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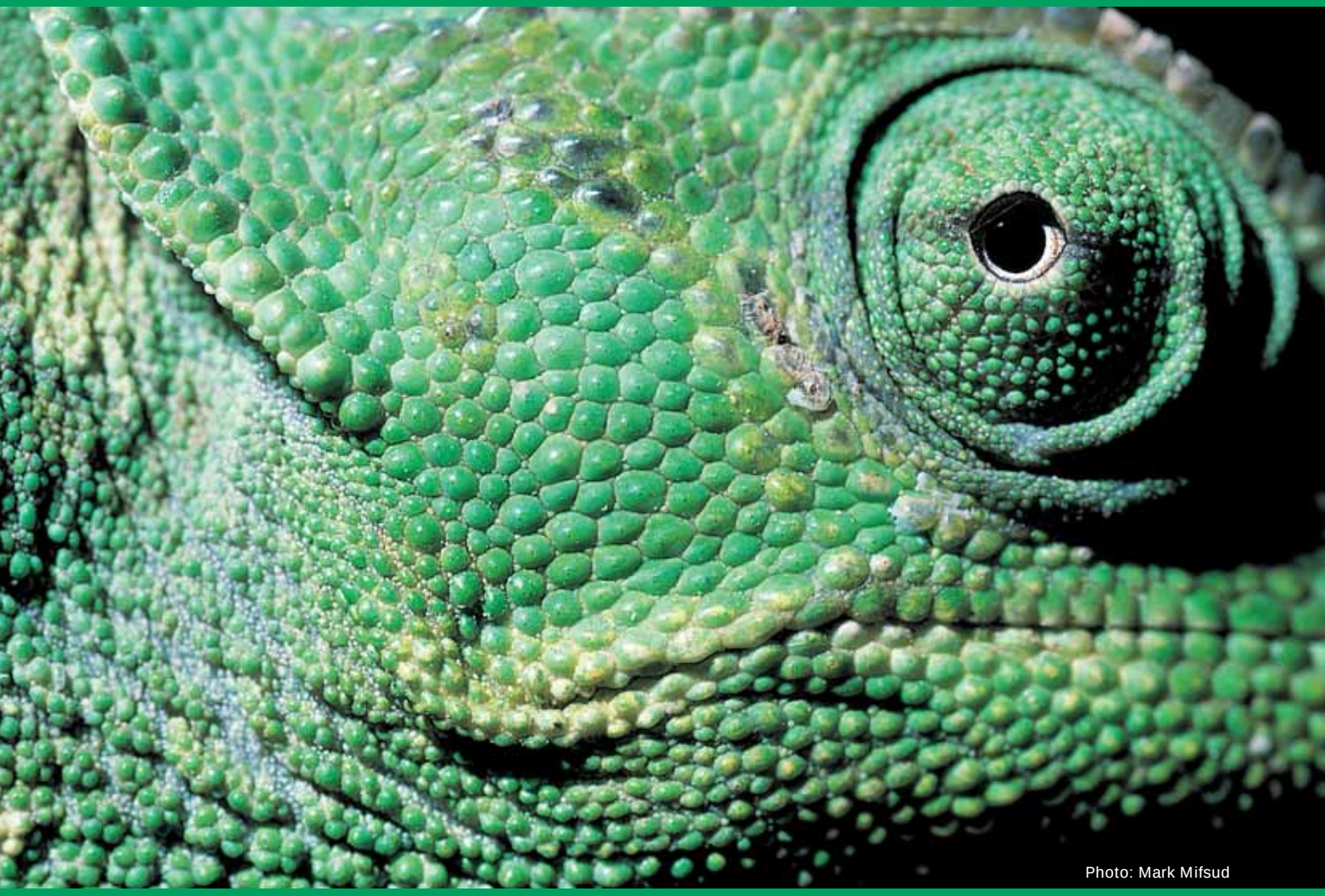

Photo: Mark Mifsud

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PROFESSIONAL BODIES ACTING TOGETHER

As the Society for the Environment gathers new adherents, the role of the multitude of smaller environmental organisations is examined by

CAROLYN ROBERTS
FRGS, FIEnvSc, MCIWEM, CEnv, Chair of the Institution of Environmental Sciences

Huge changes are currently occurring in the professional and actual climate of environmental activity nationally and globally, and it can be quite difficult to keep track without having some overarching reference points. Many members of the Institution will be familiar with the United Kingdom Sustainable Development Commission's framework for 'sustainable development', which has five main principles:

- living within environmental limits
- ensuring a strong, healthy and just society
- achieving a sustainable economy
- promoting good governance, and
- using sound science responsibly.

This section of their website (*www.sd-commission.org.uk/pages/principles.html*) provides an interesting read, and the home pages carry frequently updated news items which would be worth including on your 'favourites' list. They provide a useful source of ideas and guidance, as well as a reminder of the breadth of the concept of 'sustainable development'.

While the principal focus of professional activity for most of the Institution's members centres on the last, the 'sound science' theme, our work typically touches on several or possibly all of the elements; we are a diverse and international Institution, as the contents of this issue of the Journal testify. The air quality scientists among us, for example, will understand very well the multiple and differential impacts of polluted air on richer and poorer groups of people, the effective 'export' of contamination to downwind nations, and the injustice of this.

Those members with responsibilities for production and purchasing within large and small corporations will have the needs of sustainable economies high on their agendas. And local authority, governmental and NGO-based members will actively be linking their 'sound science' to the promotion of good governance.

There are many other examples of the breadth of our joint experience, as the buoyant applications for Membership or Fellowship of the Institution demonstrate. Indeed it is a requirement of achieving individual Chartered Status through the auspices of the Institution that these linkages and interactions between environmental science, economics and society are understood and demonstrated in applicant members' routine operations.

An holistic and broadly conceived

Cover picture: *The chameleon was brought to Malta from North Africa between 1846 and 1865 by Jesuit priests who seemed to be particularly fond of this peculiar reptile. Some chameleons are still captured by children or their parents to rear as pets, although this is illegal.* *See page 13.*

IN SUPPORT OF SUSTAINABLE DEVELOPMENT

approach is clearly necessary for addressing the many and pressing environmental problems that humanity currently faces, and the route to Chartered status recognises this.

Other professional bodies embracing environmental disciplines share similar criteria when awarding the highly-regarded 'CEnv' postnominals to members, also recognising the overlapping and complex web of societal, technical and ecological influences underpinning truly sustainable development. However, the overlap in the interests and activities of the different bodies does not end there. Within the UK there are probably 30 or 40 learned and professional environmental organisations of different sizes, with their own specialisms and aspirations. A dozen or so of the more significant have already come together under the auspices of the Society for the Environment, in order to endorse the cause and practice of sustainable development more effectively in the national and international arena.

Within the Society, they have been joined by some of the very large professional associations whose members also have a key role to play in exploring and promoting this concept – the Institution of Chemical Engineers, the Institution of Civil Engineers and the Royal Institution of Chartered Surveyors, for example. The Society is moving progressively towards its goal of becoming the 'leading and co-ordinating professional body in environmental matters and a pre-eminent champion of a sustainable environment' as more and more organisations join. Recent converts include the Landscape Institute and the Arboricultural Association; a full list may be found at *www.socenv.org.uk/member-bodies/list-of-member-bodies/*

What then is the role for those organisations such as our own, specifically with an environmental and scientific focus? The Institution of Environmental Science's Council has been considering the role of the UK's multiple environmental professional organisations, and the overlapping remits that they embrace – the Chartered Institution of Water and Environmental Management, the Institute of Environmental Management and Assessment, and the Institute of Ecology and Environmental Management being but three examples with spheres of activity which overlap our own.

Each of these is a distinguished organisation, with a unique history and structure, and a distinctive level of presence in different sectors of the economy and geographically. Each has particular strengths, as scientists or auditors for instance, or additionally in the case of the Institution as the pre-eminent body accrediting UK higher education programmes in environmental disciplines. As components of Society for the Environment, every one of these bodies is crucial in terms of the expertise and philosophy of its members but each is only a small player in terms of membership numbers in comparison with the engineers and surveyors. They also have overlapping memberships – several of the IES Council are also members of cognate organisations, for example – and in some cases they may even effectively compete for new members.

One obvious outcome of Council's consideration is a desire to work more closely in partnership with these cognate organisations, specifically in the area of continuing professional development, a requirement for our Chartered Members. This is being pursued. But we have also speculated about the broader history and the future trajectory.

If, for instance, one took a blank sheet of paper and planned a national professional establishment to promote the cause of sustainable development, or even of the education of the public in environmental science (the Institution's own mission, see *www.ies-uk.org.uk/about/activity.html*) would we generate multiple and overlapping professional organisations? And does the current situation assist UK plc to move effectively towards sustainability, as defined by the Sustainable Development Commission?

The Institution is always delighted to hear ideas from members, as it helps us to plan events, resources and activities. So do write or e-mail the London office with your views, or consider producing a short piece for the electronic newsletter or for this Journal.

IN A TIME OF LEGACIES, LET'S CREATE OUR OWN LEGACY FOR THE FUTURE

Tomorrow's leaders will need the illumination of the environmental sciences if they are to do their jobs properly, says **MARK EVERARD**

In the big game that we call 'politics', it is a time of transition. Because of that, people speak of legacies. Our lives are largely prescribed by the legacies of the past, both good and bad. Whatever it is that we do, or that we opt passively or actively not to do, also precipitates a further legacy for the future. So, while other commentators preoccupy themselves with the legacy of the past decade or so, it is perhaps more worthwhile to ask about the legacy of the next five years. This 'future legacy' is at least within our capacity to influence, is not yet set in stone, and also represents perhaps the most important 'turning point' in human history as we seek to change sustainable development from aspiration into everyday practice. And this is certainly a transition about which the environmental sciences have much to inform.

The legacy of the past couple of centuries of human history, at least in the urbanised world, includes many positives. We live today with unprecedented levels of public health, life expectancy, prosperity, education and opportunity. A quick trip to any developing country is sufficient to remind the open-eyed sceptic that our preoccupation with minute aspects of health and safety and modest declines in air and water quality are as nothing compared to the horrors of rivers blackened by pollution, skies choking with sooty fumes, lack of basic sanitation, access to clean water and associated disease. And yet, as our currency becomes more buoyant, we are also becoming all too familiar with its 'shadow' legacy of pollution of various environmental media, particularly so along out-of-sight supply chains, increasing levels of social marginalisation and widening inequities, degradation of environmental functions, and destruction of irreplaceable biodiversity.

The true bequest of our recent model of progress comprises both intended benefits and malign shadow. A little scientific examination hints at the likely passing of our current phase of human development. The UN's Millennium Ecosystem Assessment and the WWF's Living Planet Index are just two of the more authoritative evaluations, built upon the evidence of environmental science, demonstrating that the gains of industrial progress are progressively becoming swamped by its unintended consequences. Through our lack of foresight, we have mined too deeply the environmental resources that support our wellbeing, wealth-creation and quality of life. Viewed from the perspective of human history, the prosperity and emancipation of the 'developed world' is but a small blip in time and benefits only a fraction of the booming global populace.

As the supply chains feeding our profligate, consumerist culture reach deeper into industrialising nations and those with resources not yet as barren as our own neighbourhood marine fisheries, fossil metal and carbon reserves, hardwood forests, soil fertility and desiccated former wetlands, we promise them the 'trickle-down' effect of our model of wealth creation. And yes, financial gain may be a consequence for some within these communities. However, in an aggressively competitive world marketplace, 'economic efficiencies' sought from those that clamour to serve our markets can all too often mean that the largesse of the economically powerful can be less than benign. When does 'cheap labour', replacement of staple subsistence foods with tradable cash crops from which local people cease to benefit, industrial production to lower environmental standards with attendant pollution, overcropping of land, degradation of endemic biodiversity, and hazardous and damaging resource extraction become not an economic partnership but a modern-day, market-driven take on imperialism?

