end of the war over 75,000 Salvadorians had perished and the country was left to rebuild itself from \$2 billion worth of damage. However, what most shocked international audiences about this particular war was the terrifying level of human rights violations. Despite the organisation of the Commission on the Truth for El Salvador, many of the most shocking abuses in human rights remained unpunished. An incident that has been described as one of the most barbaric massacres in recent history happened in a small town in El Salvador called El Mozote. In 1981, units of the Salvadoran army, trained on US soil, raped, tortured and slaughtered more than nine hundred Salvadoran civilians, most of them children and women. Despite news reports from the New York Times revealing the massacre as early as January 1982, the Salvadoran army and government reported that no such massacre had taken place and the Reagan administration dismissed the reports as 'gross exaggerations'.



*Hard at work, the resilient students were provided with only basic tools*

It is perhaps unsurprising that social fabric of El Salvador was shattered after the war. To add oil to the fire, El Salvador is located on the western part of the Caribbean Plate where it overrides the Cocos Plate. This unfortunate geographic location means that earthquakes are a serious threat to the country as was seen in 2001 when over 100,000 homes were destroyed. Hence, post-conflict resolution and nation building have been particularly slow and difficult, hindered by the frequent earthquakes that shatter both physical and social infrastructures, and by an air of mistrust and hostility.

In July 2010, thirteen students from the Imperial College Civil Engineering department travelled to El Salvador in order to undertake a six-week construction project. The purpose of this project was to improve the quality of life in San Simon, a small rural community in the northeast corner of El Salvador through building better sanitation. The team travelled to El Salvador with a budget to construct ten composting toilets, or *aboneras*, and ten outdoor water storage units, or *pilas*.

In order to carry out this plan, the students liaised with a local NGO, REDES (Fundación Salvadoreña para la Reconstrucción y el Desarrollo). REDES was set up in 1988 to work with the urban and rural sectors for post-conflict reconstruction. REDES identified the need for improved sanitation. On their suggestion, the students interviewed over sixty families, living in extreme poverty, to discover which would benefit most from the construction of sanitation units.

### **Delicate Discussions**

The initial interview process was, unexpectedly, the most difficult aspect of the project. Everyone interviewed was in desperate need of improved sanitation; it felt unjust having to decide which families should receive the units. The process of discussing existing sanitation with locals had to be dealt with delicately. It became evident that psychologically, it was the women who were most affected by the lack of adequate sanitation. Many women were uncomfortable with admitting that they did not have an *abonera* and were often unwilling to discuss their current sanitation conditions. In contrast, men rarely seemed embarrassed about discussing sanitation.

It was decided that families with many women or young girls were more in need of *aboneras*. The hardest aspect of the interview process was that it provided false hope for the families who eventually did not receive an *abonera* or *pila*. This led to a certain level of hostility towards the project.

In the poorest communities, there is an air of mistrust towards anyone who claims to offer aid. San Simon has been continually promised an improvement in living conditions by the government for the last twenty years. Despite these assurances, very few people have received any support, and so believe that they can only rely on themselves. In addition, there is often severe degree of hostility between neighbours.



This hostility is down to two key factors. Firstly, as so many people have so little materially, self-preservation becomes a survival technique. People can barely afford basic goods for themselves let alone to share with others. Secondly, during the civil war, neighbours with conflicting views were forced to fight against each other, damaging all communal trust and respect. NGOs like REDES actively change living conditions and attitudes in El Salvador. Their mark on communities is evident, having constructed hundreds of houses within the poorest communities.

### Ferrying Blocks

Once the families who would receive sanitation units were selected, the students spent the following five weeks constructing the units. Students were provided with only basic tools such as shovels and no machinery was used. Many of the sites were located in remote areas. All materials had to be carried by hand as there was no vehicle access. One specific site consisted of two households comprising two single mothers, each with five young children. Their houses were located on a hillside, a mile from the nearest road. It was decided that they would both receive an abonerias and pila. In order

to construct two abonerias and pilas, 1500 breezeblocks are required. It took the students eight days to carry these breezeblocks to this particular site.

Despite the initial mistrust towards the project, when members of the community saw what the students were trying to achieve and saw them struggling with the construction materials, support was gradually offered. On one occasion, a group of local school children helped carry five hundred breezeblocks, and embarrassingly, were much swifter and stronger than the students!

The El Salvador project provides students with an opportunity to discover how the application of engineering can help rebuild a country, not only physically but also socially. The project will continue to run every summer. Hopefully with its growth and expansion, future teams will raise enough funds to carry out a project that allows communities to work together, such as the construction of a school. Although El Salvador has managed to start rebuilding itself slowly, nearly two decades on the emotional and financial destruction caused by the war remains devastatingly evident.



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# Home Grown School Feeding

## Smallholder Farmers Providing Local Food for Local Children

*Kristie Neeser* is a Doctoral student for the Partnership for Child Development at the School of Public Health at Imperial College London. She works with Home Grown School Feeding and school health and nutrition more broadly.

**S**ixty million children go to school hungry every day in developing countries. Children that don't eat don't learn.

School feeding programmes exist in all sub-Saharan African countries. However, whilst these programmes seek to reach and feed all children, they are often too small, unsustainable and unable to offer nutritious food.

In the same communities, smallholder farmers, often unable to reach a market, struggle to make a living selling their food. The solution is clear: local food for local children. From this, a new revolution is underway, known as 'Home Grown School Feeding' (HGSF).

As part of its role as a global leader in school health and nutrition programmes the Partnership for Child Development at Imperial College is working with governments, communities and agencies to enable effective and sustainable HGSF programmes feeding millions of children every day.

Over half of the population of sub-Saharan Africa live on less than \$1 per day. Two-thirds of the population make their living in agriculture and 70% of these smallholder farmers are women. As farmers struggle to make a living, they must contend with overused soil, small parcels of land, crop diseases and unstable markets; this means that despite their labour, millions of farmers find it hard to make a living.

Home Grown School Feeding programmes provide an opportunity to benefit both schoolchildren and small-holder farmers by creating a stable, structured market for local produce. The advantages of linking local agriculture and school feeding are substantial: more prosperous small-holder farmers, with a more secure future; stronger rural communities, with more stable economies; increased demand for local, fresh food; and healthier, happier children.

Healthy children learn better. School health and nutrition (SHN) interventions have been shown to improve not only children's health and nutrition, but also their learning potential and life choices both in the short- and long-term. As such, they are recognised as making a significant contribution towards countries' efforts to achieve Education for All (EFA) and their Millennium Development Goals (MDGs).

### Global Momentum for Linking Education, Health and Agriculture

Over the past decade, HGSF programmes in sub-Saharan Africa have been driven by national governments. In 2003, the New Partnership for Africa's Development (NEPAD) of the African Union launched a pilot HGSF and Health Programme. That same year, African governments included locally sourced school feeding programmes in NEPAD's Comprehensive Africa Agriculture Development Programme (CAADP).

