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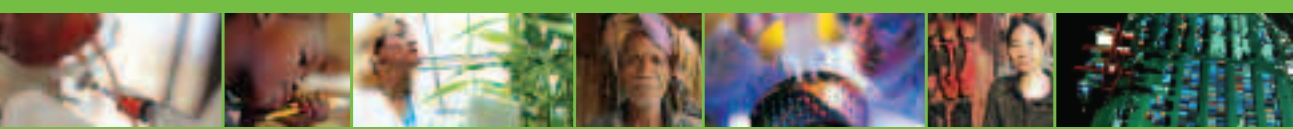
Science, technology and globalisation

ESRC Science in Society Programme

vaccinations biotechnology databases



science in society

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Preface

The science-society relationship is recognised as no longer being one in which the needs of the public are dictated by those in authority. But what is it to become? How can those in government, science and the private sector facilitate the science-society relationship more effectively? How can the public in all its diversity become more engaged in the production of science and its role in society?

The goal of the ESRC's Science in Society Programme is to explore and help develop the rapidly changing relations between science (including engineering and technology) and the wider society. These brochures are intended not only to bring together the findings of research projects in the Programme, but also to draw on wider insights into the relationship of science and society.

To that end, although these brochures provide an overview of academic research, they hope to prompt questions that go beyond the academic to the role of science and technology in daily life and experience, in all its diversity.

"In the 20th Century, science and technology became a truly a global phenomenon"

Foreword

In the 20th Century, science and technology became a truly a global phenomenon. Scientific labour markets are no longer constrained by geography, politics, or language. The brain drains of the 1960s have become the brain circulations of the naughties, as scientific labour markets have become truly international. For good or ill, technological innovations in one place swiftly spread across geographical space, even if access to them remains constrained by economic and social inequality.

Under the theme of science, technology and globalization, the Science in Society Programme set out to explore some of the cultural, scientific and technological developments that drift, flow, and leapfrog across borders without concern for the nation state. Several of the projects in this theme discuss the effects of technological change and development between countries as well as in other parts of the world to our own. The flow of information, the issue of brain drain and the use of technology to assist those in developing countries are all subjects of projects discussed. They try to unpick the areas in our lives that we sometimes take for granted or don't dwell on too much, such as how internet search engines may restrict our access to information at the point at which we expect to have the widest access. Are we really only looking at a fraction of the information that is out there? Many of us are aware of the controversy surrounding buying GM foods in the supermarket, but how many of us think past this and consider how genetically modified maize seeds might allow people in Ethiopia or Kenya to develop their own industries and create solid scientific research bases that will be independent of first-world interests? How does change in intellectual property law affect the production of pharmaceutical drugs in India and how is this intensified by movement of scientists from the west back to India?

These are all questions that are asked by the researchers whose work is discussed in these pages. I hope that you will find them thought-provoking as well as demonstrating the richness and diversity of the social science research that is commissioned through the ESRC's Science in Society Programme.

Steve Rayner
Science in Society Programme Director

Executive Summary

Science, technology and globalisation are powerfully linked. Science is a global enterprise, and increasing numbers of new technologies are developed on a global scale for global markets.

At the same time, many of society's most powerful challenges, from water scarcity to questions about access to knowledge, are intimately linked with developments in technology, raising a number of significant questions:

- Is globalisation happening, and if so how is it linked to science and technology?
- Will science and technology reduce or reinforce global inequalities?
- Does globalisation mean that we need to re-think the way we support, manage and regulate science and technology?
- Are we simply becoming too clever for our own good; lacking the wisdom to use science and technology to create sustainable futures?

Partly as a result of these debates, the idea of what constitutes sound science is being challenged. Once, knowledge claims had only to meet quite restricted 'expert' criteria to form the basis for policy decisions. Now, new knowledge needs to establish broader credentials to be socially robust.

Globalisation – the idea that people, technology, information, finance and culture are increasingly mobile on a global level – is a resonant force in itself in politics around competition and technology. At the same time, global developments can help to drive efficiencies in countries such as the UK, for example through the availability of cheap goods that drive down costs and inflation.

But while acknowledging that certain aspects of globalisation are happening, their effects are often far more varied than popular and political discourse sometimes suggest. Debates about the spreading influence of the forces of science, technology, communications and culture often overlook the huge disparities in their impacts in different regions. Globalisation is not making everything become the same. It is also not deterministic – there remain levers to influence it.

If science and technology are themselves increasingly globalised, what does this mean for how publics engage with science? We need to re-think many of the established debates about democratic participation for this globalised world.

While science and technology are often portrayed as engines of social progress, how do they really measure up in an increasingly connected yet divided world? How can technologies be adapted and regulated for different social contexts, especially in countries that have relatively less capacity to regulate than others?

We challenge five common assumptions that:

- science and technology are freely available
- scientific and technological knowledge is universal, independent of context
- technology is socially neutral; technology is often seen as being outside politics
- science and technology automatically address social needs
- there is a strong contrast between public reactions to science and technology in the rich and poor worlds.

We debate two complementary themes: 'divides' and 'diversity' in science, technology and globalisation:

- The research within the Science in Society Programme has thrown up evidence that in the context of globalisation, science and technology are involved in a series of struggles that might be characterised as 'divides'. These are the gaps that often appear between those that have or do not have access to the resources of the knowledge economy and related policy processes.
- The other, complementary theme, is that of diversity. Here, the research is suggesting that far from apparently 'universal' science and technology making the world more the same, they are resulting in widely diverse practices and supporting diverse institutions, cultures and communities of interest.

These themes are explored through the lens of a range of research projects conducted within the Science in Society Research Programme, leading to ten key insights:

- Many policies and initiatives for science and technology often seemed to be aimed at promoting innovation and growth for their own sake. These often receive more attention that policies designed to achieve social development.
- Diverse influences shape the development and use of science and technology, from global institutions such as the WTO to local political and commercial interests. Science and technology are neither 'neutral' nor globally uniform.
- 'Educating the public' is unlikely to overcome the controversies that surround certain developments in science and technology. Different values and interests create competing 'framings' of what is at stake.
- Implicit visions of society – both now and in the future – are embedded within science and technology. It is around these visions that much of the most heated debate takes place.
- Moves aimed at standardising scientific knowledge and bringing it together run the risk of alienating people on the ground who generate and use such knowledge.
- The increasing reliance on internet search engines raises the question of whether we should rely on a narrow range of 'the best' scientific advice.
- All countries are struggling to govern new global technologies. Is there one right way to do this, or should we accept and work with the diversity of approaches that emanate from different cultures, interests and political circumstances?
- The perspective that science is a universal, standardising form of knowledge is now in direct conflict with the view that diversity is a legitimate strategy and goal in itself.
- Global science can gain democratic legitimacy only if it understands itself in relation to other cultures, and learns to negotiate and accommodate them rather than dismiss them as peripheral, untrustworthy or emotive.
- With the tendency to view problems from an increasingly global perspective, poor people's needs can be misrepresented, leading to technology developments that prove culturally unacceptable, or miss opportunities.

The research questions whether science and technology are about economic competition and domination, or about helping society face up to its most urgent and intractable problems. This is perhaps the question that most urgently needs to be addressed in debates about science, technology and globalisation.

Introduction

Science and technology are global forces: their influence on people's lives is visible everywhere. Indeed, science and technology seem to be forces of globalisation, itself an idea that is increasingly influential in media and political debate. But what is the relationship between science, technology and globalisation? And where do real people come in? Are these apparently distant, powerful forces amenable to democratic participation and accountability?

People all over the world are engaging with science and technology. As several contributors to this brochure have noted, people are asking how their lives are going to be affected by advances in fields such as medical genetics, agricultural biotechnology and genetically modified foods, HIV/AIDS and the environment (Scoones, Leach and Cockburn 2006).

Science and technology are constantly changing on the global scale, bringing with them significant impacts on people's social and economic fortunes, and even political options within countries. Some of these impacts are specific to particular countries, such as the controversy over the cause of HIV/AIDS in South Africa, while some are international or global in dimension – such as the increasing numbers of trained scientists and engineers who are returning from the US to countries such as India.

How will these developments affect the futures of developing and developed countries alike? What are the challenges for policymakers? Can policies be designed that can steer such strong forces? Can science and technology be made to work for the poor, or will they simply further reinforce existing inequalities?

There are increasing public debates and controversies around both of the ideas central to this topic – globalisation; and science and technology. These debates are:

- Definitional/analytical – what is globalisation? What are its effects? What counts as science? What is the relationship between science and technology themselves?

- Political – who benefits from globalised science and technology? Who controls them? Who are the winners and losers? How do we think about measuring the benefits and losses? Does globalisation mean that we need to re-think the way we support, manage and regulate science and technology?

"Science and technology are now two of the most potent forces in human society"

Globalisation seems to have resulted in uneven 'gains and pains'. The so-called 'anti-globalisation movement' has challenged the policies of groups such as the G8 and the World Trade Organisation, often expressing scepticism of the benefits that science and technology might deliver for the world's poor. There is a fear that science, technology and globalisation will reinforce rather than reduce inequality because of the unequal access to knowledge and technology and the difficulties for poor people in gaining the investment needed to join in. On the other hand, what will be the results of the huge advances in technological and industrial capacity in Brazil, China, India and South Africa? How will realities within these countries change and how will they affect growth potential and inequality in other countries, particularly within Africa?

