**The climate change threat to nuclear power**

*Far from solving the climate problem, nuclear power may be highly vulnerable to it*

Figure 1 Fukushima was always vulnerable (Image: Aflo/Rex Features)

THE accident at the Fukushima power plant in Japan has led to much discussion about the future of nuclear power. I believe one important lesson of the accident has been overlooked. Nuclear power is often touted as a solution to climate change, but Fukushima serves as a warning that far from solving the climate problem, nuclear power may be highly vulnerable to it.

Of course, the emergency in Japan was caused by an earthquake and tsunami. But the effects of climate change could cause very similar problems.

Two facts that everyone should now know about nuclear power are that it needs access to large volumes of water to cool the reactor and a supply of energy to move the water. For this reason nuclear power plants are typically sited near large bodies of water, often seas or estuaries. It is this attachment to water that makes nuclear power vulnerable to climate change ([*Energy Policy*, vol 39, p 318](http://dx.doi.org/10.1016/j.enpol.2010.09.046)).

First of all, coastal areas are highly dynamic: storms batter, sea levels rise, and land shifts. This already poses problems for the safety of nuclear plants, and is only going to get worse. Secondly, nuclear power can be disrupted by water scarcity and rising water temperatures.

Nuclear regulators are already well aware of several safety issues, including flooding, loss of power, loss of communications, blockage of evacuation routes and equipment malfunction. Hurricanes pose the greatest threat.

Many climate models predict an increase in hurricane intensity. Even if they are wrong, existing reactors were built (along with most coastal developments) during a period of historically low hurricane activity and a return to baseline seems likely.

This is not to say an accident will happen every time a hurricane passes by a nuclear power plant. Unlike earthquakes, hurricanes can be predicted, allowing time for preparation. Still, preventative measures are not always taken. For instance, during hurricane Francis in 2004 doors designed to protect safety equipment from flying debris at the St Lucie nuclear power plant in Florida were left open.

Another cause for concern is floods. All nuclear power plants are designed to withstand a certain level of flooding based on historical data, but these figures do not take climate change into account. Floods due to sea-level rise, storm surges and heavy rain will increase in frequency.

This isn't a hypothetical future scenario. In 1999 the Blayais nuclear power plant on the Gironde estuary in France flooded due to a high tide and strong winds that exceeded anything it was designed to withstand. Two of the reactor units on site were severely affected by flooding.

Heat waves are another serious concern, for two reasons. One, the colder the cooling water entering a reactor, the more efficient the production of electricity. And two, once the cooling water has passed through the system it is often discharged back where it came from in a much warmer state.

During the 2003 heat wave in Europe, reactors at inland sites in France were shut down or had their power output reduced because the water receiving the discharge was already warmer than environmental regulations allowed. Citing "exceptional circumstances", the French government relaxed the regulations to maintain the supply of electricity. After subsequent heat waves it became a permanent measure during the summer months.

The relaxing of the regulations causes thermal pollution that reduces the ability of aquatic ecosystems to adapt to warmer temperatures. Some may argue these regional impacts are insignificant compared to the global ramifications of climate change, but they illustrate that nuclear power can actually worsen its impact.

There is a human cost too. As the heat wave wore on, French consumers were asked to conserve energy, and exports to some countries, especially Italy, were reduced. While France, which generates over 75 per cent of its electricity from nuclear sources, avoided blackouts, Italy did not. The heat wave caused an estimated 40,000 deaths, around half of them in Italy. These deaths cannot be attributed directly to the failure of nuclear power but energy conservation and blackouts surely made people more vulnerable.

The final problem is droughts, which climate models predict will become longer and larger. Legal battles have already been fought in the US over scarce water resources in regions with nuclear power plants, including the Catawba river basin in the Carolinas and the Apalachicola/Chattahoochee/Flint river basin in Georgia, Florida and Alabama. These battles show us that adapting our systems - including nuclear power - to a reduced supply of water will not be easy.

The International Atomic Energy Agency advises the nuclear industry to build power plants to last for 100 years. Given that climate models don't agree on what to expect within this time period, it is not at all clear how this can be achieved.

New reactors could use dry or hybrid systems with lower water requirements, but the costs of running these systems are likely to be prohibitive. Considering nuclear power plants already have problems with construction cost overruns, any additional costs are likely to meet resistance.

What is to be done? Most forms of energy generation are vulnerable in some way to the effects of climate change, and the fact that nuclear power is among them is yet another argument against a wholesale shift towards this source of energy.

The bottom line is that if nuclear power is to be used to mitigate the effects of climate change, it must also be capable of adapting to them. There are serious doubts that it can.

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