In many low-income countries, school feeding programmes have also been a critical part of the response

to the global economic crisis. The World Bank and World Food Programme are already partnering with a number of countries to scale up school feeding programmes and other food-based safety net interventions, with the aim of helping countries transition to sustainable national programmes with domestic financing.

Building on this momentum and in response to requests for technical assistance, the Partnership for Child Development (PCD) has launched a new five-year initiative that is supporting government action to deliver cost effective HGSF programmes in sub-Saharan Africa.

*Children are more likely to stay in school, providing them with a healthier and better-educated future*

The initiative, supported in part by the Bill & Melinda Gates Foundation, engages with a wide range of stakeholders to provide direct, evidence-based and context-specific support and expertise to governments. This will aid in designing and managing effective school feeding programmes that are sourced with local agricultural production. Cote d'Ivoire, Ghana, Kenya, Mali, and Nigeria are already implementing programmes and the demand from other governments in Africa is growing.

#### **Country Action on HGSF in Africa**

But one HGSF size does not fit all. As country settings differ, governments are developing context specific

strategies to address the various needs and beneficiaries that have been identified. This is highlighted in the three examples below.

The HGSF programme run by the Ministry of Agriculture (MoA) in Kenya provides one example of the local food for local children concept in action. Community members are supplied with agricultural inputs such as irrigation, fertiliser, seeds and training. Local schools then purchase food from these smallholder farmers to supply the meals programme. This benefits the schoolchildren while providing a stable and predictable market for the farmers.

The national programme in Cote d'Ivoire feeds over a million schoolchildren every day and features strong links with local women's groups. Similar to the MoA programme in Kenya, groups of women farmers are provided with agricultural inputs as well as land. From their produce, one-third is kept for consumption, another third is sold on the market for income generation, and the final third is supplied to the school feeding programme.

Empowerment and skill development for women is also a key feature of the HGSF programme in Osun State, Nigeria. Over 2,600 jobs have been created for women who purchase food on the local market and then prepare meals at the schools. A community-based process

*Children that don't eat don't learn*



for hiring the cooks is also in place, whereby local community members, traditional leaders, parents and teachers are all able to participate in nomination and selection. With this decentralization, strong monitoring exists at the grassroots level – in this way, parents and children are able to provide feedback, for example they can report whether the one egg included in the menu per week has been provided. The Osun State HGSP programme has also featured strong domestic financing, with 40% of funding provided by the state government and 60% by the local government.

### **Strengthening the Evidence of the Multiple Benefits of HGSP**

Despite recent efforts, there are several important gaps in our current knowledge about the optimal implementation and measures of effectiveness of HGSP, especially given the potential multiple impacts. Many of the educational benefits of school feeding have already been established, including improved enrolment, attendance, educational achievement and cognition. However, less is known about areas such as the nutritional impact of using local foods, entrepreneurial opportunities across the supply chain and income gain for smallholder farmers. Additionally, complementary activities such as school-based de-worming and nutrition education could provide further opportunities to address common health problems of school-aged children in a comprehensive manner.

With the complex and cross-sectoral nature of HGSP, further research is needed to enable evidence-based decision-making about programme design and targeting. Building on the world-renowned research expertise of Imperial College, PCD is currently working with countries to conduct rigorous impact evaluations. These are aimed at bridging the knowledge gap on the links between school feeding and the food systems value chain

that begins with smallholder farmers.

This strengthened evidence base is feeding into the ongoing development of country technical assistance plans, which outline needs and target beneficiaries as well as provide opportunities for technical assistance activities in order to strengthen national HGSP programmes. As many countries are currently in the process of transitioning towards locally-sustainable government-funded implementation of school feeding programmes, now is the opportune time to link with smallholder farmers.

Such linkages can provide subsistence for farmers who can gain access to a stable market and provide fresh, nutritious food for local schoolchildren, improving the livelihood of the community and increasing rural prosperity.

## *Complementary activities such as school-based deworming and nutrition education could address common health problems of school-aged children.*

*Groups of women in Cote d'Ivoire are provided with agricultural inputs as well as land*



# Making An Impact: Treating & Preventing NTDs In Niger

Anna Phillips is the West Africa Programme Manager at the Schistosomiasis Control Initiative (SCI), Imperial College London.

If you haven't heard of schistosomiasis, lymphatic filariasis, onchocerciasis, soil-transmitted helminths (STH), and trachoma, you aren't alone. Most of these diseases have little recognition because they have a low case mortality rate but nevertheless they cause severe disability in the world's poorest countries. In addition, their impact is often underestimated as many of the effects, such as anaemia or diarrhoea, are attributed to other causes.

The entire population of Niger, some 15 million, are at risk of contracting one of these chronic and debilitating diseases. The Niger government launched its schistosomiasis and STH control program in 2004 with support from the Schistosomiasis Control Initiative (SCI). Between 2004 and 2010 over 13 million people have been treated against NTDs in Niger – with treatments distributed by local volunteers in what has been described as a 'people's public health revolution'.

Without treatment, neglected tropical diseases (NTDs) such as schistosomiasis, lymphatic filariasis, onchocerciasis, soil-transmitted helminths (STH), and trachoma erode the general health of a population. They cause impaired physical and cognitive development in children, hindering their ability to develop and learn. However, regular annual treatment with anti-parasitic drugs can help cure infections and alleviate these health risks.

These diseases have earned the name 'neglected' because although they weaken impoverished populations, they receive a disproportionately meagre amount of funding,

with respect to the burden of disease caused. Nevertheless, more recently their significance to public health and economies has convinced governments, donors, and the pharmaceutical industry, to invest in preventing and controlling this diverse group of diseases.

*These diseases have earned the name 'neglected' because they receive a disproportionately meagre amount of funding*

In Niger alone the entire population is at risk of contracting one of these debilitating diseases. The Niger government launched its schistosomiasis and STH control program in 2004 with the financial and technical support from the Schistosomiasis Control Initiative (SCI) at Imperial College, through the Bill and Melinda Gates Foundation (BMGF). By 2007 over 6.2 million treatments had been delivered across the 8 targeted regions. In 2007 the programme expanded to include trachoma, onchocerciasis and lymphatic filariasis, becoming an *Integrated NTD Control Programme* funded by the Niger Ministry of Health and USAID. Efforts to control Niger's high NTD burden are well underway.

