The Environmental Competence of Science and

The Public Understanding of Science

[published in Shimizu K (2009) The Public Understanding of Science and Technology for Environmental Sustainability, Proceedings of the Symposium held at HICEC, Hiroshima University, Sept 7, 2009]

Martin W Bauer (LSE, m.bauer@lse.ac.uk)

Abstract

The paper investigates the relationship between environmental attitudes and public understanding of sciences. EU surveys of 1992 and 2005 allow us to investigate science culture – literacy, interests and positive attitudes – as a factor of environmental attitudes. Environmental attitudes have many facets, awareness, world views, and the evaluation of policy option. This paper focuses on the public attribution of competence to be part of the solution, an aspect of trust in science. A logistic regression model shows how science culture, in conjunction with age cohort, time, education, country and gender, drives the perceived competence of science to stem the limits of resources and to play a protective role. Science culture explains two third of the variance in perceived competence. Religious orientations come into play by rejecting the competence of science. We speculate that because reversing climate change depends on individual life style changes, it will be insufficient to rely on science culture to drive such personal changes. Dispositions for personal change are traditionally the domain of religion rather than of science.

Keywords: public understanding of science, science culture, environmental attitudes, the competence of science, European countries, Eurobarometer Surveys, longitudinal analysis.

I have been asked to address how does the public's understanding of science relates to environmental attitudes. This is a pertinent question, not least because the research on public understanding of science and attitudes to science and the research on environmental attitudes and are often conducted in splendid isolation, quasi in an academic silo mentality.

Public understanding of science (henceforth 'PUS') research can look back to an active history of 30+ years making some progress on issues of measurement and conceptualisation (see Bauer et. al, 2007 and 2009). The accumulating empirical evidence of these exercises assesses the issues of PUS on several dimensions: general interest, knowledge, attitudes, and public engagement with science and technology. One of the promising developments of recent years is the global integration and comparison of a database of PUS data, which allows us to compare the structure of public understanding across very different cultural contexts (North and South America, Europe, India, China and Japan), and to map historical changes across time and age cohorts in the US, Europe and in Japan.

By comparison research on environmental awareness and attitudes is numerous and multifaceted, and probably not easily summarised. I appears that environmental attitudes have been assessed on the following dimensions: problem awareness, environmental attitudes, causal attributions and evaluation of policy options.

Environmental awareness has steadily increased. In the 1970s, in most countries only a minority was environmentally conscious, i.e. exhibited any awareness of a problem or a concern with regard to pollution, biodiversity or climate change. Nowadays, depending on the world region, opinion polls show awareness levels reaching 80% or more in the population, and what was once an issue of the conservative political right, has moved to the political left in the form of Green Parties and agendas.

Another dimension is the value foundations that motivate awareness and political mobilisation, as for example 'deep ecology' and its view of humans within nature. Representations of nature and the position of humans therein are drivers of powerful and complex attitudinal positions comprising beliefs, evaluations and the impetus to act. An informative typology of such basic positions explores whether people are anthropocentric or eco-centric. Anthropocentric means that 'nature' is perceived entirely in function of human needs and interests. Eco-centric means that nature is seen as an absolute value in and of itself; humans do have no privileged position therein. The second dimension explores whether this concern is self-interested or self-transcendent, i.e. considering only one's own or other points of view. People's positioning on these dimensions is a function of education, income, political affiliation, rural or urban residency, age and gender (see Maloney & Ward, 1975; Baikle, 1992; Thompson & Marton, 1994; Gobb, 1995; Fransson & Garling, 1999; Schultz, 2001; Milfont & Duckitt, 2004). One of the purposes of these investigations is to relate these values orientations to political preferences. As environmental issues became global politics over 'climate change', the focus of attitude research is on attribution patterns and policy options: adaptation of life style and business opportunities, or mitigation and causal intervention at the source of the problem, the CO2 emissions; geo-engineering or social engineering with carbon taxation or similar schemes (see

Pittock, 2009). Opinion research on these matters proliferates with the global agenda and ties in with the political realities of different countries.

In the remainder of this paper, I will suggest a fourth dimension of environmental attitudes: the extent to which the public sees science as part of the solution; the attribution of environmental competence to science to solve the problem. But before, let us briefly explore how this question relates of PUS research in general.

1. General and specific indicators of public understanding of science

From the point of view of PUS research, the relationship between PUS and environmental attitudes is an example of the old problem of general and specific indicators of PUS. This problem has both a conceptual and an empirical angle, and touches on the added value of general indicators.

Conceptually, science must be considered as a social institution like the courts or the parliament. It developed as such in the course of the last 300 years, with its own history in different contexts, and a strong international ethos, but fuelled by competition. The reputation of its institutions, laboratories, universities depends on a general understanding.

