interest in the data. Launches of the Tellus Border data in October 2013 and the Tellus South West data in May 2014 brought together data users from the minerals, energy, agricultural and water industries, from local government and environmental regulators, from heritage and conservation bodies, and from researchers in geoscience, ecology, hydrology, agricultural science and environmental health. Most importantly, the data from both projects are available free of charge both to view and download from easily accessible web portals. This catalyses the further sharing of environmental data among these groups, and the development of new partnerships to deliver value and innovation from new cross-disciplinary combinations of research capability. Momentum is building from one Tellus project to the next, with new surveys and new partners contributing to more diversity of data and joined-up research. With a bid for INTERREG V funding, we hope to expand Tellus into the marine environment, joining the Irish Sea, western Wales and eastern Ireland, and partners are currently being sought for other projects in the so-called Energy Coast of north west England and in the major regeneration areas of the central belt of Scotland.

Airborne geophysical surveys require low altitude flying to acquire high resolution data on the subsurface. Image courtesy Tellus Border project, supported by the EU INTERREG IVA Cross-Border programme.

So what of Natural Capital, and the White Paper commitment? The Tellus Effect helps to pull together the partnerships of businesses, decision makers and researchers that need to work in concert to value, manage and sustain our natural capital. The projects provide an 'instrument panel' of indicators and 'big data' to observe and learn lessons from past and present human impacts on our environment, and measure our future progress towards a 'better state' for future generations. Working together, we hope that these projects, and others like them, can help us understand the business of the environment, and ensure that economic growth and a sustainable natural environment are mutually compatible objectives.

Authors:
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Tellus Partners:
Geological Survey of Northern Ireland http://www.bgs.ac.uk/gsni/
Geological Survey of Ireland http://www.gsi.ie/
Natural Environment Research Council http://www.nerc.ac.uk/
British Geological Survey http://www.bgs.ac.uk/
British Antarctic Survey http://www.bas.ac.uk/
Centre for Ecology and Hydrology http://www.ceh.ac.uk/
University of Exeter Camborne School of Mines http://emps.exeter.ac.uk/csm/

Tellus websites:
Tellus http://www.bgs.ac.uk/gsni/Tellus/
Tellus Border http://www.tellusborder.eu/
Tellus South West http://www.tellusgb.ac.uk/

WHY EXPLORE THE SOLAR SYSTEM?

Tom Gunner
Parliamentary Space Committee

In September last year, the P&SC teamed up with the Parliamentary Space Committee in a special session chaired by Andrew Miller and Phillip Lee, to hear from Britain's leading planetary scientists what we have learnt recently about our own Solar System, what more there is to find out, and why it matters.

Space still has a mixed rep in and around Parliament. Probably the most common question asked on the subject, is "I didn't know we did space!" rapidly followed by, "why do we do space? Isn't that a cold war superpower thing? Can we really afford to do that kind of thing?"

... rely on gas pumped through National Grid's national network ...

There are many responses to these questions. The response to the first question, is yes, we do space. And we do it very well. Britain's space sector now supports 83,000 jobs, and adds £9.1 billion to the economy. When you think about it, it's perhaps not surprising. In your average day, you will quietly depend on a host of space-enabled services. The shower you take, if it is gas powered, could rely on gas pumped through National Grid's national network of 170,000 miles of pipeline, managed by a network of nearly 500 switch points. The instructions to these points are transmitted up into orbit and back, because satellites offer some of the most secure form of communications available. Whether you pick up a brolly or suncream will depend on the information satellites provide the Met Office. All data for five day forecasts, and 90% of the data for shorter term forecasts, come from satellites. And then of course as you move about, most people now depend on navigation services powered by satellites. And no, satellites are not responsible for driving you into ditches. That's the software. For many in remote areas, satellites are the only realistic chance of getting online, to fill in DEFRA's online farm payment forms, perhaps. But perhaps most of all, the space industry is a real wealth creator for the UK, exporting high technology goods and services across the world. Last year, the PM and the premier of China witnessed the signing of £1.2 billion of UK export deals to China. 10% of these came in the form of a single satellite contract, supplying the data from three earth observation satellites.