## People's Public Health Revolution

Assisted by external organisations such as the SCI and USAID, and with generous donations of drugs from international pharmaceutical companies, Niger has established a program to simultaneously combat a range of NTDs and empower it's people to both educate the population about sanitation and primary

Schistosomiasis ( <i>Bilharzia</i> )	is caused by a blood-borne fluke that uses freshwater snails as an intermediate host. The disease can progress from the first symptom, blood in urine, to the life-threatening conditions such as bladder cancer. Control can be achieved by treating infected people with <i>Praziquantel</i> and providing adequate disposal of faeces and urine.
Lymphatic filariasis (LF or elephantiasis)	is one of the leading parasitic diseases causing disability in Niger. <i>Lymphatic filariasis</i> is a mosquito borne parasitic disease; the affects of this include gross enlargement of the legs and male genitalia due to the collection of fluid. Over 70% of the population of Niger is at risk of infection and so the Niger NTD Control program has made the elimination of LF a priority.
Soil transmitted helminths (STH)	are intestinal worms transmitted through contact with faeces or unclean water. STH cause anaemia, stunting, malnutrition, and intestinal obstruction. In some areas, 90% of children are infected.
Trachoma	is an infection of the eye, easily spread through direct contact with infectious discharges. Repeated occurrences scar the upper eyelid, eventually turning it inward. The eyelashes then scratch the cornea, leading to blindness. <i>Trachoma</i> can now be controlled with a strategy called <i>SAFE</i> (Surgery, Antibiotics, Facial cleanliness and Environmental improvement) that combines treatment with prevention.
Onchocerciasis ( <i>river blindness</i> )	is caused by a parasitic worm and is transmitted to humans by bites from black flies, often near water. The disease causes intense itching, disfiguring skin diseases and eye lesions that can result in blindness. Treatment includes a single, annual dose of <i>Mectizan™</i> .

*There are five neglected tropical diseases (NTDs) targeted by the integrated NTD control program in Niger*

health-care and distribute life-saving treatments on a scale never-before seen in the region. To date, nearly 40 million people have been treated for NTDs across Niger, with treatments distributed by local volunteers in what has been described as a ‘people’s public health revolution’.

Community Drug Distributors (CDDs) are selected by their respective village leaders to take on the responsibility of administering medications in the mass drug distribution in Niger. Training workshops are organised prior to the distribution after which, armed with dose-poles, the volunteers return to their villages to treat the local population en masse. The drugs are allocated based on the height of each patient.

A similar programme has been rolled out in neighbouring Burkina Faso, supported by the SCI. In both countries, the most heavily infected regions have been identified, local health staff and teachers have been trained, and health education has been provided to the people in those regions. As the programmes expanded, their effects were monitored in each country to demonstrate the impact of the treatments on health and well-being, and the success of the volunteer distribution model. Local and international partnerships have been forged to improve training and

treatment delivery, and to assist other African nations in the development of similar national control plans and research programmes.

### **Just 50 Cents**

There are long term crippling consequences, including high school drop-out rates and physical impairment, of such diseases yet they are easily and cheaply treatable. For only \$0.50 per year, a person can be treated with four drugs that fight all five NTDs that are responsible for more than 90% of the disease burden. The cost of treatment at \$0.50 per person, per year includes all costs associated with drug delivery, equipment, educational materials, personnel training and monitoring and evaluation.

The secret to the country’s success is not only the excellent commitment from the Niger Ministry of Health and the hard work of the NTD control program, but increased funding from the U.S Agency for International Development (USAID) as well as donations from pharmaceutical companies Merck and GSK. Indeed the NTDs are now much less neglected. The US Government recently expanded its existing NTD program, committing \$350 million to combat the five “able to treat” conditions over the next five years. The G8, the EC and the Director General of WHO have also made strongly supportive statements. Furthermore, the

*To date, nearly  
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UK's department for international development (DFID) is putting £25 million over five years. The money will pay for 75 million treatments against intestinal worms and schistosomiasis to help ensure that the serious consequences of schistosomiasis will be eliminated from countries such as Niger.

With continued lobbying for contribution of donors such as USAID and DFID; drug donations from pharmaceutical companies such as Merck and Pfizer; and input from smaller scale private donors we can move towards elimination of such diseases. According to the WHO, five rounds of yearly treatment against LF and three rounds against Trachoma are sufficient to potentially eliminate these respective diseases in endemic areas. In the fifth year of the integrated NTD control program Niger such elimination goals are in sight.

Contributions from individuals also make a big difference. In 2007 a private donor from Arizona, Allan Lewis, donated \$200,000 to organize surgical camps for those affected by Lymphatic filariasis. In addition, Elly Varvarina, a UK school student, raised £1,000 to pay for washing kits to reduce swelling and infection in elephantiasis sufferers.

### End the Neglect

Recrudescence of infection is possible. It is important therefore to compliment chemotherapy with sustainable

control measures such as management of vectors (molluscicide treatment of rivers to kills the schistosomiasis snail host or mosquito control for LF control) as well as water and sanitation efforts. Currently few NTD control programs have the financial and logistical support to implement such complementary activities. The reason for this is because chemotherapy, thanks to the contribution from the pharmaceutical companies, is the currently the cheapest means of NTD control. 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.

Although NTDs threaten the lives of millions in the developing world, their burden on global health remains under-resourced. Continuing action is needed to facilitate the dissemination of information about

NTDs, to identify funding opportunities and the most cost-effective ways to fight NTDs. If elimination is to be achieved it is important to also explore possibilities for promoting and implementing projects beyond chemotherapy, such as water and sanitation strategies, that will support sustainable alleviation of the NTD burden. By highlighting important implementation challenges, the SCI calls on the global community for continued support as well as innovative efforts in tackling the global burden of NTDs.

*For only \$0.50 per year, a person can be treated for all five NTDs that are responsible for over 90% of the disease burden*

*Taking a short-cut: this innocent stream may be host to many dangerous parasites*



# Malaria Nets

## Saving Lives Locally

## by Thinking and Acting Globally

John Lucas is currently Business Development Manager at Sumitomo Chemical and a graduate of Applied Entomology at Imperial College London.

**T**he United Nations' eight Millennium Development Goals or MDGs aim to improve social and economic conditions in the world's poorest countries. Whether these goals will be accomplished by 2015 is debatable, but one thing is certain – malaria prevention is fundamental to their achievement. A wholly preventable disease, malaria contributes directly or indirectly to the achievement of at least four of these MDGs. While MDG Six focuses directly on combating malaria and HIV/AIDS, MDGs Four and Five deal with the reduction of child mortality and improving maternal health – malaria is the primary cause of death amongst mothers and young children, with nearly 1 million dying each year, the majority being in sub-Saharan Africa.

Aside from the tragic loss of life, the incidence of malaria has a direct influence on development and wealth creation, for example, children miss education due to sickness or farmers struck down by the disease cannot work their land and feed their families. Recent estimates put the impact of malaria on the African subcontinent as costing the equivalent of between \$8 and \$12 billion in lost productivity a year.