On the other hand, the history of science is marked by specific concerns and discussions, which are likely to have influenced the present image of science. The current image of science is the layered sedimentation of past debates and activities. Water fluoridation and space exploration, nuclear power, computing and communication technologies, various developments in genetic engineering and biotechnology mark specific topics where science and society have met in public debates, and public attitudes became a focus of attention.

However, the reputation and authority of a social institution cannot be reduced to any of its specific activities; reputation is indeed the effect of accumulation of many activities over time. Actions will affect the reputation of an actor, however, not in a one-to-one mapping. The actor might be rely on a stock of public good-will, and is thus able to temporarily deflect the negative outcomes in any particular discontent; not the social body is wicked, but some of their activities.

In order to be able to study the transfer of evaluation from actions to actors, we must keep the general and the specific separate, and not reduce the general appreciation of science to opinions on any particular issue, a distinction that is common in the political sphere (see Easton, 1976).

So for example, the debates over nuclear fission encountered in the 1970s and 1980s in many parts of the world as a techno-scientific solution to the energy problem, is a specific issue in the history of science and technology, which impacted on the reputation of the scientific and technological enterprise to some extent, but the difficulties of the nuclear programme did not

transfer entirely to the scientific institutions. To some extent people distinguish the science and the policy.

Empirically, the distinction between actor and actions, institution and policies, comes to the crunch in the definition of indicators. The construction of general PUS indicators must have a long-term orientation. It cannot restrict itself to issue of the day which are likely to be irrelevant 10 years later, when the issue is resolved or has otherwise gone away. Issues tend to have an ‘attention cycle’, they appear, attract attention, and fade away or linger on. For example, it makes little sense of assess the cultural authority of science in 2010 on the issue of water fluoridation, which was controversial in the USA of the 1950s. Nowadays, few people might even understand what this was about. However, people might currently take a keen interest in global warming or genetically modified food. Thus, the long-term mapping of changes in the cultural authority of science requires consistent measures which lie beyond the issues of the day, but which can be related to such issues as they come and go. But with limited resources and the pragmatic pressures of social research, a competition between the general and the particular will persists. It is therefore important to stress the conceptual significance and the empirical value-added of this distinction.

I will now present some observations on the changes in general PUS across Europe (EU-12), between 1989 and 2005, and then relate these changes to how Europeans judge the competence of science to play a role over limited natural resources and the protection of the environment.

2. The culture of science in the EU12 from 1989 to 2005

The public understanding of science is measured on several dimensions for which we have longitudinal evidence across Europe: First, knowledge is measured by 13 quiz-type items where respondents identify whether a statement is true or false. Second, respondents declare a general interest in new discoveries (intdis). And finally, a general attitude to science is measured by the confirmed expectation of general well-being: ‘science and technology are making our lives healthier, easier and more comfortable’ (att1). For details of these measures see Appendix.

Across Europe, we observe long-term changes in public knowledge, attitude and interest. Adult scientific knowledge of science increased between 1989 and 2005. In 1989, the z-value was -.10, in 2005 the z-value was +0.18 (z-value is a measure of deviation from the overall mean, mean=0, stdew = 1). The average level of knowledge moved from 10% of a standard deviation below the mean, to 18% of a standard deviation above the overall mean. Positive attitudes to science also increased on average over the same period, but not as much. However, interest follows a non-linear trend. In 1989 and 2005, interest in scientific discoveries is lower than in the middle period of 1992 and 2001. This is a counter-intuitive result. PUS models often assume positive

correlations between knowledge, positive attitudes and interest in science. But over time and in aggregate, this correlation is not borne out by the evidence. Interest can decline, while both knowledge and positive attitudes increase. This is a cultural conundrum that needs further analysis.

But average figures hide considerable variation across European countries. In the manner of a horse race we might compare countries by their average level of adult science literacy. Some countries like DK, Belgium and Germany improve their positions over the years, while others like Luxembourg and Italy fall back. Again others like Portugal or the UK hold their relative position stable, UK in the middle field, Portugal at the end of the running order.

Another way of looking at the data compares age cohorts. Cohorts consist of members of a population born in the same period of time; for example the ‘baby boomers’ are born between 1950 and 1962. 1962 is the cut-off point, because new birth control techniques came into play with implications on child bearing and the relationship between the sexes. Future generations are likely to grow up differently. Similar things can be said for those who lived through economic crisis and Worlds Wars. It is assumed that age cohorts share a common experience of history that shapes their world views, and their familiarity and expectations of science and technology addition to the influences of education or social status.

