

8. Survey Results in “Environment”

8.1. Trends in areas of attention

With the United Nations Framework Convention on Climate Change (FCCC), which was signed in 1992, as the catalyst, international consensus for global environmental problems has been established, and we are at the stage where serious efforts must be made to find a solution. Global-scale climate change has been dubbed the ultimate environmental problem because of the extreme difficulty in addressing it. Although discussions have so far been focusing on the stabilization of greenhouse gas emissions in the year 2000, which is a relatively short-term target, the achievement of the ultimate goal of the FCCC would require long-term targets as well. Namely, rather than merely stabilizing emissions, there is a need to go a step further and actually reduce them, and this highlights the inadequacy of Band-Aid measures. Indeed, with the Third Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3) scheduled to be held in Japan in 1997, awareness of global environmental problems has been steadily increasing.

In the latest survey, there were 39 questions, which were roughly divided into two groups: global environment and local environment. Of the 10 topics ranked high in terms of the degree of importance index, six were from the global environment area, and this should be interpreted as an expression of the view that, to conserve the global environment, effective global environmental conservation measures should be given priority. However, the global environment is far more complex an issue than conventional local industrial pollution. Notably, the “waste” area accounted for as many as two topics. For these problems, there are no simple solutions. Rather, they require complete rethinking in terms of urban structure and product design concepts.

By purpose, nine out of the 10 topics regarded most important were in the “countermeasures, control and management” category, and this points to a shift in people’s perspective from the traditional heavy emphasis on the “prediction/elucidation of phenomena and impacts” to greater importance attached to environmental management techniques and prevention/control measures.

Global environmental problems have also reached the stage where the “think globally and act locally” approach, which has become a favorite catchword in recent years, must be put into practice. As areas of attention regarding the latest survey, we have chosen the (1) introduction of design technologies for the realization of a recycling society (LCA) and (2) establishment of environmental management techniques, and will discuss their trends below:

8.1.1. Introduction of design technologies for the realization of a recycling society (LCA)

Any realistic and meaningful investigation into a social system that gives the environment priority must address city concepts and corporate philosophy as well. At the city level, it is, as a matter of course, desirable to minimize energy or resource input. While demand reduction through demand side management (DSM) is a prerequisite, the ultimate goal for future cities should be to build energy/resource recycling societies based on the idea of environmental load reduction.

The hitherto-prevalent people’s propensity to mass energy consumption and environmental problems are consequences of a rapid expansion of a “one-way-traffic” society based on the mass production, consumption and disposal of energy and resources, and the findings of the latest survey are testimony to the importance of a switch to an energy/resource recycling society structure as soon as possible.

There are basic models in realizing an energy/resource recycling society. The ultimate type is a zero-emission society, which requires a city structure that allows the concentration of companies that form the core of an industrial food chain amenable to the total “digestion” of input (no waste) or total reuse of byproduct output (waste) as an input (raw material). In this regard, it is interesting to note that topics relating to technologies that bring existing cities closer to the zero-emission level, such as RDF-based wide-area waste power generation and biotechnology-based wastewater treatment systems were considered important. Namely, while technological development tended to focus on the “arterial side” in the past, the perspective is shifting to

the development of “veinal side” technologies from the environmental load reduction point of view.

For the large-scale implementation of global-scale environmental measures, the establishment of assessment techniques for increasingly diverse technologies will be indispensable. In doing so, life cycle assessment (LCA) involving energy requirements and environmental impacts will be effective, apart from economic merits. From this viewpoint, the introduction of an LCA approach geared towards recycling and reuse will be a crucial element of product design that gives priority to the environment. In the past, the concept of manufacturing was to produce brand-new goods at factories by pouring in raw materials. However, as recycling-oriented societies take off, manufacturing will have to be redefined as a closed-loop process in which byproduct output (waste) is fed back to the same subprocess or reused as the input (raw material) to another subprocess to ensure sustainable corporate activities. This gives rise to the concept of “a reverse factory”. It is interesting to note that, of all the topics, the one that was ranked highest in terms of the degree of importance index was “32: Wide acceptance of LCA-style product design concepts that encourage recycling and reuse”, with its realization time forecasted to be 2007.

8.1.2. Establishment of environmental management techniques

Against the background of the above is the effectuation of the ISO 14000 series of environmental management and auditing system standards, which began in 1996. The foreword of ISO 14001 states that an environmental management system is a tool devised in search of compatibility between the environment and the economy. The introduction of an LCA approach is essential for the development of a sustainable society, and this is becoming a basic condition for international competition.

This means that 21st century-style production and manufacturing processes represent an all-out change, and we are now at a new stage of industrial development not seen since the Industrial Revolution. Namely, it is very important to scrutinize industrial processes associated with high environmental loads and establish thorough environmental management techniques, such as process rationalization, from an LCA viewpoint.

According to the results of the latest survey, a new perspective is needed, if an environment-conserving economy and society are to be realized. In this regard, in addition to the participation of the general public through lifestyle changes etc., the participation of businesses as powerful members of society is very important, and their role crucial. Ultimately, it is important to facilitate the transition to an environment-conserving society by making the best use of the vitality of the private sector, and, to this end, the implementation of measures based on the following three basic policies is considered effective: i) active utilization of the market mechanism premised on the internationalization of environmental costs; ii) setting of clear goals for future social and technological environmental management; iii) active inducement of continued investment into the future.

