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Some Aspects of the Relationship between Society and the Disposal of Radioactive Waste

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Society accepts that its demands for materials, energy and transport all create wastes, and yet no community will willingly absorb its share of waste, let alone accept a regional or national share.

Community rejection of such a burden is exemplified by the NIMBY (“not in my back-yard”) phenomenon. Recent examination of NIMBY suggests that it could be the child of “top down” siting decisions usually based upon a “decide, announce and defend (DAD)” policy. There are indications now that a counter culture of “volunteer communities” could mitigate or even overcome this rejection process.

There is also concern that any compensation made to a subject community, whether declared or volunteered, is nothing more than a bribe. Surrounding communities and opposing agents, to appeal to the moralists in the political process, use this connotation to counter such a reward. The reward should not be “cash” alone but encompassed within the concept of the maximisation of utility for the subject community.

Recent polling indicates that society believes that a community that accepts waste disposal in its area should be compensated for the apparent risk. The same poll indicates that society is undecided as to whether a subject community should be compensated for its loss of space. The rationale is that a community that agrees to a repository would enjoy some immediate local benefits such as jobs and an added value within its municipal rate base. These benefits are seen, in part, as offsetting any loss of space.

Polling has also quantified the time horizons of the “common man” and found that most people think no further forward than to the life of their grandchildren, or say 100 years forward. This time horizon falls well short of the time dimension required for the isolation of radioactive waste.

Waste disposal companies and government departments working alone are not trusted as much by society as are composite bodies incorporating many elements of society.

This paper argues that the siting of waste repositories can be advanced by taking into account volunteer communities, appropriate rewards for risk and

community perceptions of time and trust. As wastes continue to accumulate at increasing rates, there is urgency for the resolution of this societal issue.

Siting

There has been some progress in obtaining sites for the disposal of radioactive wastes. The Finnish, Swedish and Spanish operating sites for the disposal of intermediate level waste (ILW) shows that it can be done. The Waste Isolation Pilot Plant (WIPP) site in Carlsbad, New Mexico, is receiving and finally placing transuranic contaminated wastes from the US defence programme. Most nuclear countries also have undertaken the disposal of low level waste (LLW) in approved sites.

Sites for the disposal of high level waste (HLW), whether encapsulated spent fuel or vitrified residues from reprocessing, have not yet been developed, although there are candidate sites at Olkiluoto (Finland), Gorleben (Germany), Meuse-Haute Marne (France) and Yucca Mountain (USA). Additionally there are underground research laboratories at Oskarshamn (Sweden), Grimsel (Switzerland), Pinawa (Canada) and Tono Kamaishi (Japan).

Siting attempts for the disposal of all forms of radioactive waste (LLW, ILW and HLW) are dominated by the many failures. Sites nominated are commonly nullified by political or technical argument. There are examples of this in many countries. The recent UK experience of Nirex losing the Sellafield site (Cumbria) for a Rock Characterisation Facility (RCF) on technical and political grounds, and the subsequent House of Lords Enquiry, is an expensive illustration of this point.^{1,2,3}

Whilst the generalities of waste disposal are universal, site selection is largely site specific and must take into account the space, geology, geography, environment, community requirements and politics on local, state, national and international levels. Whilst disposal sites are so burdened, there is in most countries some element of choice of site. On the other hand, the development of a mineral resource or a disposal site once nominated does not have the same freedom.

As the number of “lost” sites globally far outnumber those approved, perhaps the causes of failure are easier to demonstrate than a guaranteed formula for success. I suggest that the following elements will contribute to site loss.

Recipe for Site Loss

- To maximise the attraction of NIMBY, have the site decided behind closed doors and then announced and defended (DAD).
- The proponent to exclude local participation and be Foreign to the subject community. Be from another state, another country, be federal, be international. As our American friends would say, be from out of town!
- Trust only yourselves. Make sure that the oversight body is male dominated, industry loaded, with perhaps some token female and government presence.

- Rush the procedure, minimising community involvement as much as possible.
- Pretend that the site selected will only be used for scientific evaluation, certainly not for final disposal.
- Distribute glossy brochures that depict the decay of radiotoxicity in obscure units over time, both on a log/log scale, and hope that the lay population will each have degrees in physics, chemistry, mathematics and geology.
- Do not publicly discuss compensation with the community or the surrounding area for fear of introducing the prospect of a “bribe”.

As a more positive contribution to site acquisition, I will now discuss four issues arising from my current research.