Sadly, none of these themes are new. We know much about many, and have campaigned about some. We have frequently been strident with our rhetoric, though oftentimes merely to salve the conscience. Environmental science has, when the market allows it the modest investment so to do, been invaluable in further illuminating the problems. Environmental science has also been sparingly deployed by our political leaders to help elucidate some potential solutions. Perhaps the most worrying thing is that the ground is familiar and the rhetoric more earnest each time the carousel revolves and 'the environment' has another five minutes of sporadic political limelight. All are eager to be seen flying the green flag alongside their other ensigns. Yet real progress is shockingly sparse. Real, practical, measurable progress based upon substantive measures implemented on the back of true statesmanship are like proverbial hen's teeth.

Change is required, that much is assured, yet this should in no way be perceived or spun as regressive. A sustainable future is not one built on austerity, but a new future innovated from a different set of assumptions informed by what the environmental and other sciences tell us about the capacities and limits of the natural processes that can sustain human wellbeing indefinitely. But, since the market currently delivers luxury and high profit margins to the privileged few, of course any effective sustainable strategy will be unpopular to multinational businesses and a public unwilling to be denied the easy virtues of its inherited, unsustainable legacy of exploitation for short-term gain. Who amongst us has the vision, dedication and leadership qualities to sell sustainability as

the more attractive model for the masses? Bold political leadership is undoubtedly needed if sustainable development is not to remain in the ghetto of concerned scientists, activists, individuals, NGOs and minority 'wonks' of other types.

This is no party-political position. It might easily become so if any one party discovered a panacea. Or perhaps one of them might suddenly articulate a vision acknowledging that the functions of the natural world underpin human progress into the future, and that we had better learn quickly to protect and restore this fundamental natural capital which can not be bought from some mythical 'elsewhere' from profits generated by its liquidation. Then, we might have the kind of vision-led leadership backed up by practical policies that will be essential to deliver us from the inevitable and looming void of continuing unsustainability. Instead, many political figureheads of all hues now make the right kind of noises on climate change, which is emerging on the evidence of sound environmental science as a potentially-devastating threat to our global future. Yet would it be honest to report any substantive progress in the face of increasing fossil fuel use, personal travel, supply chain lengths and domestic energy consumption? And what of the continued degradation of irreplaceable biodiversity, traditional land use practice, water resources, waste absorption capacity of the atmosphere, and many other metrics beside with real consequence for our collective wellbeing? Are these environmental issues even anywhere near the lower-to-middle orders, let alone the upper reaches, of political attention?

This short article has, let's be honest, been a bit of a rant! It is, sadly, a rant that could have taken place at any stage in the last decade and maybe even longer ago than that. But what makes this rant pointed right now is that others talk freely of legacy, whilst ignoring these major, generally darker elements of our gift to the future. If we can't find the courage and initiative to confront and address them now, if we fail to rise to the opportunities that they present, then we inevitably force their dire consequences upon those occupying further political terms and future generations. So what better way to cement a legacy than to turn it into a manifesto; to make an unshakeable commitment to change what must be changed in the very few years available to us to make the big differences that the task requires? This has to be more heroic than seeking selective laurels upon which to rest from a bush that is withering from its very roots.

It is environmental functions and their 'goods' and 'services' – clean water, fresh air, pollution treatment capacity, timber and fibre, fertile soils, beautiful landscapes and the like – that underwrite future wellbeing, prosperity and realisation of human potential. It is then as certain that tomorrow's true leaders will need the illumination of the environmental sciences to help them with the noble task of forging a lasting, positive legacy for the benefit of all. Or, in other words, to do their jobs properly.

SUSTAINABLE DEVELOPMENT AND HIGHER EDUCATION

Education for sustainable development represents a major shift in the way we teach – and learn, argue **STEPHEN MARTIN** and **SIMON G. SMITH**

A recent report[1] commissioned by the Higher Education Academy describes some of the trends in the teaching and curriculum development of sustainable development within the English higher education system. It is only a snapshot of a dynamically changing process. Indeed, some evidence of the dynamics is provided by UCAS statistics: in 2001 there were 24 courses in the subject search for sustainability; for 2006 applicants this has risen to 85.

The report is the culmination of a six-month investigation by a research team commissioned by the HE Academy into how different subject disciplines taught within the English higher education system are contributing to creating sustainability literate graduates. By undertaking such an investigation, the HE Academy sought to identify good practice in approaches to teaching and curriculum development; what barriers exist in embedding sustainable development in institutional teaching and learning strategies; as well as assessing the support required for widening and deepening the embedding process. This is in line with the government aims of building a workforce and civil society better qualified to meet the challenges of sustainable production and consumption.

This report is of particular interest to professional bodies and all those professionals working in business, public institutions or voluntary organisations seeking to develop more effective management of their organisation's sustainability performance. And sustainable organisations

1 Sustainable Development in Higher Education: Current and Future developments: *www.heacademy.ac.uk/4074.htm*

can be powerful drivers for more sustainable consumption and production.

Effective management of an organisation's sustainability performance has been shown to improve cost-savings, reputation and communication with all its stakeholders as well as enhancing risk management. Innovative business models are now emerging which are more resource efficient and ethical.

Local authorities also recognise that services need to be delivered in more sustainable ways. They are responsible for vital areas of people's lives such as education, health, housing, waste disposal, transport and planning. More sustainable communities are their objective, but this can only be achieved by creating the capacity of staff to manage sustainable development.

Many of those who are employed by our public, private and voluntary institutions are among the estimated 5.5 million people in the UK who call themselves professionals. A sizeable proportion of these would belong to a recognised professional body or trade association or union. Professionals in all sorts of roles increasingly have to deal with complex social, environmental and economic issues. Employers are seeking new kinds of competency in ethics, human ecology, conflict resolution and environmental management. There is an urgent need for people with interdisciplinary problem solving capability rather than a traditional and often over-specialised scientific or technical competence.

All of this has a major bearing on curricula and the processes of learning in higher education, since many professional bodies now rely on accredited degrees as the main route for membership. Trade unions in the TUC representing some 6.5 million members in every sector of the UK economy also recognise the need to build the capacity within their membership to manage sustainable development. Through their Greening the Workplace programme and membership of TUSDAC (the Trade Union Sustainable Development Advisory Committee) they are beginning to make a positive contribution to policy and practice in sustainable development in the work place and the wider community.

Higher education's contribution

Higher education has a significant role to play in enacting the sustainable development agenda because of its core activities in teaching and research. Developing the teaching and curriculum for education for sustainable development (ESD) is probably the greatest contribution higher education can make by enabling students to develop new skills and knowledge.

The research found that most of the disciplines represented by the HE Academy's 24 subject centres are making a contribution to the sustainability literacy of their students. But it is a dynamic and changing picture with many academic staff recognising ESD as an important component of the development of their respective subjects, and by inference what is taught and how.

Skills for ESD

There is universal acknowledgment that a wide-range of skills and knowledge are required to create an action orientated sustainability literate graduate body. Some of these skills and attributes are shown below.

Skills for ESD

- An appreciation of the importance of environmental, social, political and economic contexts of their discipline
- A broad and balanced foundation knowledge of sustainable development, its key principles and the main debate within them, including its contested and expanding boundaries
- Problem solving skills in a non-reductionist manner for highly complex real life problems
- Ability to think creatively and holistically and to make critical judgments
- Ability to develop high level of self-reflection (both personal and professional)
- Ability to identify, understand, evaluate and adopt values conducive to sustainability
- Ability to bridge the gap between theory and practice, in SD only transformational action counts
- Ability to participate creatively in interdisciplinary teams
- Ability to manage change

Many of these skills and attributes are not easy to teach in a traditional sense, but there are a growing number of examples of new teaching orientations or approaches which support the development of such skills as interdisciplinary thinking and problem solving and team working.

Curriculum responses

The research survey identified a wide-range of curricula connections in response to the sustainability agenda. Several disciplines have introduced relevant themes such as climate change, biodiversity and environmental management systems. However, the overall picture is patchy with major gaps in areas such as sustainable production and consumption, eco-efficiency and national and international sustainable policy.

The research revealed four major barriers to the successful embedding of ESD into many of the subject disciplines in HE:

- Overcrowded curriculum

- Perceived irrelevance by academic staff
- Limited staff awareness and expertise
- Limited institutional drive and commitment.

Next steps

The report sets out the current state of progress on embedding ESD in many of the subject disciplines within the higher education sector. It also identifies some of the barriers and their resolution. The significance of this report is that it is a reflection of the views of practitioners in the disciplines that make up the HE sector in England. While the progress might appear patchy and painfully slow in some important disciplines this research provides evidence of strong underlying support for more action in support of the embedding process. To this end the HE Academy and its subject centres plan to support and strengthen the links between ESD, employment and career choices of graduates, and are commissioning research that will seek to triangulate the needs and attitudes of employers and students to inform the further development of ESD into curricula.

Education for sustainable development is an emerging imperative. It represents a major shift in the way we teach and learn within the higher education sector. It requires a broader and more flexible approach to the development and teaching of academic disciplines. Much of this is in line with what graduates will need in an increasingly complex work environment. This is the challenge that the HE Academy and the subject centres it supports recognise must be addressed.

EARTH PORTAL

The National Council for Science and the Environment (NCSE) is pleased to announce the formal launch of the Earth Portal *(www.EarthPortal.org).*

Earth Portal is a comprehensive, free and dynamic resource for timely, objective, science-based information about the environment built by a global community of environmental experts: educators, physical, life, and social scientists, scholars, and professionals who have joined together to communicate to the world.

In contrast to information from anonymous sources with no quality control, the Earth Portal is created and governed by individuals and organisations who put their names behind their words and where attribution and expert-review for accuracy are fundamental.

THE EARTH PORTAL INCLUDES:

Encyclopedia of Earth *(www.eoearth.org)* has an initial 2,300 articles from over 700 experts from 46 countries, as well as such content partners as the World Wildlife Fund and the United Nations Environment Programme. The Encyclopedia is a means for the global scientific community to come together to produce the first free, comprehensive expert-driven information resource on the environment. The Encyclopedia includes articles, e-books and reports, interactive maps, and biographies, and will eventually be published in other major languages. Environmental scholars and experts are invited to become contributors to the Encyclopedia.

Earth News *(www.earthportal.org/news)* includes breaking news updates from many sources, with links from key words to Encyclopedia articles, enabling readers to learn about the science behind the headlines.

Earth Forum *(www.earthportal.org/forum)* allows the public to engage in discussions with experts, ask questions and get answers, and to participate in community debates about issues that matter to them.

Environment in Focus *(www.earthportal.org/?page_id=70)* provides an exploration of a major issue each week – energy, climate change, environmental economics and other topics – led by a prominent expert in the subject and involving articles, news, places, discussions, Q&A, interesting facts, and more.

The National Council for Science and the Environment *(www.NCSEonline.org)* is a not-for-profit organisation dedicated to improving the scientific basis for environmental decision-making. The NCSE specialises in programs that foster collaboration among diverse institutions, communities and individuals. The NCSE serves as secretariat for a growing Environmental Information Coalition of environmental experts and organizations, which is building the Earth Portal. ManyOne Networks, an innovative IT firm based near San Jose, California, has provided engineering and vision for the Earth Portal.

BIOMIMICRY – AN ALTERNATIVE ROUTE TO PETROCHEMICALS?

AREND HOOGERVORST looks at attempts to mimic nature instead of relying on man-made solutions to scientific challenges

Many material and process problems that human beings encounter in their lifestyle and industrial activities have been solved in Nature. With some 3.8 billion years of research and development through evolution, Nature has probably solved all the likely combinations of process and material problems that we are ever likely to confront. It is probably also true that any human designed process has a parallel somewhere in Nature.

The new science of biomimicry studies nature's models and then imitates or takes inspiration from the designs to solve human problems. Perhaps one of the easiest examples to illustrate this is the leaf which inspired the solar cell. (The leaf uses solar energy to 'fuel' the process of photosynthesis which chemically combines carbon dioxide, water and basic salts to produce simple sugars such as glucose to 'fuel' the growth of the organism.)