The most important thing about conducting corporate activities in a sustainable manner in the future is thorough environmental management shown in ii) above, and, as a noteworthy recent trend, the importance of the introduction of product design concepts with an LCA perspective has been recognized, according to the results of the latest survey.

(Takao Kashiwagi)

8.2. Forecast topic framework

In the course of compiling forecast topics, a framework representing the organization of technologies in tabulated matrix form was drawn up for each field, with objectives and technological domains defining the rows and columns of the table, respectively. The framework is designed to present an overall picture of technological development in each field in terms of future prospects, importance, etc. as seen from the present perspective, and is also used as a working framework for future reviews of forecast topics.

Table 8.2-1 Forecast Topic Framework for Environment Field

Domain Objective	Global environment						
	Depletion of ozone layer	Global warming	Acid rain	Marine pollution	Diminishment of tropical rainforests	Desertification	Common
Elucidation, prediction and observation of phenomena	01 02	05 06	12	14			22
Elucidation, prediction and observation of impacts	03	07 08	13	15	17 18	20	
Prevention, control and management	04	09 10 11		16	19	21	23

* Figures appearing in the table represent topic numbers.

Domain Objective	Local environment					
	Air quality	Water quality	Noise/vibration	Waste	Nature/ecosystems	Cross-sectional
Elucidation, prediction and observation of phenomena		25				35
Elucidation, prediction and observation of impacts						36
Prevention, control and management	24	26 27 28	29	30 31 32 33	34	37 38 39

* Figures appearing in the table represent topic numbers.

8.3. Topics with high degree of importance

Degree of importance index scores (Note 1) averaged at 72.0 for topics in the environment field as a whole. Topics considered of particular importance to Japan (top 20 topics in terms of degree of importance index score) are listed in the table below. 32. Wide acceptance of LCA-style product design concepts that encourage recycling and reuse was rated most important (91 points), while 18. Elucidation of the impact of diminishing tropical rain forests on wildlife ecosystems was rated least important (49 points).

Table 8.3-1 Top 20 Topics in Terms of Degree of Importance Index

Topic	Degree of importance index	Forecasted realization time (year)
32 <u>Wide acceptance</u> of LCA-style product design concepts that encourage recycling and reuse.	91	2007
24 <u>Widespread use</u> of control technologies in <u>virtually all</u> types of automobiles, capable of meeting the emission control standard for nitric oxide at the order of <u>0.1 to 0.2 g/Km</u> . (The current level for heavy diesel motorcars is on the order of 4 to 5 g/Km, and the standard control value for gasoline passenger cars in 1978 is 0.25 g/Km.)	89	2007
34 Establishment of assessing socio-economic damage/loss because of the destruction of natural environment by soil contamination and land subsidence (e.g., loss of natural beaches, forests, or fields) and <u>incorporation</u> of its countermeasures in regulatory system.	87	2012
38 <u>Widespread use more than 10% in the world</u> of automobiles as urban transportation system (electric vehicles) which do or noise pollution. not cause air	86	2013
23 <u>Introduction</u> of environment tax aiming at global environmental conservation.	85	2006

Topic	Degree of importance index	Forecasted realization time (year)
08 <u>Determination and general understanding</u> of the impact of global warming on world agricultural production.	84	2012
31 <u>Widespread use</u> of power generation using refuse derived fuel (RDF).	82	2006
04 <u>Practical use</u> of materials that replace fluorocarbons and halons, that do not damage the ozone layer and cause global warming problem.	82	2007
27 <u>Widespread use</u> , including use at home, of compact waste-water treatment systems based on biotechnology for <u>the highly efficient treatment</u> of persistent substances and hazardous materials.	82	2010
09 <u>Reduction</u> of global carbon dioxide emissions to <u>20% below</u> the 1990 level.	81	2022
25 Progress of investigation of mechanisms for both concentration of heavy metals and other pollutants in ecosystems and occurrence of eutrophication, and <u>realization of prediction and forecasting</u> of the impact of water pollution in closed water bodies, such as lakes and semi-closed bays, on their ecosystems.	81	2010
35 <u>Elucidation</u> of a <u>long-term</u> exposure effects of quantities of most of the harmful chemical substances in ordinary environment, on human beings.	80	2016
12 <u>Elucidation</u> of the worldwide long-distance migration mechanisms of acid-rain-causing substances, such as SO _x and NO _x , considering regional characteristics.	79	2010
36 <u>Establishment</u> of a technique to predict the fate of newly discovered chemical substances through the accumulation of knowledge on matters such as the behavior of persistent chemical substances in the environment.	79	2015
26 <u>Widespread use</u> of formulation methods for water environment plan based on quantitative understanding of natural purification functions of paddy fields, reservoirs, rivers, water channels and water permeating into the ground.	79	2010
15 <u>Elucidation</u> of impacts exerted by marine pollutants upon marine ecosystem.	79	2016
30 <u>Widespread use</u> of biodegradable plastics that can be fully decomposed by anaerobic microorganisms as a means of properly handling containers and packaging materials with short intended service lives.	78	2009
29 Development of low-noise engines and tires, and sound-absorbing construction materials, leading to the reduction of automobile noise <u>within the environmental standard</u> for <u>the area specified to be for resident</u> .	76	2011
13 <u>Elucidation</u> of the mechanism of the impact caused by acid rain to animals and plants.	76	2009
22 Generalization of <u>global-scale</u> monitoring of various factors causing air and water pollution and other forms of pollution, and <u>realization</u> of a system for centralizing all environmental information.	75	2013