Risk and Reward

When living in a modern industrialised society we are immersed in ubiquitous risk. Whilst these risks are quantified and well known to experts, they are not necessarily recognised or quantified by a subject lay population. These risks impact on the individual when eating, sleeping, travelling, working and certainly on vacation. The general population is more inclined to accept such risks without specific conscious decisions on its part. If such risks are not subliminal, then at least they are tolerable. We might accept this as the *ubiquitous risk profile* of our time.

The provision of health, energy, education, travel, comforts and entertainment are the compensatory rewards to society to offset these risks. It may also be in the mind of the individual that he can load the dice in his favour by eating less beef, ventilating his house to reduce the radon content and by driving his own car when travelling rather than travelling with an unknown driver.

Peter L Bernstein, in his 1996 book *Against the Gods, the Remarkable Story of Risk*,⁴ reminds us that: “The revolutionary idea that defines the boundary between modern times and the past is the mastery of risk: the notion that the future is more than a whim of the gods and that men and women are not passive before nature.”

Ulrich Beck, in his well-known paper, *From Industrial Society to the Risk Society: Questions of Survival, Social Structure and Ecological Enlightenment*,⁵ plots the evolution of the risk profile of individuals and societies as they move from the pre-industrial to industrial era and increasingly base their decisions on “techno-economic” factors. He concedes that with industrialisation the traditional risks of infant mortality, famine, epidemics or (the effect of) natural catastrophes have been continually reduced but replaced by new risks “that might arise from nuclear power, chemical and biotechnical production”.

Moving to a less industrialised society however, may not reduce the overall risk to health if mortality is a good measure. An extract from *A Concise History of World Population* by Massimo Livi-Bacci⁶ illustrates the point (see Table 1). The life expectancy in the “more developed countries” is greater than in the world overall and certainly greater than in the “less

developed countries". The increase in life expectancy has increased in all three categories in the period 1950–55 to 1990–95, but more so in the less developed countries. Perhaps this is due to the rate of improvement in agriculture, medicine, supply of energy and transport, all of which have an industrialised base and attendant risks.

An individual does not necessarily align his actions to the given numeric expression of a given risk and there are no better examples of this than in the cases of smoking and the riding of motor cycles. The UK National Radiological Protection Board publication, *Living With Radiation*,⁷ includes data on the comparative risks of causes of death (see Table 2). Faced with these data, it could be assumed that those with knowledge of health and risk would be non-smokers. But apparently not so, as many medical doctors and nurses continue to smoke. So why do they? Is there a belief that it won't happen to them, can they load the dice by only smoking low tar cigarettes, do they not inhale, is there statistical evidence to say that they and their family are less prone to the hazard? Or, if we set aside addiction, is this a matter of getting sufficient comfort from the device such that the perceived risks are equated to or outweighed by the apparent benefits? Is this an illustration of reward and risk at work?

Those who work in casualty or orthopaedic wards in general hospitals and at the same time travel to and from work by motor cycle have a similar perception of the rewards outweighing the risks. This issue was explored in *The Economist* in a 1997 article, *Tobacco and Tolerance, Blowing Smoke*: "Motorcycling is about 16 times more dangerous than driving a car; but a motorcyclist will tell you that the pleasure of wind in the hair and a powerful engine between the thighs is worth the risk. Smoking, which can both soothe and stimulate, entails just the same sort of risk-for-pleasure trade." I can add to this, that there are many examples of otherwise sensible people who both smoke and ride motor cycles!

I posit that the lay population does not comprehend numeric expressions of risk, and this view has been reinforced by witnesses to the recent House of Lords Enquiry.³ The view of some experts in the field is best captured by the reported evidence from Professor Brian Wynne of Lancaster University: "Professor Wynne argued that abstract figures on risk like these (numeric probabilities) are not meaningful to the public." I agree with Professor Wynne.

People do trade reward for risk in many aspects of daily life. At the same time they do not necessarily have the expert's view as to the hazard or frequency but develop an intuitive respect for risk.

Volunteer Siting

The 1996 book, *Hazardous Waste Siting and Democratic Choice*,⁸ comments: "Opposition to siting of waste facilities has become commonplace throughout the industrial world. Much of it arises from what have come to be called NIMBY movements, organised local groups that oppose the siting of facilities in their neighbourhoods or communities." I believe that the failure of many siting attempts is due to the "top down" process illuminated in Reference 8 as DAD. It is the emergence of the "Voluntary Choice Process"

(also discussed in Reference 8) that is providing encouragement that there will be a solution to the siting problem.