Figure 2 shows the ranking of twelve EU countries within each of the five age cohorts (for definitions of cohorts see appendix). Their relative position varies with each age cohorts. For example Denmark (DK) ‘improves’ its position from the oldest to the youngest age cohort, so do the Spanish (E). The younger Danes and Spanish are more scientifically minded than their parents and grand-parents among other Europeans. The opposite is true for the UK (UK), Ireland (EIRE) or Belgium (B). Here the younger generation does less well than their parents and grand-parents relative to others in the EU. While the age cohorts in the Netherlands (NL) and Portugal (P) have held their positions. These are relative results, comparing the relative standing of the different countries. Overall we know that the level of science literacy increased across the five cohorts.

Figure 1: rank ordering of EU countries by level of adults science literacy for each age cohort

	Relative positioning of the age cohorts				
	>1977	**1963-76**	**1950-62**	**1930-49**	**<1930**
Rank	**new order**	**gen X**	**babyboom**	**Crisis&War**	**Roaring 20s**
1	DK	LUX	DK	NL	F
2	NL	DK	F	LUX	LUX
3	D	NL	NL	D	NL
4	LUX	IT	IT	DK	D
5	F	F	D	F	DK
6	E	D	LUX	UK	UK
7	GR	E	UK	IT	B
8	IT	UK	B	B	IT
9	UK	B	E	EIRE	EIRE
10	B	GR	GR	E	GR
11	PORT	EIRE	EIRE	GR	E
12	EIRE	PORT	PORT	PORT	PORT

If we correlate knowledge, attitudes and interest in science within each cohort, we find that for the older generations these inter-relations are much stronger than for the younger ones. For the oldest cohort 25% of general attitude variance is explained by differences in knowledge and interest, for the Baby Boomers this is less than 12%, among the New Order cohort, born after 1977, this figure increases again to over 15%. While for the older generation the logic held 'the more you know, the more you are interested and you also like it', for the younger age cohorts, this is no longer so clear. Science literacy does not necessarily feed higher interests nor positive attitudes. Observations like this are consistent with predictions of the post-industrial model of public understanding of science (Bauer, Durant & Evans 1994).

3. An aspect of trust: science's competence to solve environmental problems

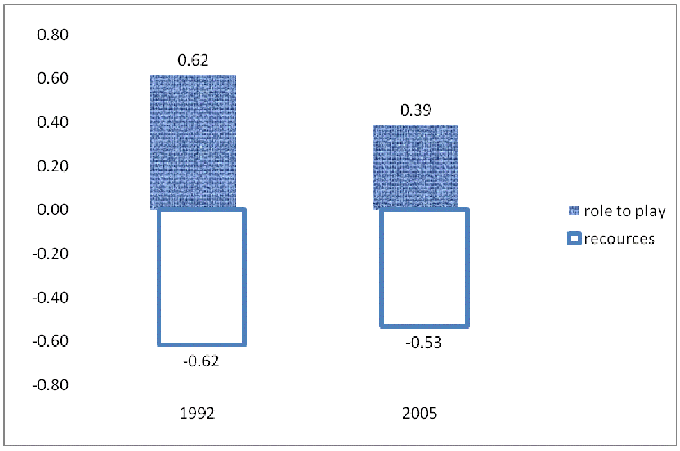
Now let us come to the key question: how does general PUS relate to environmental attitudes. I have to approach this question within the resources at my disposition. The European surveys under consideration do not include many questions on environmental issues, neither on awareness, nor world views, nor on causal attribution nor policy options. However, in 1992 and 2005 the surveys carried two items that are pertinent to our question. They refer to the fourth dimension of environmental attitudes: the attributed of science to be part of the solution. We might consider this an aspect of trust in science, of its perceived ethos in public debates.

The item Att2 states '*thanks to scientific and technological advances, the earth's resources will be inexhaustible*'. Respondents who agree with this statement express an optimistic view of the competence of science to stretch the limited resources available on earth and to push the limitations put on economic growth which arise from depleting resources (variable name 'resources'). We assume that people who disagree with this statement belief in the 'limits of

growth' echoing the discussions pushed by the Club of Rome in the 1970s, and no longer subscribe to an over-optimistic view that science will find new resources as it repeatedly managed to do during the last centuries. Those you agree with this statement see science as part of the solution, those who disagree do not see science as part of the solution to the problem.

Att4 states '*science and technological research cannot play an important role in protecting the environment and repairing it*'. Respondents who agree with this statement do not expect much of science with regard to environmental problems. While, respondents who disagree with this statement express an optimistic view of the competence of science to protect the environment and to reverse environmental deterioration (variable name: 'play a role'). We assume that those who agree with this statement will not see science as part of the solution, while those who disagree see science as part of the solution to the problem.