Note 1: Degree of importance index = (number of "high" responses × 100 + number of "medium" responses × 50 + number of "low" responses × 25 + number of "unnecessary" responses × 0) ÷ total number of degree of importance responses

8.4. Forecasted realization times

Forecasted realization times were distributed as shown in the diagram below. About 90% of the topics saw their forecasted realization times concentrated in the 2006 - 2015 range, and the overall distribution was similar to the general trend covering all topics.

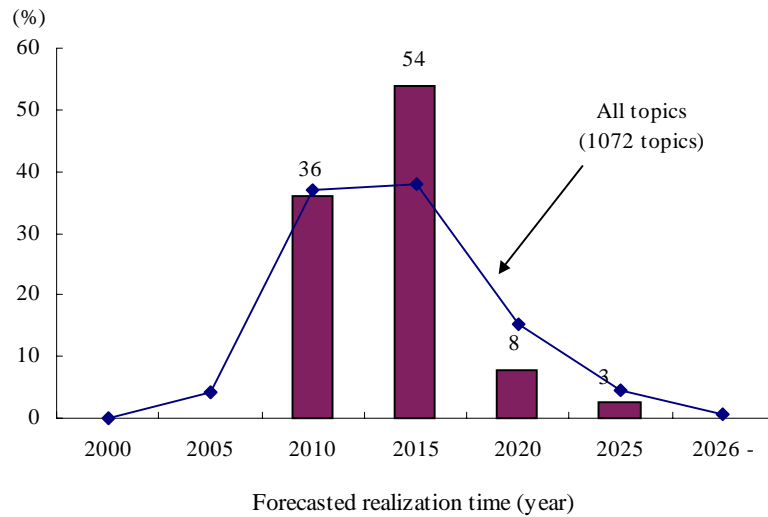


Fig. 8.4-1 Trends in Forecasted Realization Times

8.5. Current leading countries etc.

Responses to the question concerning current leading countries etc. were as shown in the diagram below. For almost all topics, the U.S. was named by the greatest number of respondents, followed by Japan and the EU with similar scores. The rating of the former Soviet Union/Eastern Europe was extremely low.

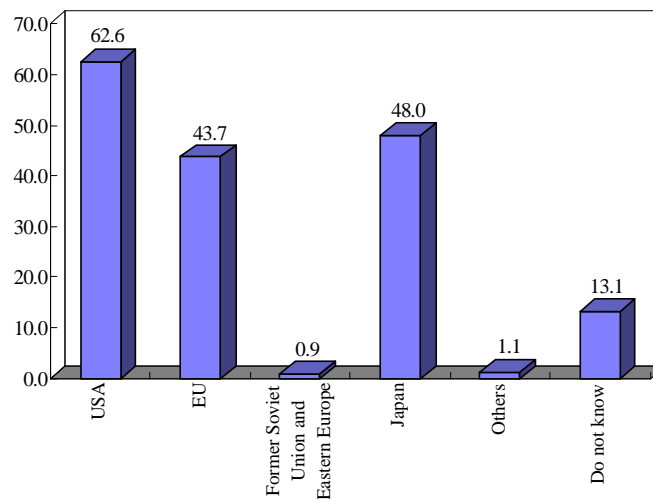


Fig. 8.5-1 Current Leading Countries etc. (%)

8.6. Comparison with the 5th Survey (previous survey)

Of the 39 topics included in the latest survey, 23 (59%) were identical to the previous survey, 9 (23%) were modified, and 7 (18%) were newly introduced. For identical topics, the results of the latest survey were compared with those of the previous survey in terms of degree of importance index scores and forecasted realization times, as shown in the table below.

Degree of importance index scores rose for 5 topics, fell for 17 topics and remained the same for 1 topic. 29. Reduction of automobile noise to satisfy environmental quality standards in Japanese urban areas designated as exclusively residential saw the greatest jump, up 15 points, while 20. Elucidation of impact of desertification on climate and weather saw the greatest drop, down 28 points.

From the 4th to the 5th Survey, forecasted realization times were pushed back for all topics. Likewise, from the 5th to the 6th Survey, forecasted realization times were pushed back for all topics, with 37. Application of useful organisms created through gene manipulation etc. in environmental clean-up having its forecasted realization time pushed back most (10 years).