But there is also space science, and here the answer to the second question, “can we really afford to do that kind of thing?”, is very different. Quite simply, we do space science for the same reasons we do science. Space is in many areas the best place to do science, and in some fields, the only place. Space is the biggest lab in the universe, free from Earth’s gravity and atmosphere. As Phillip Lee highlighted in a recent debate, the International Space Station is a unique lab for the world’s scientists to conduct experiments in microgravity, looking into the impact of ageing on human skin cells, or the impact of zero gravity on bone density (our bones lose 1% of their density for every month in space). And there is also the other reason for discovering more about our Solar System – curiosity. Because we can. As Fabio Favata of the European Space Agency argued, curiosity was the primary driver in mankind’s interest in the Cosmos. Curiosity gave birth to the ancient science of astronomy. Astronomy provided the key to long-distance navigation. Astronomy therefore enabled the British Empire! And today, a new constellation of man-made stars position us anywhere on the Earth’s surface to less than a metre.

... Why does such an old moon have such an unrippled surface? ...

In September last year, the Parliamentary and Scientific Committee joined with the Parliamentary Space Committee to find out more about some of the most exciting research being conducted today by Britain’s leading planetary scientists, alongside the European Planetary Science Congress, held last year in London for the first time. According to Dr Lewis Dartnell of Leicester University, Mars, our closest and most accessible planetary neighbour, could once have been teeming with life. We now know that billions of years ago, Mars was a more inviting place for life to set hold – it was wetter, warmer and had a thicker atmosphere. Organic molecules would have rained down on its surface, in the same way that brought life to Earth – perhaps, even from Mars, according to one new theory. Europe’s response is its Mars rover, the most sophisticated robot ever to be sent to Mars. The Mars rover is being designed and tested here in the UK, by Astrium, in Stevenage. Capable of withstanding cosmic radiation which would fry a human, this lab on wheels has a six wheel drive and twin robotic cameras, allowing it to see in 3D. But it is its drill that most excites planetary scientists, allowing it to drill into the Martian soil and search for signs of life. There is no better way to inspire young people into STEM subjects than the search for life. If one day we find the signs of past life on Mars, we will have our new post-Apollo generation of scientists and engineers. And the advanced technology needed to develop this miniaturised box of tricks has been spun off and down to Earth, powering mobile solar powered radios, for instance, in Africa.

... The Mars rover is being .. tested here in the UK, by Astrium ...

Further afield, Michele Dougherty, professor of space physics at Imperial, has been enquiring into the properties of Enceladus, one of Saturn’s oldest moons and one of the brightest objects in our solar system. Why does such an old moon have such an unrippled surface? Could it be the source of Saturn’s E-ring, the largest ring in the Solar System, made up mostly of water compounds? The surface of Enceladus is also mainly ice. The European spacecraft Cassini has undertaken two flybys of Enceladus to take a closer look. What they found was that the magnetic fields emanating from Enceladus suggested an atmosphere, and at its poles, vast water vapour plumes were belching out from vast cracks on its surface. So there is a sub-surface heat source, which is a surprising feature of such an old moon. For life to form, you need water, organic material, a heat source and stable conditions over time. Enceladus, tantalisingly, has three of these conditions. In 2022, Europe’s next explorer, the Jupiter Icy Moons Explorer, or JUICE for short, will be launched, reaching Jupiter by 2030, and will spend 2½ years exploring the Jupiter system, focusing on three moons, Ganymede, Europa and Callisto. Ganymede is the largest moon in the solar system, and scientists believe it has a large, deep ocean beneath its surface. In a generation, we should know far more about the solar system’s second biggest planet, and perhaps solve some of these mysteries.

... Asteroids and comets offer us a unique glimpse ...

