Is your fear of radiation irrational?

July 14 2015, by Geoff Watts

Bad Gastein in the Austrian Alps. It's 10am on a Wednesday in early March, cold and snowy – but not in the entrance to the main gallery of what was once a gold mine. Togged out in swimming trunks, flip-flops and a bath robe, I have just squeezed into one of the carriages of a narrow-gauge railway that's about to carry me 2 km into the heart of the Radhausberg mountain.

Fifteen minutes later we're there and I'm ready to enjoy what the brochures insist will be a health-enhancing environment. Enjoyment, of course, is a subjective term. The temperature inside the mountain's dimly lit tunnels is around 40°C, and the humidity is 100 per cent. The sweat's already begun to flow. More important, I'm breathing an atmosphere rich in radon.

Hang on… radon? That's a radioactive gas. Yet here I am, without so much as a film badge dosimeter, never mind the protection of a lead apron, among a group of people who have paid to come to the Gasteiner Heilstollen ("healing galleries") and willingly, even eagerly, undergo gruelling sessions in physical discomfort because of a much-contested theory that small doses of radiation are not just harmless, but act as a stimulant to good health.

Our view of radiation and its risks and benefits is complicated and mostly – the delights of the Heilstollen notwithstanding – negative. We are all aware of the effects of a nuclear weapon, the Armageddon scenario of a nuclear winter, cancers and birth defects caused by high doses of radiation and the like. Images of mushroom clouds have struck

fear into our hearts since the 1940s, but it is what we can't see in those pictures that scares us the most.

Invisible threats are always the most unnerving, and radiation is not something you can see. Nor can you control it. Many years ago, a veteran researcher told me how much he wished he could paint radiation blue. If we could see it, he said, we'd be better placed to deal with it and less nervous about it. The traditional secrecy of the biggest commercial user of radiation, the nuclear power industry, hasn't helped. Only belatedly did it realise that doing things out of sight, behind closed doors, is the best way to fuel public suspicion. So it is perhaps understandable why many people say that (medical X-rays and CT scans aside) the only safe radiation is no radiation.

Nevertheless, I disagree. I believe that a justified fear of high and uncontrolled levels of radiation has undermined our willingness to see that the risks it poses at low levels are either acceptable or manageable. Imagine if we treated fire in the same way as all things nuclear: we would have responded to house fires by banning matches.

And I am worried that, as a result of these exaggerated fears, we are failing to make the most of radiation for our greater good.

To appreciate the measure of our hot-button fixation with radioactivity, recall the events of 2011 in Japan. The magnitude 9 earthquake and subsequent tsunami that hit the country on 11 March was by any measure a disaster. 20,000 people died and more than 500 square kilometres of land were flooded. Families lost their homes, their businesses and their livelihoods.

It didn't take long for the media to discover that one of the casualties, in pole position when the tsunami struck, was the Fukushima nuclear power station. From that moment the story ceased to be about a natural event

and became, in effect, about a man-made one. It became that chilling scenario: a nuclear disaster.

Of the 20,000 deaths, some were directly due to the earthquake itself, while others were caused by drowning. How many deaths were the result of radiation from the damaged plant? None. In its section on the health consequences of the Fukushima tragedy, the report by the UN's Scientific Committee on the Effects of Atomic Radiation says: "No radiation-related deaths or acute diseases have been observed among the workers and general public exposed to radiation from the accident."

The dose to the public, the report goes on to say, was generally low or very low. "No discernible increased incidence of radiation-related health effects are expected among exposed members of the public or their descendants."

This is not to play down the impact of the event. Three of the nuclear plant's reactors suffered damage to their cores, and a large amount of radioactive material was released into the environment. Twelve workers are thought to have received doses of iodine-131 that will increase their risk of developing cancer of the thyroid gland. A further 160 workers experienced doses sufficient to increase their risk of other cancers. "However," says the report, "any increased incidence of cancer in this group is expected to be indiscernible because of the difficulty of confirming such a small incidence against the normal statistical fluctuations in cancer incidence."

In short, while a terrifying natural event had killed many thousands of people, the focus of attention in Japan and round the world was on one component of the tragedy that killed no one at the time. Radiation exposure may have shortened the lives of some of those directly involved, but its effects are likely to be so small that we may never know for sure whether they are related to the accident or not.