The Commission for Africa convened by the UK government in 2005 recommended funding more research and development in medicine and vaccines, as well as a major increase in agricultural research and innovation. As part of a broader programme of capacity building, it also recommended the commitment of US$3 billion over ten years to develop centres of excellence in science and technology in African institutes. But do such suggestions go far enough in engaging with the livelihood concerns of poor people and involving them in the decision-making process? Or will the plans provide islands of technical excellence, which fulfil donor requirements but are divorced from the lives of the people they are intended to help (Scoones et al. 2006)? What is the relationship between institutions and the evolution of technological and scientific trajectories (Chataway 2005)? How can firms in developing countries compete with industrialised counterparts (Forbes and Wield 2002)? Are public private partnerships offering new opportunities for developing technological and scientific capacity (Ayele and Wield 2005, Chataway and Smith 2006).

Science and Technology

Science and technology are now two of the most potent forces in human society. Governments look to them for jobs and tax revenues. Consumers engage enthusiastically with the latest gadgets but also respond sceptically to other facets of science and technology. Firms search for the next source of technology-driven profit. Those involved in development seek answers to poverty.

But stepping back we can also see that science and technology are also intimately involved in some of the biggest challenges of our time. In the context of climate change, biodiversity loss and the intractability of global poverty and inequalities, science and technology are implicated in producing as well as in helping to address the biggest question of all: is there a viable future for humankind on planet earth? Are we simply becoming too clever for our own good, lacking in the wisdom needed to use science and technology to create a sustainable future? Does globalisation undermine any attempts to regulate science and technology for the common good, or conversely is it our best hope?

Partly as a result of these debates, the idea of what constitutes sound science is being challenged. Once, knowledge claims had only to meet quite restricted technical tests, conducted by scientific communities themselves, to be accepted as reliable knowledge on which policy decisions could be based.

Now, new knowledge must also be relevant to a much wider range of social interests and must establish broader credentials to be socially robust. This is both because of a growing realisation that some developments in science and technology favour particular interests differently, and because a wider array of actors are demanding a role in governance. Questions include:

- How does institutional scientific knowledge relate to lay or amateur knowledge?
- How does official scientific expertise relate to the experiential expertise often held by publics?
- How do the ways that knowledge is collected and organised affect its relevance and use?
- How do the discourses created in 'official' science influence policy debates, and what impact do these discourses, along with related policy prescriptions, have on locally variable social challenges?

What is more, new science creates new uncertainties and areas of ignorance. Albert Einstein made a sharp observation when he said words to the effect that "as the circle of light grows, the circumference of darkness also increases." For example, scientific debate and uncertainty over the adverse effects of vaccines is intensifying as a result both of new generations of technology such as DNA vaccines, and the proliferation, combination, and interaction of vaccines and also their interplay with the evolution of the diseases they are designed to address.

"People talk today less of globalisation and its benefits, more of globalisation and its discontents"

Gordon Brown, UK Chancellor of the Exchequer, 21st June 2006.

Globalisation

At the same time, globalisation is seeing an acceleration in the movement of ideas, people, technology, information, finance and culture. As an idea, globalisation is so resonant that it is frequently picked up and used by influential players such as politicians in their rhetoric – viz the almost continuous reference to it and the 'competitive threat' that workers and firms in the rich world face from China and India.

The influence of developments in China and India are important, and are undoubtedly having global effects. But not all of the effects are negative. Competition from cheap labour in sectors such as call centres can divert jobs abroad, but can also help to drive efficiencies in countries such as the UK. And China's exports of cheap goods have helped to drive down costs in developed and developing countries.

But while acknowledging that globalisation is happening, its dynamics and effects are often far more varied than popular and political discourse sometimes suggest. The effects of globalisation are positive or negative depending on your perspective of developments such as the movement of people, the exchange of ideas and the cross-pollination of cultures. Globalisation also allows for trans-national alliances for the transfer of science and technology and also for the exchange of information among those involved in the civic sector and activism.

The idea that the spread of forces such as trade, technology, communications and culture are having global impacts often overlooks the huge disparities in their impacts in different regions. Globalisation seems to imply both that everything will become the same, which does not seem to be happening, and that this is deterministic – that there are few levers to influence it; this is also open to question. It may seem obvious that factors such as trade and the Internet are making knowledge and culture global, but what do we see if we look closer?

Much research over the years has shown how global transformations are intimately connected with local ones; as global forces are appropriated and creatively transformed in local settings, and as diverse local movements connect up across localities to influence global processes.

Science, Technology and Globalisation

Within this context, we need to ask how science, technology and globalisation are linked. As some of the research reported in this document shows, the global movement of scientists and scientific and technical knowledge and innovations are both facilitated by globalisation and help to reinforce it.

As we shall see, science and technology are often assumed to lead to social and economic change (whether economic growth, allowing countries to become more competitive in a global economy; or direct impacts on poverty reduction) – yet there are hotly contested questions around who really benefits, when and where.

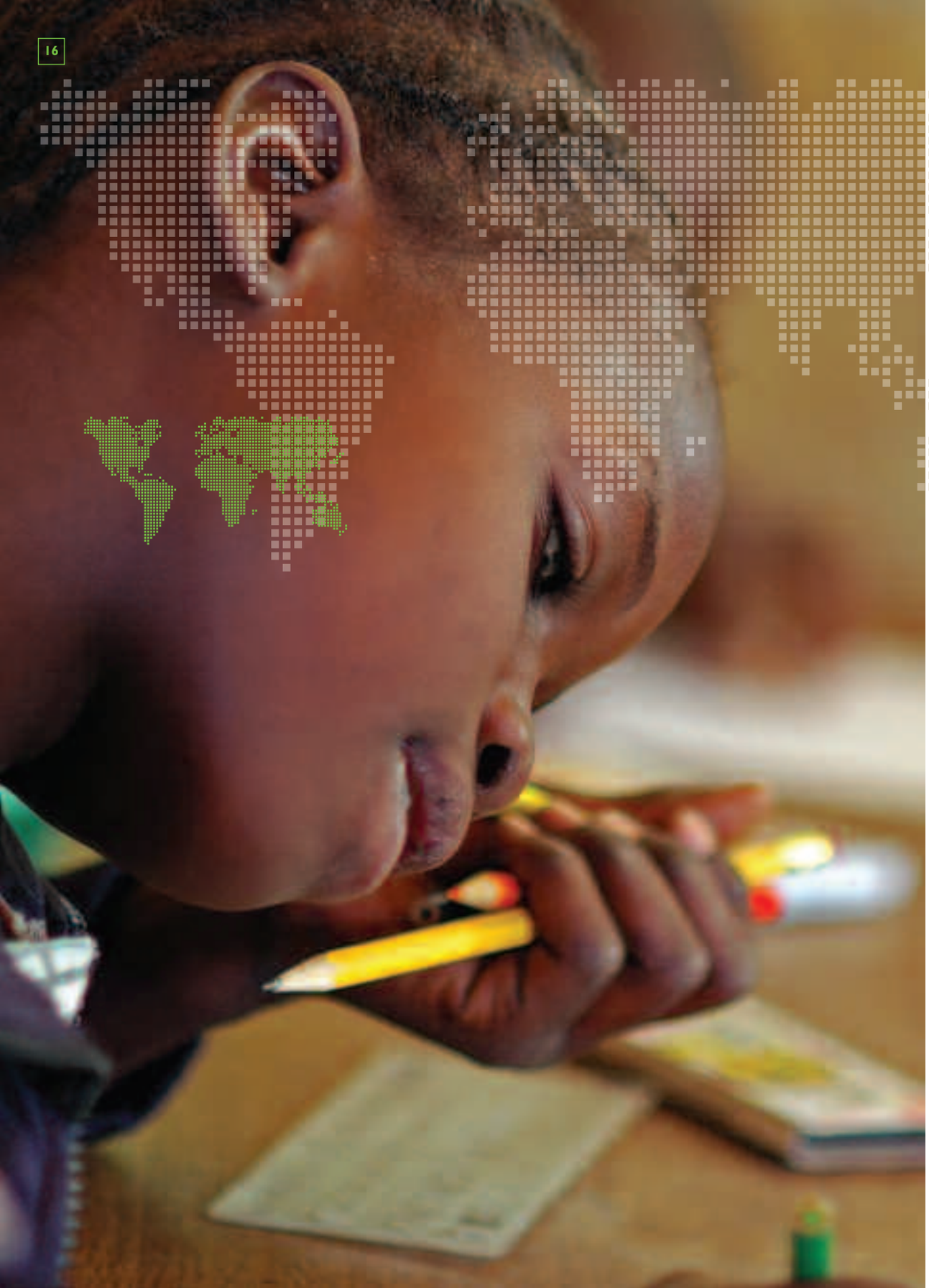
Partly this is about the risks and uncertainties associated with science and technology, leading to outbreaks of controversy and opposition to particular developments in both North and South. But partly these displays of scepticism towards science and technology are founded on a different basis – that scientific and technological solutions are pushed by technical elites who are disconnected from local needs and understandings. People are suspicious of the motives behind the futures being suggested, and are not sure if they like the way that some scientific and technological developments will change their way of life.