Table 8.6-1 Comparison with 5th Survey for Identical Topics

Topic	Degree of importance index / forecasted realization time	
	6th survey	5th survey
01 <u>Completion</u> of high-accuracy, high-density observation system capable of determining global trends in the change of stratosphere ozone for each altitude.	57/2010	68/2002
02 <u>Quantitative grasp</u> of effect of fluorocarbon and the like on change in the ozone layer.	60/2008	77/1999
04 <u>Practical use</u> of materials that replace fluorocarbons and halons, that do not damage the ozone layer and cause global warming problem.	82/2007	91/1998
06 <u>Availability</u> of accurate forecasting the extent of climate change to a 50 Km-mesh square level throughout the world.	63/2011	73/2008
08 <u>Determination and general understanding</u> of the impact of global warming on world agricultural production.	83/2012	91/2004
09 <u>Reduction</u> of global carbon dioxide emissions to <u>20% below</u> the 1990 level.	81/2022	91/2015
12 <u>Elucidation</u> of the worldwide long-distance migration mechanisms of acid-rain-causing substances, such as SO _x and NO _x , considering regional characteristics.	79/2010	79/2001
13 <u>Elucidation</u> of the mechanism of the impact caused by acid rain to animals and plants.	76/2009	82/2001
14 <u>Completion</u> of global automatic and remote sensing networks for monitoring marine pollution and marine ecosystem.	67/2015	73/2009
15 <u>Elucidation</u> of impacts exerted by marine pollutants upon marine ecosystem.	79/2016	76/2009
16 <u>Practical use</u> of effective technologies for restoring ocean areas contaminated by tanker accidents, etc. (e.g., oil pollution control technologies utilizing marine microorganisms).	72/2011	73/2004
17 <u>Elucidation</u> of impacts of destruction of tropical forests upon climate and weather.	58/2012	80/2004
18 <u>Elucidation</u> of the impact of diminishing tropical rain forests on wildlife ecosystems.	49/2014	71/2009
19 <u>Development</u> of a technology effective for regenerating damaged tropical rain forest ecosystems.	61/2014	85/2007
20 <u>Elucidation</u> of effect of desertation on climate and water.	51/2013	79/2005
22 Generalization of <u>global-scale</u> monitoring of various factors causing air and water pollution and other forms of pollution, and <u>realization</u> of a system for centralizing all environmental information.	75/2013	77/2006
24 <u>Widespread use</u> of control technologies in <u>virtually all</u> types of automobiles, capable of meeting the emission control standard for nitric oxide at the order of <u>0.1 to 0.2 g/Km</u> . (The current level for heavy diesel motorcars is on the order of 4 to 5 g/Km, and the standard control value for gasoline passenger cars in 1978 is 0.25 g/Km.)	89/2007	90/2003

Topic	Degree of importance index / forecasted realization time	
	6th survey	5th survey
29 Development of low-noise engines and tires, and sound-absorbing construction materials, leading to the reduction of automobile noise <u>within the environmental standard for the area specified to be for resident.</u>	76/2011	61/2006
33 <u>Widespread use</u> of household trash cans which are capable of automatically classifying <u>whatever wastes</u> are thrown into them and also easy to move.	58/2012	61/2005
34 Establishment of assessing socio-economic damage/loss because of the destruction of natural environment by soil contamination and land subsidence (e.g., loss of natural beaches, forests, or fields) and <u>incorporation</u> of its countermeasures in regulatory system.	87/2012	80/2005
35 <u>Elucidation</u> of a <u>long-term</u> exposure effects of quantities of most of the harmful chemical substances in ordinary environment, on human beings.	80/2016	81/2009
37 Establishment of assessment and safeguarding standards for <u>the utilization</u> of useful organisms created through gene manipulation etc. <u>in open system environments, leading to their application</u> in environmental clean-up.	61/2016	53/2006
38 <u>Widespread use more than 10% in the world</u> of automobiles as urban transportation system (e.g., electric vehicles) which do not cause air or noise pollution.	86/2013	81/2006

Note: Up until the 5th Survey, realization meant realization in Japan unless otherwise specified. However, this was changed to mean realization somewhere in the world in the 6th Survey. Therefore, care should be taken when comparing forecasted realization times from the two surveys.

