IDEC DP² Series Vol. 1 No. 7

Developmnet Discussion Policy Paper

Allocating Costs of Environmental Management among Generations: A Case of Environmental Liabilities in Transition Economies

Satoru Komatsu, Andrey Kalugin and Shinji Kaneko

December, 2011

Department of Development Policy
Division of Development Science
Graduate School for International Development and Cooperation (IDEC)
Hiroshima University
1-5-1 Kagamiyama, Higashi-Hiroshima
739-8529 JAPAN

Allocating Costs of Environmental Management among Generations: A Case of Environmental Liabilities in Transition Economies

Satoru Komatsu

(Coresponding Author)

Graduate School for International Development and Cooperation,
Hiroshima University
1-5-1 Kagamiyama, Higashi-hiroshima, Hiroshima 739-8529, Japan
Email: skomatsu@hiroshima-u.ac.jp

TEL: +81-82-424-6932

FAX: +81-82-424-6904

Andrey Kalugin

Graduate School for International Development and Cooperation,
Hiroshima University
1-5-1 Kagamiyama, Higashi-hiroshima, Hiroshima 739-8529, Japan
Email: andrey-kalugin@hiroshima-u.ac.jp

Shinji Kaneko

Graduate School for International Development and Cooperation,
Hiroshima University
1-5-1 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8529, Japan

Email: kshinji@hiroshima-u.ac.jp

Abstract

The objective of this paper is to examine cost allocation in relation to remediating environmental liability issues in Russia, where significant environmental damages, continuing from the Soviet era, present serious impediments to pursuing sustainable development. The research attempts to highlight citizens' preferences for remediating facilities and sites with environmental liabilities, and elicits preference differences among citizens using choice experiment methods. Intergenerational issues are involved in addressing environmental liabilities in transition economies because the causes and effects are spread among generations. Therefore, evaluating citizens' preferences provides more policy implications for future remediation initiatives. The econometric analysis reveals that citizens demonstrate positive preferences for reducing pollution of drinking water and soil decontamination. The research also suggests that the households with higher incomes, older household heads (or spouses), and more young children have higher preferences for remediating environmental liabilities in Russia. Estimation of the marginal willingness to pay (MWTP) for age and income segments of the households allows the government to determine a suitable taxation policy. The findings provide new insights on cost allocation in relation to remediating environmental damages in transition economies that have suffered from these serious environmental legacies.

Keywords Environmental management • Willingness to pay • Preference • Generation • Transition economics

JEL classification: O13, P28, Q56

Introduction

Accounting for intergenerational issues when remediating environmental issues is of primary importance for analyzing potential beneficiaries. This will be particularly indispensable in considering environmental problems in transition economies, where massive environmental pollutions occurred during the former communist era and have become a serious burden and impediment to sustainable economic development for the present generation. Environmental issues dating from the previous regimes have remained abundant and have resulted in serious risks to the regional and national economies, in terms of polluted lands, poor water quality due to the discharge of toxic wastes, and degradation of ecosystems.

The environmental pressures in the transition economies involve environmental liabilities of the previously state-owned companies. The Soviet system placed great emphasis on heavy industries, giving environmental concerns a minor priority when compared with the need for industrial development. After the collapse of the Union of Soviet Socialist Republics (USSR), various mines, chemical factories, and sludge damp sites were shut down without appropriate treatments. As a result, the transition economies have had to start their new regimes facing great environmental challenges in the form of high levels of air pollution caused by inefficient industry and transport, increasing drinking water pollution due to industrial discharges and the deterioration of plumbing, and soil contamination due to the hazardous waste in the closed facilities. Moreover, the pollutants on such sites extend beyond the immediate area of the site, affecting adjacent land and property, with some pollutants being widely transmitted to other areas via ground or surface water.