This is because science and technology are themselves increasingly globalised – they involve global institutions, international organisations, multi-national corporations, as well as global communications and networks of scientists and policymakers. What does this mean for how publics engage with science (Harsh 2005, Wafula and Clark 2005)? We need to re-think many of the established debates about democratic participation for this globalised world (Leach, Scoones and Wynne 2005).

While science and technology are often portrayed as, or assumed to be, engines of social progress, how do they really measure up in an increasingly connected yet divided world in which the poor have less input into decisions about the directions for, and uses of, science and technology? Can technologies developed for profit serve needs across society? How can they be adapted and regulated for different social contexts, especially in countries that have relatively less capacity to regulate?

Do science and technology 'solve' human problems? For example, vaccination is argued to be critical for reducing mortality and tackling 'diseases of poverty', and yet it has also become a source of new problems in the form of public anxiety and distrust of the medical establishment and associated government policies, not only in the rich world. What are the forces at work here? What does science need to learn from the public, as well as the other way round? An important consideration is the unevenness of involvement in science and technology, innovation, diffusion and regulation.

Another consideration is the difficult role of science in resolving public policy dilemmas – especially those involving trade disputes over the desirability of controversial commercial products. Science and technology are linked together in producing new global technological trajectories, yet are also called upon to provide 'neutral' evidence to inform public debate and policy decisions.



Challenging Common Assumptions

In discussions around science, technology and globalisation, several assumptions are commonly made that have been challenged by research within and beyond the Science in Society Programme. This section examines several of the most high-profile of these assumptions in the light of the research, challenging them on the basis of evidence from research.

The first common assumption is that science and technology are freely available through publication of scientific information, making it straightforward to diffuse knowledge and information; knowledge is effortlessly 'global'. But the problem is not information but the ability to create and use it, the uneven distribution of people who have had the training required to be able to handle such information, and related consequences.

Equally, who has control over scientific information, particularly in an era of ever-strengthening regimes for protecting intellectual property? At a more basic level, the world's poor and illiterate still lack access to the most straightforward knowledge and information; billions have no access to libraries let alone the Internet.

Numerous studies of innovation in firms show that success is based on 'tacit' knowledge that exists in the heads of employees as well as 'codified' knowledge that is written down (Forbes and Wield 2002, Smith, 2005). As we shall see, studies such as that by Professor Wield and Dr Kale on scientists and managers returning to India are starting to analyse the challenges associated with the movement and management of people.

A second assumption is that scientific and technological knowledge is universal, independent of context. But science is highly diverse in practice, and in the aims it serves, and needs to be adapted to local circumstances. As Claire Waterton's research shows, attempts to collect universal styles of scientific knowledge can alienate some of those who have valuable on-the-ground knowledge. There is a tension between the policy-led drive to standardise and globalise biological data to make it relevant for biodiversity policy, and the quite different set of motivations and expectations that drive the disparate and localised members of the community who contribute biological records.

Equally, applying 'universal' ideas developed within the realm of science can be inappropriate to local needs, interests and cultural settings. For example, western science has developed ideas about vulnerability to HIV/AIDS among different social groups, but how suitable is it to transfer these ideas to the Indian context (Karnik 2001)? As several analysts point out, the social conditions in India are very different from those in rich countries: there are groups with 'endemic diseases and immune-system weaknesses due to extreme poverty, lack of hygiene or malnutrition' (Wynne 2005:

"At a more basic level, the world's poor and illiterate still lack access to the most straight forward knowledge and information"

75). Here, the transfer of western science is a form of globalisation, but it is one that is largely unaccountable, uncritical of its own assumptions, and may be irrelevant to local conditions and social needs or worse – it may produce policy proscriptions that are actively damaging.

In response to these challenges some initiatives are clearly fashioning more collaborative styles and strong civil society organisations; governments such as the Indian Government are insisting on deeper partnerships (Chataway and Smith 2006). In Africa, NEPAD's (New Partnership for Africa's Development) leadership in establishing regional centres of excellence is one of several initiatives trying to establish institutions that are directed from that continent and more responsive to local conditions.

A third common assumption is that technology is socially neutral; technology is often seen as being outside politics. But technological trajectories are dependent on people making decisions at many different levels. How are these decisions made? Who has the authority and influence to make and shape decisions? How can decision processes be structured to be more open, explicit and democratic? These are particularly difficult questions at the global scale and there is not one single authority or institution responsible.

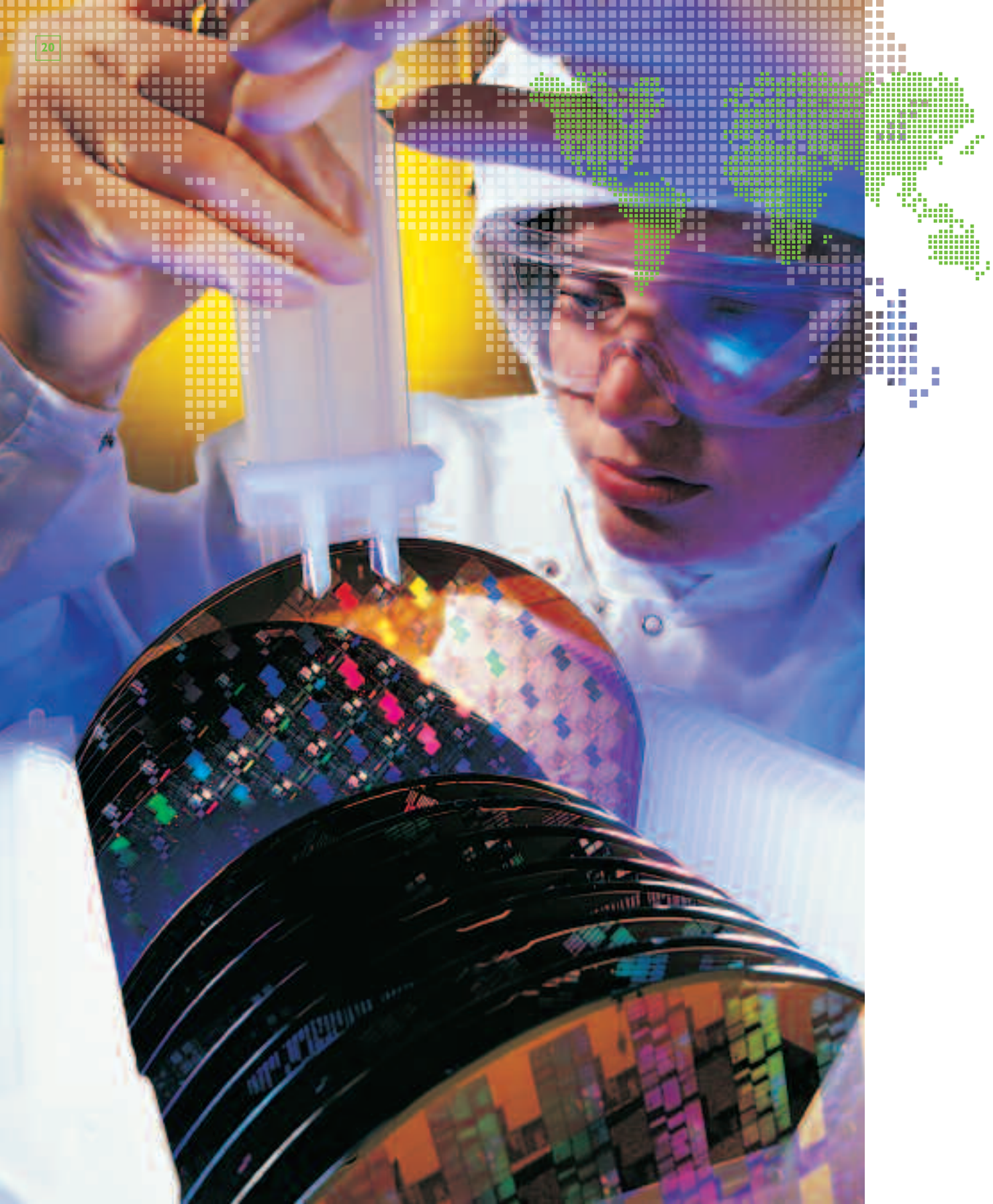
As Professor Stirling argues, "the form and direction taken by science and technology are no longer seen as inevitable and monolithic, awaiting 'discovery' in nature. Instead they are increasingly recognised as being open to shaping by individual creativity, collective ingenuity, cultural priorities, institutional interests, stakeholder negotiation and the exercise of power." (Stirling 2005; Scoones, Leach and Cockburn 2006).

A related fourth assumption is that science and technology automatically address social needs. But in a world where most technological innovation takes place in private-sector firms, and is therefore driven by the prospect of profits, the needs of the poor – who by definition rarely present a lucrative marketing opportunity – often simply remain unaddressed. As Professor Chataway's research shows, various attempts are being made to bring together the public-interest institutions of the public sector with the capabilities of the private sector through various forms of partnership.

Adopting an 'innovation systems' approach can be helpful as it draws attention to the need to look not at the science and technology but at consumers and manufacturers and the complicated sets of interactions that go into getting science and technology based products to those who might benefit from them. Another set of questions relates to how research agendas are set within public-sector science, and whether criteria relating to social need are built into scientific decision-making.