Division	Topic serial No.	Topic	Questionnaire round	Number of respondents	Degree of expertise (%)			Importance (index, %)				Expected effect (%)			Forecasted realization time						Leading countries (%)						Measures the government should adopt (%)						Potential problems (%)			
					High	Medium	Low	Index	High	Medium	Low	Unnecessary	Socioeconomic development	Resolution of global problems	People's needs	Expansion of intellectual resources	Will not be realized (%)	Do not know (%)	USA	EU	Former Soviet Union and Eastern Europe	Japan	Other countries	Do not know	Foster human resources	Promote exchanges among industrial, academic and government sectors and different fields	Upgrade advanced facilities and equipment	Develop a research base	Increase government research funding	Adjust regulations (relax/toughen)	Others	Adverse effect on the natural environment	Adverse effect on safety	Adverse effect on morals, culture or society	Other adverse effects	
																																				2001
Depletion of ozone layer	1	Completion of high-accuracy, high-density observation system capable of determining global trends in the change of stratosphere ozone for each altitude.	1	190	6	26	68	58	24	58	17	0	13	83	20	21		3	9	75	34	0	25	2	17	61	32	36	11	57	6	2	41	5	8	1
			2	169	5	21	73	57	20	67	13	0	7	92	14	14		2	6	82	31	0	25	1	11	63	27	35	8	66	4	1	47	5	5	1
			X	9	100	0	0	67	33	67	0	0	22	89	11	11		0	0	100	11	0	11	0	0	56	22	33	0	67	11	0	67	0	0	0
	2	Quantitative grasp of effect of fluorocarbon and the like on change in the ozone layer.	1	213	7	22	72	62	33	51	15	0	15	87	21	16		2	5	73	35	1	28	0	16	68	32	30	8	58	5	1	38	6	8	2
			2	185	6	19	75	60	25	62	12	0	7	95	16	12		2	4	78	34	1	24	0	13	70	28	26	6	64	3	0	45	6	3	1
			X	12	100	0	0	67	42	42	17	0	8	92	0	17		0	0	92	33	0	25	0	0	67	33	42	0	67	0	0	58	0	8	0
	3	Elucidation of the impact of increased UV radiation as a result of depletion of the ozone layer on humans as well as plants and animals, including its interaction with other environmental impact factors and accumulated exposure effect.	1	220	5	21	73	63	33	53	14	0	11	73	51	18		4	5	64	43	0	21	4	23	65	36	25	19	55	3	1	38	9	11	2
			2	196	4	19	77	61	28	59	13	0	8	81	49	12		3	5	71	45	1	20	3	17	68	35	23	15	61	1	0	40	8	7	1
			X	8	100	0	0	81	63	38	0	0	13	75	25	25		0	0	88	38	0	25	13	0	50	63	38	25	25	0	0	63	0	25	0
	4	Practical use of materials that replace fluorocarbons and halons, that do not damage the ozone layer and cause global warming problem.	1	217	6	22	71	79	60	36	3	1	62	84	26	7		1	4	71	35	1	56	0	15	45	56	26	4	49	25	2	47	9	9	4
			2	190	4	21	75	82	66	30	3	1	57	88	19	3		1	2	77	31	0	62	0	11	42	64	20	2	53	25	1	56	8	6	2
			X	8	100	0	0	94	88	13	0	0	75	100	13	13		0	0	88	38	0	50	0	0	50	88	13	0	50	38	0	75	0	0	0
Global warming	5	Elucidation of the accurate mechanism of carbon dioxide generation and absorption.	1	287	12	35	53	72	49	41	9	1	20	91	8	36		5	6	73	44	0	42	0	15	68	31	32	14	57	5	2	40	5	12	2
			2	244	9	37	54	72	47	46	6	0	16	92	3	28		3	3	81	43	1	44	0	9	75	25	28	10	66	4	1	41	2	8	2
			X	22	100	0	0	81	62	38	0	0	9	100	9	9		0	5	91	41	0	55	0	0	59	45	27	5	50	5	0	36	0	9	5
	6	Availability of accurate forecasting the extent of climate change to a 50 Km-mesh square level throughout the world.	1	205	6	26	68	67	40	47	12	1	27	82	33	25		12	3	79	35	3	41	0	14	60	26	34	19	53	2	4	36	14	11	2
			2	177	4	27	69	63	32	57	10	1	16	88	25	18		10	2	82	30	2	42	0	11	66	19	35	17	57	2	2	41	9	8	1
			X	7	100	0	0	82	71	14	14	0	14	86	29	0		0	0	86	86	14	71	0	0	71	29	29	29	57	0	0	43	29	0	0
	7	Elucidation of the impact of global warming on forests and other natural vegetation quantitatively on a global scale.	1	270	8	32	60	72	50	41	8	1	24	93	14	24		9	7	64	46	3	25	0	22	66	33	25	23	53	4	2	41	6	12	1
			2	232	6	29	65	74	52	42	6	0	19	95	5	17		8	3	72	50	0	25	0	16	72	31	22	20	60	3	0	42	4	11	0
			X	14	100	0	0	89	79	21	0	0	7	100	7	7		0	0	93	71	0	64	0	0	86	29	36	36	57	7	0	50	0	7	0
	8	Determination and general understanding of the impact of global warming on world agricultural production.	1	245	4	32	64	78	59	35	6	0	40	90	16	11		6	7	71	40	6	28	0	20	60	39	22	27	49	5	2	41	7	18	2
			2	223	2	27	71	83	69	27	4	0	35	88	9	6		3	5	78	43	6	30	0	15	67	38	16	23	52	5	2	43	4	16	0
			X	4	100	0	0	100	100	0	0	0	50	75	0	0		0	0	100	75	25	75	0	0	50	50	50	50	50	0	0	75	0	0	0
9	Reduction of global carbon dioxide emissions to 20% below the 1990 level.	1	267	13	31	55	77	59	33	7	1	39	90	17	11		34	12	41	49	1	56	0	16	43	41	19	9	42	42	4	40	6	22	1	
		2	230	8	33	59	81	65	30	4	1	30	92	11	5		32	6	45	54	1	67	0	10	44	40	15	7	46	47	3	45	4	20	0	
		X	19	100	0	0	87	79	16	0	5	32	95	5	5		32	5	47	74	5	84	5	0	26	37	0	5	37	42	11	42	5	11	0	
10	Development of storage methods of carbon dioxide at deep sea levels of more than 3,000 m below surface.	1	234	8	29	64	53	28	40	22	10	28	85	3	16		18	12	41	17	0	50	1	28	38	40	21	4	47	14	6	70	9	5	2	
		2	199	7	27	66	56	29	45	20	7	25	85	3	11		19	6	44	16	0	60	0	21	38	47	17	3	57	12	6	75	10	6	2	
		X	14	100	0	0	86	71	29	0	0	21	93	7	0		7	7	57	36	0	79	0	0	57	36	21	0	57	7	0	71	0	7	0	

(Note) See page 7 for the interpretation of the graphs.