Nature versus humans

It has been argued that the human approach of 'heat, beat and treat' as a way of making materials is both wasteful and unnecessarily energy inefficient. Kevlar is a petroleum-derived substance which comes from being pressurised in a vat of pressurised concentrated sulphuric acid, boiled at high temperatures, subjected to high pressures in order to force fibres into alignment and thus create the hard protective shell that we know so well. The process requires large quantities of energy and considerable toxic by-products. One of Nature's examples is a spider's waterproof silk which is tougher and more elastic than Kevlar, gram per gram, five times stronger than steel and is produced by the spider in water at normal temperatures using no additional heating, chemicals or pressures. If necessary, the spider can also eat part of an old web to make a new one.

Petrochemical alternative

Biomimicry proponents argue that we have become blinded by petrochemicals as the route to solve human resource and energy problems. Current pressures on the future availability of hydrocarbons suggest that alternatives need to be sought. Biomimicry specialist, Janine Benyus, talks about the concept of 'quieting human cleverness'. She believes that the human race needs to mature and accept the principle that Nature knows best. The steps in her biomimicry model are

1. quiet human cleverness,
2. listen to Nature,
3. echo Nature, and
4. protect the wellspring of good ideas through stewardship.

There is nothing new about biomimicry – for example, Alaskan seal hunters stalk seals in exactly the same way as polar bears. Natural systems agriculture does not require excessive amounts of chemical fertilisers to produce diverse food sources. Hydrocarbon-based fertilisers and pesticides add to the cost of food production from monocultures and it is clear that something is wrong when data suggest that ten kilocalories of hydrocarbons are required to produce one kilocalorie of food.

Product examples

There are many examples of products that have come from recognising the lessons of Nature. The barbs of many varieties of weed seeds have inspired the development of Velcro. BASF have developed a stain repellent, used in coating fabrics used in making tents and awnings, called Mincor®TXTT, which uses the physical characteristics of the swampland lotus plant. (By creating microscopic, mountainous surfaces on its leaves, dirt particles cannot adhere to the leaf surface to block photosynthesis, and instead are 'caught' and balled up by rainwater droplets like a snowball removing leaves from a lawn. The concept, i.e. creating fine 'bumps' on a surface, has been used to create a self-cleaning effect for roof tiles, car paint, and building façade paint.)

Potential opportunities

There are many examples which are still to be properly developed and exploited. Blue mussel adhesive, so hated by yachtsmen and ship owners, is a glue that sets underwater without a primer or catalyst and could revolutionise paints and coatings and even enable surgeons to operate without using sutures to close wounds. Blue mussel byssus sealant is an alternative to plastics whereby it becomes a time release coating for disposable cups or containers, protecting for a certain time period, then degrading and allowing the degradable material underneath to be composted or organically disposed of. Fish antifreeze is a substance that could revolutionise the storage and transportation of potential transplant organs. Spider silk has the potential to become the basis of a new fibre technology for parachute strings, bridge cables, protective clothing and wound sutures.

Janine Benyus argues that the potential is limitless. Of

the estimated 5-30 million living species on earth, only about 1.4 million have been named, and even fewer properly studied. She argues that the innovations locked up in the as yet undiscovered biological resources on earth could solve many of our current and future problems. She is on record as saying that she would like to see current environmental commentators and activists such as Clinton and Gore promoting a 'Biological Peace Corps' whereby people could volunteer to assist in the inventorying and study of biodiversity for two years to speed up the discovery process.

For more information on biomimicry, go to Janine Benyus's website at *www.biomimicry.net*

EDUCATION! WHAT EDUCATION? SWITZERLAND AND THE CHALLENGE OF EDUCATION FOR SUSTAINABILITY

If we wait until we have defined unambiguously what ESD/EfS is, the world won't need it any more, say **ROLF JUCKER** and **DAVID HAWKINS.** Only by putting it into practice on the ground can we clarify and correct the theoretical concepts

We must never underestimate the fundamental conflict between the existing western politico-economic system and what might qualify as a sustainable society. The differences are embodied in their guiding values. The current system is based on exponential growth, accelerated progress and technological innovation, along with short-term orientation, individualism and unlimited consumption. A sustainable system which works for all (not just for us in the rich countries) is very difficult to imagine without the acceptance of planetary limits, reduction of resource throughput/consumption, long-term planning, acknowledgment of the diversity of systems, group effort and a collective slowing down of the pace. As a society we must be aware of our impact and take responsibility for the consequences of our ways of life.

The educational discourse, at least here in Switzerland, tries to ignore or suppress this uncomfortable potential for conflict by concentrating on skills, quality indicators and other formal tools which have no intrinsic connection with sustainability. The much-touted Education for Sustainable Development (ESD)/Education for Sustainability (EfS) 'competence' of 'critical thinking', for example, are very much at play in many scientific developments and new technologies which have limited, if any, potential for enhancing our transition to a sustainable world.

The development of new weapons of mass destruction, or new generations of unnecessary consumer electronics and much of the new wave of nanotechnology research are instances of this. 'Critical thinking', as an abstract skill, can help genocide as much as sustainability. The same applies to other 'competences' such as 'systemic thinking' and 'ability to act'.

As I have attempted to show in my book *Our Common Illiteracy*, the big problem with sustainability is that it is not a rigid blueprint – a precisely defined plan which only needs implementation – but a process which has to be refined, redefined and developed along the way. On the other hand, it is not an 'everything is possible' post-modern idea either. Particularly if we leave the lofty heights of theoretical discussion and go down to real life problems on the ground, it is usually possible to decide which solution is more or less sustainable. It is also very often obvious which solutions are clearly unsustainable, such as feeding everyone on a meat-heavy diet, or expanding worldwide private motor-car usage to US levels.

Unfortunately, this means that the constructivist theory of learning (as Chet Bowers has succinctly shown) is, despite its international hegemony, ill-suited to dealing with the challenge of sustainability. The assumption that instruction is manipulation and that learners should 'construct' their own worldview (with educators as mere facilitators in their learning process) is both factually wrong and ignores the crucial point above. It is factually wrong insofar as the 'liberal' hope that students will 'freely' construct sensible worldviews out of their own depths is illusory. They will, for the most part, simply modify those views most effectively mediated to them by the 'shadow curriculum'. (As the history of mass media shows, for good or bad instruction does work extremely well. And, of course, this insight places an immense responsibility on us

educators not to abuse it. But we cannot run away by hiding behind the 'empowering students' mantra.) It is ignorant because sustainability is more than just what every individual thinks it is.

Naturally, every individual will have to integrate sustainability with his/her own perspective on the world (i.e. engage in ESD/EfS), yet it would be a total misunderstanding of the concept to assume that it can be filled with whatever content one desires. There is a whole host of well established scientific facts, cumulative social and historical knowledge and experience of sustainable systems (e.g. indigenous societies) which must form part of any EfS/ESD. Both factually and morally there are Rights and Wrongs in sustainability and unless we start to accept this and develop ways in which these facts and values become socially acceptable and accepted, there can be no transition to a sustainable society. To turn a famous slogan by Bob Jickling on its head, there is no sense in talking about 'the need to move beyond sustainability'. Beyond sustainability there is only one thing: a depleted planet Earth.

'ESD/EfS practice means applied learning in the real world – doing, not conceptualising… academics are very good at concepts, but have a limited standing as ESD/EfS role models.'

Let me make it clear that I don't want to impose 'my version' of sustainability onto all the others. But the discussion of sustainability and our role in this endeavour as educators needs to mature and leave behind the notion that it's enough to have students just critically debate the issues. Studies in Switzerland have shown that current students are not able to do this. They are only able to 'promote' the positions they have 'learnt' before. They seem to lack a framework against which they can judge and evaluate information, deciding whether or not it makes sense. You might say, 'this is precisely what we mean by "critical thinking".' I concede this, but 'critical thinking' means being able to sort right from wrong. So the 'liberal' hypocrisy that we need to allow all positions as equally valid is simply not compatible with SD, nor is this a sensible skill in ESD/EfS.

My belief is that the problem we face with the ESD/EfS discourse has largely to do with the abstract level on which the discussion takes place. As soon as ESD is lived in reality, in concrete projects, the points above become obvious. I am not saying it is always easy to go for the sustainable option and enhance this ability as educators, but I am saying that it is possible in most cases. In Switzerland the authorities responsible for the national action plan in the context of the UN Decade still argue that ESD/EfS is not clear, that we need more concepts and theories. I argue that there is no point investing too much time in theory at the beginning. If we wait until we have defined unambiguously what ESD/EfS is, the world won't need it any more. What we need is direct implementation on all levels. Only putting it into practice on the ground will clarify and correct the theoretical concepts. This action research loop seems to me the only way forward.

Yet here we run into problems at HE level. ESD/EfS practice means applied learning in the real world – doing, not conceptualising. And I suspect this is a real threat for academics and students. Indeed, my experience is that academics are very good at concepts, but have a limited standing as ESD/EfS role models. Ultimately, the only test for ESD/EfS is whether or not it leads to sustainable behaviour, sustainable consumption and sustainable lifestyles. Where are the publicly visible showcases of academics who demonstrate to the wider community how a sustainable life could be led here and now? Again, this is not about prescribing a certain way of life, but about showing the various ways in which it is actually possible (without any further technological progress or economic growth, with what is around now).

I've got to say it: I've rarely felt that a slogan was more appropriate to ESD/EfS than Gandhi's words: 'Be the change you want to see in the world'. This also means get the tutors and students out of the box! Make sure they engage with reality. One of the most common problems with people's views about wind or solar energy, for example, is that they have never been near a real example; they only know it through the media, with all the spin attached. The reaction to the real thing is more often than not unabashedly positive.

This leads me back to a point which I have always stressed: be realistic about your sphere of influence. All the other 'educators' (mass media, peer groups, technology, industry, family) have a far wider impact on the learning of students than you will as a tutor, and their message, at present, is pretty much the opposite of ESD/EfS. If on top of this you then send mixed messages (ESD/EfS in classes, non-ESD behaviour outside them) you will have lost before you've begun.

Finally, here is a little reality check to back this up: the largest public event in Switzerland this year which could be broadly placed in an ESD/EfS context attracted 50,000 people. The SD/ESD/EfS scene was well pleased. The annual Geneva motor show attracted more than 700,000 people – that's more than 10% of the entire Swiss population…

THE SUSTAINABLE DEVELOPMENT INSIDER

Environmentalists should be out in the world, evangelising for sustainability, Andrew Lee, Director of the Sustainable Development Commission, tells **ADAM DONNAN**

Nestled within Defra's building at Ergon House, just a couple of hundred yards from Westminster, is the Sustainable Development Commission (SDC), the UK Government's independent watchdog on sustainable development. As you pass through the tight security, you might muse upon how sustainable development has made it onto the government's agenda.

The SDC has three main roles: advice and advocacy – researching the big issues of the day and providing an independent viewpoint for the government; a watchdog function, auditing government and holding it to account in terms of sustainable development policies; capacity building – going into departments and helping to embed the skills for staff to work sustainably. For example, the SDC has worked with the NHS to develop a tool kit that NHS trusts can use to make sustainability real in their hospital.

Andrew Lee reports to the Chairman, Jonathon Porritt, and as Director leads up a team of 55 staff. He has spent his career trying from the outside to influence government policy, first at the Wildlife Trust and then WWF. For the past year he has been working within government. He seems to have spent so long with politicians that he sounds very much like one; not necessarily in what he is saying, but in the way he delivers it with a smooth, calm manner, careful to get the important buzz words in every sentence.

There is no doubt that he has worked hard to get to the position he is in. His career is one that many environmental scientists with a political bent would be jealous of. Andrew Lee started off as a biology student, which he found boring, then he discovered 'there was another course where everyone was doing fieldtrips to interesting places.' This was environmental biology, which he coupled with conservation volunteering, sparking a lifetime interest. This was an unusual career to pick at the time and his parents asked why he didn't want to be a chartered accountant.

