SCIENCE AND EMERGENCIES IN JAPAN

Chris Pook
Counsellor, Science and Innovation
British Embassy, Tokyo

Before 11 March 2011 an article on science and innovation in Japan would have focused on the country's unwavering and longstanding commitment to investment in science and technology, a commitment which propelled it to the position of the world's second largest producer of advanced science and technology over a period of 30-40 years. During this time Japan has created some of the world's most recognisable and successful advanced engineering and IT companies – including Toyota, Panasonic, Nissan and Sony – as well as securing 15 Nobel prizes in science and countless patents and publications.

However, after 11 March 2011, when Japan was hit by a multiple disaster of a kind that had never been seen before, it became apparent that one of the biggest challenges facing S&T in Japan lies in the softer side of science and innovation – the systems, processes and relationships which underpin science and which influence the relationship between science and society. This is an area which Japan has long recognised needs greater attention and which was thrown into sharp relief by the crisis at the Fukushima nuclear power plant.

It is only now, 3 months after the event, that details of what actually happened over the first few days of the crisis are starting to emerge. At 14.46 on 11 March a magnitude 9.0 earthquake struck off the coast of North Eastern Japan unleashing a 14m tsunami that swept away coastal towns and villages and hit the Fukushima Dai-ichi and Dai-ni nuclear power plants, 110 miles from the epicentre. A total of seven reactor units at the two sites were operating at full power when the earthquake struck.

Fukushima Dai-ichi lost all power and all back up capacity. Fukushima Dai-ni retained a single power supply to one unit and engineers, working without break for three days, were able to use this to restore power and cooling functions to each of the reactors. 9km of power cable were laid by hand in a single 16 hour period and by 14/15 March all four reactors at Fukushima Dai-ni were on track for cold shutdown.

But at Dai-ichi the story was different. Although only 10km away, the site had been hit by a larger and more devastating tsunami. With no power supply, no instrumentation and no cooling capability engineers were powerless to stop the deterioration of conditions in reactor units 1-3 and the spent fuel pond at unit 4. It is now accepted that at least one reactor (and probably all three reactors) suffered a partial meltdown due to loss of water from the reactor vessels and exposure of the fuel rods to air. Between 12 and 15 March the world watched as a series of explosions and fires destroyed the outer containment buildings of units 1,2 and 4. A total of 770 terabequerels of radiation appears to have been released from the reactors, roughly the same order of magnitude as was released from Chernobyl and justifying the highest rating of 7 on the international nuclear emergency scale.

The impact of this triple disaster – earthquake, tsunami and nuclear crisis – has been devastating. Nearly 25,000 people are dead or missing as a result of the earthquake and tsunami. None have died as a direct result of the Fukushima nuclear crisis, but over 10,000 households have been displaced from the 20km evacuation zone surrounding the plant. Supply chains have been disrupted and many businesses have taken a big hit. However many commentators also talk about a fourth disaster – the loss of public confidence in the ability of science, of business and of government to maintain proper checks and controls on nuclear technology, and to provide robust and independent advice to the general public.

The FCO and British Embassy in Tokyo were in the frontline of this, with a responsibility to provide accurate and up-to-date advice to British nationals on the situation in Japan and to provide support and assistance to those who may have been caught up in the disaster. There was a huge demand for information in the first few days of the crisis driven by the need to provide an accurate assessment of the threat from Fukushima as well as the status of power supplies, food, water and transport links. In the first week of the crisis the Embassy provided over 40 situation reports to the FCO crisis response team in London, working 24 hour shifts around the clock to report on the latest situation on the ground. By the end of the first month we had provided over 60 reports.

The nuclear situation at Fukushima and the threat from radiation soon came to dominate the information being provided to London, and became one of the key issues with respect to the travel advice being issued by the UK and other foreign governments. The Civil Contingencies Committee in the UK, meeting in Cabinet Office Briefing Room A (COBRA) commissioned the Scientific Advisory Group in Emergencies (SAGE), chaired by the Chief Scientist, Sir John Beddington, to provide advice on the risk from Fukushima – particularly to residents in Tokyo.

Working closely with expert agencies from across the UK and independent advisors, the group developed reasonable worst case and enhanced worst case scenarios which were to provide a robust and enduring basis for the British government's advice. In addition, the group established a modelling capability which would produce predicted radiation dose maps every four

hours, should the situation at Fukushima deteriorate. A response system was established which would enable the Embassy in Tokyo to receive advice within 30 minutes of an event at Fukushima.

One of the most frequently asked questions in Tokyo and elsewhere was what information was available, where could it be found, and was it reliable. With the exception of the first few days, when very little data could be obtained from the plants, it soon became apparent that the Japanese government was doing all that it could to make as much information available as possible, as quickly as possible. The government made clear to TEPCO (the power company responsible for the Fukushima site) and other agencies that there should be full transparency, insisting for example that results of the Japanese radiation dose modelling system (SPEEDI) should be made available to the public. A wealth of data became available on government and industry websites and the Japanese Foreign Ministry held daily briefing sessions for the diplomatic community. It was not uncommon to see government spokesmen giving press briefings in the small hours of the morning.

Key pieces of data, such as reactor temperature, pressure and water levels, were absent due to lack of instrumentation and in some quarters became something of an obsession. However the issue was not so much the volume of data, but expert interpretation of the data and what it meant for the general population. There was a sense that what was needed was an authoritative, independent, consensus view of the risk.