A final set of assumptions relate to the strong contrast that is often drawn between public reactions to science and technology in the rich and poor worlds. For example, as the research by Professor Fairhead and colleagues shows, it is often assumed that a concern with vaccine side-effects is a luxury of those in the north who are no longer familiar with the childhood diseases ravaging the south, where the more important clamour is for vaccine access. This evokes a broader contrast between late-industrialised 'risk society' and a still-to-modernise 'underdeveloped society'.

Commentators have often drawn a contrast between the anxious middle classes, as against a more compliant poor. A further contrast turns on irrationality vs. rationality, associating vaccine anxieties in the south with incomplete (although rising) scientific rationality in settings where 'traditional' beliefs still predominate and in the north, with a 'rise of irrationality' in society, as evidenced for instance in the increasing popularity of alternative medicine. Vaccine anxieties in the north are often cast as part of a generalised breakdown of trust in public institutions, evidence of growing critical public engagement with scientific expertise. In contrast, southern analytical traditions stressing the non- or incomplete integration of expert science with 'indigenous knowledge' and beliefs tend to attribute vaccine anxieties to collective resistance based on religion or traditional beliefs. Yet as we shall see, research challenges these stark characterisations of the differences between perceptions of science and technology in the rich and poor worlds.



Divides and Diversity in Global Science and Technology

This section explores two complementary themes within science, technology and globalisation: divides and diversity.

- The research within the Science in Society Programme has thrown up evidence that in the context of globalisation, science and technology are involved in a series of struggles that might be characterised as 'divides'. These are the gaps that often appear between those that have or do not have access to the resources of the knowledge economy and related policy processes.

- The other, complementary theme, is that of diversity. Here, the research is suggesting that far from apparently 'universal' science and technology making the world more the same, they are resulting in widely diverse practices and supporting diverse institutions, cultures and communities of interest.

Science and technology are deeply involved in processes of globalisation. Emerging global technologies such as biotechnology and vaccination bring the need for styles and institutions of governance that allow for the appraisal and adoption of innovations but also their regulation. But there exists a series of divisions around the production, use and evaluation of technologies: the 'digital divide'; vaccines; and access to resources.

"Science and technology are deeply involved in processes of globalisation"

Globalisation, Science and Technology – Analysing the Divides

How does science, technology and globalisation create divides? How are decisions over science and technology made, and who is involved? How much scientific research and development is done in and for developing-country challenges? For example, the Global Forum for Health Research has concluded that 90 per cent of the world's health research is spent on research into problems that only affect ten per cent of the world's people. Are the millions of dollars being put into treatment of neglected diseases helping to rectify this imbalance or are they missing their targets? What will be the impact on the global picture of newly powerful pharmaceutical industries in India and elsewhere?

In other cases, there are fierce debates about the acceptability of new technologies and scientific perspectives, approaches and solutions, including global resistance in some cases but not others. The controversy in 2002 over US food aid to some African countries using GM maize has been notable.

Science and technology are involved in generating several forms of global 'totalising' knowledge or discourses. For example, Dr Mehta suggests that 'scarcity' is a totalising discourse – an idea that explains a wide range of phenomena in different locations, despite widely variable local realities. Here, scarcity is playing a similar role in developing societies that 'risk' has come to occupy in the industrialised world. In both cases, science and technology are often expected to provide solutions, but such expectations embody a multitude of unexamined assumptions about the nature of the 'problem' and give rise to technocratic expertise that may be disconnected from local needs and priorities.

The research highlighted in this section illustrates the theme of 'divides' by showing how science and technology can become implicated in promulgating ideas that reinforce disconnections between local needs and national/global policies, and expert knowledge from local knowledge. Much of the work also challenges some of the assumptions outlined earlier, such as when technological choices or expert 'solutions' are considered to be free of politics; technology is supposed to provide solutions that are socially neutral.

In Mehta's research, economic theory is used to justify demand-oriented solutions that enhance the efficiency of water use, such as privatisation and the creation of water markets. Engineering perspectives are also powerful: in the water domain, most of the solutions suggested by global agencies such as the World Bank are supply-oriented and call for the need to build more dams and other innovations such as inter-regional water pipelines in order to 'provide water to all'. Yet each of these solutions favours certain interests over others, and the needs of the poor often remain overlooked; science and technology are implicated in further reinforcing social divides.

Project: Science, Technology and Water Scarcity

Water scarcity is one of the world's most pressing problems: around a billion people currently lack access to clean water and the United Nations estimates that 2.7 billion people will face water scarcity by 2025. But what is scarcity? Why is there so much controversy around many of the solutions to water scarcity that are suggested by experts and international agencies?

In this research, Dr Lyla Mehta of the Institute for Development Studies examined the idea of scarcity in the way it is used to inform water policies and programmes. She concluded that the definition of scarcity used by many analysts and agencies tends to ignore the local, social dimensions of access to clean water, focusing instead on apparently 'global' technological or economic solutions. Many of these are simplistic and inappropriate to local needs.

Global agencies such as the UN, the UK's Department for International Development and various aid charities are concerned with an emerging water 'crisis'; there is even talk of the possibility of 'water wars'. But there are many fierce debates about some of the 'solutions' that are suggested for reducing water scarcity: interventions such as large dams, the creation of markets in water provision, and privatisation.

At the global level, science and technology are often expected to provide solutions to problems such as that of water scarcity. This research indicates that such expectations embody many unexamined assumptions about the nature of the problems. The research found that global ideas such as scarcity – and the global solutions that are suggested – can give rise to technocratic expertise that is disconnected from local needs.

The project examined how engineering, economic, hydrological and other scientific perspectives define 'scarcity' and how science is used to legitimise potential solutions. It then investigated the scientific, ideological and technological premises behind these 'solutions'.

The research focused on global portrayals of, and solutions to, scarcity as put forward by the World Bank, UN and other supra-national bodies concerned with water, and examined how these debates are picked up or resisted in South Africa and India.

Debates about scarcity often focus on volume and physical measures – the social dimensions are often ignored. Yet we have long known that access to resources is often not purely about absolute volumes. For example, Sen showed that many famines have occurred in countries where there is enough food; people's poverty and the absence of any political desire to re-distribute resources have often been the real causes of famine.

So it was a surprise even to Dr Mehta how much the idea of scarcity is taken for granted, not only among the agencies that she studied, but also in debates around science policy and environment/ development more generally. The

idea of scarcity powerfully frames problems, justifies technological interventions and legitimises policy approaches. Dr Mehta concludes that scarcity is not a 'natural' condition, yet most global portrayals of water scarcity see it as something natural, instead of something that is social in character.

Globally as well as in national contexts such as India, official definitions of scarcity usually look at absolute population numbers and absolute quantities and talk little about the politics of distribution. In South Africa, questions of equity and access have emerged as key and the socio-political nature of scarcity is recognised in official debates. Despite this, there are serious problems in bringing this perspective into policy-making, leaving the risk that the poor and historically excluded may not benefit from redistribution for a variety of reasons.

Even though scarcity is a multifaceted and complex phenomenon, in most popular and official discourses it is universalised and naturalised; it is convenient to stick to this simplified notion. Scarcity is a concept widely assumed to provide 'explanations' for a wide range of phenomena over which humans ostensibly have no control. Unfortunately, this leads to global solutions such as dams or water privatisation that are often inappropriate in local contexts, and that often fail to address the deeper social causes for lack of access to water.

Science, Technology and Water Scarcity: Investigating the 'Solutions'

Dr Lyla Mehta, Institute of Development Studies, University of Sussex

Water scarcity is one of the world's most pressing problems: around a billion people currently lack access to clean water and the United Nations estimates that 2.7 billion people will face water scarcity by 2025. But what is scarcity? Why is there so much controversy around many of the solutions to water scarcity that are suggested by experts and international agencies?

This project concluded that:

- the definition of scarcity used by many analysts and agencies tends to ignore the local and social dimensions of access to clean water, focusing instead on apparently 'global' technological or economic solutions
- many of the definitions used are simplistic and inappropriate to local needs.

http://www.sci-soc.net/SciSoc/Projects/Globalization/Science+technology+and+water+scarcity.htm

Regulatory Divides: Capabilities and Pressures

There are clearly also divides in the capabilities required to regulate the risks associated with new technologies such as biotechnology ('biosafety'). African countries face extreme constraints in scientific and technical resource. And yet the African experience of regulation echoes the difficulties experienced in Europe and elsewhere of constructing regulatory systems that are harmonised between countries, for example on biosafety.

Across the region the convergence of biosafety systems is perceived as desirable. But methods of achieving it are unclear, as there is no one single model to converge to. Some initiatives lack a mandate and actor participation, in addition to practical logistical and financial constraints. Participation is often influenced by donors and professional interest groups; some actors, notably farmers and consumers, miss out in many cases.

Some of the initiatives subscribe to one or the other divergent approach to the regulation of GM crops followed by North America (or the US) or the European Union, adding difficulties in terms of choosing a particular model in the countries as well as for harmonising national biosafety systems at Africa level. The biggest challenge to harmonisation, however, can be the disparities in African economies and resource distributions. These in effect will determine how the different players will benefit or lose from harmonisation; countries with better scientific and technological capacity are bound to reap the best benefits from harmonisation.