The House of Lords Enquiry finds that “volunteer siting” and compensation are both valid concepts. The Third Report³ states: “The final list of sites for field investigation would be derived by consultation or by using a volunteer approach. It would be the Commission that handled the consultation or “volunteering” process...”; and: “Blight would occur when the short-listed sites are named. It would be appropriate to offer some form of compensation to mitigate this “nuclear blight” and to enable people to derive some form of benefit from hosting a repository. Government should consider how this is to be achieved, *bearing in mind that generosity may succeed but parsimony will not.*” (My emphasis.)

I have also reflected on the “halo effect”, that is, even if a local community becomes convinced as to the worth of it accepting a repository, the surrounding region usually rejects the proposal. Is this just jealousy, or is there a failure to recognise that the region also has costs and risks, but to a lesser degree? The Third Report picks up this theme under the heading of *Associating Risks And Benefits*: “From the evidence of Copeland Council we conclude that, while the local community there stood to gain indirect benefits from accepting a waste facility, for example in increased employment opportunities and in the provision of services to the contractors, much of the local electorate would have seen little direct benefit. There is little motive for them to support any proposal to site a repository in their locality.”

The Third Report also develops the concept of “nuclear blight”, which is described as “the fall in land and house prices in any affected area”. It is recognised that the blight will attach to any listed potential site and I believe that it is a term that reflects the real discomfort and the perceived risks for a community and its surrounding area. It is worth keeping in mind that some communities have already been blighted by previous industrial activity, such as iron or steel making, salt or coal mining. These communities could achieve a net improvement in the overall environment by accepting a new industry.

The case for compensation to a local community, and to a lesser extent to the surrounding region, will raise the old issues of decision making under duress, bribes and the possibility of an unequal distribution of rewards paid to compensate for risk. Equally, there is the case of a subject community holding a development to ransom, as has often been the case with fishing communities in the areas of reactor cooling water outflows.

It needs to be stated that in the case of the siting of a hazardous waste facility, the risks need to be extremely low, manageable and interruptible if safety, health or environmental standards are not maintained. State, national and international bodies will need to provide oversight to prevent circumvention of these requirements.

My research specifically addresses the issue of public opinion on rewards for risk and loss of space together with the merits of compensation to surrounding areas. The research polling in the UK was based upon the views of 700 fresh first year undergraduates in geography in the universities of Oxford, Reading,

Oxford Brookes, Southampton and Manchester, and University College, London. In each case the groups were 100% of the intake and all students returned questionnaires. The rationale for such groupings is that they would bring with them to university their home and school values and that these could be representative of a wider community.

It was essential to capture such groups in the first weeks of their university life so that they had not been contaminated by the aura of higher learning. The questionnaire included 15 questions related to aspects of the disposal of wastes. Parts of the same series have subsequently been run in omnibus polls in Japan (2203 people)⁹ and in German-speaking Switzerland (1057 people),¹⁰ and there is a demonstrable correlation with the UK student poll results for those questions. Interviews with sample adults, industry and institutions in the UK and several other countries have also added confidence that the UK student results could be representative of the broader population. I am, however, of the view that all polling is at best a qualitative reflection as to public opinion.

Four of the relevant questions and results from the UK Student poll follow:

Q1. Do you believe that a community that accepts a hazardous waste dump in its area should:

- (a) receive compensation for the possible risks? Yes (85%) or No (15%).
- (b) receive compensation for the loss of space? Yes (52%) or No (48%).

Q2. If you answered 'Yes' to Q1 (a) and/or (b) above, then do you believe that such a community should also receive a reward in addition to a compensatory payment? Yes (26%) or No (64%).

Q3. If you answered 'Yes' to Q2 above then should the reward be:

- (a) minimal? (13%)
- (b) moderate? (62%)
- (c) generous? (25%)

This extensive poll suggests that compensation to a community for possible risk is not alien to the public. Clearly there is a greater acceptance of compensation for 'risk' than for 'space', although half the population also agree with compensation for a loss of space. A possible interpretation is that any community that gives up space does so because there is some other obvious offsetting compensation, such as jobs.

The combined answers to questions 1, 2 and 3 suggest that compensation should be "not too much and not too little". This tempers somewhat the Third Report statement "...that generosity may succeed but parsimony will not". The agreement to the form and quantum of any compensation will need to be adequate but not seen to be excessive. The compensation does not need to be all in cash terms. The Third Report heralds this prospect: "These benefits might be in the form of specific measures to improve the local infrastructure, to compensate for increased road traffic or loss of other business, or it might take the form of more direct assistance in the form of community services." Is this not an illustration of the maximisation of a reward to a subject community?