The first ten years of his career were spent at the Sussex Wildlife Trust. Later he mentions that some of the most rewarding experiences came in this job; actually seeing pieces of land protected in perpetuity as nature reserves gave a tangible reward that was never quite so clear in the rest of his career.

Seemingly liking to do things in decade periods, he spent the next ten years at WWF. There he helped to generate ideas that have become so popular that the terms they set out have entered the environmental lexicon. For example 'One Planet Living', the concept that highlighted if everyone lived like we did in the UK, we would need the resources of three planets to sustain the human population. Under his leadership the WWF campaign and policy work started to move away from 'the charismatic species around the world', to also tackling the consumption pressures that threaten the habitats and integrity of ecosystems. A flagship project, hatched in his office when he held the post of campaigns director, was the 'One Million Sustainable Homes' campaign. This was not an issue that one would immediately connect with wildlife protection, but Lee was always keen to find issues that would mean something to the general public; 'Housing is an issue which very directly connects people with environmental issues.'

Sustainable Development Commission

I ask him how the transition from the WWF to the SDC was? 'Not that difficult,' he replies, 'as the issues are not very different to what I was working on at the WWF, on the policy side of the organisation.' My carefully prepared questioning angle of the great outsider moving into government collapses. 'The style is different. We are the government advisors so we have a level of access that is quite different from an NGO. The flip side is that it is sometimes more difficult to demonstrate change to the outside world. SDC is on the inside and is trusted to see early drafts of documents. We don't have the big public support base that an NGO can bring to bear in a meeting with the Government.'

The SDC has done a lot of work over the last year, some of which has been picked up by the media, and other

bits slip off the radar. When I return to my office I pick up a copy of the Royal Commission's Urban Planning Report; SDC research is quoted in nearly every chapter. They also did a great deal of research for the energy review, looking at nuclear and now at tidal and wind power. The SDC advice on nuclear was very clear – this is not the time to be going for a new round of issues such as costs, waste and lead times. Was he secretly happy then when Greenpeace won a high court injunction against the way the government was pushing ahead with the nuclear option without proper consultation? 'The judgment used a lot of SDC evidence.' A smile flitted across his face, a flash I suspect of the old campaigner, pleased to give the government a bloody nose. 'Instead of the government making policy and then defending it against the inevitable backlash, for example road pricing, it needs to engage people in developing the policy, as the policies will be deep-seated and involve a great deal of personal change.'

An item which received a lot of recent press coverage was the sustainability audits that the SDC conducted over all Whitehall departments. The worst was the Cabinet Office – 'disappointing as it needs to be showing leadership.' Defra is middle-rank and the DTI is on top. His comments on the results? 'The speed of change within government departments is far too slow… It is very frustrating because it undermines other good messages that are coming out of Government.' This wasn't just a playful exercise to give the tabloids a story on a slow day – the size of the government departments means that they have a big material impact. Government actions can also affect the supply chain, so changing what and how they order supplies could have a positive effect on businesses trying to work sustainably. 'What we are interested in is not the media story *per se*, but achieving change within government.'

When I asked him whether during his career he had found the most resistance from business, government, the public or the media, he gave a politician's answer: 'You can't point a finger, although I did in an NGO capacity. It's never that simple… If you draw a triangle with Government, business and individuals at each corner, you'd have a situation where no one wants to move first. Government says if it moves too fast the public will vote it out, businesses say if we go too far ahead we might lose out to competitors, individuals say I don't want to be a mug and stop flying if my friend is off to Spain every weekend. That's the dynamic we need to change: from "After you" to "I will if you will".'

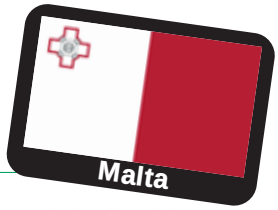
I put to him my theory that there is more appetite for change on green issues within the general public than politicians believe. This seems to spark in him a hitherto hidden frustration with politics: 'People are fed up with hearing rhetoric, then seeing small actions. For example, there is a great deal of rhetoric about sustainable transport, but policies are put in place to make flying easier and public transport is crumbling. People are not stupid. They know that if China is building three hundred coal-fired power plants our Government running a campaign to turn off your lights is not enough. People draw the logical conclusion that the issues are not as important as the Government is claiming, because it isn't matching actions with words. Take for example Gordon Brown's increases in car tax. That was a minuscule step, and our own research showed the increase would have to have been much larger to send a signal to people to buy a smaller car.'

In that case, I ask him, should we be looking to Europe for our environmental legislation? 'Historically the strongest legislation has come from the EU, but the golden age is over as the expanded Europe has changed radically.' He hopes that the EU might still be a driver in some areas, for example the Emissions Trading scheme, a policy on which Andrew Lee campaigned while at WWF. I ask if he was disappointed with how it turned out. 'It depends on which day of the week you ask me; some days I will be bitterly disappointed – the price of carbon is still far too low to send a serious signal to business to reduce emissions – on another day I think well, this is life, it's going to take a long time to get this right. You're dealing with a lot of political trade-offs, at least there is a market working. There is progress, but it is frustratingly slow.'

As with anyone who engages with politics, Andrew Lee seems full of frustrations. They huddle in his sentences, manifesting in terms like 'lack of engagement' and 'no appetite for change'. At times these frustrations form whole sentences. 'A lot of choices to live sustainably are not available, either the pressure or cost not to do it are too much' and 'We have been talking about it for 30 years and people's capacity for denial on issues such as collapsing fish stocks is incredible.' But I suspect the reason Andrew Lee has been such a success in his career is because he realises, despite the regular setbacks, that society's beliefs are slowly aligning with his own: 'Sustainability is a lot more mainstream, no longer a fringe activity. The feeling of being a small group of people against the system is no longer true… The world has changed – ideas such as personal carbon allowances, that would have been deemed far too radical a few years ago, now get serious consideration in government meetings.'

I ask him what message he would like to give to our 2,000 environmental sciences readers. 'Get out and talk to the rest of the world, particularly the professions that would never think of themselves as environmental or sustainable and in whose hands a lot of this lies, for example engineers, transport planners and doctors. The challenge is to embed sustainability into the key professions. These are the people that will be able to build the changes that we need in society into their own jobs. Be evangelists and go out and talk to them.'

ENVIRONMENTAL ISSUES IN THE MALTESE ISLANDS



The often conflicting demands of Malta's flora and fauna and her human population are described by **MARK C. MIFSUD** MSc, MIENVSC, MIBIOL, MIEEM, CBIOL, CENV, of Junior College, University of Malta

The Maltese islands are a small archipelago, situated in the centre of the Mediterranean some 96km south of Sicily and 290km north of the coast of Libya. The Maltese archipelago comprises three inhabited islands; Malta (245.7 km^2), Gozo (67.1 km^2) and Comino (2.8 km^2), together with a number of uninhabited smaller islands; Cominotto (9.9 ha), Filfla (2.0 ha), Fungus Rock (0.7 ha) and St Paul's islands (10.1 ha). The islands are composed almost entirely of marine sedimentary rocks of Tertiary age, mainly Oligo-Miocene limestones, calcareous sandstones and clays (Schembri, 1992).

Originally, the islands were covered by the Upper Coralline Limestone which forms limestone platforms with karstic topography. This is now limited to areas in the west of Malta and the tops of hills and ridges. Where this layer has been removed, the less resistant Greensand and Blue Clay have been rapidly eroded to expose the underlying Globigerina Limestone. The Globigerina Limestone is the most extensive, exposed formation, which forms a gentle rolling landscape, intersected by the sloping and often terraced valleys. The low lying Globigerina Limestone areas have, over the centuries, been reclaimed for agricultural purposes and contain a soil cover, which is shallow and extensively modified through human influence. The Lower Coralline Limestone, the lowest stratum of the Maltese stratographic succession, is only found inland in a few areas of faulting, and is a massive limestone forming the lower part of the sea cliffs on the southern and western coasts of Malta and Gozo. Malta and Gozo, the two principal islands, have a seaward tilt to the Northeast, and the highest points are 253 metres at Dingli Cliffs in Malta, and 191 metres at Dbiegi in Gozo (Schembri, 1992).

Most of the valleys on the islands are dry valleys, carrying water along their courses only during the wet season. A few, however, maintain some water flowing throughout the year. The shelter provided by the valley sides, and the availability of water, makes these valleys some of the richest habitats on the islands. Together with valleys, inland cliffs are of particular ecological importance. The cliff base is invariably surrounded by screes of boulders eroded from the rock face. Both the cliffs and the boulder scree provide a suitable habitat for many species of flora and fauna, including endemic forms.

The surrounding sea is temperate and the coast is generally steep. The total length of the coastline is 190 km, 64% of which is natural, 18% seminatural with another 18% artificial, the latter consisting mostly of harbour shorelines. Some 5% of the coastline is composed of sandy beaches, only a few of which have significant sand dunes. At least 38 km of the coastline consists of sheer cliffs (Mifsud, 1996).

The climate is typically Mediterranean with characteristic hot and dry summers and mild, wet winters. The seasonal distribution of rainfall defines the wet period, from October to March with approximately 85% of the total annual precipitation, and the dry period from April to September. The islands have an average annual precipitation of 530mm, which is highly variable from year to year. Air temperatures may be described as moderate with a mean of 18.5°C, and never fall too low to affect the growth of vegetation (Chetcuti, 1988). Wind is common on the islands, with approximately 87% of the days of the year being windy. The commonest wind is the northwesterly, which prevails on 18% of windy days. The islands receive an average of 8.3 hours of bright sunshine per day (Chetcuti, 1988).

Originally, prior to colonization by man, the Maltese islands most probably supported large tracts of Mediterranean sclerophyll forest, dominated mainly by Holm Oak (Quercus ilex) and Aleppo Pine (Pinus halepensis), with an undergrowth of shrubs. Following colonization, man started to clear the woodland in order to make room for farmland and habitation. Grazing by domestic animals, goats in particular, also had a significant effect on the remaining natural forest, which is now only present in a few localised pockets on the principal island.

The only semi-natural woodland of any extent is the conifer wood at Buskett, which is dominated by Aleppo Pine. This semi-natural wood is relatively important as it represents the only well established woodland ecosystem in the Maltese islands, with its specifically associated flora and fauna. Maquis, frequently containing some large trees such as the carob (Ceratonia siliqua) and the olive (Olea europea), is often found in small sheltered pockets were grazing is prevented, or on steep slopes. Garigue is typical of rocky terrain and is characterized by low growing shrubs on karstland. Typical shrubs forming the garigue community include the Thyme (Thymus capitatus) and the spiny spurge (Euphorbia spinosa). Some garigue communities are natural, while others are the result of degradation of woodland and maquis. Likewise, steppe grassland is a community type which results in turn from the degradation of the maquis and garigue. The garigue and steppe communities are widespread and are consid-

ered the most common natural vegetation types occuring in the Maltese islands. Other habitat types found in the Maltese islands include: transitional coastal wetlands, sand dune systems, saline marshlands, temporary and permanent freshwater pools and water courses, cliffs and caves (Schembri, 1989).

Rubble walls and carob trees are typical features of the Maltese islands. This is even more apparent in summer, when most other plants dry up while the deep green leaves of the carob tree remain as green as ever.