Yet, there are factors that are distinctive in Africa. For example, pressures to overcome trade constraints place many countries in a difficult position as they are squeezed between contradictory messages from the US (broadly pro-GM) and Europe (where much policy and consumer preference remains anti-GM).

"Many African countries are too resource poor to develop and exploit biotechnology"

Project: Regulation and Biotechnology in Africa

New technologies such as biotechnology bring uncertainties and public concerns about their environmental safety and potential impacts on human health. Various international efforts to ensure biosafety – such as the Cartagena Protocol in the biotechnology field – have been developed to help in these cases. Yet little is known about how regulation is developing in poor countries in Africa.

In this research, Professor Joanna Chataway and colleagues investigated how crop biotechnology is being regulated in three African countries – Ethiopia, Kenya and South Africa. The study clearly indicates that increased R&D and commercialisation of GM crops in Africa, and trade and food aid in GM products have brought the GM debate into the public domain. There is a perceived need to harmonise African biosafety systems.

As signatories of the Cartagena Protocol on Biosafety, many African countries are currently engaged in implementing the Protocol's framework, which aims at a harmonised system for regulating biotechnologies. As part of the harmonisation effort, different approaches, such as voluntary regulation, have been applied but no regional African directive has yet emerged.

In a number of countries, GMO (genetically modified organisms) regulation is being conducted on the basis of interim (legally non-binding) instruments such as 'guidelines'. Only South Africa, Egypt and Mauritius have GMO Acts. The researchers also found that the governance of GMOs lacks wider participation. For example, the implementation of the Protocol's biosafety framework in Ethiopia and Kenya has been taken over by one or other of the dominant protagonists, limiting the participation of many important actors.

Hence, adding to the disagreements about the inherent attributes of the technology, the process of institutionalising GMO governance has become a source of contention in some contexts.

What is more, the challenge of governing biosafety requires skilled people and appropriate institutions, yet this capacity to govern biosafety is limited, and skewed towards relatively richer countries in the region. Despite this, governments are putting in place complex biosafety systems. In Kenya, decisions about GMOs are monitored by no less than five government departments whose mandates are inadequately defined, and whose understanding of the technology is limited. By contrast, in South Africa, which is widely considered to have relatively high levels of biosafety capacity, a single inspectorate monitors decisions on GMOs.

The rising cost of regulation is a concern, particularly to small (and publicly funded) GM technology developers and suppliers. Regulatory costs emerge from complex application and decision-making processes, regulatory fees, and most importantly from the cost of collection and verification of evidence related to risk assessment. The Insect Resistant Maize for Africa (IRMA) project in Kenya, for example, has put facilities in place (labs, greenhouses and field test facilities) with substantial finances spent on risk management.

Many African countries, taken separately, are too resource poor to develop and exploit biotechnology. This raises several potential constraints on the development of biotechnology:

- National differences over the scope of regulation and criteria for decision-making over GMOs and labelling of products.
- Disparities in African economies are making harmonisation more difficult.

These problems could – as suppliers argue – put up artificial barriers to using the technology, and raise the production cost of the technology and the prices to users. In response to such limitations, agencies like the New Partnership for Africa's Development (NEPAD) are developing regional centres of excellence.

However, regulatory procedures can improve over time. Despite the extreme constraints that many African countries face in terms of scientific and technical resources, regulatory systems are innovating. For example, in the IRMA project in Kenya, it took one year to approve the first application to import Bt* maize in 2000; application forms and decision-making were complicated, and there was no proper documentation of decisions and communications. In many areas these have improved through concerted internal learning, and via a series of capacity-building and training initiatives. IRMA's third application in 2004 to move seeds from greenhouse to controlled field tests took only three months.

Regulatory Practices and Challenges of the African Crop Biotechnology Sector

Professor Joanna Chataway, Open University

How do societies ensure that new technologies are approved for biosafety? How is biotechnology regulation conducted in Ethiopia, Kenya and South Africa?

This project found that:

- increased R&D and commercialisation of GM crops in Africa, and trade and food aid in GM products have brought the GM debate into the public domain
- there is a perceived need to harmonise African biosafety systems.

http://www.sci-soc.net/SciSoc/Projects/Globalization/Regulatory+challenges+and+pratices+of+the+African+crop+biotechnology+sector.htm

* Bacillus thuringiensis is a soil dwelling bacterium also found naturally in the caterpillars of some moths and butterflies, as well as on the surface of plants. Spores and crystalline insecticidal proteins produced by Bacillus thuringiensis are used as specific insecticides, and some genes have been used in genetically modified crops such as cotton and tobacco.

"Technological goals have been pursued at the expense of user perspectives"

Scientific Expertise and Lay Knowledge – Another Divide?

There also often appears to be a divide between scientific expertise and lay or amateur-practitioner knowledge. Is lay involvement a tokenistic nod at participation or driven by a genuine belief that it can assist substantively? What are the implications of plural knowledges for the conduct and governance of science, and what are the interactions between different knowledge systems?

The question of how we approach the substantial challenges of making strong connections between centralised, standardised information on the one hand and the specific exigencies and information needs of local people and places on the other has been explored in the next research project.

Project: Databases, Local Knowledge and Global Conventions

There is widespread concern about the loss of biodiversity, not just in high-profile cases such as the tropical rain forests but also in countries such as the UK. The last 60 years have seen the fragmentation of many habitats and the loss or dramatic decline even of once-common species. The need to halt this decline is the job of several agencies in the UK, and a core part of this job is to collect scientific information on the state of our biodiversity.

In this research, Claire Waterton and colleagues at Lancaster University investigated how information on biodiversity is collected, and how this influences its use in informing policy decisions. She was particularly interested in the design of the databases that are used to collect information on biodiversity. Does this design influence whether people contribute to and use the databases, especially those who are working on the ground to record and protect biodiversity?

One of the three databases being studied – 'Recorder' – is officially sponsored by the UK Joint Nature Conservancy Council (JNCC). It has been costly to develop and is elaborate in design: technologically it is impressive. However, technological goals have been pursued at the expense of user perspectives, potential input and needs. It is clear that the database, as it has increased in complexity over recent years, has become distanced from those that work to protect biodiversity at various levels.

There are several problems. First, it does not appeal to many naturalists: its structure is too elaborate, and it takes too long to input data. Second, because of this distance between naturalists who record nature and this official database, even those who work in government institutions are wary of using it as a source for accurate information. Instead they may by-pass the database and contact individuals whom they trust to give them the latest up-to-date information on a given species or location.

The technological achievements of the database have ironically alienated many of the people on whom it depends for good data. Unused by trusted naturalists, the database is in danger of losing authority. Its impressive abilities to collate data and create reports for those who are creating policies for protecting biodiversity in the UK and beyond are impotent without the input of reliable data from those who are monitoring biodiversity on the ground.

Given time, this database may become trusted and used. Yet the fundamental problem of its design-unfriendliness to the time-pressed naturalist may lead to its demise as a useful tool in biodiversity policy. A likely scenario is that the database continues to be used in policy, even though its data may be incomplete and out-of-date. If this happens, the scenarios and reports it creates will be utilised only by those who are out of touch with realities on the ground.

Symbolically, the database may perform well at national and global levels. However, an underlying circuit of actors who are in the know about species trends and decline will view this symbolic show of data as a charade, further alienating them from official data-gathering technologies and driving them into communities of knowledge production and exchange that have no purchase on biodiversity policy or decision-making.

By contrast to this expensive, elaborate and centralised database, another database – 'MapMate' – is much simpler, and sees approximately 100 million records trafficking between users in most months. MapMate has been a more stable software, always belonging to the same company and with minor changes being introduced. It answers to the more grounded needs of naturalists and it fosters collaboration and exchange of data amongst them. These millions of records about the natural world, however, are not likely to reach the databases that inform policy judgements or decision-making about environmental protection.

Databases, Naturalists and the Global Biodiversity Convention

Claire Waterton, Lancaster University

What are the different implicit visions of science, society and environmental governance embedded within the two main biodiversity database technologies? What potential fruitfulness could be gained by intermingling what appear to be two distinctive philosophies of constructing information about the natural world?

This project aims to find out:

- how information on biodiversity is collected, and how this influences its use in informing policy decisions
- if the design of databases influences whether people contribute to and use the databases, especially those who are working on the ground to record and protect biodiversity.

http://www.sci-soc.net/SciSoc/Projects/Globalization/Databases+naturalists+and+the+global+biodiversity+convention.htm

Scientific Controversy: Divides or Framings?

So far we have dwelt on the theme of divides in global science and technology. On closer inspection, however, research suggests that this divide is sometimes more about different framings of the topic in hand – we see a diversity of ways of seeing a scientific or technological question rather than a narrowing on any simple dichotomy. Sometimes the 'divides' are more apparent than real; they are part of policy stereotypes, but realities on the ground can challenge them, or nuance them.