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Division	Topic serial No.	Topic	Questionnaire round	Number of respondents	Degree of expertise (%)			Importance (index, %)			Expected effect (%)			Forecasted realization time					Leading countries (%)					Measures the government should adopt (%)					Potential problems (%)									
					High	Medium	Low	Index	High	Medium	Low	Unnecessary	Socioeconomic development	Resolution of global problems	People's needs	Expansion of intellectual resources						USA	EU	Former Soviet Union and Eastern Europe	Japan	Other countries	Do not know	Foster human resources	Promote exchanges among industrial, academic and government sectors and different fields	Upgrade advanced facilities and equipment	Develop a research base	Increase government research funding	Adjust regulations (relax/toughen)	Others	Adverse effect on the natural environment	Adverse effect on safety	Adverse effect on morals, culture or society	Other adverse effects
					2001	2006	2011	2016	2021	2026	Will not be realized (%)	Do not know (%)																										
Global warming	11	Practical use of carbon dioxide fixing technologies using marine organisms such as microscopic algae.	1	246	18	31	51	62	36	44	18	2	39	89	8	15		16	9	54	27	2	54	1	22	52	45	25	15	58	7	3	60	5	7	3		
			2	209	16	30	54	63	36	46	16	2	35	92	4	13		16	6	62	20	1	63	1	18	56	46	20	12	64	5	1	65	4	5	2		
			X	34	100	0	0	75	55	36	9	0	35	100	6	3		12	3	59	24	0	85	3	0	50	35	15	12	68	18	0	62	6	3	3		
Acid rain	12	Elucidation of the worldwide long-distance migration mechanisms of acid-rain-causing substances, such as SOx and NOx, considering regional characteristics.	1	267	12	24	64	76	56	37	8	0	21	94	23	14		2	5	54	61	4	46	1	12	59	38	29	18	56	6	2	43	7	10	1		
			2	234	11	24	65	79	61	33	6	0	18	94	18	12		2	3	58	70	2	51	2	9	69	37	24	15	65	3	2	50	5	9	1		
			X	25	100	0	0	96	92	8	0	0	16	88	32	16		0	0	68	88	0	64	8	0	68	52	20	8	76	8	8	60	8	8	4		
Acid rain	13	Elucidation of the mechanism of the impact caused by acid rain to animals and plants.	1	256	11	27	62	72	49	43	9	0	18	91	24	17		1	4	45	70	6	41	0	12	67	34	25	20	59	5	2	46	8	9	0		
			2	227	10	29	62	76	54	40	6	0	14	93	23	11		0	3	45	82	4	42	1	7	72	31	23	17	67	2	1	49	5	6	0		
			X	22	100	0	0	93	86	14	0	0	14	95	23	5		5	0	64	95	5	45	5	0	91	41	27	9	77	5	0	59	9	18	0		
Marine pollution	14	Completion of global automatic and remote sensing networks for monitoring marine pollution and marine ecosystem.	1	194	11	24	65	70	44	46	10	0	24	89	9	21		10	10	67	37	2	42	1	21	57	38	24	13	63	5	3	40	9	9	2		
			2	173	8	22	71	67	38	55	8	0	21	95	5	17		11	4	79	32	3	50	1	14	64	40	21	10	71	1	2	47	8	3	2		
			X	13	100	0	0	83	67	33	0	0	31	85	23	23		8	0	92	62	15	62	0	0	54	69	23	8	62	0	0	31	8	15	0		
Marine pollution	15	Elucidation of impacts exerted by marine pollutants upon marine ecosystem.	1	212	11	25	65	74	52	41	6	1	19	91	17	26		9	8	69	42	1	43	3	16	66	36	18	21	60	4	3	39	6	8	1		
			2	183	5	26	68	79	61	34	4	1	19	93	13	20		8	4	81	42	1	49	2	11	76	38	13	19	67	3	2	48	6	4	1		
			X	10	100	0	0	100	100	0	0	0	10	100	30	40		10	0	90	60	0	70	0	10	60	40	20	20	50	0	10	30	10	10	0		
Marine pollution	16	Practical use of effective technologies for restoring ocean areas contaminated by tanker accidents, etc. (e.g., oil pollution control technologies utilizing marine microorganisms).	1	215	11	28	61	70	44	46	10	0	39	84	20	9		6	7	69	42	0	45	1	18	50	51	21	11	53	11	1	52	14	4	1		
			2	187	9	26	65	72	46	50	4	0	39	88	13	6		4	5	78	43	0	48	0	10	52	56	15	9	64	10	0	61	12	3	2		
			X	17	100	0	0	88	76	24	0	0	35	100	6	18		6	6	100	41	0	47	0	0	59	41	24	12	59	0	0	41	6	0	0		
Diminishment of tropical rainforests	17	Elucidation of impacts of destruction of tropical forests upon climate and weather.	1	208	5	20	75	59	26	58	15	1	21	95	12	24		2	10	68	41	3	27	3	21	67	37	15	19	57	5	4	44	5	11	1		
			2	187	4	20	76	58	21	69	10	1	17	97	5	18		2	6	76	43	1	27	3	16	76	38	12	17	61	3	2	48	3	10	2		
			X	7	100	0	0	68	43	43	14	0	14	100	14	0		0	0	100	29	0	14	14	0	57	71	14	14	57	0	0	57	0	0	0		
Diminishment of tropical rainforests	18	Elucidation of the impact of diminishing tropical rain forests on wildlife ecosystems.	1	177	5	16	80	52	19	54	27	0	11	90	8	28		3	9	67	45	2	26	5	23	66	31	14	25	56	2	3	43	5	11	0		
			2	173	3	12	85	49	12	62	26	0	7	92	3	26		4	6	74	48	1	21	3	18	76	29	10	23	61	1	2	51	3	9	1		
			X	5	100	0	0	90	80	20	0	0	20	100	20	0		0	0	80	80	0	60	0	20	60	40	0	40	100	0	0	60	0	0	0		
Diminishment of tropical rainforests	19	Development of a technology effective for regenerating damaged tropical rain forest ecosystems.	1	200	6	19	75	63	34	50	15	0	44	94	11	13		8	10	55	33	1	37	4	29	60	40	16	19	60	7	5	46	7	11	2		
			2	181	4	19	77	61	28	60	12	0	41	92	6	10		8	7	69	35	1	39	4	20	64	39	11	18	66	4	3	56	6	9	1		
			X	8	100	0	0	88	75	25	0	0	75	100	25	25		0	0	88	63	0	63	13	0	88	38	0	38	88	0	0	50	13	13	0		
Desertification	20	Elucidation of effect of desertation on climate and water.	1	194	5	20	76	50	16	54	30	1	19	94	8	22		4	6	61	40	3	25	4	26	62	34	18	19	54	2	3	43	5	9	1		
			2	177	5	18	77	51	15	59	26	0	18	98	6	16		3	5	71	44	2	24	5	21	74	34	12	15	58	1	2	50	5	7	1		
			X	8	100	0	0	56	25	50	25	0	25	100	13	38		0	0	88	88	13	50	13	0	63	50	0	25	50	0	0	50	0	13	0		