There are many interventions that can combat malaria, but if this disease is ever to be eradicated an effective and affordable vaccine is necessary. Whilst significant

progress has been made, a highly effective and long lasting transmission blocking vaccine is still a long way off – and until then, other interventions are needed. Long lasting insecticide treated bed nets (also referred to as LNs) can be one of the most cost-effective tools for combating malaria. Great strides have been made in recent years by the international community -including the Global Fund, the World Bank, DFID, Unicef and numerous NGOs - towards raising the necessary funds in order to provide bed nets to everyone at risk of contracting malaria; this is the aim of 'Universal Coverage'.

### **Made in Africa, by Africans, for Africans – and for Africa**

Several years ago the Sumitomo Chemical Company (SCC) developed Olyset® Net<sup>1</sup>, which was the first WHO fully recommended LN. The tough polyethylene fibres of the net contain the pyrethroid insecticide permethrin, which slowly releases to the surface of the net, acting

to kill and repel malaria-transmitting mosquitoes. These nets remain effective for over 5 years.

From the outset, SCC's strategy has focused on encouraging the development of African-based net production facilities to help provide direct economic benefits to the local community. In 2003, the manufacturing technology for Olyset Net was transferred – on a royalty-free basis – to A to Z Textile Mills, based in Arusha, Tanzania. A to Z already had skills and experience in working with plastics

*A highly effective  
and long lasting  
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<sup>1</sup> Trademark of Sumitomo Chemical Co. Ltd

and textiles and now undertakes most elements of the net production process – extruding the yarn, knitting, sewing and packaging while maintaining strict quality control procedures – with the plastic raw material incorporating the insecticide and slow release technology being supplied by SCC from Japan.

Following initial success with this business model, and in the drive to produce enough nets to help reach Universal Coverage targets, a massive expansion of net production was made in 2007 through the establishment of the purpose-built, state-of-the-art Vector Health International (VHI) facility that is jointly owned and run by SCC and A to Z. Today, total production capacity is at 29 million nets a year – this represents approximately 50% of global Olyset Net production. This facility, which includes employee housing as well as a football pitch, is now the largest employer in Arusha, and has created over 7,000 local jobs with indirect support for over 40,000 people in the vicinity of the two factories. Nets made in the factory are shipped all over East Africa. The aim has been that the Olyset Net is a product ‘Made in Africa, by Africans, for Africans – and for Africa’.

To further help stimulate local economies, a number of community-based net sewing operations have also been established. For example, in June 2009, hundreds

of additional jobs were created following the opening of two net stitching facilities, one in Lilongwe, Malawi, the other in Kombolcha, Ethiopia. These factories have the capacity to produce one and three million nets a year respectively.

#### **“Your Life is Important, Use Your Net”**

Manufacturing and distributing bed nets however, is not enough – people need to understand the benefits of bed nets in order to encourage their proper use and care. South Africa’s staging of the World Cup in 2010 provided the ideal platform for an Africa-wide malaria awareness program. The use of bed nets was publicised via the simple message “Your life is important, use your net” broadcasted by Public Service Announcements involving African football stars.

### *South Africa’s staging of the World Cup in 2010 provided the ideal platform for an Africa-wide malaria awareness program*

The launch of a landmark communication project with the famous Senegalese singer Youssou N’Dour and the advocacy charity Malaria No More also helped to encourage people to use these nets. The ‘Senegal Surround Sound’ campaign is activating key sectors of Senegalese society – including entertainment, sport,

*SCC’s strategy has focused on encouraging the development of African-based net production facilities*



© M.Hallahan  
Sumitomo Chemical Olyset Net



faith, local business and government – to deliver the message across the country that “no family need suffer from malaria”. Youssou N’Dour kicked off the campaign with a concert in Senegal in June 2009 to raise awareness about the national mosquito net distribution. A study that tracks shifts and trends in attitudes and behaviours shows that this campaign is making a measurable, life-saving difference. The ‘Surround’ model has also been adapted to East Africa in the Tanzanian “Zinduka!” campaign.

### 100 Million Nets

The Millennium Development Goals are not just mere numbers and statistics; they are about real lives being transformed by our shared efforts. With only four years remaining until the 2015 MDG deadline, now is the time to step up our efforts and accelerate the pace of change. The impact of bed nets as well as medical interventions such as better malaria diagnosis and treatment has resulted in a dramatic fall in malaria prevalence in many parts of Africa, and the Millennium Villages provide some good examples of this success story. In the Sauri Millennium Village in

*Conservative estimates indicate that over 100 million nets will be required each year once coverage has been achieved*

Kenya malaria prevalence rates fell from 55% in 2005 (immediately prior to bed net distribution) to 12% in 2007, with rates falling further to a low of around 7% today.

With Universal Coverage targets in Africa set to be achieved within the coming months, the outlook is positive. However, the work does not stop here – new nets need to replace those that are old and exhausted. Many companies have initiated production of their own long lasting nets, making it possible to both achieve and maintain Universal Coverage – with conservative estimates indicating that over 100 million nets will be required each year once coverage has been achieved.

The World Health Organization estimates that bed nets have saved over 750,000 lives since 2005 – with more lives being saved daily and communities transformed through the use of this simple but highly effective tool.

For those interested in learning more or making a donation towards the purchase of LNs, please visit

[www.againstmalaria.com](http://www.againstmalaria.com)  
[www.olyset.net](http://www.olyset.net)  
[www.millenniumpromise.org](http://www.millenniumpromise.org)

*A young convert: WHO estimates that bed nets have saved over 750,000 lives since 2005*



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Sumitomo Chemical Olyset Net

# Pregnancy In Pakistan

## The Forgotten Millenium Development Goal?

*Najia Sultan* is a fifth year medical student at Imperial College London and the current Head of Publicity and Marketing for the International Education Fund, an Imperial College student-led project tackling poverty and health in the developing world through education.

**M**illenium Development Goal Five requires a 75% reduction in maternal mortality ratio (MMR) by 2015 for achievement. Together India, Pakistan and Bangladesh account for 46% of the world's maternal deaths<sup>1</sup>. However, with only four years remaining before the 2015 deadline, Pakistan's progress significantly lags behind its south Asian neighbours.

Maternal death as a result of hypertensive disorders is thought to account for up to 30% of total maternal mortality in Pakistan. Pre-eclampsia is the most serious of hypertensive diseases and affects up to 5% of pregnancies<sup>2</sup>.

The IEF will be launching two new projects in Pakistan in 2010: a 'Community Screening Programme for Pre-eclampsia' in Azad Kashmir in addition to a 'Centre of Excellence for Maternal Health' in an empty hospital in Jhelum, Punjab.

Pakistan has spent a great deal of its short sixty-three year history on the world stage. Unfortunately, much of the attention has been a consequence of tragedy – the 2005 earthquakes and 2010 floods being most recent examples. In the context of a volatile political and natural

environment, it is perhaps unsurprising that the development of social and healthcare services have been sidelined. Less than 1% of GDP expenditure is on health, and medical services are widely thought to be inadequate in catering for a population of 170 million.