Take the case of citizen action around the MMR vaccine. Here, rather than seeing a divide between 'scientific' and 'public' approaches to vaccination, we see coalitions of different scientists and publics line up on either side. This challenges established models of expert-led science, expert-determined delivery of technology, and public education for compliance, as well as distinctions between 'neutral' science and 'messy' politics. While emergent public concerns are evident in both the UK and parts of Africa, these are far from generalised across society and run alongside acceptance of, and often a strong desire for, other vaccinations and delivery regimes. Such understanding is essential to inform new and more nuanced approaches to public engagement amongst medical research and public health organisations. Many now recognise that 'top-down' education to secure public acceptance of vaccine technologies is insufficient, and are reflecting on appropriate ways to respond to public concerns. This may involve developing new forms of dialogue and public involvement in setting and developing vaccine research, scheduling and education agendas.

Project: Childhood Vaccination: Global Science and Public Engagement

The production and delivery of new vaccines has become a major focus of globalised science and investment. Multi-national pharmaceutical companies, global health organisations and others now interact with both wealthy and poor governments to extend vaccines to every person on the planet, moulding health services in the process. Yet recent, high-profile controversies point to public anxieties around the production and application of vaccine technologies.

In this research, Professor Leach and colleagues compared such controversies in several parts of Europe and West Africa. What happens when this rapidly advancing, globalised health technology and associated technocracy encounters the deeply intimate personal, cultural and social worlds of parenting and childcare? Although the science of vaccination – and many of the institutions involved – may seem global, vaccination programmes play out in very different ways depending on the diverse political and institutional contexts involved.

"Many now recognise that 'top-down' education to secure public acceptance of vaccine technologies is insufficient"

Since the 1990s, parental concerns in the UK over possible adverse effects of the measles, mumps and rubella vaccine (MMR) have built into a movement that has engaged vigorously with scientific and media debate. MMR uptake has fallen by 30 per cent in some localities. In Northern Nigeria in 2003-04, parents and their communities refused the Oral Polio Vaccine, associating it variously with HIV transmission, infertility and international and national genocidal politics. The global polio eradication programme stalled, and polio re-appeared throughout West Africa.

Health policymakers have often treated the MMR controversy as a case of 'science' versus misguided publics who misperceive vaccine risk. Yet a closer look reveals a different dynamic. On the one hand, the pro-MMR lobby has united government interests with population-level epidemiological science. On the other, a parental movement has questioned the effect of MMR on a particular group of vulnerable children, through their own experiential expertise, citizen science and alliances with certain clinicians. These distinct framings have spoken past each other, prolonging the controversy.

In West Africa, many Gambian citizens have expressed anxieties about participation in globally orchestrated vaccine trials. Whereas scientists and global bio-ethical debates see this as a problem of information and 'informed consent', local perspectives are broader, turning on fears that the research institution 'steals' blood from local people for sale in Europe. A local discourse about an 'economy of blood' links people's lay knowledge of bodily processes with reflection on global political economy – are the rich gaining at the expense of the poor?

In both the British and Gambian settings, parents treat vaccination issues as part of a wider reasoning concerning child well-being, which interplays with observation and evaluation of a child's particular health history, strength and vulnerability. It is not simply a matter of generalised risk perceptions or trust/distrust of state, scientific, corporate and global institutions.

The research also found similarities between the West African and British settings, which have conventionally been theorised very differently. The research finds many commonalities that undermine influential ideas about the stages that different societies are at: that African societies are moving into a 'modern' phase – becoming bio-medicalised, post-traditional, and rational – and that European societies are becoming de-medicalised, post-modern and more irrational.

As interviews revealed, local health professionals frequently face two dilemmas: between their felt institutional obligations to deliver information that MMR is safe and their own uncertainties, and between advice to vaccinate for the social good of herd immunity and encouragement to personal choice – leading to a wide variety of interactions in practice. The 'framings' perspective developed here should help public health authorities to think in richer ways about how they respond to public controversies around medical science and technology.

Childhood vaccination: Science and Public Engagement in International Perspective

Professor James Fairhead, University of Sussex and Professor Melissa Leach, Institute of Development Studies, University of Sussex

This project investigated aspects of the science-society relationship in the context of childhood vaccination, focusing on the case of measles, mumps and rubella (MMR) in Brighton, UK, and on the intersection of routine vaccination with Medical Research Council (MRC)-orchestrated vaccine research in The Gambia.

It explored:

- how different parents' concerns are shaped by conceptual frameworks and knowledges around disease and immunity, and broader experiences of the state and of science and how different people consider trade-offs between social and individual benefits and risks
- how vaccine scientists and public health professionals conceive of public perspectives around vaccination, and how 'frontline' staff mediate professional and public views?

http://www.sci-soc.net/SciSoc/Projects/Globalization/Childhood+vaccination.htm

Convergence and Diversity in Global Science and Technology

Rather than the divides that arise from globalised science and technology, the second of our cross-cutting themes explores the convergence and diversity of knowledge, policy and practice that often result from them. In science and technology studies, a key recent argument has been that the implications of technology cannot be gauged in the abstract, but only in their use. Thus much of the research reported here builds on empirical studies of science and technology in use, and the diverse results that we see as a result, as well as attempts at harmonisation and convergence.

One of the concerns around globalisation is that we are seeing an international concentration of expertise in rich countries, and with it the potential for economic success and social progress. Several of the research projects here comment on this theme, pointing to the existence of a growing 'reverse brain drain', and also to the use of a partnership approach to help facilitate international transfer of the benefits of science and technology. The generation of indigenous capabilities in science and technology will have impacts on their ability to interact with international markets, help frame global agreements, and adapt and develop regulations to local conditions.

Another strand of research has looked at the internet: is the huge amount of information on the net helping to create and support a diversity of perspectives and expertise, or is it resulting in a concentration of information resources, and a reliance on just a small number of sources of expertise? In an age of information overload, coupled with the increasingly controversial character of debate about the options we face over our scientific and technological futures, such questions may seem distant from the everyday concerns of 'real people' but are nevertheless likely to be increasingly significant for the development of governance.

Capabilities are Key

People are central to global science and technology – they carry with them the capabilities that determine scientific and technological outcomes. Recent decades have seen a 'brain drain' from poor to rich countries, as talented young people seek a higher quality of life with their educational achievements as their passport. This further reinforces the divides between the 'haves' and the 'have-nots', and between developed and developing countries.

Evidence suggests that mobility of experts or scientists who have had foreign education has played a crucial role in the economic success of countries such as South Korea and Taiwan. Here, the 'reverse brain drain' proved critical in shifting these countries from being a peripheral source of cheap labour to being global leaders in IT production. Research within the Science in Society Programme explored this reverse brain drain in the Indian pharmaceuticals sector.

Project: Brain Drain or Brain Circulation?

If developing countries are to benefit from global science and technology, they need people with the relevant knowledge and skills. Yet in recent years, countries such as India have seen many of their brightest and best-trained people leave to take up opportunities and education in rich countries such as the US. This brain drain contributes to the uneven global distribution of scientific expertise.

In this research, David Wield, Dinar Kale and colleagues investigated the opportunities and challenges brought by the fact that Indian scientists in the pharmaceutical sector are starting to return to India, particularly from the US.

Traditional concerns about the brain drain from poor to rich countries are changing: talented engineers and scientists are returning to their home countries to pursue promising opportunities. This 'brain circulation' can accelerate the technological upgrading of developing economies by transferring up-to-date technological knowledge and market information. Such scientists or engineers can provide the skill and know-how needed to help local firms shift to higher value-added activities.

However, this project showed that Indian pharmaceutical firms are realising that bringing scientists back is not enough; assimilating and making their knowledge useful brings several challenges. These include integrating scientists into established routines, and making sure that 'return incentives' do not have negative impacts on existing employees.

Changes in patent law, particularly the emerging Trade Related Intellectual Property laws, have severely affected the pharmaceutical industries in countries like India, which have grown on the basis of weak patent laws. To survive in an era where patents provide strong protection for intellectual property, Indian pharmaceutical firms must develop competencies in research and development (R&D).

Scientists from two generations are returning; junior scientists who have recently completed doctoral research, and senior scientists who are close to retirement. For the senior scientists, differences in working culture in the Indian and western firms are significant. Most of the Indian firms are family controlled businesses that have grown in the era of weak patent regimes. This has meant that the working culture in the Indian firms is shaped by the market for generic drugs, where firms have focused on early returns and tight control over margins. This mindset creates conflicts with returning scientists who have mostly worked in western firms whose aim has been to create new drugs protected by strong patents; the latter is based on specialist R&D and long-term investment rather than early returns.

There are also differences between the requirements of Indian pharmaceutical firms and the skill sets of returnees. Indian firms need scientists who can guide or contribute to the firm around the whole drug discovery process. But most of the returning scientists have specialised knowledge in a particular discipline due to their working experience in academia or large western firms, where specialisation was possible and desirable.

The analysis shows that Indian firms responded to these issues by adopting global R&D management practices, such as less hierarchical and more open management structures. The research also shows the importance of social infrastructure on the decisions of US-based Indian scientists to return to India, suggesting an important role for government policy in providing and establishing adequate physical and social infrastructure.

Diffusion of Knowledge Through Migration of Scientific Labour in India: Issues, Challenges and Implications

Professor David Wield, Open University

What kind of advantage can companies in developing countries such as India gain if their best and brightest train abroad and develop their skills in another country before returning? Are the skills and priorities sufficiently similar to allow movement from one environment to the other?