Environmental issues in the Maltese islands

The most serious environmental problems arise from the fact that Malta is one of the smallest states in the world, with an area of 316 km^2, also making it one of the most densely populated. The population density stands at more than 1,274 persons/square kilometre (State of the Environment Report, 2005). The high population density is augmented further by high tourist arrivals of approximately 1.2 million yearly (Mallia, 2002). Since 1995, the population has continued to increase and in 2000 stood at 388,613 (Planning Authority, 2001). The high population density has a significant effect on the natural environment of the islands. Natural sites are continually being removed to make way for structures. It is enough to consider that in 1955 only 6% of Malta was built up, in 1988 this figure had reached 15.4% (Structure Plan For The Maltese Islands, 1990), while in 2004 it had reached 16.5% (State of the Environment Report, 2005). The influence of a high population density on the environment and its resources is highly significant and clearly apparent. Some of the main threats include the clearance of natural habitats for agricultural and building development; activities such as the dumping of domestic and building waste; quarrying; and the collection of flora and fauna for commercial and domestic purposes and the hunting and trapping of birds (Mifsud, 1996).

One of the main problems directly arising from the high population density is waste production and management. The generation and management of wastes is of utmost importance in sustainable development, and current waste practices in the Maltese islands cannot be said to be sustainable. Materials and resources are not being conserved and future generations will inherit large dump sites and wastes created by the present generation. Municipal solid waste generation has steadily increased from 0.39 tonnes per inhabitant per year in 1998 to 0.59 tonnes per inhabitant per year in 2001 (Axiak, 2002a). However the majority of solid wastes produced comes from the construction industry where it is estimated that approximately 2 million tonnes of construction wastes are generated annually. The main waste management strategy in the Maltese islands is deposit of waste on land. The majority of solid waste is currently being collected, unsorted and dumped in a relatively large open dump (Maghtab dump) close to the coast in Malta and at Il-Qortin in Gozo. Considerable amounts of hazardous wastes are being stockpiled. These include materials such as asbestos, waste oils and used batteries. The Maghtab and Qortin sites are causing a negative impact on the landscape, reducing its aesthetic beauty. The sites are also areas that are causing air pollution including increased levels of particulates, methane and odours. Saliba (1999) identified the presence of toxic heavy metals including lead, copper, cadmium and arsenic in runoff water, in groundwater and in marine sediments in the vicinity of the Maghtab site. Illegal tipping of several categories of waste is still relatively common and the penalties imposed on the polluter do not seem to be a strong enough deterrent (Axiak, 2002b). A more sustainable approach based on waste minimisation and recovery is needed and this necessitates an increased awareness of Maltese people towards the limitations of the Maltese environment. Malta's EU accession and subsequent membership in 2004 has had a positive effect on solid waste management policy and legislation. Such measures lay down a time schedule of programmes and projects which need to be achieved over the next few years, although it remains to be seen how effective all this will be.

The sewerage system in Malta consists of two main networks: the largest one serves the southern part of the island and the smaller one the northern part (Malta Structure Plan, 1990). About 80% of the sewage produced in the islands is pumped untreated to the sewage outflows of Ghammieq and Cumnija, causing marine pollution. It was estimated that 23.2 million cubic metres of untreated sewage were dumped into the sea in 1992 (COWIconsult, 1992), and this increased to 25.8 million cubic metres in 1995 (Castaglia, 1996). The environmental impact of sewage in Maltese coastal waters results in an increased bacterial load (Axiak *et al*, 2000), and hence relatively poor

bathing water downstream of the Ghammieq outflow. High levels of lead, copper and zinc were also found in the vicinity of Wied Ghammieq. In addition, another study by Stafrace indicates that fish (Mullus surmuletuus) collected in the vicinity of sewage outflows had the highest metallothionein induction caused by exposure to heavy metals (Stafrace, 2001). One should remember that the natural beauty of the Maltese coast attracts a large number of tourists every year.

The only sewage treatment plant on the island, Sant Antnin, treats approximately 20% of the wastewater produced (State of the Environment Report, 2005). The treated water is used for agriculture and for industry. Other treatment plants are planned in the North of the island and in Gozo and will be partly financed by the European Union. All domestic and industrial wastewaters are planned to be treated by 2007.

The extraction of limestone dominates the mineral industry in Malta. Limestone quarrying is carried out for two basic rock types: the softstone – derived from Globigerina Limestone and used as a building stone and the hardstone – derived from Coralline Limestones and mostly used for the manufacture of concrete products and road building and maintenance. The softstone quarries are mainly located in the central and eastern areas of Malta and occupy an area of 1.1 km^2, while the hardstone quarries are more widely distributed and occupy a land area of 1.3 km^2 (State of the Environment Report, 1998). Gozo has a smaller number of quarries and nearly no hardstone extraction activity. Quarrying results in resource depletion, impacts on landscape, ecology, water resources, archaeological sites and buildings, and also in the generation of noise, air pollution and waste (Mallia, 2002). Limestone is a non-renewable resource and current rates of production, consumption and waste production cannot be sustained indefinitely. In fact the Malta Planning Authority has set out a policy against the development of any new quarries until the first review of the structure Plan in 2010 (Mallia, 2002). Quarries sometimes lead to the destruction of whole habitats and ecosystems and the subsequent elimination of species. Unusable rock and rubble is often stockpiled close to the quarry and this together with the quarry and mechanical plant itself creates unsightly visual pollution in the countryside. In addition roads are built to service the quarry and this generates traffic which exposes the countryside and groundwater to possible sources of contaminants. About 80% of all the material deposited at the Maghtab dump during the year 2000 consisted of waste generated by the construction and building industry (Planning Authority, 2002).

A major determinant of the state of the environment is the types and intensity of use of energy resources. Malta imports all of its significant primary energy; currently this comprises refined oil products and liquid petroleum gas (State of the Environment Report, 2005). There are two power stations for generating electricity in the Maltese islands, one at Marsa and the other a newer facility at Delimara. Both power stations utilise heavy fuel oil as coal was phased out in 1995 because the open coal storage facility at Marsa was identified as a source of severe coal dust pollution in the area (Mallia, 2002). However problems are far from over as the close proximity of the power stations to built up residential areas magnifies problems. For instance, teachers and students have been forced out of their school at Marsa a number of times due to high concentrations of sulphur dioxide coming from the Marsa power station (Enemalta Annual Report, 1998). Furthermore, the Delimara power station uses sea water as cooling water. Approximately 450,000 m^3 of chlorinated water with a temperature of around 7°C more than the intake water temperature is pumped into the Hofra iz-Zghira shoreline, destroying Posidonia oceanica, which is a keystone species of the sea grass meadows ecosystem (State of the Environment Report, 1998). As the generating capacity of the power station increases so will this problematic water discharge.

A Bath White butterfly emerging from the pupa. The wings are not yet fully extended. Notice the breakage in the pupa from which the adult butterfly emerged.

Alternative sources of energy are at best under-utilised. Wood is used in a very limited quantity as biomass and wind energy is only used to pump water from the local aquifers (State of the Environment Report, 2005). Solar energy is the most commonly used alternative source of energy although it still under-utilised. The average daily solar energy falling on the Maltese islands ranges from a peak of 2.7 KWh/m^2 in winter to 7.8 KWh/m^2 in summer (State of the Environment Report, 1998). But only a small fraction of this energy is utilised. The popularity of solar water heaters is low with the population, although rising electricity prices and government subsidies for the purchase costs of the solar water heater might increase their popularity. Photovoltaic electricity production is very limited on the island, probably due to the high initial cost of the technology.

Private motor usage amongst the Maltese population is very high with an average of 1.5 cars per household (Planning Authority, 1998), possibly because of the inadequacy of the public transport system. At the end of the year 2000 there were about 300 km of major roads and 182,105 private cars in Malta, which means that there are 1.6 m of road per car (Mallia, 2002). This indicates the potential and actual congestion of local traffic. Motor-vehicle generated air pollution includes carbon dioxide, carbon monoxide, nitrogen oxides, particulates and, up to 2001, particulate lead owing to the use of leaded petrol. Lead content in playground dust was found to be at an alarming level (Savona, 1996); thus, leaded petrol was phased out in 2001. Volatile organic compounds are also emitted by cars, and a high level of VOCs including the carcinogen benzene have been identified in the Maltese islands. More than 78% of sites tested for benzene were found to exceed the WHO limit value of 1.5ppb (Vella, 2002). Motor traffic also generates noise pollution and residents in a number of areas are being subjected to levels of noise of approximately 65dB for at least 1-2 hours daily, which can be detrimental to health (Mallia, 2002).

Freshwater production in the Maltese islands is dependent on electricity. About 50% of the total water produced on the islands comes from reverse osmosis plants that desalinate sea water and require large amounts of electricity to function. The water thus produced is of a very high quality but it is then mixed with the lower quality groundwater from local aquifers, which is cheaper to extract. This reduces the water quality to levels that do not always comply with EU standards (State of the Environment Report, 1998). Leaching from artificial fertilizers results in groundwater with very high levels of nitrates, while the proximity of the groundwater table to seawater results in high levels of salinity in groundwater (Department of Health Policy and Planning, 1997, State of the Environment Report, 2005).

The flower of the milky orchid, Orchis lactea, which flowers in winter and grows in garigue, steppe and disturbed grounds.

The Maltese islands have a rich variety of flora and fauna considering their relatively small size. However, small, isolated islands tend to have a somewhat impoverished resident avifauna and the Maltese islands are no exception (Sultana and Gauci, 1982). Nevertheless, the Afro-European migration system has three principal migration routes over the Mediterranean, one of which passes over the Maltese archipelago. The islands' strategic location plays an important role for many species of migratory birds during the annual spring and autumn

migrations. More than 360 species of birds have to date been recorded in the Maltese islands, of which 15 are resident breeders, and the rest either regular or irregular migrants (Sultana and Gauci, 1982).

Bird hunting is a popular hobby pursued with a passion by people in various countries over the world and especially so in the Maltese islands. In Malta this issue attracts a large amount of public attention, most probably because of the very large hunting and trapping population that has increased from 11,300 in 1996 (Mifsud, 1996) to 15,216 in 2004 (State of the Environment Report, 2005). This creates a relatively large number of hunters with respect to the whole population and a high individual hunter figure per unit area of land. In addition, hunting of protected species and hunting during the closed season are extensive in the Maltese islands, most likely due to the lack of law enforcement and the hunters' attitudes (Fenech, 1992). Hunting and trapping of birds may be minority pastimes but they still constitute very powerful lobbies, and the two large political parties in the islands are normally unenthusiastic about moderating the practice.

Birds are almost certainly the most publicised threatened organisms on the Maltese islands. However, other important organisms such as the Maltese Freshwater Crab, Potamon fluviatile, are also decreasing in number owing to increased influence by humans such as direct persecution, and habitat destruction due to development. Some flowering plants, including the French Daffodil, Narcissus tazetta, are still being removed from the natural environment and sold at flea markets even though it is an illegal practice.

In summary, the major environmental issues in the Maltese islands include waste management, quarrying, habitat destruction, pollution from electricity generation and vehicle transport, the under-utilisation of alternative sources of energy, water quality, and the collection or hunting of flora and fauna. The main cause of these issues is the high population density that exerts a significant impact on the environment and its resources. In addition, the unwillingness of the major political parties to moderate practices and traditions, amplifies some of these issues.

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ENVIRONMENTAL ISSUES IN NEW ZEALAND

NZ holds a unique position in environmental history. It is Earth's youngest nation – and its last frontier. In the last 150 years, it has developed much more quickly than earlier frontier nations. This has been due to a number of factors, for example because advanced technology has enabled build-fast projects – for instance the rapid proliferation of high-tech dairy farms over the last decade. I also dub NZ the 'risk capital' of the world. Risk-taking was a defining character of the early (mainly British) settlers. Sailing halfway round the world was not for the reticent. (Want some examples of the risk mentality? Consider Sir Edmund Hilary, the first to climb Everest; also NZ is the birthplace of commercial bungee-jumping; and it leads the world in unsubsidised, go-it-alone agriculture). One consequence of this risk /entrepreneurial mentality is the headlong acceleration of national development over the last 15 years.

NZ has a population of just 4.1 million people over an area 10% bigger than the UK. Its main economic drivers are primary production (agriculture, forestry, fisheries) and tourism, all critically reliant on a clean and secure environment, and on oil. So, the big issues for NZ's future are as follows.