### **Pregnancy, A Risky Enterprise**

In 2000 Pakistan was one of 191 countries that endorsed the eight United Nations Millennium Goals (MDGs). The MDGs emerged from the United Nations (UN) Millennium Declaration and are arguably the most politically important pact

made for international development. The goals were intended to improve the distribution and prioritisation of aid and have been categorised into over 20 targets and 60 indicators.

Goal Five requires a 75% reduction in maternal mortality ratio (MMR) by 2015 for achievement. Maternal mortality – defined as death during pregnancy, childbirth or in the 42 days after delivery – remains a major challenge to health systems worldwide. Together India, Pakistan and Bangladesh account for 46% of the world's maternal deaths<sup>1</sup>. However, with only four years remaining before the 2015 deadline, Pakistan's progress significantly lags behind its south Asian neighbours. Investment in midwives and emergency obstetric care has meant India and

<sup>1</sup> AbouZahr C. et al. (1991). Maternal mortality: A global factbook. *WHO*.

<sup>2</sup> Fikree F.F. et al. (1997). Maternal mortality in different Pakistani sites: ratios, clinical causes and determinants. *Acta Obstetrica et Gynecologica Scandinavica*.





*Childbirth in Pakistan remains dangerous: there is a 1 in 10 chance this recent mother will not make it*

Bangladesh were recognised by the UN's 2008 MDG Report as achieving a 'substantial decline' in MMR. Pakistan, on the other hand, has made insufficient progress.

### **Truth in Numbers**

30,000 women a year in Pakistan die due to pregnancy related causes and the maternal mortality ratio is approximately 340 per 100,000 live births. In reality this number may be even higher due to the under registration of deaths and the absence of official cause of death information. To put this into context, Britain's maternal mortality rate was last at this level in 1937.

No doubt the practical implications of reducing maternal mortality in Pakistan are huge

due to the variety of problems that need to be overcome in order to reach the MDG target. One third of the inhabitants of the seventh most populous country in the world live below the poverty line. Yet despite this, the majority of antenatal care is privately funded, and therefore remains beyond the reach of most of the population. There is also a general absence of appropriate antenatal care (defined by WHO as having had one or more visits to a trained person during the pregnancy), whilst 97% of British mothers can expect to receive

routine antenatal care. In the Pakistani province of Sindh this drops to 63% in urban centres while in rural areas a meagre 15% of mothers receive antenatal care<sup>3</sup>.

The general acceptance of maternal death in labour is an additional psychosocial hurdle. A Doctor from the National Commission for Human Development, Pakistan, illustrates this issue: "I asked a group of health workers in a village how many mothers they would expect to die out of 100 births, and one doctor responded with 10 or 15. I asked if he thought this was too much, and he said no, this was to be expected. This is dangerous as it has become the norm."

There is considerable correlation between the causes of maternal death in developing countries today (haemorrhage – 21%, eclampsia – 18.6% and sepsis – 13.3%) and prominent causes in developed countries in the early twentieth century. This suggests that measures taken to reduce maternal mortality in the developed world fifty years ago may work today in regions with high rates of maternal mortality.

***Britain's maternal mortality rate was last at this level in 1937***

<sup>3</sup> Karim, M. S. et al. (1998) MIMS-Sindh: Report of Household Socioeconomic, Demographic and Maternal Health Survey Conducted in Sindh Province, Pakistan. *UNICEF*.

<sup>4</sup> WHO (2005). The world health report 2005: make every mother and child count.

As only 21% of women in Pakistan are literate, an educational approach will be needed alongside improvements in antenatal care to fully address the problems.

### The International Education Fund

The WHO recognise that the presence of an intrapartum-care package can 'prevent a large proportion of obstetric deaths' and that 'first level care does save lives and manage emergencies'. The provision of obstetric health care in the community by trained health personnel forms the backbone of any such efforts<sup>4</sup> and it is with this in mind that Imperial College's International Education Fund (IEF) intends to launch a project focussed on maternal health education in Pakistan.

The IEF is a young charitable organisation comprising of academics and students. Upon visiting Pakistan as part of a schools project three years ago, the IEF realised that health education was seriously lacking. Research identified maternal mortality as a particular area of concern and thus the IEF, in collaboration with Maternity Worldwide, will be launching two new projects in Pakistan: a 'Community Screening Programme for Pre-eclampsia' in Azad Kashmir in addition to a 'Centre of Excellence for Maternal Health' in an empty hospital in Jhelum, Punjab. Throughout the year the IEF will be raising awareness and funds for the Pakistan Maternal Health Project. Keynote lectures and sponsored activities will culminate in a trip to Pakistan to implement these screening programmes.

### Good Intentions

Maternal death as a result of hypertensive disorders is thought to account for up to 30% of total maternal mortality in Pakistan. Pre-eclampsia is the most serious of hypertensive diseases and affects up to 5% of pregnancies<sup>2</sup>. It can be fatal if left untreated yet is easily screened for. The IEF plan to use non-invasive testing

(using urine dipstick and blood pressure measurement) to enable early detection of pre-eclampsia based in two rural hospitals in Azad Kashmir – the District Headquarters Hospital (Bagh) and the Combined Military Hospital (Rawalakot). The programme will include patient workshops and educational material to educate women and their families on the signs of pregnancy complications; and in the case of a diagnosis through screening, a prompt referral to hospital for appropriate treatment. Additionally, local midwives and healthcare professionals will receive proper training on standards of maternal care.

In a prominent 2005 programme that trained traditional birth attendants in Pakistan, rates of puerperal sepsis and haemorrhage as a complication of pregnancy were noticed to be significantly lower. There was also a reduction of about 30% in perinatal mortality in cases with a trained birth attendant<sup>5</sup>. These methods clearly work.

In addition, 77% of total maternal mortality is recognised to be in mothers who lived greater than 40 km from the nearest hospital. In order to address this issue, an empty hospital donated to the IEF by a philanthropist in Jhelum (Punjab) will be used to create a local Centre of Maternal Health Excellence. Following a needs assessment conducted by a local charity, Kashmir Islamic Relief Fund (KIRF), the IEF propose preparing this hospital for dealing with obstetric emergencies and reducing local maternal mortality.

It is also intended that both projects will help to generate epidemiological data to enable effective targeting of future interventions. There is currently no national antenatal screening programme in Pakistan and detailed data on maternal health will help us to tailor guidelines to the specific needs of women in Pakistan. It is hoped that in time, similar programmes can be established around Pakistan.

This is an excellent opportunity for those with an interest in international development to get involved. Please email [katherine.smith06@imperial.ac.uk](mailto:katherine.smith06@imperial.ac.uk) for more information.