Figure 2: the competence of science to solve environmental problems



These two items measure the same underlying concept 'attributing to science the competence of being part of the solution'. Both items were treated so that agreement on resources (att2) and disagreement 'role to play' (att4) score in the same direction from -2 to +2: a high score means the 'attribution of competence' (see appendix).

The overall results show that most Europeans are pessimistic with regards to stretching the earth's resources with the help of science (mean=-.59: stdew=1.25). On the other hand Europeans are more optimistic regarding the role of science in environmental remediation and protection (mean=+0.54; stdew=1.29). Figure 2 shows the average scores for both questions on a 5-point scale. A positive score means that the majority of EU attributes competence to science; a negative score means that this is a minority. By 2005 people are less optimistic over the role of science, but also less pessimistic over their role in stemming the limits of growth. Over time

people are also less certain. Those with no position on these issues increased from one seventh in 1992 to about a quarter by 2005.[1] Considering only those who agree (a binary variable), we conclude that only 23% believe that science can stem the limits of growth, and no change from 1992 to 2005, and 57% see a role to play for science in environmental remediation, a decline from 59% in 1992 to 52% by 2005.

This trend masks considerable variance. We can observe that on science stretching the earth's resources Italy, Spain, Portugal, UK and DK became less pessimistic; other EU countries like Germany, Netherland, Sweden, and Ireland remain at their level of pessimism. Considering the role of science for environmental remediation, only the UK and Ireland become more optimistic, all others reduce their attribution of competence to science.

Figure 3 shows how these two attributions arise in relation to a number of predicting factors. Logistic regression determines the predictive power of factors expressed by the odds change arising from membership of certain categories compared to a reference category. The results for each variable are net of other influences in the model. For example, people with level 1 of 5 in scientific literacy are 74% less likely to attribute a role to science for remediation than people with level 5 science literacy, everything else being equal. On the issue of resources the attribution of competence to science is 47% more likely. Knowledgeable people are more likely to attribute a protective role, but less likely to believe that science will stem the limits of growth. In the model, knowledge, year and education have the strongest influence on 'role to play', while general attitude is strongest on 'resources'.

Figure 3: logistic regression: % of odd changes relative to reference category

Dependent variable / Predictor Categories	**Role to play**	**Resources inexhaustible**	**Role to play**	**Resources inexhaustible**
Know low	-0.74	0.58	-0.64	0.47
know(2)	-0.55	0.67	-0.46	0.66
know(3)	-0.33	0.43	-0.28	0.46
know(4)	Ns	ns	Ns	Ns
Know high				
Life healthier: disagree	-0.27	-0.73	-0.31	-0.73
Attitude 1(2)	-0.16	-0.65	-0.22	-0.64

[1] This increase in ambivalence could be an effect of the data collection process: Eurobarometer changed the survey company between 1992 and 2005. Different companies use different interviewing protocols and different protocols can change the proportions of DK and N/N responses. The shift form definite answers to the uncertain middle position could be an effect of this change in protocol; we cannot exclude this possibility for the moment. But, Let us for the sake of this analysis assume that the data reflects a change in opinion on the competence of science.

Attitude 1(3)	-0.61	-0.75	-0.62	-0.75
Attitude 1(4)	ns	-0.38	-0.14	-0.37
Life Healthier: agree				
Interest in discoveries no	-0.28	ns	-0.23	Ns
Interest in discoveries yes				
New order			0.51	Ns
Generation X			0.66	Ns
Baby boomers			0.56	Ns
Crisis & war			0.35	Ns
Roaring 20s				
Primary education			-0.36	0.19
Secondary education			-0.32	0.29
Tertiary education				
Women			-0.14	-0.11
Men				
France			0.86	-0.62
Belgium			0.71	-0.41
Netherlands			0.74	-0.38
Germany			0.51	-0.17
Italy			0.17	Ns
Luxembourg			0.18	-0.50
Denmark			2.05	-0.41
Ireland			0.26	Ns
United Kingdom			0.63	-0.35
Greece			Ns	-0.16
Spain			Ns	Ns
Portugal				
1992			0.51	Ns
2005				
Constant	2.25	-0.66	0.66	-0.60
Nagelkerke Rsq	**0.11**	**0.05**	**0.16**	**0.08**

With regard to general attitudes to science, the expectation that science makes our lives healthier, more comfortable and easier, the relation is not straight forward. The higher people's expectations, the more likely they also see science stemming the limits of growth. Those who disagree with 'science is making our lives healthier' are 74% less likely to attribute science environmental competence. With regard to science playing a remediation role, those who are unsure about the general impact of science are least likely to be optimistic or 62% less likely to attribute competence to science than those who have high expectations. Whether you expect a lot or not, you attribute more competence to science. Being interested in scientific discoveries is irrelevant for 'resources', those interested are 23% more likely to attribute a role to play for science. The same is true for age cohorts. Resource competence is equally bleak in all generation groups, while for the question of 'playing a role', the younger are much more forthcoming than

the younger age groups. Generation X is 60% more likely to see science in this role than those born in the early part of the 20th century.