- Energy – especially acute, as NZ is among Earth's most remote, transport-dependent nations. 20 years ago, 70% of NZ electricity was from hydro-generation. Now it is less than 60% (still remarkably high), due to expanding population and development.
- Water. Irrigated agriculture is intensifying, and (despite low population density) water is becoming a limiting resource (e.g. dairying is a thirsty industry: producing 1 litre of milk requires pasture evapotranspiration of c. 900 litres of water).
- Biosecurity – a critical issue for protection of both primary production, and NZ's unique natural biota. NZ is already host to a wide range of invasive alien species. Even the iconic kiwi bird is in decline, partly due to the introduction of new species.
- Natural hazards. NZ is tectonically active (Fig. 1). Only 1,800 years ago a huge volcanic eruption (now Lake Taupo) re-mantled much of the North Island.

Both water scarcity and biosecurity problems will be exacerbated by global warming.

However at the time of writing, NZ's Prime Minister Helen Clark has announced that building a sustainable nation is now a leading priority, with an aspiration to make NZ Earth's first 'truly sustainable nation'. This will, however, require huge changes in social norms and practices, and the technology and infrastructure to support sustainability; but then… 'Man is best in adversity'.

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Lincoln University lies 20km SW of Christchurch City (the gateway to the Antarctic) on the Canterbury Plains (alluvial plains covering 750,000 ha). The Southern Alps lie along the western side of the South Island. NZ lies astride the boundary of two tectonic plates, and so is a dynamic landscape prone to earthquake and volcanic activity.

KEEPING NEW ZEALAND GREEN THROUGH VOLUNTARY ACTION ON CLIMATE CHANGE

Wine lovers reading this article may have heard of Grove Mill from Marlborough, New Zealand. If they purchased a bottle of their excellent 2006 Sauvignon Blanc, they will have noticed a CarboNZeroCertTM label adorning the neck of the bottle.

The trade mark is awarded by Landcare Research, a Crown Research Institute that has taken the lead in New Zealand to develop practical ways for organisations to take action to reduce their greenhouse gas emissions.

The programme is the result of over five years' worth of credible scientific research. Participants complete four steps before becoming carbon neutral and asserting this status in the marketplace.

1. **Measure:** Understand and measure your carbon dioxide (CO_2) emissions
2. **Manage:** Make a commitment to manage and reduce your emissions
3. **Mitigate:** Offset or mitigate your remaining, unavoidable emissions.
4. **Market:** Show your customers that you have attained CarboNZeroCertTM certification

Participants know the calculation of their potential liability is as robust and accurate as possible. If they choose to offset through the associated native forest regeneration programme (Ebex21), they can also contribute to New Zealand's biodiversity.

Martin Fryer comments 'There are a plethora of

carbon calculators and offset opportunities out there. We wanted to create a programme that was based on sound science and rewarded those actively reducing emissions as well as offsetting. This ensures participants don't just salve their conscience through buying credits but also explore energy efficiencies and emission reductions opportunities themselves.'

To find out more visit *www.carbonzero.co.nz*, *www.landcareresearch.co.nz*, *www.ebex21.co.nz* and *www.grovemill.co.nz*

Martin Fryer MIEnvSc, CEnv,
Senior Advisor, Business and Sustainability,
Landcare Research, New Zealand

IES: NEW MEMBERS

The Institution of Environmental Sciences is pleased to welcome the following new members and regrades:

Professor James Irwin	Head of Risk & Forecasting (F)	Ms Fong Wong	Assistant Consultant (M)
Mr Kwok Au	Environmental Scientist (M)	Mr Adrian Young	Officer for Air Quality, Health & Transport (M)
Mr Nigel Bellamy	Consultant - Air Quality (M)		
Mr Robert Boelema	Principal Environmental Scientist (M)	Mr Jonathan Brookes	Air Quality Consultant (A)
		Mr Michael Burrows	Owner of a scientific film company (A)
Dr Gregory Borne	Associate Fellow; Sustainable Development (M)		
		Mr Benjamin Cornet	Environmental Scientist (A)
Mr Christopher Burrows	Senior Consultant (M)	Mr Bijoy Dey	Graduate (A)
Mr Paul Ciniglio	Innovations & Environmental Mananger (M)	Mr Jonathan Flitney	Technical Officer (A)
		Miss Katherine Grant	Environmental Consultant (A)
Mr Owain Davies	Air Pollution Scientist (M)	Mr John Hodgson	Air Quality Consultant (A)
Dr Stephen Finnegan	Senior Transport Planner (M)	Mr Ross Hunter	Environmental Scientist (A)
Mrs Jayne Fish	Education Officer (M)	Miss Kathryn Iddon	Environmental Scientist (A)
Mr Christopher Gall	Environment Protection Officer (M)	Miss Emma James	Senior Graduate Air Quality Consultant (A)
Dr Jorge Gomez-Perales	Senior Environmental Scientist (M)	Miss Hannah Jones	Environmental Scientist (A)
		Dr Jessica Lenham	Air Quality Consultant (A)
Dr David Harrison	Senior Consultant – Air Quality (M)	Miss Anneliese Lithgow	Graduate Environment Scientist (A)
Mr Phil Holmes	Research Assistant (M)		
Mr Tim Johns	Senoir Scientist (M)	Miss Kay Lunnon	Scientist (A)
Mr Stephen McKeown	Consultant (M)	Ms Claire McCready	Environmental Scientist (A)
Mr Giovanni Nacci	Assistant Manager – Local Implementation Plans (M)	Mrs Margaret Moore	Student (A)
		Miss Emily Nicholl	Environmental Scientist (A)
Dr Mark Pawlett	Research Officer (M)	Mr Ducan Orr	Graduate (A)
Dr Pattanathu Raham	Project Development Officer (Environmental Sustainability) (M)	Mr Mfon Oton	Graduate (A)
		Mr Rob Quinn	Environmental Consultant (A)
		Mr Giancarlo Serra	Principal Environmental Enforcement Officer (A)
Mr Ian Renshaw	Environmental Consultant (M)		
Mr Michael Robertson	Environmental Consultant (M)	Miss Chloe Smith	Junior Conusltant (A)
Dr Lesley Sloss	Principal Environmental Consultant (M)	Mr Matthew Wong	Assistant Air Quality Consultant (A)
Dr Abhishek Tiwary	Research Fellow (M)		
Mr Duncan Urquhart	Environmental Scientist (M)	Miss Natalie Bissell	Student (Af)
Mr Edward Wan	HSE Manager (M)	Mrs Janice Blumenkrantz	Retired (Af)
Mr Richard Wearmouth	Environmental Engineer (M)	Mr Richard Bowles	Student (Af)
Dr Denise Welch	Consultant (M)	Miss Ruth Kernohan	Student (Af)
Dr Adrian Whittle	Environmental Consultant (M)	Ms Soma Mukherjee	Student (Af)
Ms Pui Wong	Teaching Associate (M)	Mr Himanshu Patel	Student (Af)

F = Fellow M = Member A = Associate Af = Affiliate

THE MASAI MARA – WHICH WAY FORWARD?

Kenya's Masai Mara National Reserve is host to one of the highest concentrations of large animals in the world. The reserve is perhaps most famous for its annual migration, which occurs between July and October each year. This is when enormous herds of Wildebeest, Zebra and Thompson's Gazelle cross into the Mara from the Serengeti, and spill over into the group ranches that form the dispersal areas to the north of the reserve.

The Greater Mara Ecosystem is being seriously threatened by an increasing number of tourist facilities, subdivision of the group ranches and elimination of dispersal areas as a result of their conversion into smallholder farms.

After much debate among stakeholders, two options were proposed for the protection and conservation of the Mara Ecosystem: either to impose a moratorium on all development inside the MMNR and in its surrounding ranches until a management plan is developed and implemented; or to form conservancies where wildlife populations are able to disperse, while at the same time tourist accommodation can be hosted – this would entice tourists away from the core MMNR area, relieving the reserve of some of its present congestion.

The stakeholders voted for the first option, and the regional development authority has now embarked on the preparation of a management plan for the Greater Mara Ecosystem.

While there is undoubtedly a need for a management plan, its development and implementation will be time consuming. Moreover, previous management plans have not been implemented. The conservancy approach provides a more immediate solution in that it can prevent, or at least slow down, the conversion of rangelands and wildlife dispersal areas into maize or wheat fields. This option is in effect 'a last stab' at curbing the impacts of land subdivision on this critical wildlife habitat.

Arundhati Inamdar-Willetts, MIES

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THE SKY OF HONG KONG IS TURNING BLUE

'Action Blue Sky Campaign' has been officially launched to reinforce the Government's determination to improve Hong Kong's air quality. The participation of the whole community is required to combat increasing air pollution.

The public is being encouraged to set air-conditioners to 25.5°C in order to save energy. Private sector employees are urged to 'dress down' in summer.

In addition, three new measures to improve roadside air quality were launched on 1st April 2007. First, the Government will provide a one-off grant to encourage vehicle owners to replace their pre-Euro and Euro I diesel commercial vehicles with new commercial vehicles complying with Euro IV standards. The grant will last for 18 months for pre-Euro vehicles and three years for Euro I vehicles. Secondly, there is a 30% reduction in first registration tax for purchasing newly registered environmentally-friendly petrol private cars. The maximum cost of the reduction is $50,000 per car. Thirdly, pre-Euro diesel vehicles of vehicle weight over four tonnes and with the following body types: concrete mixer; gully emptier; lorry crane; pressure tanker, except those issued with a cross-boundary road permit, must install emission reduction devices. Failure to do this will lead to cancellation of vehicle licences.

The Hong Kong Government hopes that launching these schemes will lead to an improvement in the territory's air quality.

Kalvin Lau

WHY DOES AIR QUALITY POLICY NEGLECT INDOOR AIR AND CULTURAL HERITAGE?

Poor indoor air quality can pose a threat to health – and even to life – say **SIMON WATTS** and **BERNARD FISHER**

In a companion paper, the discussion at a recent Institution of Environmental Sciences Workshop on Indoor Air is reported. The paper proposes that despite its complexities some aspects of indoor air quality can be treated using a risk assessment approach. This paper considers two aspects not considered at the workshop: cost-benefit analysis and cultural heritage.

Cost-benefit analysis for outdoor air

The motivation for further improvements in outdoor air quality arise from its health benefits quantified in terms of money by cost-benefit analysis. The UK Air Quality Strategy[1] (AQS) set targets for the reduction in the outdoor concentrations of nine pollutants, and assessment of the outcomes of this strategy[2] seem to indicate that on the whole it has been broadly successful. It has been instrumental in allowing the UK to meet EU air quality objectives, reducing the population's exposure to road transport generated pollution and other atmospheric pollutants, as well as delivering major health benefits to large sections of the population. Estimates of the total benefit over the period 1990-2010 are £10-50B[2]. The total costs over the same period are estimated to be 'significantly lower' than these.

In terms of outdoor pollutant concentrations, it has been so successful that it has also acknowledged[2] that for some pollutants, on a cost benefit basis, there is no motivation to increase the stringency of targets These include the 'threshold' pollutants, (e.g. NO_2), although for other 'non threshold' pollutants, (e.g. PM_{10}), clearly this is not the case.

The rationale for the scope of the Air Quality Strategy (presumably as for any publicly funded environment/science policy) is the balance of the cost-benefit analysis (CBA) which underlies it[3], and the science which it uses. The Air Quality Strategy specifically excludes indoor air pollution, although in the consultation on the Air Quality Strategy four responses[2] felt that it should be included. It does seem a little odd that the health benefits won by the Air Quality Strategy and highlighted in the economic analysis are recognised in the outdoor situation, but seemingly not indoors where pollution concentrations can be many times higher than outside[4], and also where people spend most of their time[5]. Additionally, indoor conditions can include high dust levels (of different size spectrum and composition from those found outside) and more chemical species (indoor atmospheric chemistry includes more of the species that usually would be found outdoors at night[6], as well as those produced heterogeneously[7]). These issues, as well as the potentially greater concentrations, suggest that people might receive a greater dose of some pollutants than outside, and hence reasonably that the health impacts of indoor air quality might be greater than those from external air quality[4].