At the Embassy, we were confident that the advice and monitoring system were robust and reliable. But we would be, wouldn't we? It helped that as Science Counsellor I had previously visited some of the UK's own nuclear legacy sites and had a good grounding in science. We had access to the best advice available and to experts in radiation health and safety and we were confident that the approach adopted by SAGE – advice based on the worst case scenario – meant that we did not need to know the detail of attempts to stabilise the reactors. Our advice was based on the worst that could possibly happen, and the calculations had been confirmed by experts in other countries. But this was not enough. There was a maelstrom of conflicting advice from foreign governments, media reports, expert opinion, speculation and just plain suspicion of anything said by the government and TEPCO.

As a result, it was just as important to find a way to communicate the British government's advice to the British community in Japan, as it was to get the advice right. To do this, between 15 March and 7 April, Sir John Beddington and experts from the Health Protection Agency and DOH, joined four telephone conferences with British nationals and British businesses in Japan to explain the basis of the science advice and answer questions on the risk from radiation.

The transcripts of the telephone conferences were posted on the website within 24 hours and broadcast on Twitter and Facebook. It quickly became apparent that the advice and transcripts were being tweeted and retweeted throughout Japan, with feedback from an international law firm noting that the Beddington transcripts had "had a huge impact in the international business community, with major law firms, banks and key multinationals using the advice extensively" and that "it had been a source or reassurance and informed decision-making to an extent that perhaps we in the Embassy hadn't realised". The importance of providing transparent, independent and accountable advice had emerged as one of the key issues of this crisis.

At the end of May, we explored this issue further at a symposium hosted jointly by the Embassy and the Graduate Institute of Policy Studies (GRIPS) in Tokyo. Sir John Beddington spoke about the challenge of providing science advice in emergencies and the British government response to Fukushima. There was a strong desire to learn more from the UK system and to find ways to increase the transparency, accountability and independence of science advice in Japan. Japanese advisers have since visited the UK to learn more about SAGE and the Cabinet Office Civil Contingencies Secretariat. The Embassy will continue to work with Japan to develop this exchange further, as well as to look for ways to promote UK expertise gained from managing our own nuclear legacy.

Cold shutdown is not expected to be achieved at Fukushima Dai-ichi until the end of the year, but this will only mark the end of the beginning. Work lasting many years will be needed to clean up and decommission the site and monitor the extent of contamination in the surrounding area. It will be difficult and challenging, but there is no doubt that Japan will eventually succeed.

However, the bigger question is whether Japan will emerge from this crisis stronger than before. Fukushima has shown that there is a pressing need to reform the cosy relationship between business, government and the regulators, and to take a fundamental look at the safety culture within the nuclear industry. The government must take steps to rebuild public confidence in science and technology and develop robust sources of independent and transparent advice.

This will take a long time but has huge implications. Thirty of Japan's 54 nuclear reactors are currently shut down for maintenance or safety reasons and plans to build an additional 14 reactors by 2030 are being reviewed. Japan needs to rebuild confidence in the industry if nuclear is to remain a long term source of clean and secure energy. More broadly, the country's overall relationship with science and technology needs to be refocused. The fourth basic plan for science and technology, which sets out government priorities for S&T investment from FY2011-2016, is being reviewed in order to give greater priority to disaster recovery and safety and an even greater emphasis on green innovation and energy R&D. It will also look more closely at how communication on risk and emergencies can be improved within Japan and with other countries and the role of the Cabinet Office Council for Science and Technology Policy.

This is to be welcomed. Japan spends 3.6% of GDP on science and technology, with the government consistently spending about £25 billion (Yen 3.6 trillion) annually. The fourth basic plans sets a goal to increase expenditure to 4% of GDP and to "cultivate science and technology as a culture". Fukushima has shown that public acceptance of technology

cannot be taken for granted, and that scientists, engineers, industrialists and politicians must pay greater attention to the needs of society and the importance of building public trust and acceptance.

The UK has a strong and mature relationship with Japan and many links at expert level. We have been able to help in many ways. During the crisis the Nuclear Decommissioning Agency and UK industry provided protective radiation equipment and monitoring equipment, while others offered to provide technical support and expertise. The UK science base offered practical support to Japanese researchers affected by the disaster by making available additional time on UK research facilities – the supercomputer HECTOR and the ISIS neutron scattering facility for example – and British scientists are participating in research programmes to look at the impact of radiation releases into the marine environment, drawing on experience from Sellafield. But when the UK-Japan Joint Committee on Science and Technology next meets in London this Autumn, one of the most important areas for discussion will be the provision of science advice in emergencies and what we can do jointly to help the world learn from the terrible crisis experienced by Japan.

The Global Experiment, the world's largest-ever chemistry experiment

On Wednesday 22nd June children from Oasis Academy and Trinity School, both in Croydon, went to Portcullis House to test the water quality there.

The Global Experiment will be the largest single collection of data on water quality ever undertaken at one time and will be achieved by hundreds of thousands of school children from around the world becoming scientists for a day.

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Desree (13) from Oasis Academy, and Khizr (13) from Trinity School are seen here with Professor David Phillips, President of the Royal Society of Chemistry, and Gavin Barwell, MP for Croydon central, at Portcullis House in Westminster, checking the pH level as part of The Global Experiment.

Anthony Upton/PA Anthony Upton ©

Children from Oasis Academy and Trinity School, both in Croydon, meet Gavin Barwell, MP for Croydon central, Professor David Phillips, President of the Royal Society of Chemistry, and Stephen Benn from the Royal Society of Chemistry, taking part in The Global Experiment at Portcullis House.