*The majority of antenatal care is privately funded, and therefore remains beyond the reach of most of the population*

### Maternal Health in Pakistan: The Statistics

- The lifetime risk of maternal death in Pakistan is 1 in 74, compared to 1 in 17, 400 in Sweden
- 30% of women in union use contraception
- 89% of deliveries take place at home
- 39% of deliveries are attended by a skilled attendant
- 15% of antenatal care is from government facilities

<sup>5</sup> Jokhio A.H. et al. (2005). An Intervention Involving Traditional Birth Attendants and Perinatal and Maternal Mortality in Pakistan. *The New England Journal of Medicine*.

# Does Synthetic Biology Need A New PR Campaign?

*Benjamin Miller* is a third year Biomedical Engineering student and was a member of Imperial College London's successful 2010 iGEM team.

**S**ynthetic biology is a fascinating emerging field with the potential to reinvent our relationship with the life sciences. The core concept includes the standardization of biological parts that may be reengineered for the creation of increasingly complex and novel biological devices. These devices have applications in diverse areas from healthcare to biofuels.

Yet to many members of the public such engineering of biological systems is akin to playing God, or at best potentially dangerous. Genetic engineering, particularly in the form of genetically modified (GM) food and crops, suffers from very low public understanding and support stemming from ineffective public and media engagement. Similar negative reactions were re-ignited earlier this year with the announcement of the creation of 'synthetic life' by the US-based Venter Institute.

## Could a student-led approach help pre-empt a similar PR fate for synthetic biology?

Synthetic biology represents a paradigm shift in the way we view the life sciences, moving from passive research into a world where we can actively develop and redesign biological systems. The core concept is the standardization of biological parts, breaking down a complex natural system into basic components that may be engineered in much the same way as electronics.

Physically this is achieved by creating sections of DNA with a specific standard prefix and suffix, allowing us to connect components together in a relatively straightforward manner. Functionally this is achieved by ensuring that there are no unexpected interactions between the

*The core concept is the standardization of biological parts, breaking down a complex natural system into basic components that may be engineered in much the same way as electronics*

separate components that are combined, enabling the creation of increasingly complex novel biological devices.

Facilitating the expansion of this new field are re-

cent technical advances that enable scientists to both rapidly sequence existing DNA and create custom DNA sequences at a low cost. When combined with a vast source of background knowledge, these factors have created the perfect opportunity for synthetic biology to flourish.

It is expected that, in the future, technologies based on synthetic biology will be applicable to many aspects of our lives, although healthcare and biofuels will be the first to see major rewards. A common example is the production of synthetic artemisinin, an anti-malarial drug difficult to obtain by chemical means but easy to obtain through biological devices made via synthetic biology. In the long-term, however, applications are likely to be seen across the entire commercial spectrum. Additionally, there is an attraction at the government level; this new

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technology requires relatively little initial investment, levelling the playing field somewhat for early adopters.

### Synthetic Life

The benefits are apparent, but what are the problems? As with any research involving the redesign of biological systems, uncontrolled release is a big concern. Unique to synthetic biology, however, is the issue of bio-hacking. The relatively low entry cost opens up the possibility of people designing biological parts in their own home, under the radar of regulatory authorities, and potentially creating something dangerous. Organisations such as DIYBio encourage amateur scientists to explore synthetic biology while at the same time providing a web-based platform for them to communicate and keep track of what individual 'labs' are doing. Interestingly, DIYBio places significant emphasis on ensuring that people understand the risks and work safely.

However, public engagement is arguably the most pressing challenge for the synthetic biology community. As the world saw with its parent technology, genetic engineering, a lack of public engagement coupled with adverse media coverage heavily influenced public perception despite the technology enjoying widespread support at a scientific level. At present the only thing saving synthetic biology from the same fate is its relative obscurity.

In May 2010, the world saw synthetic biology hit the headlines for the first time. Craig Venter, a biologist formerly involved in the race for the human genome, claimed to have 'created' Synthia, the first synthetic life. Whether this was technically true or not, the media's use of language was inflammatory.

Headlines such as 'Scientist plays God' and 'Man creates Artificial Life' steered debate in the same direction as it had done previously with GM. The scientific community seemingly remains unprepared to stimulate an informed debate regarding issues such as the potential for misuse of technologies and ethical, social and environmental implications. It has even been suggested that the name 'synthetic biology' immediately triggers a negative innate reaction in the wider public by implying that it is something artificial and thus reducing trust. These issues need to be addressed for synthetic biology to progress with widespread public backing—crucial from both a research-funding and implementation-deployment perspective.

### Pre-Emptive Strike

Evidently, the importance of upstream public engagement cannot be underestimated. A pre-emptive effort is needed to encourage the public to participate in a broad dialogue with scientists about the central issues raised by synthetic biology. Answers to challenging questions such as how might we ensure the safety of the technology, ownership of intellectual property rights and how the use of the technology is regulated must be communicated to the public in a transparent manner.

There have already been some attempts to engage in

*Students are unlikely to have formed concrete opinions surrounding the various questions synthetic biology raises, placing them in a position to embrace discussions with an open mind*

a dialogue with the public. The BBSRC recently published a lengthy report on a public engagement programme implemented across the UK involving both social scientists and experts in synthetic biology. However, the workshops with the public were small

in number and not as far-reaching as one would hope. It is unclear whether reports like this will have any impact on the way research is carried out in the UK, how research priorities are decided and whether or not a UK-wide regulation system will be implemented.

Perhaps a more effective strategy is for university students to play a role in public engagement exercises. Crucially, students would explore the translational aspects of the research they might one day carry out and learn right from the start that engaging with the public is a fundamental aspect of life as a scientist. When research is funded by public money, scientists need to be accountable and therefore have a responsibility to inform and engage with taxpayers. In addition to this, the experience of explaining complex scientific theories to non-specialists is an important skill for researchers in any field and one that is all too often neglected in a scientist's training.

Furthermore, public engagement, when carried out by university students, may well receive better reception from members of the public. Students are unlikely to have formed concrete opinions surrounding the various questions synthetic biology raises, placing them in

a position to embrace discussions with an open mind. This is in stark contrast to current public engagement, which has a tendency to stray towards a one-way flow of information. The public must be engaged, not lectured.

### **iGEMers Try Something New**

One example of public engagement at a student level came from the Imperial College London iGEM team. The International Genetically Engineered Machine competition (iGEM) allows teams of undergraduates from all over the world conduct a research project throughout the summer to develop an idea for how to put synthetic biology into action. The competition culminated in the presentation of these ideas at the iGEM Jam-boree, held in November at MIT in Boston. In addition to their core research, the Imperial team undertook a series of workshops hosted at various London secondary schools.

The team decided that school students would be an interesting demographic to present the subject of synthetic biology to – the idea was that engaging a younger audience could be an effective method of introducing synthetic biology to a wider public. The workshops consisted of three main sections. To start with, the concept of synthetic biology was explained and various potential applications were described. The students then brainstormed their own ideas for synthetic biology. This was a fundamental part of the workshop because the students soon became genuinely excited about the potential for a large degree of creativity in synthetic biology. Ideas the students suggested included using mice to detect mines and bacteria that live on the skin to give a tan, amongst many others.