This project found that:

- scientists returning to India from the US were often too specialised in one part of the drug development process to assist companies with the development process in its entirety
- returning scientists found that the priorities of Indian drug companies were very different to those of US companies, developing generic drugs with high profit margins rather than developing new drugs to be protected by patent law.

http://www.sci-soc.net/SciSoc/Projects/Economics/Diffusion+of+knowledge+through+migration+of+scientific+labour+in+India.htm

"In spite of high expectations, private-sector participation from north and south in partnership is marginal and largely symbolic"

Bridging Global Divides: A Diversity of Partnerships

Apart from the market-based trends that we have just seen, which are helping some developing countries to gain access to global scientific and technological expertise, is it possible to design mechanisms for technology transfer? Given the power and speed of technological change, much of which is commanded by the private sector, can the relatively modest resources of public-sector organisations make any impression?

Rather than try to buy or command proprietary technical knowledge to serve the needs of poor countries, those involved in seeking to harness global science and technology for development purposes have recently started to rely on the idea of 'partnership' – bringing together various players with different capabilities to achieve outcomes aimed at poverty alleviation and innovation.

Project: Biotechnology Partnerships for Development in Africa

What is the potential of biotechnology to address the challenges posed by food insecurity, disease, and environmental degradation in developing countries? African countries are particularly vulnerable to these problems, yet have so far reaped hardly any benefit from new biotechnology. Partnership is a widely accepted mechanism for helping developing countries to gain access to global biotechnologies and tools.

In this research, Joanna Chataway and colleagues investigated a range of public-private partnerships (PPPs). These involved research institutions and non-profit and private-sector participants from African and developed countries as well as multilateral organisations such as international research centres.
Many African countries lack the necessary resources – financial, technical and scientific – to acquire, adapt and exploit biotechnology. There are a number of complex reasons for this:

- Biotechnology is knowledge and resource intensive – those who invest in its R&D are largely companies and research institutions in developed countries.

- Most biotechnology products are also proprietary – they belong to the companies that have developed them, and patents protect the intellectual property invested in them.

The project looked at three case studies in depth: the Millet and Sorghum Improvement Initiative in Mali; the Insect Resistant Maize for Africa (IRMA) project in Kenya, and the Agricultural Genetic Engineering Research Institute (AGERI) in Egypt.

The researchers concluded that the partnerships investigated had helped to develop scientific and technological capacity in African countries. However, the PPPs were largely driven by the concerns of donors, and inadequate emphasis was given to the demand side, such as the capacities that allow the delivery and diffusion of products, or ways of making sure that the partnerships reflected national priorities. Some interviewees also felt that partnership was sometimes used as an instrument for mitigating opposition to GM crops.

The study highlights three positive impacts:

- R&D capacity was created to some extent in all three case studies. In particular, scientific staff were provided with the necessary cutting-edge research tools, and appropriate salaries. These provisions motivated staff to stay in their respective countries and mitigated the risk of brain drain.

- These PPPs also helped the development of policy and institutions for biotechnology. For example, the IRMA project in Kenya catalysed the development of guidelines and regulation for biotechnology (Ayele, Chataway and Wield 2006).

- The partnerships also assisted the creation of a variety of new products and companies. In Egypt, Biogro International was a new start-up company supplying the biological pest control tool called Agerin, the exclusive right for the technology being obtained from AGERI.

The major players in global transfer of biotechnology into Africa are: brokers, donors, national agricultural research institutions, and multilateral agencies. In spite of high expectations, private-sector participation from north and south in partnership is marginal and largely symbolic – in Kenya an exception was Monsanto, which donated Bt technology for the production of virus-resistant sweet potato.

A large number of partnerships, at least as far as the evidence from Kenya shows, are formed between public institutions and non-governmental organisations. Predominantly, projects are financed by northern NGOs and public organisations such as aid agencies.

Two major patterns/channels of global technology transfer were identified: those initiated and set up by brokers/facilitators, and those in-built in government/donor development programmes. Approaches pursued by brokers, governments and donors were also different. For example, some facilitate the transfer of biotechnology largely on a commercial basis, whereas others stress royalty-free transfer. On an individual basis, some researchers based at universities and agricultural research institutions have made exceptional contributions to the facilitation of technology transfer.

Institutional Impacts of North-South Partnerships in Agricultural Biotechnology

Professor Joanna Chataway, Open University

What is the potential of biotechnology to address the challenges posed by food insecurity, disease, and environmental degradation in developing countries? What advantage can public partnerships bring to the capacity of African countries to gain access to global biotechnologies and tools?

The researcher concluded:

- that the partnerships investigated had helped to develop scientific and technological capacity in African countries
- the partnerships were driven by the concerns of donors, and more attention needs to be paid to ways of making sure that the partnerships reflected national priorities.

http://www.sci-soc.net/SciSoc/Projects/Globalization/Nov2003.htm

Global Science and Technology: 'Matthew Effect' or Diverse Benefits?

Just as in the case of capabilities, where brain-drain effects can give rise to an exacerbation of global disparities, technical systems do not necessarily lead automatically either to a concentration of 'winners' or, conversely, a spreading of benefits. There is an argument within the social sciences as to whether science and technology are deterministic – they lead inevitably towards certain outcomes – or whether they are open to social influences, policy pressures and 'governance'.

One example to illustrate this question is the World Wide Web. What is its impact as a tool for communicating expertise? Is it more inclusive than more traditional methods? Are we seeing a 'Matthew effect' on the net – referring to the biblical saying (Matthew 25: 29) that 'to those that have shall be given' – where a few sources of knowledge and expertise win out?

Project: The World Wide Web and Access to Global Expertise

In just over ten years, the Web has become – at least for those with access to it – a central tool for seeking information. But we know very little about how – and what type of – information is found. The presence of large amounts of information does not guarantee that anyone will see or use it; there is a risk that we will confuse retrievability with visibility (Hindman, Tsioutsiouliklis and Johnson 2003).

In this research, Dr Ralph Schroeder and colleagues at Oxford University examined how academic researchers access online resources in their field. The academics work in four fields, all of which are global in scope and interest: HIV/Aids, climate change, terrorism, and Internet and society.

The structure of information on the web, and the fact that most of the well-used internet search engines rank sites by the number of in-bound links to web sites, raises the question of whether a few sites will usually dominate when people search for information; how many people will look further than the first few 'hits'? Will the Internet therefore produce a democracy of knowledge, a narrowing of our sources or a 'balkanisation' of knowledge? Will the move from broadcast media to 'narrowcasting' undermine the social discourse and our sense of the collective, weakening attempts at governance?

To give a concrete example, if you were to look for research about climate change or terrorism, would you expect to find a wide array of diverse sources of information about these topics, or by contrast to be directed to only a few top sites? Would you expect to encounter the most highly regarded researchers, or marginal, less-well-regarded ones?

The central question of this project was: does the 'winner take all' on the Internet? That is, is there a greater concentration – or a democratising effect – of online as opposed to offline resources? With academics and others increasingly using the Web and search engines to find information and expertise, the question of whether the use of online resources enhances or diminishes access to the available sources of expertise is bound to become more pressing.

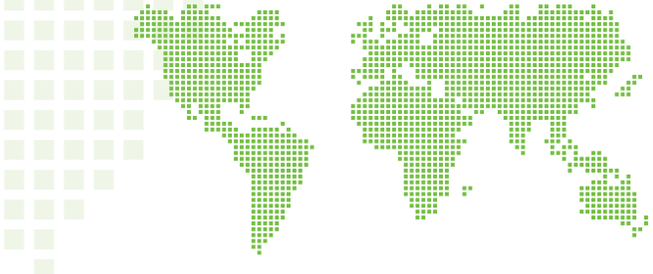
The researchers found that certain clusters of institutions and websites are more prominent than others. A 'webmetric' analysis (of web site links that influence search results) indicated that a few clusters of highly linked sites dominate all four topics. However, interviews with academics indicated that although webmetric analysis correctly identified some of the top 20 sites that were well known to researchers, this top 20 also left out some of the sites that the academics regularly used and regarded as among the most important in the field.

The research also highlighted that the type of search and the topic make a difference, ie whether it is a directed search on a topic where there are established sources, or if the topic requires a more explorative approach aimed at tapping a range of diverse sources.

Search engines, particularly Google, exercise a gate-keeping function that is not sufficiently appreciated. All of the academics interviewed use Google (almost exclusively) to find information on a regular basis; they use Google to look for individual researchers as well as for institutions and particular keywords. Similarly, all of the academics increasingly use online resources at the expense of offline library use.

Implications for researchers include that they need to consider not only what information they make available on the Web, but also how this information will reach its audiences. It is not just the quality of the sites and of the information presented, but also how it is positioned in relation to other sources, and how many sites link to it.

The Web is not just a pathway to unlimited amounts of information, but has a particular structure that determines access. In general, the visibility of a particular topic or source matters more and more. It is perhaps too soon to confirm a 'winner-take-all' effect on the Web, but it is clear that online resources concentrate expertise as well as adding new sources of information.



The World Wide Web of Science: Emerging Global Sources of Expertise

Dr Ralph Schoeder, Oxford Internet Institute, University of Oxford

What type of information is found when we search on the web? How is that information presented to us and will a search engine bring up the 'best' or most appropriate hits?