During the process of the regime change, which included privatization, land contamination emerged as a primary environmental concern because inherit environmental pollutions substantially discouraged investors' motivations to purchase lands. To date, a number of research articles have examined governmental policies and firms' behaviors in relation to the privatization and remediation of the lands (for example, Boyd 1996, Bluffstone and Panayotou 2000, Earnhart 2004, Bluffstone 2007). These studies imply that governmental initiatives on auditing, disclosure of environmental information, and remediation activities are crucial for the success of privatization. Although the previous research agrees on the responsibilities of the government entities, the roles and opinions of the taxpayers who financially support the governmental entities have not been explored fully, apart from de la Motte (2007), who described public participation in the process of privatizing Poland's water systems during the 1990s. Moreover, regardless of the land privatization goals, remediating polluted land and improving the quality of the environment are essential to reduce health risks for the residents.

Because the environmental issues occurred in the Soviet era and have remained a serious environmental burden in the current era, the cause-and-effect relationship among generations needs to be taken into account. Elderly citizens who lived under the previous communist regimes and caused the environmental liability issues, even unintentionally, may now feel responsible for the current environmental pollutions associated with the past regimes. Therefore, elderly citizens may have bequest intentions to create and preserve a better environment for the next generations, which inclines families with children to be willing to pay for environmental improvements. By contrast, however, elderly citizens have a relatively lower life expectancy compared with the younger generations and, therefore, they will benefit less from the environmental improvements. Younger generations, on the other hand, have less responsibility for the environmental liabilities but higher life expectancy, which means they receive greater benefits from environmental improvements. Suitable cost allocations for funding environmental management actions need to be analyzed in the context of these different generational issues, the complexity of which are delaying the clean-up process in transition economies. Therefore, although the issue of allocating the costs of environmental liabilities is highly relevant to policy making, to the best of the authors' knowledge, empirical analyses have not examined this point. Identifying the implications of the optimal intergenerational cost allocation is the aim of this paper.

The objective of this study is, therefore, to determine citizens' preferences regarding the cost allocation among generations. As the research highlights the cost allocations among generations, other household characteristics are also accounted for. The case studies that applied the choice experiment approach were carried out in the western part of Siberia, Russia. If statistically significant relations were observed between the preferences and environmental managements, the research could yield policy implications for solving intergenerational environmental issues from the perspective of citizens' preferences.

The remainder of the paper is organized as follows. Chapter 2 reviews the empirical literature on environmental liabilities in transition economies and sheds light on the intergenerational aspects of these issues. Chapter 3 then provides information on the surveyed region and the methodologies applied in the research. Chapter 4 presents the estimation results, which are then discussed in chapter 5. Chapter 6 concludes the paper.

Environmental Liabilities in the Former USSR Countries and their Relation to Generational Aspects

The former USSR regimes prioritized industrial development and paid little attention to environmental conservation. The philosophy of the Soviet systems was that nature should be subordinated to man and, therefore, environmental services had no implied prices (Vorobyov and Zhukov 1996). Serious environmental issues occurred in various parts of the USSR, and became serious impediments to the economic growth of the new transition economies. Shahgedanova and Burt (1994) examined the emissions and ambient concentrations of four major air pollutants (suspended particles, SO_2, NO_X, and CO) of the USSR between 1980 and 1991, and noted the severity of the pollutants during this decade. Several countries, including (East) Germany, Poland and Bulgaria, came to regard these environmental liabilities as barriers to economic development, and have instituted policy and regulatory frameworks for managing issues (World Bank 2007a). For example, Bulgaria spent 25 million USD for remediation of the arsenic-contaminated sludge discharged by the large copper smelter in Pirdop during its privatization process (World Bank 2007a). During 1996, eastern Germany spent 6.4 billion USD for remediation activities that were prioritized because of the associated health risks (Bruffstoine 2007). The World Bank (2007a) defined the environmental liabilities as the residual cost that would be incurred ultimately for removal, mitigation, and/or containment of environmental, health, or property risks caused by past and continuing economic activity and, where applicable, recommended legally assigning financial liabilities to the responsible parties to address these risks.