The next part of the workshop focused on the regulation and safety issues synthetic biology raises and involved a debate between the students. This allowed them to formulate their own opinions and discuss the direction that synthetic biology may take in the future. One interesting suggestion which arose was creating a ‘driver’s license’ for users of synthetic biology so that authorities could ensure that users had the appropriate training to use the technology safely and ethically.

The last exercise of the workshop involved the production of a TV advert for a synthetic biology product of the students’ choice. Having discussed how the media can

affect public perception, the students had to reassure the public that their product was safe and outline the advantages of using synthetic biology over traditional alternatives.

The response from the school students was far from what was expected. The team was greeted with a genuine fascination for synthetic biology and its emerging applications in society. There are relatively few opportunities available to school students to be creative with science and, if we are to inspire next generation’s scientists, it is initiatives such as this that have the potential to lead the way.

### *The public must be engaged, not lectured*

The UK has huge potential to become one of the leading nations in the drive toward deploying applications of synthetic biology. To achieve this, it is essential that the necessary resources are made available. This can only be accomplished with full support from the general public. Our experiences indicate that a student-led public engagement programme can be both successful and mutually beneficial, and we hope to expand our efforts in the future.

## PARASIGHT

The Imperial College London iGEM project focused on a detection kit for the waterborne parasite *Schistosoma*, which causes schistosomiasis (bilharzia). This neglected tropical disease infects 200 million people around the world, and is found in developing countries where sanitation is inadequate.

The aim was to create a bacterial system that enables the detection of the parasite in water by giving a visual output. The team started with the bacteria *Bacillus subtilis*, removed various unwanted parts, put in some from other cells, and even designed a few genes of their own.

In addition to this the team contextualised the project by considering how the detection kit would be implemented in the field, contacting various experts along the way and getting prototypes manufactured. An application has been put forward to the Bill & Melinda Gates Foundation, with the hope that this research may one day become a reality.



# Cyber-Space: The Next Frontier

*Yun William Yu* is a doctoral student in Biomathematics and Theoretical Chemistry at Imperial College London, where he is a British Marshall Scholar.

**R**anging from Iran's nuclear facilities to thousands of American diplomatic cables, recent high profile breaches of IT systems have highlighted the growing importance of cyber-security for this Information Age. Cyber-crime crosses national boundaries, and the issue is further exacerbated by the anonymity of attackers and the disproportionate potential for damage. While a notable problem in its own right, cyber-crime presages the inevitable conflicts that will arise from the close contact afforded by the Internet between varying cultural norms.

The advent of the Information Age has enabled unprecedented connectivity between not only individuals around the globe, but also connectivity across organizational scales. Large governments and corporations may quickly – and cheaply – directly reach and be reached by almost anyone with Internet access, as information transmission to even to non-networked systems is greatly facilitated by common software platforms used throughout the world. Such access, while beneficial to all, comes at a potential price.

## **Under Attack**

Perhaps the most popularly reviled incarnation of cyber-crime comes in the form of malware. It is a rare computer user who hasn't at some point dealt with viruses, worms, Trojan horses, spyware, and other similar programs of their ilk (see table). These generally unwanted inhabitants of our IT systems, while personally devastating – as anyone who has lost data to particularly virulent malware can testify – are almost always undirected, causing damage, stealing information, and taking over

computers throughout the computing world wherever improperly secured systems can be found.

Originally the province of hobbyists and academics, organized cyber-crime has, in the last decade, been the driver of much development in this field. However, the appearance of Stuxnet in mid-2010 suggests the growing involvement of national governments both as instigator and target of cyber-attacks. A very sophisticated computer worm, almost certainly requiring the efforts of multiple skilled programmers, Stuxnet appears to have targeted centrifuges in Iran's nuclear facilities thus delaying the uranium enrichment program. Given the lack of obvious commercial motive and the significant investment in the creation of Stuxnet, many people believe it to be the work of a Western power, possibly the United States or Israel, though no direct evidence has surfaced to indicate one way or the other.

More directed attacks against particular IT systems are most commonly seen against large, juicy targets like corporate servers, government databases, etc. These range from the technologically simple Distributed Denial of Service (DDoS), which involves simply overwhelming a server with junk traffic, slowing or even completely blocking legitimate traffic, to carefully crafted 'hacking' of data servers to steal information. Successful attacks can result in the exposure of important personal information, such as credit card numbers, for thousands of people or the crippling of Internet services; as we come to rely more and more upon the Internet for everything from communication to payment, the potential for damage only grows.

Very recently, highly publicized DDoS attack attempts have been made by ‘hacktivists’ against companies perceived to have crossed Wikileaks, such as Paypal, Visa, and Mastercard. Not long later, the self-styled group ‘Gnosis’ stole over a million user emails and encrypted passwords from Gawker Media, which runs a number of fairly popular websites. National governments are not immune either, as demonstrated by the defacement of Georgian government websites during the 2008 South Ossetia war.

Conversely, Google made a splash in early 2010 when it announced a pullout from operations in mainland China due to the hacking of Chinese human rights activists’ Gmail accounts. Google, the American government, and the Western press generally level suspicion at the Chinese government, yet a concrete link was never made. Leaked American diplomatic cables suggest that these incidents were part of a more extensive network of cyber-attacks traced to hackers geographically located in China using Chinese-language keyboards.

As damaging as the immediate ramifications of critical infrastructure and data systems being under adversarial control may be, the ease of duplication and dissemination of information on the Internet, and the subsequent irreversibility of damage, only compounds the problem. There has been much in the news lately regarding the dissemination by Wikileaks of confidential American diplomatic cables, almost certainly leaked by someone authorized to access SIPRNet, a ‘secure’ classified network used by the US Department of Defense and Department of State. While Washington’s response was perhaps of debatable justification, despite its best efforts, all of the leaked information is still online and will likely remain so.

### Insecure by Design

Why is it that the IT landscape proves so resistant to securing? One reason is that many of the network protocols

and paradigms used in today’s Internet date back to a bygone era in which it was reasonable to assume that no one was acting maliciously or deceptively. For instance, SMTP, the protocol by which nearly all email is sent, allows the sender to arbitrarily specify the ‘from’ address; similar types of spoofing are possible with other protocols, hiding the actual originator of a transmission. There are of course many proposed technical solutions to these sorts of issues, but the need to retain backwards compatibility,

coupled with the uneven adoption of new protocols, has limited the success of such mechanisms.

Yet there exists an even more intractable issue: us,

the general populace. As Internet access becomes both cheap and increasingly necessary for day-to-day affairs, a growing number of people have always-on high-speed connections. Unfortunately, this makes personal computers a target not only in their own right, but also for use in further cyber-crime. By assembling large teams of compromised computers, or ‘botnets’ consisting of ‘zombie’ computers, malicious agents are able to significantly increase not only their available network firepower for sending spam email or performing DDoS attacks but also may better cover their tracks – the attacks come directly from the systems of innocent but insufficiently security-conscious bystanders. It is thus impossible to identify the actual adversary in most cases.