When it comes to disaster, nuclear trumps natural. Our sense of the relative importance of things is absurdly skewed.

Chernobyl, of course, was much worse. A poorly designed reactor operating under weak safety arrangements in a bureaucratic and secretive society was a recipe for disaster. On 26 April 1986 all the ingredients came together – ironically during an experimental and bungled safety check. One of the reactors overheated, caught fire, exploded and released a large quantity of radioactive material into the atmosphere. 116,000 people were evacuated; another 270,000 found themselves living in a zone described as "highly contaminated".

It sounds bad. For 134 of the workers involved in the initial cleanup, it was very bad. The dose they received was enough to cause acute radiation sickness, and 28 of them soon died. Then, distrust of official information together with rumours of the dire consequences to be expected created a disproportionate fear. One rumour circulating during the period immediately following the accident claimed that 15,000 nuclear victims had been buried in a mass grave. Nor did such rumours die away; another in 2000 held that 300,000 people had by that time died of radiation.

The reality, though hardly inconsequential, was less catastrophic. A World Health Organization expert group was set up to examine the aftermath of the disaster and to calculate its future health consequences. On the basis of average radiation exposure for the evacuees, the people who weren't evacuated and the many more thousands of workers later involved in the cleanup, the report concluded that cancer deaths in these three groups will increase by no more than 4 per cent. The report's conclusions have been, and still are, contested – but the weight of orthodox opinion continues to line up behind the expert group's calculations.

"There was certainly a rise in thyroid cancer," says James Smith, Professor of Environmental Science at Portsmouth University and a coordinator of three multinational European Community projects on the environmental consequences of the accident. But he goes on to add a qualification: "The Soviets didn't put in enough measures to stop people eating contaminated food and drinking contaminated milk, and this particularly affected children." The deaths, in other words, were not all inevitable.

Any death from any cause in any industry is regrettable and, ideally, to be prevented. But is nuclear power inherently more dangerous than other forms of energy? A 2002 review issued by the International Energy Agency compared fatalities per unit of power produced from several energy sources, including coal, biomass, wind and nuclear. The figures included each stage of energy generation from the extraction of any raw materials required to the health consequences of generating and using it.

Coal came out on top while nuclear emerged as the least damaging to health. When you think of coal-fired energy generation, from the hazards of mining to atmospheric pollution, this rank order is hardly surprising. But while the choking murk over many big Asian cities on a still day is clear to see, deaths related to the coal industry don't mobilise either fear or indignation on the same scale as a nuclear incident does. Perhaps it is radiation's invisibility that fuels overheated reporting of relatively minor events – and then the reporting, by its extent as much as by sensationalism, confirms and heightens our fear.

A number of governments responded to the events in Japan in 2011. Most notable was Germany. Although unenthusiastic about nuclear power, it had recently accepted a need to prolong the period for which its existing nuclear plants would operate. Following the events at Fukushima, it changed its mind. Critics of the policy change were left trying to recall the last time Germany had experienced a really severe

earthquake, never mind a tsunami.

Ironically, despite being a nation encompassing some of Europe's most strident opponents of nuclear power, Germans make up a significant proportion of visitors to the radon-rich clinic at Bad Gastein.

The particular Gasteiner Heilstollen tunnel in which I spent my 30 radon-breathing minutes had room for 20 or so people who had signed on for its protective value or its alleged benefit in alleviating conditions such as rheumatoid arthritis, asthma and sinusitis or skin conditions like psoriasis.

The doctor in charge on the day of my visit was Simon Gütl. He told me of clinical trials, of surveys testifying to the popularity of the treatment, and of patients who are able to cut down on or even abandon the drug therapies they would otherwise have been using. How much of this evidence would rate as gold standard in quality, I have no idea – but I was struck by the enthusiasm with which some people seek out the same force of nature that most others think we have to avoid at any cost. One of my fellow transient troglodytes was on her 70th visit.

The managing director of the Gasteiner Heilstollen is Christoph Köstinger, a physicist by education. Some 9,000 patients, he told me, do a full spa therapy of one session per day for 2–4 weeks, and several thousand more have shorter courses. He is well aware of people's conflicting feelings about radiation: "I divide people into three groups," he says. "Those who are really frightened of radiation don't come to us. Then there are people who are not frightened of radiation and say it's all OK. And a lot of people are a little bit frightened, but you can usually explain the balance of risk."