Q4. If you believe that the community should receive some compensation then do you believe that the region (county) surrounding the community should also receive some compensation? Yes (41%) or No (59%).

Clearly a majority declines to compensate the surrounding region, and the rationale for this remains unclear. Perhaps it is based upon a feeling that the risks and/or loss of space in the surrounding region are minimal and any compensation to it would be unearned and possibly construed as a bribe. As there are some identifiable costs, inconveniences and risks to a surrounding area, usually associated with heavy road and/or rail transport through the region, it is clear that any proponent will need to educate the region as to the likely impost on it. Equitable compensation to the surrounding region could then be considered as a counter to the “halo effect” and yet meet the satisfaction of the broader public.

Perceptions of Time

The disposal of waste is a four-dimensional issue requiring space (three dimensions) and time for isolation (the fourth dimension). The temporal dimension required for the isolation for each class of radioactive waste is in the order of 300–500 years for LLW, 5000–8000 years for ILW and 100 000 years or more for HLW. Does the lay community hold a perception of time commensurate with the issue? The answer is clearly no, and the following four questions quantify this element. The results are from the UK student poll (with Japanese and Swiss results shown where applicable).

Q5. When considering the future welfare of yourself and your family, how far forward do you think? 92% (Japan 91%, Switzerland 87%) have an outer time horizon of 100 years or less. That is, an outer time horizon not greater than the life of self plus two generations forward (grandchildren).

Q6. When considering the environmental welfare of your home township, how far forward do you think? 90% (Japan 89%, Switzerland 84%) have an outer time horizon of 100 years or less (see Figure 1).

From these data, the outer time horizons of the population are clear. However in democracies subject to plebiscites, it should be remembered that a simple majority decision is sufficient to decide the outcome. Figure 2 illustrates that in the case of quantifying the forward horizon in the categories of family and community, approximately 50% of the people have a horizon of 40 years or less!

Q7. When considering the total global environment, how far forward do you think? 46% have an outer time horizon of 100 years or less. Cumulatively, 81% (Swiss 91%) expressed a horizon of 1000 years or less.

This is markedly different from the views expressed for ‘self’ and ‘community’. There is a lengthening of the time horizon when considering global effects. I believe that the spatial dimensions inherent in the greenhouse issue fits it into the global scenario, whereas the spatial dimensions of waste disposal clearly puts it into the dimensions of a community.

Q8. If hazardous waste is buried in solid rock 500 metres below the Earth's surface, do you believe that it will be isolated from the living environment (Swiss poll):

- (a) for 100 years? (58%)
- (b) 1000 years? (19%)
- (c) 10000 years? (5%)
- (d) forever? (13%)

These data have lead me to the realisation that the time spans necessary for the isolation of radioactive waste are far beyond the time horizons of the "common man", as illustrated in Figure 3. This is a very significant finding for the nuclear industry. The finding may also be the underlying factor as to why the answers to Q8 have a relatively short horizon when compared to the scientific perspective. That is, perhaps the cause is not that there is a belief that the isolating barriers will break down in such a short time (58% in 100 years), but that these impressions reflect the natural outer limit for analytical thought of the "common man" when considering self, family and community.

Trust

Research in Japan by the Steering Committee on High Level Waste Project (SHP)⁹ alerted me to the fact that the lay community has the greatest trust in composite bodies (quoted by SHP, as "a circle of professors"). This question illuminates the point:

Q9. The control of the disposal of hazardous wastes requires the involvement of many companies, authorities and government departments. Who would you trust the most to oversee that wastes are disposed of properly:

- (a) a government department?
- (b) the manufacturer of the waste?
- (c) scientists?
- (d) environmentalists?
- (e) a composite body that includes government, industry, environmentalists, scientists, doctors and academics.

In response, 81% selected option (e), 12% option (d). There is an overwhelming move towards trusting composite bodies (such as the UK's Radioactive Waste Management Advisory Committee) and the discounting of industry or government working alone. This point needs to be brought to the notice of the waste industry and regulators. The respondents also expressed a high degree of confidence in their choice: 46% expressed a 'medium' degree of trust and a further 45% a 'high' degree of trust.