While it is easy to blame naive end users for not securing their personal computers, adopting such an attitude is of little use. It is almost trite to refer to the annoying persistence of Windows Vista security prompts, but this exemplifies how willing people are to repeatedly trade minor intangible risks for more immediate concrete rewards. Although the results of individual security breaches at the personal level are relatively minor, except when in the aggregate form of botnets, similar patterns of behaviour

*Perhaps the most popularly reviled incarnation of cyber-crime comes in the form of malware*

Virus	A computer program that can copy itself and infect other programs.
Worm	Similar to a virus in that it can copy itself, but additionally does not need user intervention or another program to latch on to, exploiting instead security vulnerabilities on the target computer.
Trojan Horse	Malware that pretends to perform a desirable function, convincing the user to deliberately install it onto their computer.
Spyware	Surreptitiously collects and sends user information, such as browsing habits, passwords, etc.
Rootkit	Grants administrative privileges to a third-party, generally while actively hiding its presence.



*The Social Network: the Facebook 'map of the world' was created using friendship connections*

by privileged users, for instance members of the armed forces, can have far greater immediate impact. Around the turn of the century, the virus Melissa was able to jump from the wider Internet to the American military's closed network after less than 24 hours, most likely due to a careless user who connected the same system to both networks. More recently, Stuxnet was designed to spread via USB memory sticks, easily hopping to the targeted Iranian centrifuge control computers, despite a rational effort to sequester them from the Internet.

Even where network connectivity is not involved, the mere existence of other similar systems provides vectors for malware transmission and a cloak of anonymity for the originator. If the Iranian computer systems had not been running the same software and operating system as thousands of other industrial plants, it would have been difficult for Stuxnet to spread as it did, hopping from plant to plant while solely activating its destructive payload on specific targets. In this scenario, a more directed attack would likely have been required, one which may have revealed the perpetrators.

### **The Great Leveller**

Before the current Information Age, barring occasional exceptions, it was difficult for a single disaffected individual to acquire huge influence over the world or damage critical infrastructure without significant personal risk to life and limb. The Internet has changed all of that: a single

person with moderate technical skills can, from the relative safety of his or her home, direct a botnet to temporarily cripple an e-commerce site through a DDoS attack, as was attempted against Visa, Mastercard, and Paypal following their decisions to suspend payments to Wikileaks.

Similarly, a single disaffected individual with access to classified information was able to make public thousands of diplomatic cables, in a manner that has proven exceedingly difficult for the US Government to suppress. Although the source may have been found and arrested in this particular case, the damage had already been done. With multiple copies of the data scattered on servers throughout the world and downloaded on individual computers, it is near impossible to prevent further dissemination.

Even something as complicated as Stuxnet, whose construction involved three zero-day exploits, two stolen security certificates, and detailed knowledge of the Programmable Logic Controllers used in industrial systems, could conceivably have been designed by a small group of vigilantes. Given the complexity of the operation, the deliberate targeting and the obvious motivators for a major Western power, this is a somewhat unlikely explanation. Indeed, a far scarier scenario would have been a malicious individual simply seeking to wreck havoc on industrial plants and using something similar but untargeted. It remains a fact that there is not, and unlikely ever to be, any direct evidence of involvement by a State.

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## Internet Without Borders

National governments have begun recognizing the challenges posed. Indeed, in the 2010 UK National Security Strategy review, 'hostile attacks upon UK cyber-space' is categorized as a Tier One priority risk. However, the dual issues of the lack of accountability and the disproportionate potential impact of single individuals present significant difficulties for governmental responses. While it has long been possible for covert operations agencies to achieve plausible deniability, most major operations could be reasonably understood not to be the work of individuals acting alone. This is no longer the case. How much of the hacking done from within Russia is actually sanctioned by Moscow? What is the appropriate response to a nearly untraceable attack like Stuxnet? Some nations have begun requiring the use of real names online, which if perfectly implemented could take away the anonymity that malicious parties hide behind. However, even ignoring the applicable free speech considerations, it is highly unlikely that any such system would work in practice, as technical systems are susceptible themselves to being misled and zombie computers could still be used.

Another possible solution is for governments to hold others accountable for all hacking activity originating from within their countries. Indeed, in an analogous fashion, Beijing has already warned that they would hold Washington responsible for terrorist attacks conducted with the assistance of Google Earth, as the US Government has not complied with China's requests for Google to lower the image resolution of sensitive areas.

However, while it may be reasonable to state a priori that each nation should police within national borders, this is technically very difficult when it comes to the Internet; cyber-crime almost inherently crosses national boundaries. How, for example, should a government respond to cyber-warfare waged by a botnet primarily situated in Britain, responding to orders given through servers in Russia, and controlled by someone located in Brazil – assuming that the attack could be traced that far back in the first place? What share of the blame should the owners of the compromised British computers take for not having properly secured their systems? In Germany,

Internet customers are personally liable if they do not properly secure their wifi networks, which are then used for illegal file sharing; unknowing participation in cyber-warfare would presumably be treated with more gravity.

Difficult as the jurisdictional and enforcement issues will be, an even thornier issue arises from the fact that citizens from various nations are in direct contact with the governments of others: the cultural norms and laws differ considerably from one nation to another. For example, much to the consternation of American free speech advocates, an English court claimed jurisdiction in the

2004 libel case surrounding the book *Funding Evil* – which was not published in the UK – based on the reasoning that 23 copies were purchased in England from online retailers and a chapter was made available on the Internet. Several American states have since passed laws specifically aimed at protecting against 'libel judgments in countries whose laws are inconsistent with the freedom of speech granted by the [US] Constitution'. What might happen to an American who aimed to disseminate in-

formation 'harmful to the spiritual, moral, and cultural sphere of' China, as the Shanghai Cooperation Organisation has chosen to define 'information war'? The United States would probably regard such dissemination of information as falling under freedom of speech, yet China may consider it an instance of cyber-terrorism; and, should the United States fail to take appropriate action, construe the American government's response as an act of cyber-aggression itself!

## The Next Frontier

Cyber-space arguably represents the next frontier in the development of international relations, as nations cope with the challenges of being able to immediately and directly influence the infrastructure, culture, and the lives of people throughout the world, and more importantly, the possibility of being reciprocal to such influences. The cross-boundary nature of the Internet is beginning to come in conflict with the existence of differing national laws and cultural norms, spurred on by the obvious difficulties in dealing with cyber-security on a global stage. Thus, in parallel with technical and educational measures to enhance cyber-security, diplomatic norms will have to be altered to account for the powers afforded to individuals by the anonymity and interconnectedness of the Internet.



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