This project found:

- search engines do not always return sites that are considered to be the most important in the field
- search engines return clusters of websites so that certain sites dominate specific topic areas.

http://www.sci-soc.net/SciSoc/Projects/Globalization/The+World+Wide+Web+of+Science.htm

Conclusions

Science plays a central role in processes of globalisation such as defining and arbitrating global trade disputes, and in structuring and legitimating policies. There is much that can be learnt from the way in which India, China, Brazil and South Africa have increased their scientific, technological and industrial capabilities (Forbes and Wield 2002). At the same time, it is clear that both in industrialised and developing country contexts there is often a gap between policies and initiatives aimed at promoting innovation and industrial growth on the one hand, and social development on the other (Hanlon et al. 2006).

However, science and technology are used by different interests to pursue their goals, calling into question whether they can play a neutral role. At the same time, there are various contrasting forms of 'science' that frame their questions differently, use a range of methods, and draw on a wide array of official and lay/experiential expertise.

The development and use of science in policy at the global level is influenced by the structures and purposes of the global institutions involved. But this science is also contested by other groups and networks, whether in particular localities, countries or regions, or in networks connecting citizens across local sites.

Scientists and experts are often portrayed as neutral arbiters, playing key roles when it comes to decisions that contain scientific and technological components. Yet, as we saw in the case of 'scarcity' in the water domain, this idea of neutrality tends to mask the influences, some of them subtle, around how the questions, ideas or risk assessments are framed.

In the context of such controversies, institutionalised science often regards the matter as being about public education, yet this education approach has failed to address people's concerns and is ultimately ineffective.

"Global technologies such as the web are changing the way people perceive and use science"

In the case of GMOs, opinions and entrenched positions remain as polarised as ever. The research on the regulation of biosafety in Africa showed that the emerging biosafety systems and the biosafety rule-making process are perceived to have failed to find a way through the competing views and concerns over GMOs. This has left sufficiently potent ground for contesting the decisions that are made on GMO activities. Despite some progress, the need to regulate biosafety, as well as generating the necessary expertise, are yet to be fully met.

More generally, the research reported here shows how implicit visions of society are embedded within science and technology. Research indicates that these implicit visions themselves lead to some of the problems around science in society. For example, people may reject the vision of a further-intensified agriculture implicit within GM technology – this may in fact be more influential than the fear of new risks, which is often assumed to be the problem.

A further challenge is to standardise and synthesize scientific knowledge without losing relevance and saliency to people 'on the ground', including those who contribute to science through less formal routes, as we saw in the case of biodiversity databases.

Global technologies such as the web are changing the way people perceive and use science. Research reported here on the use of the web to search for scientific information suggests that policymakers need to consider whether they wish to encourage a reliance on a narrow range of 'the best' scientific advice or a more diverse set of sources.

All countries, no matter how industrialised, struggle to govern and reach consensus over new global technologies. There is much variety in countries' regulatory styles and capabilities, leading to widely different outcomes for particular technologies. While much energy is expended in trying to reach agreement over 'the right' way to handle global technologies, it might be more realistic to accept this diversity.

Global-level institutions seem to have spent the last half-century trying to standardise scientific and technological issues and applications; the research on the idea of 'scarcity' provided an example of the impact of such global ideas in practice. Perhaps the tide is turning and we are now having to think – at a global level – about how to live with plural sciences and plural technologies that should not be standardised. Diversity is becoming acknowledged as a legitimate goal that should be creatively pursued and protected even as it shelters under the seemingly ubiquitous reach of globalisation.

Globalisation and diversity in science and technology – are they compatible? Perhaps the inescapable humanness of science and technology will ensure that they are. Global science can gain democratic legitimacy only if it understands itself in relation to other cultures, and learns to negotiate and accommodate them rather than dismiss them as peripheral, untrustworthy or emotive.

While debates on participation in science frequently take place at a local level, the world is now too connected, and science and technology policy too globalised, for public engagement to be confined to the local sphere. Today's science and technology initiatives involve networks of institutions, researchers, funders, policy organisations, non-governmental and private sector actors that link national and local settings into globalised forms of governance, debates, and ways of thinking. At the same time, new internationalised networks and treaties affect and connect people across local sites.

With the tendency to view problems from an increasingly global perspective, poor people's own local needs and perspectives can be misrepresented. This can lead to technology developments that prove culturally unacceptable, or miss key opportunities that emerge from the local, context-specific conditions in which people live. A focus on the overall growth or health of a society may also miss the particular vulnerabilities of its poorest and most marginalised members and their particular technology needs.

The challenges around global science and technology are huge. Not least, policymakers need to decide which race they are in – a competition to beat others in the global economy, an expert-led race to find solutions to global problems, often through partnership, or a 'slow race' involving citizens in their local contexts (Leach and Scoones 2006). Here, science and technology on their own will not be enough.

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Research projects listed under topical themes

The Science in Society Programme is one of the ESRC's major investments and is a six year commitment running from 2002 to 2007. The Programme, originally conceived following a parliamentary report on science and technology, is both broad in scope and diverse in its research focus and has been host to 45 different research projects during its lifetime. The Programme is separated into six themes, each one acting as an umbrella for a variety of projects, all of which consider a different aspect of the science-society relationship.

Science in Governance and the Governance of Science

Social and Human Rights Impact Assessment and the Governance of Technology
Dr Andrew Barry, research undertaken at Goldsmiths College, London – now based at the University of Oxford *andrew.barry@ouce.ox.ac.uk*

Interdisciplinarity and Society: A Critical Comparative Study
Dr Andrew Barry, University of Oxford *andrew.barry@ouce.ox.ac.uk*

Using Public Environmental Knowledge in Industry
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Childhood Cancer Tissue Donations: A Gift Relationship?
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Contesting Environmental Science: Business and Environmentalist NGOs
Dr Sally Eden, University of Hull *s.e.eden@hull.ac.uk*

Credibility Claims as Scientific Commodities
Dr Sally Eden, University of Hull *s.e.eden@hull.ac.uk*

Inside or Outside the Bio-science Tent? The Presentation of the Laboratory-self
Dr Lena Eriksson, research undertaken at Cardiff University – now at the University of York *le502@york.ac.uk*

Caught Between Science and Society: Foot and Mouth Disease
Dr Brigitte Nerlich, University of Nottingham *brigitte.nerlich@nottingham.ac.uk*

Public Perceptions of Risk, Science and Governance
Professor Nick Pidgeon, research undertaken at the University of East Anglia – now at Cardiff University *pidgeonn@cardiff.ac.uk*

Accountability and the Governance of Expertise: Anticipating Genetic Bioweapons
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Simulation Modelling of Contentious Scientific Knowledge Claims in Society
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Resolving Conflicts in Selecting a Programme of Fisheries Science Investigation
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Reproducing the Centre: Performing Innovation at Xerox PARC
Professor Lucy Suchman, Lancaster University *l.suchman@lancaster.ac.uk*

Governance and Accountability Relations in Mundane Techno-Scientific Solutions to Public Problems
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Re-modelling Science Communication

Deliberating the Environment: Scientists and the Socially Excluded in Dialogue
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Spinning Science: The Nanotech Industry and Financial News
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Public Involvement, Environment and Health: Evaluating GIS for Participation
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Communicating Science through Novel Exhibits and Exhibitions
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Experiments In Science Communication: A Pilot Study with a Digital TV Channel
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The New Zoos: Science, Media and Culture
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Consultation as Science Communication? The Case of Local Air Quality Management
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Divided we Stand: Bridging Differential Understanding of Environmental Risk
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What Does Social Change Mean in the Context of Engineering Education?
Dr Jane Pritchard, University of Glasgow *j.pritchard@udcf.gla.ac.uk*

Science in the Economy and the Economics of Science

Mobility and Excellence in Scientific Labour Markets: The Question of Balanced Growth
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The Impact of Enlargement of Scientific Labour Markets
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Work Roles and Careers of Academic Scientists in University-Industry Collaboration
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Making Science History: The Regionalisation of Science Policy
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Building Science Regions in the ERA: Governance in the Territorial Agora
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Labour Markets and Knowledge Flows in the Chinese National System of Innovation
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Issues Involved in the Diffusion of Knowledge through Migration of Scientific Labour
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The Impact of Gender Innovation on Regional Technology, Economy and Society
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Science Technology and Globalisation

Institutional Impacts of North-South Partnerships in Agricultural Biotechnology
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Regulatory Practices and Challenges of the African Crop Biotechnology Sector
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Science, Technology and Water Scarcity: Investigating the 'Solutions'
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Childhood Vaccination: Science and Public Engagement in International Perspective
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The World Wide Web of Science: Emerging Global Sources of Expertise
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Databases, Naturalists and the Global Biodiversity Convention
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Science and Gender, Ethnicity and the Lifecycle

Boundary Work, Normal Ageing and Brain Pathology
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Public Perceptions of Gamete Donation in British South Asian Communities
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Gender Theories and Risk Perception: A Secondary Analysis
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Asbestos Diseases: Scientific Definitions and Gendered Identites
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Genomics and Society

Doing Embryo Ethics: Safety and Efficacy in Research and Practice
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Farmers' Understandings of Genetically Modified Crops within Local Communities
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Pharmacogenomics, Diagnostic Tests and Clinician Acceptance
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Science, Security and Regulation: How Effective are Export Controls?
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Dual Use Controls and Genomic Research
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