Conclusion

Public attitudes to the recognition of risk are changing, particularly in respect to additional discretionary risks such as those associated with the acceptance of a waste repository in a subject community or region. I am of the view that compensation to a subject community is expected and is now acceptable to a majority of the public, provided it is not over-generous. Failures to obtain sites for investigation, let alone for a repository, have in part been due to technical failure, but more importantly due to industry and government failure to understand public concerns and attitudes. The resolution of this problem,

now quite urgent for many forms of hazardous waste in many countries, should be re-assessed taking into account volunteer communities, appropriate rewards for risk, and community perceptions of time and trust.

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Table 1. Life expectancy at birth (1950–55 and 1990–95).

	1950-55	1990-95
World	46.4	64.7
More developed countries	66.5	74.3
Less developed countries	40.9	62.9

Source: World Population Prospects: The 1994 Revision (New York, 1995), taken from Reference 6, Table 5.2.

Table 2. Average risk of death in the UK from some common causes.

Causes	Risk of death per year		
Smoking 10 cigarettes per day	1 in 200	or	500×10^{-5}
Natural causes, 40 years old	1 in 700	or	140×10^{-5}
Accidents on the road	1 in 10 000	or	10×10^{-5}
Accidents in the home	1 in 10 000	or	10×10^{-5}
Accidents at work	1 in 50 000	or	2×10^{-5}
Most exposed from nuclear effluents (0.3mSv)	1 in 70 000	or	1.4×10^{-5}
All causes	1 in 80	or	1200×10^{-5}

Source: Reference 7, p.24.

Figure 1. Q6. When considering the environmental welfare of your home township, how far forward do you think?

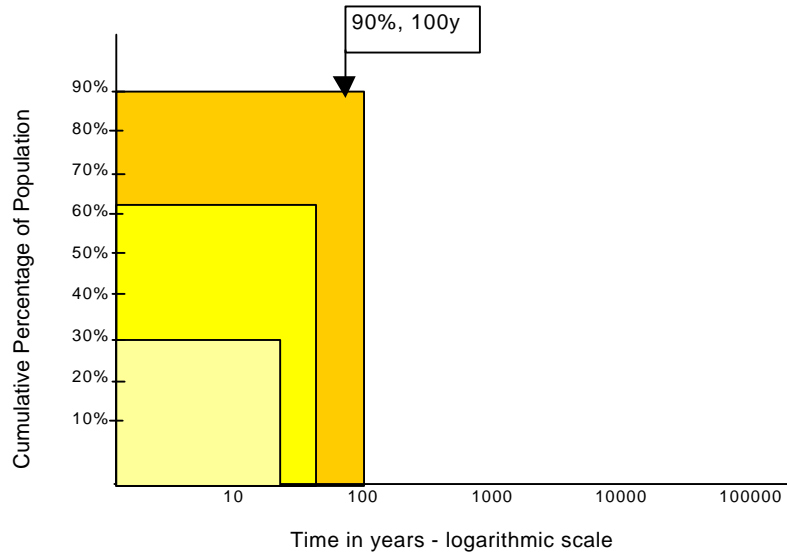


Figure 2. The outer time horizons when considering the future welfare of family and community.

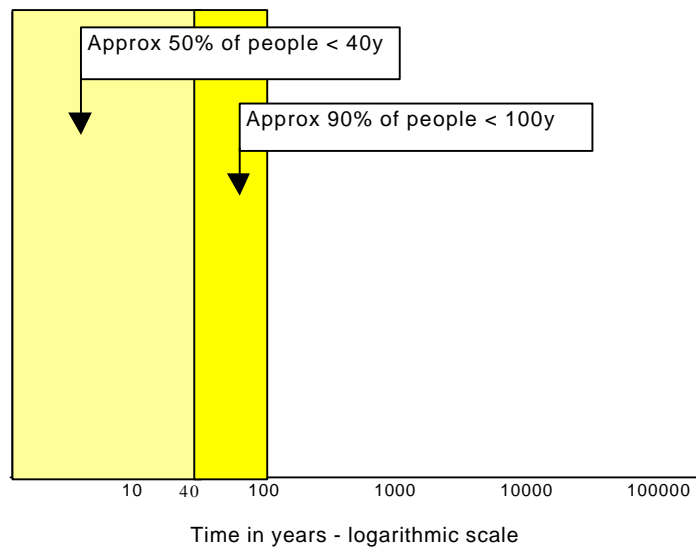


Figure 3. Isolation period for radioactive waste compared to time horizons