Why bother looking at comets and asteroids? Professor John Zarnecki of the OU gave us three reasons. Firstly, science. The solar system was formed when a cloud of dust congealed to form our planetary system. Asteroids and comets offer us a unique glimpse into the founding blocks of our solar system. It is almost certain that a major asteroid strike 65 million years ago wiped out the dinosaurs. In the case of a killer asteroid hitting the Earth again, the question is not if, but when. The problem is, we don’t know if it will happen tomorrow or in a million years! The spectacular and damaging airburst of an asteroid above Chelyabinsk on 15th February this year, on the same day, in fact, as a near miss, in cosmic terms, of a far bigger comet, reminded us that the date may be closer to tomorrow than a million years! Fortunately, Britain’s space industry could provide the answer. A team of engineers and scientists at Astrium in Stevenage are working on a suitably Hollywood named project, NEO shield, to look into the technologies to avert the next strike, whenever it may happen. Three ideas are currently being looked at: blasting it into tiny fragments, deflecting it, and slowing it to a halt using gravity.

There have been five close-up views by spacecraft of comets. Some of Man’s earliest recorded art are from China, 3,000 years ago, of comets. The first spacecraft to conduct a flyby of a comet was part designed and built in Bristol in 1986. The hard bit is to land on a comet. Europe's spacecraft Rosetta hopes to rendezvous with and actually put a lander on the surface of a comet. Put the 10th November 2014 in your diary! About 10:30am. The lander will carry a whole suite of clever stuff, to study its chemical and isotopic composition, all in a piece of kit not much bigger than a shoebox, so compact in fact that the technology has been spun off to detect tuberculosis in sub-Saharan Africa, and monitor air quality in submarines. But now the race is on. Several space agencies are mounting missions to asteroids to bring back significant amounts of material. In the UK, Astrium is developing special technologies to land the lander and carry the samples safely back to Earth without contaminating them.

There are also at least two private consortia developing technologies to mine asteroids, backed with big money from serious investors, including Larry Page of Google and Walt Schmidt. If only Britain had somehow managed to net the passing comet in February, we might have been able to pay off the national debt!

... carry the samples safely back to Earth ...

It is easy to dismiss space science as an area of luxury Britain can ill afford. But in our world leadership in space science and industry, we still walk tall as a nation, and our eyes are set firmly on the horizon.

MARS – did life ever evolve there and what will future exploration reveal?

Dr Lewis Dartnell
Department of Physics and Astronomy, University of Leicester

Last autumn saw the prestigious conference, EuroPlanet, come to London, hosted by UCL. Attended by nearly one thousand scientists from around the world, this was the biggest such conference yet, and included sessions in planetary science on everything from Mars missions to distant solar systems. But, most importantly, this was the first EuroPlanet ever to hold a session in a legislative body: hosted jointly by the Parliamentary and Scientific Committee and the Parliamentary Space Committee. I was one of three scientists invited to present an overview of the research we are involved in, and its wider significance, to the packed audience.

I am an astrobiologist; I investigate the possibility of life beyond the Earth. I'm not talking about green bug-eyed aliens and UFOs, but the possibility of hardy microorganisms surviving in the watery environments found on other planets and moons in our solar system. As you might imagine, astrobiology is a deeply 'interdisciplinary' field of science – it sits as the overlap between geology and planetary science, biochemistry and microbiology, and physics and astronomy.

My own piece of the puzzle involves studying what effect the bombardment of cosmic radiation might have on the survival of bacteria, or 'biosignatures' of their past existence, in the martian surface, and what are the best ways to look for them. One especially exciting forthcoming mission is the ExoMars probe, due to launch in 2018 to look for signs of past life. The UK is playing a leading role in many of the systems and instruments for this Mars rover. The UK Space Agency is funding my fellowship to work on a Raman spectrometer – a laser-based technique which reveals both the minerals of a rock as well as organic molecules indicative of life that might be there. Raman spectrometry is a classic example of a technology that has been tried and tested in civil applications, proving itself time and time again before being adopted for space missions. It is now used for analysing the pigments used in oil paintings to spot fakes, drugs testing, and security scans for traces of explosives at airports. ExoMars will be the first mission to try Raman spectrometry beyond the Earth; scrutinising martian soil and rocks.