He's also aware of the widespread aversion to nuclear power throughout Germany. "Some patients explain it to themselves by saying that this

[radon] is natural radiation," he explains, hastening to add that as a physicist he's aware of the meaninglessness of any distinction between 'natural' and 'unnatural' radiation.

Lying on my bed of discomfort in the Gastein galleries, breathing in the radon, just how much radioactivity was I taking on board? Very little. I was inside the mine for slightly over an hour. Köstinger reckons that during a three-week treatment programme, patients receive a dose of around 1.8 mSv (millisieverts), or roughly three-quarters of a full year's background radiation – because, of course, we are all exposed to low-level radiation all the time.

First, there is cosmic radiation from the Sun and the rest of the stars in our galaxy and beyond. How much we get depends on the altitude at which we live and on fluctuations in the Earth's magnetic field. And then there's radiation from the Earth itself, including radon. Here, too, geography is a factor: in some places radon can be found leaking into the atmosphere in significantly larger amounts. Naturally radioactive solids such as uranium and thorium in rock and soil also make their contribution. The global average annual radiation dose is 2.4 mSv. To put this in perspective, that's about the same as 120 chest X-rays.

Much of what we know about radiation's effects on human beings comes from far higher doses following nuclear explosions – the bombs dropped in 1945 on Hiroshima and Nagasaki. The Radiation Effects Research Foundation has studied the health of some 100,000 survivors of the two bombings, and the health of their children.

The findings from the survivors themselves came as no great surprise. For cancers other than leukaemia, an excess risk started to appear about ten years after the event. The extent of the risk depended on each individual's distance from the site of the explosion, as well as on age and gender. As an example, anyone about 2.5 km away had a 10 per cent

greater risk of developing a tumour. In the case of leukaemia, the excess number of deaths began to appear just two years after exposure and peaked four to six years later.

What hadn't been expected were the findings from the Hiroshima and Nagasaki survivors' children. The assumption had been that they too would be more likely to develop malignancies of some kind – but so far this has not been the case.

"At this point we have not seen any excess of cancer or non-cancer mortality," says Roy Shore, chief of research at the Radiation Effects Research Foundation. He goes on to point out that a large part of their disease experience will occur over the next 30 years, so he can't entirely rule out a late effect. Nonetheless, the findings so far are a bit of a surprise. "Based on experimental data ranging from fruit flies to mice we would have expected to see some," he adds.

Of the unresolved debates about radiation, the most contentious is the true extent of the harm (or even the benefit, if the Gasteiner Heilstollen evidence persuades you) that it causes at low levels.

There are two schools of thought. The generally accepted view derives from the known relationship between higher levels of radiation exposure and the subsequent likelihood of developing cancer. Plot one against the other, and what emerges is a more-or-less straight line. The uncertainty is over this being extrapolated to very low doses, and whether there is a threshold below which the risk vanishes.

"At really low doses – down in the range of, say, a CT examination – we don't have strong evidence one way or another," says Shore. "It's a matter of interpretation." He himself sees it as prudent to assume there isn't a threshold: the so-called 'linear no-threshold' (LNT) hypothesis.

Professor Gerry Thomas has a chair in molecular pathology at Imperial College London and takes a close interest in the effects of radiation. As she points out, illnesses caused by radiation are also caused by other things, so at the lower end of the dose range you need a very large group of people to prove it either way. "Most scientific opinion is that there's no data to say it's dangerous until you reach about 100 mSv."

Even so, most radiation regulatory authorities and their advisers back the LNT view. Safety limits are set accordingly low. The upper limit for exposure for a member of the UK public, for example, is 1 mSv per year – less than half the annual average background dose.

Speaking for the Bad Gastein clinic, Köstinger takes a pragmatic view. He balances the risk of low-dose radiation against what he describes as the "scientifically proven effect" of the treatment. "We have a hypothetical risk [from radiation]," he says, "but even in the worst case it is minimal compared to the risks of the drugs our patients are usually able to stop using. If there's a risk, we can live with it. If scientific knowledge suggests there's a threshold, that's also OK."