(Note) See page 7 for the interpretation of the graphs.

Division	Topic serial No.	Topic	Questionnaire round	Number of respondents	Degree of expertise (%)			Importance (index, %)				Expected effect (%)			Forecasted realization time					Leading countries (%)					Measures the government should adopt (%)					Potential problems (%)								
					High	Medium	Low	Index	High	Medium	Low	Unnecessary	Socioeconomic development	Resolution of global problems	People's needs	Expansion of intellectual resources						USA	EU	Former Soviet Union and Eastern Europe	Japan	Other countries	Do not know	Foster human resources	Promote exchanges among industrial, academic and government sectors and different fields	Upgrade advanced facilities and equipment	Develop a research base	Increase government research funding	Adjust regulations (relax/toughen)	Others	Adverse effect on the natural environment	Adverse effect on safety	Adverse effect on morals, culture or society	Other adverse effects
					2001	2006	2011	2016	2021	2026	Will not be realized (%)	Do not know (%)																										
Desertification	21	Development of plants that are resistant to dry and saline conditions via biotechnology with the aim of greening deserts.	1	193	8	20	72	49	18	48	29	6	37	89	7	22		8	10	61	30	2	44	7	21	54	35	20	35	48	3	4	54	5	10	1		
			2	177	8	18	73	50	15	55	28	2	36	92	5	17		6	8	70	32	2	51	7	18	63	32	16	34	53	3	2	66	3	7	1		
			X	15	100	0	0	67	40	47	13	0	33	87	7	20		7	7	80	40	7	73	13	0	73	47	7	47	67	0	0	67	7	20	0		
Common	22	Generalization of global-scale monitoring of various factors causing air and water pollution and other forms of pollution, and realization of a system for centralizing all environmental information.	1	273	13	26	60	73	49	44	7	0	27	93	21	23		4	6	71	47	3	44	1	15	49	37	29	26	58	7	3	35	10	10	1		
			2	234	12	28	60	75	51	46	3	0	25	95	18	18		2	3	82	53	3	48	3	10	57	38	25	23	65	3	2	39	9	7	2		
			X	29	100	0	0	84	69	31	0	0	17	97	21	24		0	0	86	72	3	69	7	0	41	55	21	21	66	3	0	31	10	14	0		
	23	Introduction of environment tax aiming at global environmental conservation.	1	262	9	24	67	80	65	27	7	1	52	84	33	6		3	9	27	67	1	21	2	16	14	26	5	8	15	65	5	23	8	50	4		
			2	232	8	21	71	85	72	24	3	0	53	88	25	4		3	6	22	81	0	22	1	11	14	28	2	6	13	77	4	22	3	57	5		
			X	18	100	0	0	88	78	17	6	0	56	83	39	6		0	0	44	94	0	39	11	0	22	39	0	11	33	67	0	28	6	67	0		
Air quality	24	Widespread use of control technologies in virtually all types of automobiles, capable of meeting the emission control standard for nitric oxide at the order of 0.1 to 0.2 g/Km. (The current level for heavy diesel motorcars is on the order of 4 to 5 g/Km, and the standard control value for gasoline passenger cars in 1978 is 0.25 g/Km.)	1	189	15	23	62	86	73	24	2	1	49	78	52	6		2	4	44	39	0	81	1	5	30	49	19	3	33	49	3	37	13	16	3		
			2	163	10	23	66	89	78	21	1	0	48	80	51	4		0	3	46	40	0	89	0	3	29	63	12	1	36	59	1	47	10	17	1		
			X	17	100	0	0	94	88	12	0	0	59	88	59	6		0	0	47	47	0	100	0	0	41	65	12	0	59	35	0	53	6	12	0		