Women are in both cases more sceptical over the competences of science than men. The year of questioning makes no difference for resources, while it does for playing a role. In 1992, Europeans were 50% more likely to see a role for science in environmental remediation than in 2005. It is likely that this result reflects the global debate over global warming that occurred in the meantime. Compared to Portugal, all EU countries attribute less competence with regard to resources, and all also see a larger role for science. The latter is particularly striking in the case of Denmark. A Danish respondent is 200% more likely to see this role for science than a Portuguese, while for the Irish, Italians, Greeks and Spanish the difference in perception is very small if at all significant. In countries like France, the UK, Belgium, Netherlands, Denmark and respondents see much more of a role for science to play, but have little faith that science will stem the limits of growth compared to Portugal. This segmentation of opinions follows very much the lines of old European centre versus periphery regions. Peripheral means that people are more likely to expect unlimited growth from science, and less of a role for environmental remediation than the more central countries of the European Union. The odd case is Germany, which remains with the periphery when expecting to stem the limits of growth. 'Fortschritt durch Technik' (Progress through technology) is the slogan of a famous German car advert, possibly expressing widespread attitudes in the country.

Figure 4: A fourfold typology of attributed competences to science

	not inexhaustible & no role	not inexhaustible & role	inexhaustible & no role	inexhaustible & role
FRANCE	28.1%	58.5%	6.6%	6.7%
BELGIUM	27.8%	53.2%	9.3%	9.6%
NETHERLANDS	28.5%	52.3%	7.6%	11.6%
WEST GERMANY	28.2%	45.7%	12.5%	13.6%
ITALY	30.0%	39.3%	16.2%	14.5%
LUXEMBOURG	35.0%	48.5%	9.9%	6.7%
DENMARK	18.6%	63.3%	4.9%	13.3%
IRELAND	34.5%	38.6%	13.6%	13.4%
UNITED KINGDOM	29.6%	49.3%	10.6%	10.5%
GREECE	40.3%	34.3%	14.7%	10.6%
SPAIN	36.6%	36.0%	15.4%	12.0%
PORTUGAL	40.4%	30.7%	17.4%	11.5%
Total	**31.3%**	**45.8%**	**11.6%**	**11.3%**

4. A typology of perceived competence of science

One further step of analysis is to construct a typology of attitudes arising from these two areas of scientific competence, resources and playing a remediation role. Taking both items as binary and combining them, the following 2x2 typology arises:

1. No resource – no role: science is not relevant neither for resource management nor saving the environment (31.3%)
2. No resource – yes role: science is irrelevant for resources management, but useful to repair the environment (45.8%)
3. Yes resource – no role: science is important for resource management, but not for saving the environment (11.6%)
4. Yes resource – yes role: science is important for both resource management and saving and repairing the environment (11.3%)

Figure 4 shows the distribution of synthetic attitudes across Europe. Portugal has the highest incident of No/no attitudes (40%), and Denmark the lowest (19%). The resource no/role yes attitude ranges from 31% in Portugal to 63% in Denmark. The resource yes/ remediation no attitude occurs 5% in Denmark and 16% in Italy; the yes/yes combination 7% in Luxembourg and France, and 15% in Italy.

One question to be addressed with this typology is the relation between attributing competences to science and people's religious orientation. Again the survey base is not very rich on people's religious outlooks. We use a proxy. The survey included the item that states: '*we depend too much on science and not enough on faith*' (agree/disagree). We assume that religious people are more likely to agree with this statement and non-religious respondents to disagree, and some will have no clear position on religion here. Our index has three values: 3 means that people consider themselves religious, 2 means they are not clear on this, and 1 means that people are non-religious, rejecting the idea that we should rely on religion rather than science.

We expect that for religious people the problem of the environment is more a problem of personal change, rather than a competence of science. Religion is traditionally concerned with creating a personal disposition to change, thus religious orientation might be factor in people's attitudes. Rather than expecting science to preserve our way of life, people consider the need to change their own life to achieve a sustainable future. Now changing one's life is a classical topic of religion, independent of creed (see Taylor, 2007).

Figure 5: correspondence graphic for religious position and type of attitude (SPSS Correspondence analysis: D1=78%; D2=22%; 1= not religious, 2= uncertain, 3= religious)

.