The overall conclusion of all this is that radiation is nothing like as damaging as is commonly assumed. Moreover, what often gets lost in the argument is that the difference between a very small risk and a slightly greater very small risk may be of no practical consequence. In fact, policies and decisions that become obsessed with radiation risk minimisation may, in the wider scheme of things, turn out to be counterproductive.

Does it matter if large numbers of people have an unwarranted dread of radiation? After all, millions of us have irrational fears about all sorts of things from spiders to flying. We cope. The world still turns.

Two instances serve to illustrate why being unduly fearful of radiation

does matter. Both, in their way, are troublesome for individuals and for the community.

The first is our reluctance to exploit nuclear power. From 1970 onward, global electricity production from nuclear power stations experienced a steady rise. In the 1990s, this rise continued, but at a slower pace. From 2000, it flattened out, and then began to slip. Even as enthusiasm for carbon-free energy generation began to increase, the use of carbon-free nuclear power first faltered, then began to decline.

There are many reasons for this, not least the arguments about the cost of building nuclear power stations and of decommissioning them. But public suspicion has possibly – probably – had the key role in policy decisions. We've watched as nuclear power stations have begun to reach the end of their working lives. In panic at the prospect of the lights going off, we've extended those lives. But some countries have shied away from replacing them, judging that the perceived risk is greater than the potential role of nuclear power to significantly limit man-made climate change. From the evidence, it seems clear to me that the balance lies overwhelmingly in the other direction.

The personal consequences of an excessive fear of radiation are, in their way, even more damaging. Evidence for this can be found in the aftermath of the events at Chernobyl and Fukushima. The WHO Expert Group set up to examine the Chernobyl disaster reported that it had a serious impact on the mental health and wellbeing of the local population who were evacuated.

"There are sad stories from Chernobyl and more recently at Fukushima of people being shunned by the communities they went to because they were thought to be radioactive or in some way contaminated," says Smith. "One conclusion of the WHO report was that the social and psychological impacts of Chernobyl had been worse than the direct

radiation impacts."

He recalls meeting a man fishing in a contaminated lake within the Chernobyl exclusion zone. "This guy said he wasn't moving: 'The Second World War didn't move me out of my home, so I'm not going to go on account of a bit of radiation.'

"You can't say for sure, because it's all about statistics, but he probably made the right decision. He certainly faced an additional risk because he was eating local food, which was contaminated, but the risk he would have taken on if he'd been forced to move to somewhere else and live a different lifestyle would probably have meant he lived less long anyway."

Although the Fukushima evacuees were less plagued by outlandish rumours than their counterparts at Chernobyl, they too suffered the nagging consequences of an undue fear of radiation and its unpredictable effects on health. A 2012 survey of the evacuees revealed that one in five of them showed signs of mental trauma.

Stress and consequent mental health problems are unavoidable when evacuation and relocation is indisputably necessary. But a zealous application of the precautionary principle, worst-case assumptions about the effects of radiation and wide safety margins have fostered counterproductive risk assessments. Together with unfounded rumour, sometimes boosted by secrecy on the part of officialdom and a reluctance to confront irrational suspicions, radiation has become everyone's worst nightmare.

Rumbling through the train tunnel on the way out of the Gasteiner Heilstollen, I remembered the idea about painting radiation blue. Whimsically, seeking distraction from the humid heat, I wondered what it would be like if we were consciously aware of radiation. Not by

painting it, but by some other means.

Imagine if our eyes could see far beyond the visible region of the spectrum and act as a radiation detector, able to signal everything to the brain as a visual sensation – or even as an auditory one. Or if our skin evolved to tingle in the presence of radiation. But radiation is everywhere, and ever-present. If we could sense it, it would be too distracting, all the time.

One man-made alternative is obvious: imagine cheap and universally available wristwatch-sized Geiger counters set to stay silent – crucial, this – below radiation levels with epidemiologically discernible consequences. Wearers predisposed to being nervous about radiation might be surprised never to hear their detector going off. Certainly not during my trip under the mountain. Not during a whole-body CT scan. Not even during a week's camping holiday beside the cemetery at Chernobyl.

But would that be enough to reassure you?