Water quality	25	Progress of investigation of mechanisms for both concentration of heavy metals and other pollutants in ecosystems and occurrence of eutrophication, and realization of prediction and forecasting of the impact of water pollution in closed water bodies, such as lakes and semi-closed bays, on their ecosystems.	1	263	23	37	40	77	57	38	4	1	28	71	44	23		4	6	59	54	2	67	2	10	59	41	24	22	55	14	1	41	6	14	0		
			2	225	22	39	40	81	64	34	2	0	23	79	44	17		1	2	64	58	2	78	2	6	65	46	19	19	62	12	1	46	4	11	0		
			X	49	100	0	0	90	80	20	0	0	20	88	39	24		0	0	71	65	4	80	4	0	67	55	14	10	69	12	2	49	8	12	0		
	26	Widespread use of formulation methods for water environment plan based on quantitative understanding of natural purification functions of paddy fields, reservoirs, rivers, water channels and water permeating into the ground.	1	249	18	31	51	75	54	39	6	1	32	64	54	11		3	5	42	43	1	54	0	18	51	42	20	17	44	28	2	41	10	12	0		
			2	212	17	29	53	79	60	35	4	0	28	71	59	8		2	2	44	49	0	68	0	12	54	47	16	12	52	28	0	48	6	10	0		
			X	37	100	0	0	86	73	24	3	0	35	68	73	8		0	3	41	57	0	81	0	3	57	62	11	14	68	38	0	57	8	8	0		
	27	Widespread use, including use at home, of compact waste-water treatment systems based on biotechnology for the highly efficient treatment of persistent substances and hazardous materials.	1	247	23	31	46	79	59	37	3	0	52	64	53	10		4	4	57	40	0	67	1	9	47	49	27	12	43	21	1	46	7	11	1		
			2	218	24	30	46	82	64	33	2	0	49	65	57	6		2	4	61	39	0	82	0	4	51	64	14	6	50	22	1	59	4	11	0		
			X	52	100	0	0	86	73	25	2	0	60	71	60	6		4	4	63	42	0	94	0	0	50	69	12	6	52	33	0	52	4	10	0		
28	Development of bioreactor systems utilizing bacteria and animalcules that ingest/decompose the algae responsible for water blooms or red tides for the purpose of improving aquatic environment.	1	237	17	34	49	69	45	41	12	2	40	68	38	11		7	5	38	24	1	65	0	19	47	46	25	17	48	11	1	49	5	9	1			
		2	207	14	34	52	72	50	42	8	1	40	71	31	6		5	4	42	25	0	76	0	14	52	52	24	14	54	8	0	59	4	8	1			
		X	29	100	0	0	84	69	28	3	0	34	79	41	3		7	0	48	31	0	93	0	0	52	59	21	14	86	10	0	52	3	7	0			
Noise/vibration	29	Development of low-noise engines and tires, and sound-absorbing construction materials, leading to the reduction of automobile noise within the environmental standard for the area specified to be for resident.	1	137	9	17	74	73	54	33	12	2	43	32	74	5		12	6	30	29	0	61	0	23	25	50	18	2	34	45	3	26	20	19	1		
			2	118	8	19	74	76	59	27	13	1	44	24	80	3		13	3	31	31	0	72	0	14	23	61	12	1	37	49	1	35	18	20	2		
			X	9	100	0	0	88	75	25	0	0	56	22	89	0		11	0	33	44	0	67	0	22	33	78	11	11	56	44	0	33	33	22	0		
Waste	30	Widespread use of biodegradable plastics that can be fully decomposed by anaerobic microorganisms as a means of properly handling containers and packaging materials with short intended service lives.	1	249	13	29	59	75	57	33	8	3	61	69	46	7		6	8	49	41	1	56	2	18	40	51	18	8	41	30	2	46	10	18	2		
			2	221	13	26	61	78	61	31	6	2	61	71	42	3		5	4	55	38	0	74	0	9	42	56	12	5	51	29	1	54	7	17	1		
			X	28	100	0	0	74	54	36	11	0	75	68	39	7		4	0	64	46	0	79	0	4	32	54	14	7	57	43	0	54	7	14	0		

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