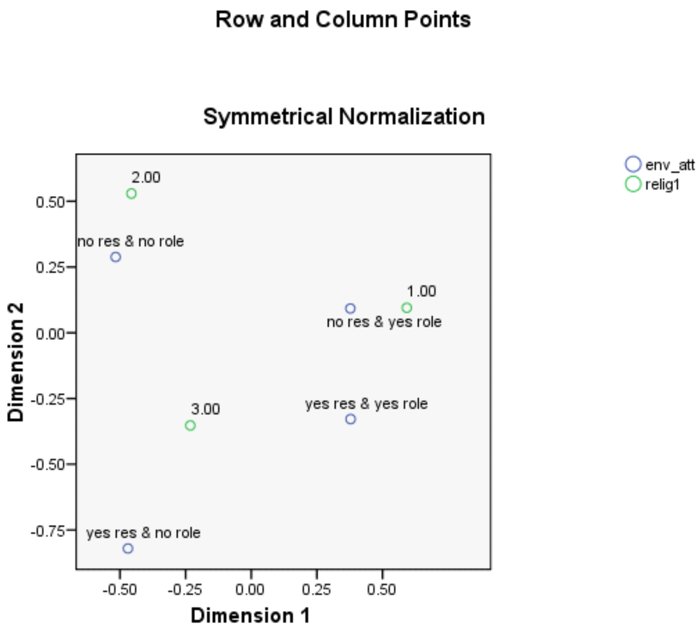


Figure 5 shows a correspondence graphic depicting the associations between the types of attitudes and religious dispositions across Europe (SPSS standard correspondence model; see appendix for cross-tabulation). We find that the non-religious respondents do less expect science to stem the limits of growth, but see a role in remediation (no/yes attitude). People who attribute the dual competence to science are also more likely to be non-religious. People with an uncertain religious positioning are most likely to deny both types of competences to science. While those who declare themselves religious are most likely to expect science to stem the limits of growth, but see less of a role for remediation (yes/no attitude). 'You have to change your life to save the world' might be the religious view on the world's ecological problems. Religious people do not expect much from science, at most to stretch the resources. However, this is a tentative interpretation of the results in need of further confirmations.

5. Conclusion

The relationship between public understanding of science and environmental attitudes is a pertinent question. From the point of view of PUS research this maps into the discussion over general versus specific indicators, and the added value of general in understanding specific issues. PUS researchers defend the position that you should dispense of general indicators because they represent the reputation of the scientific institution that is relative independent of specific issues. The equivalent in the field of politics is the evaluation of political institutions compared to the evaluation of specific policies. People support democracy, but not all the

policies. The reputation of the institution carries potential for actions that are otherwise controversial. Hence, both aspects need to be assessed separately.

The present paper studies the relation of general and specific indicators in several surveys which have been undertaken since the 1980s across EU countries. These studies include two relevant specific indicators: the attribution of competence to science a) to manage resources that stem the limits of growth and b) to play a role in protecting and remediating the environment. These attitudes show different patterns of consent across countries, age groups, gender, level of education, and in relation to scientific literacy, general expectations of science to improve our lives, and interest in scientific discoveries. To be scientifically literate also means to recognise the irrelevance of science with regard to the limits of growth and to assign a protective role for science to play. This pattern of attitudes is more prevalent in the core regions than in the peripheral regions of Europe. Literacy, attitudes and interest in science plays a role for environmental attitudes. In our model, around two third of the variance of attributed competence to science is due to science culture express in literacy, interest and attitudes.

Beyond the influence of science culture, women expect generally less from science than men everything else being equal. Furthermore, religious orientations go together with the rejection of a role for science in protecting nature, but with an expectation to stem the limits of growth. This suggests that we might pay more attention to religious orientations as a determinant of environmental attitudes beyond science literacy. The religiously minded reject the scientific competence, which suggests a different solution. The solution of the problem of global warming might lie in personal change. Instead of expecting others, i.e. science & technology, to save the world, the burden is on everybody’s personal life. For religious people internal attribution might prevail over external attribution. This disposition deserves further exploration. As the environmental problem is unlikely one with a techno-scientific fix, dispositions to personal change are an important part of the solution. We must recognise that life style changes are less a matter of scientific culture - literacy, interests and high expectations of science - but rest in other culture resources, not least in those arising from religious traditions and practices.