Factors omitted from the cost-benefit analysis

This brings two questions to the fore. The first concerns the cost-benefit analysis itself. If scientific and medical inquiry produces data which indicates a possible health problem of air quality origin (in this case indoor air), and furthermore that the magnitude of the problem is likely to

Left: Silver tarnish: The effects of the atmosphere are easy to see.

Right: Artefact from Pitt-Rivers Museum Oxford. How can these be seen by the public but also protected?

be large, then one would expect that a work purporting to be an 'economic analysis to inform the Air Quality Strategy review' would examine the impacts of that health problem and that not to do so might open itself up to criticisms of being incomplete or flawed. Possibly this was in part at least the view of nine of the respondents who felt the cost-benefit analysis was flawed[2]. Secondly, the fact that the cost-benefit analysis specifically excludes an area predisposes decision-makers to not engage the area, so in fact it delays any actions to address the problem.

1. Indoor air

Of course, the situation with indoor air pollution is less simplistic than just health effects, and possibly the issues around its non-inclusion in the cost-benefit analysis have some relation to the difficulties around strategic planning of activities that take place in the private domestic setting. With outdoor air quality, there are a whole range of policy instruments that can be brought to bear from emissions standards for manufactured vehicles, emissions testing during MOTs, through to planning, road and traffic policy. By contrast with indoor air quality (particularly in private homes) there are few instruments that can be brought to bear that are acceptable in a modern, free, democratic society. Arguably dangers from domestic gas appliances, such as cookers and fires, might be singled out as potential major indoor pollution sources, but in a free market situation compulsory measures become very problematic.

At root, individuals have the right to harm themselves by their own activities (e.g. smoking and excessive alcohol intake), but it is required that those individuals understand the potential harm they are doing to themselves by their own actions (e.g. health warnings on cigarette packets). With indoor air quality, it might well be that individuals are taking apparently innocuous decisions (e.g. by purchasing an appliance that has a very negative impact on indoor air quality), and that even though they are not aware of it, nonetheless this appliance has the potential to negatively impact on their own health.

In all other walks of life the freedom of the individual within the UK legal framework is predicated on an awareness of the risks and consequences of any particular action by that individual. In the area of indoor air quality people are not being made aware of risks that may exist, primarily because although it appears that there may be considerable risks within the indoor atmospheric environment, there is no programme that addresses the identification and resulting mitigation of these risks. Until an area of government takes full responsibility for this area, and can then initiate such a programme, the current situation in which it is possible or likely that people are losing their health or even in extreme cases possibly their lives, will continue.

2. Cultural Heritage

The other main area of importance for indoor air quality is not the health of people, but the conservation of artefacts of cultural, historic or artistic importance. For most artefacts, the medium in which they exist is the atmosphere. Putting to one side events such as theft, floods etc., the things which damage cultural heritage (e.g. light, certain trace gases, permanent atmospheric components, etc) are mediated by the atmosphere. The artefacts may emit substances into the atmosphere, and crucially pick up their doses of pollutants from the atmosphere. Unlike human health, where some pollutants have thresholds beneath which there are no observable adverse effects, for artefacts all species are non-threshold, so the total damage is related to the total and cumulative dose of the agent(s) of damage.

Indoor air quality in both of its main spheres – health and cultural heritage – certainly has a history of falling between mainstream areas in both research funding as well as regulation[1]. Possibly this is more understandable in the health sphere, as discussed above. However, it is very much more difficult to understand in the arena of the conservation and preservation of cultural heritage. Although many culturally important artefacts are outside (e.g. buildings, statues, etc), many are indoors in the care of museums, library archives and other institutes charged with their conservation. The funding for scientific research into the effects of atmospheric composition on these artefacts, like the health areas discussed above, has traditionally fallen between funding agencies, and until recently none has taken responsibility for the area. However, in 2005 the new Arts and Humanities Research Council (AHRC) was formed, and theoretically at least it is able to fund conservation science and research, although as yet this remains to be tested. It is concerning that 'science' does not feature on its website, and the Natural Environmental Research Council (NERC) has retained the remit for 'scientific archaeology'. Historically NERC has not included conservation science within this definition, and the UK Department of Trade and Industry has also not included it within its funding remit for 'ventilation systems'. This lack of a UK centre for responsibility for the area means that there is often a lack of co-ordinated policy and joined up thinking in the area.

Air quality standards for cultural heritage

Of some concern is that different national, regional or even individual institutions are generating 'air quality standards' for cultural heritage, as well as 'display case and storage exchange rate standards' which are often not compatible with each other. This is a potential threat to the way that museums operate because traditionally only a very small percentage of an institution's collection is ever on display; most is kept in storage. Hence artefacts are

often loaned to other museums or form part of travelling exhibitions that are hosted by other museums. The host museum is then required to meet what sometimes seem to be the arbitrary air quality 'standards' of the donor museum. This is very often not possible, so the loan or travelling exhibition cannot take place, or the exhibition can only travel to national or pan-national centres. The losers here are the general public and the smaller regional museums.

What future for these Cinderella subjects?

It is certainly true that some major work on air quality in the area of cultural heritage has been funded by the EU, and occasionally a single proposal (albeit under heavy disguise) gets through either NERC, EPSRC, DTI or DETR (as was), but there is no real home for this work within the UK research funding system. Like its sibling area of indoor air quality for health, until it is adopted by a particular area of government, progress will not be as fast, joined up or useful as it otherwise might be.

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◆ The views expressed in this paper are those of the authors and are not necessarily those of the organisations for which they work.

PERSONAL CHOICE OR NATIONAL RESPONSIBILITY FOR INDOOR AIR QUALITY?

BERNARD FISHER and **SIMON WATTS** consider current thinking on indoor and outdoor sources of air pollution

This article arose from a meeting of the Institution of Environmental Sciences and the Institute for Air Quality Management on 24th January 2007 at the BRE Watford, London. Presentations from the event are available from the Institution of Environmental Sciences web site (see Appendix).

Introduction

The workshop was prompted by the current revision of the UK National Air Quality Strategy, which is largely driven by health effects, but is almost entirely concerned with outdoor air quality. It is accepted that there are regulatory difficulties dealing with indoor air. However, given that the National Strategy has been regarded as a success with improvements in ambient air quality and the designation of some 200 Air Quality Management Areas by local authorities, it seems appropriate to turn attention from the outdoors to the indoors.

Some pollutants are emitted indoors, and concerns over them are restricted to the indoor environment. For others, one cannot ignore the relation between outdoor ambient concentrations and indoor levels. As outdoor levels decline this relationship assumes greater importance. To our knowledge other countries have not found a clear regulatory way of dealing with outdoor–indoor relations. It is hoped that the workshop leads to some policy ideas or proposals to deal with this dilemma. This could be along the lines of risk assessment and mapping personal exposure, which are outlined in some of the presentations given at the workshop, and later in this article.

Who takes responsibility for indoor air?

Both formal and informal responsibilities for indoor air pollution in the UK are spread between a number of Government departments and agencies. The formal regime includes policy and regulatory functions and the informal regime includes provision of information and advice on such things as safety of gas appliances and the application of building regulations and controls. This makes the regulation of indoor air very complex, as illustrated by the following outline of responsibilities.

The Department of Health recognises the need to

reduce the impact of environmental factors on health, especially children's, including that from indoor air pollution. Many factors depend on personal choices or priorities and cannot be imposed on individuals. The Committee on the Medical Effects of Air Pollution have provided guidance on indoor air, recommending guideline values (COMEAP, 2004).

More formal responsibilities lie with the Department of Communities and Local Government. The department has responsibility for the state of existing housing quality. One aspect is the ventilation of buildings involving heating requirements and exposure to carbon monoxide. (See presentations by Tadj Oreszczyn, 'Ventilation, energy efficiency and the indoor environment' and Ben Croxford, 'Indoor air risk assessment based on gas appliances in the home'.) The question of ventilation raises the potential conflicts regarding staying warm, avoiding condensation and maintaining a safe environment. Investment in better quality housing may lead to more of a house's living space being heated comfortably. This can lead to difficult choices over the priorities between the environment, ventilation and energy, with implications for global warming.

This is the indoor/outdoor environment quality balance. The balance involves minimising energy consumption for financial and environmental reasons, while providing adequate ventilation to remove pollutants. It was recommended that care should be exercised over theoretical models, which may not anticipate real human behaviour in response to a more comfortable indoor environment, i.e. heating the whole house. In relation to carbon monoxide, surveys of gas appliances using practical indoor monitoring equipment, suggest that concerns remain over gas fire safety, particularly when used to heat living rooms (see presentation). Accepting that good practice is to reduce or eliminate indoor sources, there is always a requirement to provide adequate ventilation to remove or reduce pollutants.

The Health and Safety Executive is concerned with the workplace and sets out general duties which employers have towards their employees and members of the public. Employers have a duty to protect the health, safety and welfare of their employees, which the Health and Safety Executive enforces by applying occupational exposure standards and maximum exposure limits for air pollutants in the workplace. This operates largely through inspection schemes.

The Department of Trade and Industry is responsible for regulations to ensure products are safe for use by consumers, and for consumer safety and trade description legislation. Products have an important role for some pollutants. The safety and installation of gas appliances to reduce carbon monoxide from flueless appliances, such as gas cookers, water heaters and gas fires, is possibly the most significant responsibility, though in this and other examples human behaviour cannot be regulated. Another area not discussed here is the use of product standards to control the release of pollutants from non-combustion sources, such as paints and furniture.

The Department for Environment, Food and Rural Affairs (Defra) has responsibility for a national strategy on outdoor air, based on the protection of health and ecology. There is a formal structure with standards, similar to the regulation of the workplace environment. Reporting of air quality in relation to European standards is also required. The air quality standards used to judge air quality in both the UK and Europe are largely derived from epidemiological studies and ambient measurements of pollution levels. The success in reducing concentrations from major source sectors, as these are controlled and technology implemented, has shifted emphasis towards poor air quality resulting from high population density and numerous small emitters, linked to personal behaviour and choice. The backbone to the system is the operation of extensive outdoor air pollution monitoring networks, although most people spend most of their time indoors, especially people susceptible to air pollution effects. There is therefore an argument for shifting the priority now towards personal exposure and the indoor environment.

Indoor air research

The indoor environment has not been ignored and there have been ongoing programmes of work. For example, BRE (see presentations by Derrick Crump, 'Occurrence and control of indoor pollutants', and Vina Kukadia, 'Relationship between ambient air quality and indoor pollution levels') produces guidance for assessing indoor air quality and the use of monitoring equipment. The BRE is also involved in writing international standards for the measurement and control of indoor air pollutants and undertakes investigations, sampling and analysis within homes, offices, hospitals and schools. The types and sources of indoor pollution are quite extensive (the presentation provides a convenient list), and only some are associated with outdoor sources. Furthermore, ambient air quality is partially dependent on indoor air being ejected to the outside. The presentations illustrate the kind of information gathered on a regular basis. An example of concerns cited is the possible exposure of people to benzene from cars in integral garages.

Monitoring is not practical in every home, but one hopes that representative characteristics can be derived from small samples, leading to the identification of problems and the setting of good practice guidelines. One simplification is identifying certain micro-environments representing typical exposure conditions. Another is that although buildings have different ventilation regimes and local factors and ventilation regimes play an important role, one can broadly define indoor:outdoor concentration

ratios for different pollutants in the absence of indoor sources; for example:

Pollutant	Indoor:outdoor concentration ratio
carbon monoxide	1
nitrogen oxide NO	0.85
nitrogen dioxide NO_2	0.6
sulphur dioxide	0.65
carbon dioxide	>1
ozone	0.45

There is no regime for the formal assessment of indoor air parallel to that for outdoor air, and it may be argued that regulation would be an infringement of personal choice. However the guidance and information produced on indoor air is valuable for education and training.

