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Lessons of a triple disaster

The aftermath of the biggest earthquake in Japan's history, and the tsunami and nuclear disaster that followed, offers a map for preparing for the next catastrophe.

It is easy to find fault when more than 15,000 people are dead or missing and thousands of square kilometres of countryside are contaminated with radioactivity. Japan's authorities, nuclear industry and scientists share the blame for the disaster that followed the giant earthquake and tsunami that struck the Tohoku coast a year ago, on 11 March 2011. However, many more lives would have been lost had it not been for the work of scientists, engineers, emergency officials and a well-prepared populace. The lessons from what went wrong and right should guide Japan as it rebuilds itself from the strongest earthquake in its history and the nuclear meltdown that followed.

First, what went wrong. The articles and commentaries in this week's special issue (see page 137) show how Japanese scientists and authorities overlooked evidence that the Tohoku coastline was prone to much larger earthquakes and tsunamis than history predicted. Coastal cities and crucial facilities, such as the Fukushima Daiichi nuclear power plant, therefore missed the opportunity to strengthen their defences in advance. At first, the Japan Meteorological Agency (JMA) underestimated the size of the quake and of the tsunami, creating a false sense of security. And coastal residents did not take enough responsibility: one survey of survivors found that 40% who had received a tsunami warning had waited before evacuating.

Japan also failed to make the best use of its technology. Underwater sensors along the Tohoku coastline detected the tsunami when it was 50 kilometres offshore, but precious minutes were lost because mechanisms were not in place to make use of the initial readings. The waves were hitting by the time the JMA corrected its underestimate.

Such criticisms should not overshadow what went right. Relatively few people died during the earthquake — a testament to Japan's rigorous building codes and emergency systems. And the JMA deserves praise for issuing a tsunami warning within three minutes of the earthquake's start. Although it underestimated the size, the warning gave perhaps hundreds of thousands of people a chance to save themselves.

There is plenty of room for improvement, however. Geoscientists must do a better job of deciphering Japan's earthquake history and monitoring current ground deformation to work out which areas are prone to damaging quakes. Researchers and civil authorities are installing new earthquake and tsunami sensors, and they must learn to analyse the data more rapidly. New tsunami simulations, which will be crucial to rebuilding the Tohoku region and fortifying other coastal areas, should be made transparent and be reviewed by external experts. And social scientists can examine how people respond to hazard information — both before and during a crisis — which should help in preparing for future disasters, in Japan and elsewhere.

The meltdowns at the Fukushima Daiichi nuclear plant also revealed both strengths and shortcomings. Despite chaos on the ground, the Japanese government managed to evacuate tens of thousands of residents living within 20 kilometres of the plant in a matter of hours. Health studies indicate that the quick response almost certainly prevented most people from receiving a significant dose of radiation. Those studies also speak of another strength of the Japanese government — the ability to conduct extensive surveys of affected areas and populations.

Meanwhile, a skilled workforce stayed inside the plant and managed to limit the damage. Much has been made of bureaucratic stumbling in the first hours of the crisis, but despite blackout conditions inside the plant, highly trained staff managed to flood the reactors with water and neutron-absorbing boric acid. Later, scientists and engineers improvised a filtration system to decontaminate cooling water. With repeated leaks and outages, it is far from perfect, but still an impressive solution.

"The inadequate tsunami warnings cost lives within minutes, but the damage from the failings at Fukushima will stretch on."

These technical achievements do not offset the government's failure to communicate the dangers of the emergency. Initially, officials downplayed the crisis. Even after the full scale of the meltdowns became clear, radiation measurements were often reported without context, and some were simply wrong. The government also failed to release some information: computer models showing the real-time spread of radioactivity were withheld from the public until 12 days after the crisis began.

The inadequate tsunami warnings cost lives within minutes, but the damage from the failings at Fukushima will stretch on. Sloppy and incomplete reporting has fed public mistrust of the government and its scientists (see page 138), which will hamper efforts both to study and to recover from the crisis. ■

Political science

The practice of science cannot be, nor should it be, entirely apolitical.

Paul Nurse, president of Britain's Royal Society, does not think he is sitting in an ivory tower, and he has made it clear that he considers that scientists have duties to fulfil and battles to fight beyond the strictly scientific — for example to "expose the bunkum" of politicians who abuse and distort science. This was evident again last week, when Nurse delivered the prestigious Dimbleby Lecture in London, instituted in memory of the British broadcaster Richard Dimbleby.

Nurse identified support for the National Health Service, the need for an immigration policy that attracts foreign scientists, and inspirational science teaching in primary education as some of the priorities