Appendix: The survey questionnaire items

Eurobarometer 38.1 of **November 1992** and 63.1 of **January/February2005** is a multi-stage sample survey of the population aged 15+ in EU countries. The Sample size is n=1000 in each country, except Luxemburg = 300 (see Bauer, Shukla and Kakar, 2008)

Knowledge scale (K13; true, false, DK)

- The centre of the Earth is very hot. **(k_earth)**
- The oxygen we breathe comes from plants. **(k_oxygen)**
- Radioactive milk can be made safe by boiling it **(k_milk)**
- Electrons are smaller than atoms. **(k_electron)**
- The continents on which we live have been moving their location for million of years and will continue to move in the future. **(k_continents)**
- It is the father's gene which decides whether the baby is a boy or a girl **(k_gene)**
- The earliest humans lived at the same time as the dinosaurs**(k_dinosaurs)**
- Antibiotics kill viruses as well as bacteria. **(k_antibiotics)**
- Lasers work by focusing sound waves **(k_lasers)**
- All radioactivity is man-made **(k_radioactivity)**
- Human beings, as we know them today, developed from earlier species of animals. **(k_human)**
- The sun goes around the earth. **(k_sun)**
- How long does it take for the earth to go around the sun? **(k_time)**

Interest in science

Let us talk now about those issues in the news which interest you. Please tell me if you are very interested, moderately interested, or not at all interested in:

- Scientific discoveries

General Attitude: positive expectation of science (att1: 1=agree, 5=disagree, 9=DK)

- 'science and technology are making our lives healthier, easier and more comfortable'. (Att1: pos att = agree)

Proxy measure of religiosity (relig1)

- 'we depend too much on science and not enough on faith' (agree=religious, disagree=non-relgious, DK and NN = uncertain)

Environmental attitude: environmental competence of science (att2, att4)

‘Thanks to scientific and technological advances, the **earth’s resources** will be inexhaustible’ (att2; pos att = agree)

		resources inexhaustible					Total
		-2.00	-1.00	.00	1.00	2.00	-2.00
YEAR AND ROUND NUMBER	1992	32.8%	25.4%	18.5%	17.5%	5.8%	100.0%
	2005	27.1%	27.2%	23.7%	15.9%	6.2%	100.0%
Total		30.9%	26.0%	20.2%	17.0%	5.9%	100.0%

Att2: Chi-sq = 108, no=17980, $p < 0.001$

‘Science and technological research cannot **play an important role** in protecting the environment and repairing it’ (att4; pos att = disagree).

		role to play					Total
		-2.00	-1.00	.00	1.00	2.00	
YEAR AND ROUND NUMBER	1992 (38.1)	7.7%	17.2%	15.4%	25.0%	34.8%	100.0%
	2005 (63.1)	7.3%	19.6%	21.1%	30.7%	21.3%	100.0%
Total		7.5%	18.0%	17.3%	26.9%	30.3%	100.0%

Att4: Chi-sq = 380, n=17980, $p < 0.001$

	N	Minimum	Maximum	Mean	Std. Deviation
resources inexhaustible	17980	-2.00	2.00	-.5885	1.24715
role to play	17980	-2.00	2.00	.5433	1.29096

Att2: Science makes resources inexhaustible (binary variable 0[-2, -1, 0] / 1[+1, +2]

Att 2		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	13858	57.8	77.1	77.1
	1.00	4122	17.2	22.9	100.0

Att4: Science has a role to play ……. (binary variable 0[-2,-1, 0] / 1[+1, +2]

Att4		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	7703	32.1	42.8	42.8
	1.00	10277	42.9	57.2	100.0

Socio-demographic variables

Sex (1=male); education includes primary, secondary and tertiary level

Age cohorts

Age cohorts are constructed by recoding of the age variable in each of the four surveys, so that each survey contributes those respondents born in a particular historical period. Because these cohorts are constructed ex-post, and not observed repeatedly, strictly speaking, we are dealing with quasi-cohorts or synthetic age cohorts. Respondents are categories according to the following criteria

New Order, born **since 1977**: this is the youngest cohort of respondents, growing up after the end of the Cold War and waking up to the rhetoric of the 'new world order' and the final victory of the capitalists style of economy, and getting their education within the rhetoric of IT and biotech 'revolutions' of the late 20th century. This is the generation of the PC and internet euphoria of 1995-2002.

Generation X is the generation born between **1963 and 1976**. They are the outcome of the birth control 'revolution' and grow up through the oil crisis of the 1970s, and the nuclear issues of the 1980s, the anti-nuclear protest, nuclear armament debates and the Star Wars initiative.

Baby boomers are born between **1950 and 1962**. They grow up during the optimism and modernisation drive of the post-war period. They witness one of the longest period of economic prosperity in history between 1945 and 1970. During this period Western societies becomes 'affluent' and free of material concerns. This generation is the protest generation of the 1970s, adhere to idealistic aspirations, are the main carriers of post-material values. They develop scepticism with regard to notions of 'Progress' and its link with science and technology.