The revision of the National Strategy for outdoor air (Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Defra, 2006) provides an opportunity for a more formal approach to aspects where indoor and outdoor air are closely related. An important new aspect of the National Strategy has been the introduction of the 'exposure reduction' approach and this is worth elaborating as it shows how thinking about achieving environmental objectives can develop.

Exposure reduction

The review of past trends of measurements has confirmed that reducing outdoor particle concentrations by any single measure can be intractable. One wishes to have an objective, which acts as a driver towards reducing concentrations, but at the same time this has the effect that attention is focused towards areas of exceedance. Eliminating these areas of exceedance does not necessarily have the desired effect of generally reducing particle concentrations, which is the objective for a pollutant that has no safe threshold of effect. Hence a proposal has been put forward, which also has support in European negotiations on the implementation of Air Quality Directives, which is based on the assessment of the exposure of the population as a whole, to particles.

The starting point is that the exposure reduction is formulated in terms of the smaller particle fraction $PM_{2.5}$. Based on measurements at urban background sites (these are fixed monitoring sites which are neither near the roadside nor in rural areas) the objective is that between 2010 and 2020 the exposure of the population to ambient levels of $PM_{2.5}$ should reduce by 15%. The 15% value has been chosen to act as a realistic reduction, since it has been estimated that existing policy should reduce levels by about 10% and the extra policy measures discussed in the strategy would lead to an extra 5% reduction. The $PM_{2.5}$ fraction is potentially more amenable to control than the coarse particles = ($[PM_{10}] - [PM_{2.5}]$) fraction. In order to evaluate this proposal the strategy review has considered the population exposed to concentrations above certain specific levels. This is not the population's personal exposure, but takes the thinking beyond just considering areas where ambient levels are above a specified standard.

There remains the long-standing issue of how well the use of fixed monitors measuring ambient air concentrations can be used to determine exposure and risk. Recent measurements of benzene (Gonzalez-Flesca *et al*, 2007) for example, suggest that data collected from fixed stations should be used with caution when assessing exposure to benzene given the influence of indoor sources and other polluted micro-environments where people spend part of their time. A recent theoretical approach (Physick, Cope, Lee and Hurley, 2007) used measurements and modelling to assess exposure variations across a city, arguing that this was better than assuming a city's population exposure to be the pollutant concentration obtained from one air quality monitor (or across several monitors) averaged over the period of the study.

Europe

The Scientific Committee on Health and Environmental Risks (SCHER), a scientific committee of the European Commission under the Health and Consumer Protection Directorate, published in January 2007 a preliminary report on risk assessment of indoor air quality. Interested parties were invited to send their comments[1].

As the committee considered all aspects of indoor air in a general way, it is not surprising it considered that the prospects of undertaking full health risk assessments were limited, because there is not enough data. However the committee stated that any 'study which correlates outdoor air with health effects needs to consider indoor exposure'.

One cannot deal with all the facets of indoor air quality in one regulatory system because of the wide range of indoor pollutants and causes. This article focuses on extending outdoor regulation to indoor environments. As well as the problem of the complexity of the indoor environment, one must also try to balance the needs of one medium or consumer group compared with another.

Population exposure frequency distribution

Any individual has a unique personal exposure to air pollution depending on his/her daily activities, much of which will be spent indoors. Even before the introduction of the air quality management regime to the UK, it was recognised that personal air pollution exposure was neither equivalent, nor necessarily closely related to ambient air

1 *http://ec.europa.eu/health/ph_risk/committees/04_sher/docs/sher_o_048.pdf*

levels measured (Loth and Ashmore, 1994). If one wishes to extend the outdoor regime to inside buildings one must have a practical assessment procedure. Such a procedure may be possible if one can substitute the personal exposure regime (direct measurement by monitors attached to an individual) by the frequency distribution of exposure in a population (an indirect estimation method) (see presentation by Mike Ashmore, 'Integrating indoor and outdoor exposure: personal exposure modelling as a tool for policy assessment'). Three key concepts need to apply for this to work

1. the micro-environment
2. representative indoor:outdoor ratios, and
3. a simple set of population groups.

One summarises the location where people spend time in terms of micro-environments. Typically these might be:

1. Bedroom
2. Living room
3. Kitchen
4. Outdoors
5. Workplace/office
6. School
7. Shops/restaurant
8. Transport.

These may be further classified according to whether the home contains a source of pollution (gas cooking), an office is naturally or mechanically ventilated, and whether transport is by car, bicycle or foot.

Indoor:outdoor ratios can be measured (Lai *et al*, 2004), or modelled (Kousa *et al*, 2002, Dimitroulopoulou *et al*, 2006). In long-term equilibrium without indoor sources, the modelled ratio can be determined by treating the micro-environment as a box, subject to (1) air exchange, the rate at which air passes into a building as a result of ventilation (natural or assisted) in air changes per hour, (2) a filtration factor (non-dimensional) describing the ability of a pollutant to enter a building, (3) the surface area and volume of the box and (4) the deposition velocity describing the rate at which the pollution deposits onto the indoor surface of the box (see Fig. 1). The modelling can be extended to include the exchange of pollution between micro-environments, or rooms, but then requires further parameters to describe the air exchange between rooms.

The filtration factor and deposition velocity will depend on which pollutant is being considered as will long-term average summer and winter outdoor concentrations. The indoor:outdoor ratio can take different values in summer and winter. A further extension of the concept was described by Nicola Carslaw, in her presentation 'Results from a new detailed chemical model for indoor air pollution'. There has been extensive study of the chemical reactions within the ambient atmosphere in recent decades, particularly focusing on ozone. Background levels of ground-level ozone have continued to increase, making it of concern to human health. Ozone concentrations indoors are linked to outdoor concentrations but are lower and vary with time of day. Indoors photochemical reactions are still important despite the much lower light levels indoors (Carslaw, 2007). Moreover there are indoor hydrocarbon emissions, such as from air fresheners, and the indoor surface area to volume ratio is much greater than outdoors.

The indoor:outdoor concentration ratio has been used in risk assessments to treat exposure indoors, to external sources. For example there are outdoor sources which are not easily controlled, such as arsenic in windblown dust in Cornwall as a legacy from the mining industry (see presentation by Jo Barnes, 'Resuspension of particulate arsenic and its potential as an indoor air pollutant'). Although monitoring is the only way of identifying the source of the problem, a health risk assessment using indoor:outdoor ratios is a way of quantifying the risk. Although modelling is useful from a conceptual viewpoint, indoor baseline monitoring of metal compounds is also required. For example, Dudley Shallcross outlined further measurements which are planned in the POPIE research project, and the complexities involved when studying pollution from outdoor sources in indoor environments.

The population groups, which may be considered in population exposure estimates, include:

1. homemakers
2. schoolchildren
3. office workers
4. retired elderly.

Each population group spends typically a different fraction of the day in each of the micro-environments. One can therefore see that by using data on how and where people spend their daily lives, air assessments of ambient concentrations and appropriate indoor:outdoor ratios, one

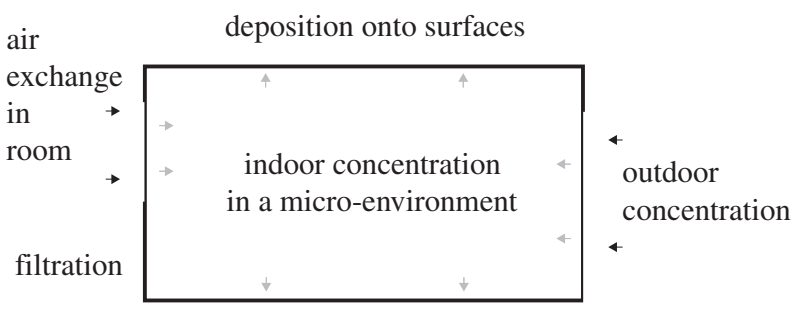

Fig. 1: Basis for calculating indoor air concentrations in a room

can calculate the frequency distribution of the population exposed to various levels of exposure in a given city. Although complicated, the calculation has been reduced to assessing exposure in a limited number of locations and times.

Incorporation into current procedures

One may contrast this with what is undertaken in local air quality management for which air quality at a future date is mapped everywhere, supported by monitoring at fixed sites. In the event of an exceedance of the air quality standard, an Air Quality Management Area may be declared by a local authority. The next step is to consider Action Plans to eliminate the exceedance. These will involve local measures, since national measures will have already been taken into account in the assessment.

The main local measures listed in the review of the National Strategy are:

1. commit to put air quality at the heart of decision making plus information public campaigns,
2. emission reductions from trunk roads and industrial sources,
3. road traffic management scheme,
4. green travel plans, park and ride, scrappage schemes,
5. alternative bus fleet operation, better bus lanes, sustainable distribution,
6. congestion charging, walking and cycling,
7. local air quality and quality of life considerations.

Indoor air as an essential part of action plans

It is apparent that many of these measures involve choice and personal behaviour and are not brought about by technological change or stricter emission control. The benefit of many of them could be evaluated in more detail by consideration of the indoor exposure (public information campaigns could also include advice on indoor air exposure). At the very least, one might consider the change in the population exposure frequency distribution as the result of such measures. It is suggested that Action Plans should be accompanied by assessments of the indoor air quality resulting from the proposed measures. Conversely some exceedances of air quality standards are not readily removed by national and local measures and consideration of the indoor exposure would lead more readily to a solution. One has already seen a move in this direction through the serious consideration of the exposure reduction approach for particles discussed above.

Population exposure assessment

Population exposure including the indoor environment enables improvement measures to be more carefully evaluated. Population exposure assessment can enhance advice and guidelines given to the public especially when personal behaviour is involved. However, to be useful and adopted, population exposure assessments must be made into a practical scheme with associated guidance to those wishing to undertake it. There is still a need for regular indoor monitoring, not everywhere all the time, but sufficient to identify characteristic behaviour in homes and offices distinguishing the different micro-environments.

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Appendix

Programme of Institution of Environmental Sciences and the Institute of Air Quality Management Workshop on Personal Choice or National Responsibility for Indoor Air Quality? January 24 2007, BRE Watford

Derrick Crump, BRE, Occurrence and control of indoor pollutants

Tadj Oreszczyn, UCL, Ventilation, energy efficiency and the indoor environment

Ben Croxford, UCL, Indoor air risk assessment based on gas appliances in the home

Jo Barnes, Cornwall College, Resuspension of particulate arsenic and its potential as an indoor air pollutant

Dudley Shallcross, Bristol University, Pollution from outdoor sources in indoor environments (POPIE project)

Vina Kukadia, BRE, Relationship between ambient air quality and indoor pollution levels

Nicola Carslaw, University of York, Results from a new detailed chemical model for indoor air pollution

Mike Ashmore, University of York, Integrating indoor and outdoor exposure: personal exposure modelling as a tool for policy assessment

Copies of presentations made at the Workshop are available at *www.ies-uk/resources/airqualityworkshop/index.html*

PowerPoint presentations from the workshop are available to download from *www.ies-uk.org.uk/resources/airqualityworkshop*

◆ The views expressed in this paper are those of the authors and are not necessarily those of the organisations for which they work.

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UCAS

Geoff Layer
Learning & Teaching Pro Vice Chancellor
University of Bradford

as well as representatives from the three disciplines:

Rita Gardner
Director of the RGS-IBG

David Sanderson
Chair of the Geological Society Education Committee

David Lambert
Chief Executive Officer of the Geographical Association

Jennifer Blumhof
Institution of Environmental Sciences

There is an opportunity to attend the Warwickshire vs. Glamorgan cricket Match at Edgbaston cricket grounds on Sunday, an additional £15, and on the Monday morning we are running, again optional although also free, excursions to Dudley museum and Wren's nest. The first 100 delegates will benefit from a subsidised rate of £150, including accommodation.

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