... everything from Mars missions to distant solar systems...

The transfer of knowledge and equipment also flows in the opposite direction: space hardware – technology literally out-of-this-world – being repurposed to solve real-world problems back down on solid ground. Instruments designed to be launched to explore other planets need to be simultaneously miniaturised and compact, lightweight, and have very low power demands. These are exactly the attributes required for portable devices – to be used by health workers in rural Africa testing for compounds indicative of different diseases, for example.

This isn’’t the only down-to-Earth benefit of astrobiology and space exploration. I devote a lot of my time to delivering public lectures and outreach events at schools (I also hold a Science in Society fellowship from the Science & Technology Facilities Council, STFC) and I have found that few things inspire young minds like hearing about our on-going exploits in exploring other worlds and searching for life. Encouraging more students to continue with STEM subjects (Science, Technology, Engineering and Mathematics) through A-levels and undergraduate degrees is utterly critical if the UK is to continue as a world-leader in fundamental discovery and innovation, and for us to financially thrive as an information economy.

Dr. Lewis Dartnell is a research fellow at University of Leicester, and author of ‘Life in the Universe: A Beginner’s Guide’

HOUSE OF LORDS SCIENCE AND TECHNOLOGY SELECT COMMITTEE

The members of the Committee (appointed 12 June 2014) are Lord Dixon-Smith, Baroness Hilton of Eggardon, Lord Hennessy of Nympsfield, Lord O’Neill of Clackmannan, Baroness Manningham-Buller, Lord Patel, Lord Peston, Lord Rees of Ludlow, Viscount Ridley, the Earl of Selborne (Chairman), Baroness Sharp of Guildford, Lord Wade of Chorlton, Lord Willis of Knaresborough and Lord Winston.

Lord Krebs’ term as Chairman concluded at the end of the 2013-14 session. He has been succeeded by the Earl of Selborne. Baroness Perry of Southwark rotated off the Committee at the end of the 2013-14 session. New Members of the Committee are Lord Hennessy of Nympsfield and Viscount Ridley.

Behaviour Change

In May and June 2014, the Committee took oral evidence from witnesses to follow up on its 2011 report into behaviour change and assess what progress has been made in this area. This focused on the two behaviour change case studies that the Committee had investigated in its original inquiry: modal shift in transport and obesity.

International STEM students

In January 2014, the Committee launched a follow up inquiry to its 2012 report on higher education in science, technology, engineering and mathematics (STEM) subjects. The inquiry focused specifically on the effect on international STEM students of immigration policy. More than forty written submissions were received, seven oral evidence sessions were held in February and March, and a report published on 11 April 2014. A Government response is expected shortly.

Waste and the bioeconomy

The Committee launched an inquiry into waste and the bioeconomy in July 2013. The Call for Evidence closed on 27 September. Evidence was collected on the technology used to exploit bio-waste and waste gases in order to generate high-value products. The inquiry aimed to assess the potential for this technology to enable bio-waste and waste gas to replace current feedstocks, and the potential contribution this could make to a bioeconomy. The Committee published its report on 6 March 2014. A Government response was received in early June.

Scientific infrastructure

The Committee launched an inquiry into scientific infrastructure in May 2013. The call for evidence closed on 22 June. Oral evidence was taken across June and July on the large and medium-sized scientific infrastructure currently available in the UK with a particular focus on: future needs and strategic planning, funding and governance arrangements, international partnerships and partnerships with industry. The Committee published its report on 21 November 2013. A Government response was received in February 2014 and a debate held on 13 May 2014.

Regenerative medicine

The Committee launched an inquiry into regenerative medicine before the 2012 summer recess. A group from the Committee visited the California Institute for Regenerative Medicine. Oral evidence was taken from October to March 2013. The Committee reported on 1 July 2013 and a Government response was received on 1 October. A debate was held in the Chamber on 13 March 2014.

Nuclear follow-up

In July 2013, the Committee undertook an