War & crisis were born between **1930 and 1949**. This generation witnessed WW2 and the formed the immediate after-war generation entering the Cold War. This generation carried the 'nuclear enthusiasm' of the 1950, which promised a scientific revolution and 'energy too cheap to meter' in the atomic society. They carry the material aspirations of post-war modernisation in Europe.

The roaring 20s, finally is the generation born **before 1930**, growing up through the buzzing period of the 1920s or the crash of 1929 and the economic crisis that followed; they experienced fully the upheavals of fascism leading into WWII. Some of them carry memories to two world wars.

env_att * relig1 Crosstabulation

			relig1			
			1.00	2.00	3.00	Total
env_att	no res & no role	Count	1390	1762	2468	5620
		Expected Count	1927.0	1269.3	2423.7	5620.0
		% within env_att	24.7%	31.4%	43.9%	100.0%
		% within relig1	22.5%	43.4%	31.8%	31.3%
		Std. Residual	-12.2	13.8	.9	
		Adjusted Residual	-18.2	19.0	1.4	
	no res & yes role	Count	3481	1631	3126	8238
		Expected Count	2824.7	1860.7	3552.7	8238.0
		% within env_att	42.3%	19.8%	37.9%	100.0%
		% within relig1	56.5%	40.2%	40.3%	45.8%
		Std. Residual	12.3	-5.3	-7.2	
		Adjusted Residual	20.7	-8.2	-12.9	
	yes res & no role	Count	460	367	1256	2083
		Expected Count	714.2	470.5	898.3	2083.0
		% within env_att	22.1%	17.6%	60.3%	100.0%
		% within relig1	7.5%	9.0%	16.2%	11.6%
		Std. Residual	-9.5	-4.8	11.9	
		Adjusted Residual	-12.5	-5.8	16.8	
	yes res & yes role	Count	834	301	904	2039
		Expected Count	699.1	460.5	879.3	2039.0
		% within env_att	40.9%	14.8%	44.3%	100.0%
		% within relig1	13.5%	7.4%	11.7%	11.3%
		Std. Residual	5.1	-7.4	.8	
		Adjusted Residual	6.7	-9.0	1.2	
Total		Count	6165	4061	7754	17980
		Expected Count	6165.0	4061.0	7754.0	17980.0
		% within env_att	34.3%	22.6%	43.1%	100.0%
		% within relig1	100.0%	100.0%	100.0%	100.0%

References

Arcury TA and EH Christianson (1990) Environmental world view in response to environmental problems: Kentucky 1984 and 1988 compared, Environmental Behaviour, 22, 387-407.

Bauer MW (2009) The evolution of public understanding of science – discourse and comparative evidence, Science, Technology and Society, 14, 2, 221-240.

Bauer MW, R Shukla, and P Kakkar (2008) The Integrated Data on Public Understanding of Science [EB_PUS_1989-2005], Codebook and Unweighted Frequency Distributions (prefinal version), London, LSE

Bauer, .M.W., Allum, N., Miller, S. (2007) What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda, Public Understanding of Science 16: 79-95.

Bauer M, J Durant and G Evans (1994) European public perceptions of science, International Journal of Public Opinion Research, 6, 2, 163-186

Blaikie WH (1992) The nature and origins of ecological world views: an Australian study, Social Science Quaterly, 73, 144-165.

Bogner FX & M Wiseman (2002) Environmental perception: factor profiles of extreme groups, European Psychologist, 7, 225-237.

Dunlap RE, KD vanLiere, AG Mertig, RE Jones (2000) Measuring endorsement of the New Econological Paradigm: a revised NEP scale, Journal of Social Issues, 56, 425-442.

Easton D (1976) A Re-Assessment of the Concept of Political Support, British Journal of Political Science, Vol. 5, No. 4 (Oct., 1975), pp. 435-457

Fransson N and T Garling (1999) Environmental concern: conceptual definition, measurement methods, and research findings, Journal of Environmental Psychology, 19, 369-82.

Gobb A (1995) A structural model of environmental attitudes and behaviour, J env Psych, 15, 209-20.

Maloney MP & MP Ward (1975) Psychology in action: a revised scale for the measurement of ecological attitudes and knowledge, Amer Psychologist, July, 787-790.

Milfont TL and L Duckitt (2004) The structure of environmental attitudes, J Env Psych, 24, 289-303.

Pittock AB (2009) Climate change – the science, impacts and solutions, Oxford, CIRSO Publishing.

Schultz PW (2001) The structure of environmental concern: concern for self, other people and the biosphere, J Envirn Psych, 21, 327-339.

Taylor Ch (2007) A secular age, Cambridge MA, Belknap Press

Thompson SCG and MA Barton (1994) Ecocentric and anthropocentric attitudes towards the environment, J Env Psych, 14, 149-57.