Surprisingly, notwithstanding the significant scale and impact of the environment liabilities in Russia, there are no comprehensive inventories or overall impact assessment of magnitude in the form of a national database or even in the individual regions (World Bank 2007b). The low priority attached to environmental protection during the command economy era and successive transition periods has resulted in the absence of appropriate measures to tackle the environmental liabilities in Russia (World Bank 2007b). For example, the decline in industrial production and military activities that occurred in the 1990s left large numbers of facilities and sites with high levels of pollution without custody (World Bank 2007b). According to the Federal Ministry of Natural Resources, which undertook an inventory survey in the provinces, the 10 provinces have 2,521 unorganized landfills (World Bank 2007a).

Poor quality drinking water has been linked with the environmental problems in the transition economies. According to the Federal Service for Consumers' Protection and Welfare of Russia (2007), 19% of the country's water sample tests did not meet quality standards for sanitary and chemical characteristics, while close to 8% exceeded limits for bacteriological characteristics. Moreover, land contamination and degradation along with low drinking water quality emerged as serious health issues caused by the environmental liabilities.

To date, a limited number of case studies have evaluated citizens' attitudes or preferences for the management of environmental liabilities in transition economies. For example, Auer et al. (2001) reviewed government initiatives in relation to the access to environmental information by citizens living amid contaminated sites in the central and eastern European countries. Dogaru et al. (2009) evaluated citizens' opinions regarding surface water quality and the economic effects of mining activities, and suggested complicated perceptions by citizens regarding the trade-off between environmental protection and economic activities in Romania. Gnedenko and Gorbunova (1998) evaluated willingness to pay (WTP) for improved water supply in Chudovo city in the Novgorod region of Russia, and compared the aggregated WTP with the actual cost of a project aimed at installation of new treatment facilities in the water supply organization. Gnedenko et al. (1999) estimated household avoidance measures to decrease health risks associated with low drinking water quality and WTP for improving the quality of water in Samara city in Russia. Gnedenko et al. (1999) also found that younger citizens showed higher WTP for water quality improvements, concluding that this could give rise to important policy implications. Although the research works mentioned above discussed the importance of considering citizens' opinions on remediating environmental liabilities in transition economies, discussions on the intergenerational allocation of management costs have not yet occurred. As the massive environmental liabilities are barriers to economic development and involve a significant financial burden for taxpayers, a discussion of the implications of the cost allocations among generations is essential.

Kalugin et al. (2010) appears to be the first attempt, using choice experiment methods, to analyze citizens' preferences for managing the quality of drinking water and the soil contamination of the land caused by the environmental liabilities. Kalugin et al. (2010) examined the marginal WTP for improving water quality and reducing soil contamination of the lands. The current paper applies the data set used in

Kalugin et al. (2010) and extends it to analyze the effects of respondents' and households' attributes on the preferences, as well as accounting for the effects, of the variables beyond the generational effects (such as sex, education, household size, location of the residential place, and household income).[1] This research aims to expand the discussions and provide new insights on the cost allocation for remediating environmental damages in transition economies, which have suffered from these serious legacy issues.

Survey Details

Location of the Survey

The household survey was conducted in Kemerovo city,[2] the second-largest city in the Kemerovo region (Oblast), which is located in the southern part of Western Siberia. Kemerovo city has a population of 521,200 (Kemerovo City Government 2010). The Kemerovo region has extensive black coal and iron ore reserves, and has been an engine for industrialization since the 1930s. In addition to the mining industries, large iron, steel and coke/chemical facilities, several large nonferrous metal producers, and machinery production are the major industrial bases for the region.

Kemerovo region is also characterized by the considerable number of closed or abandoned facilities, which negatively affect residents' health. The exact number of such facilities is difficult to identify because the relevant data are scattered among multiple agencies. However, estimates by Perfilieva (2006) of the sectoral distribution of the facilities and the sites of environmental liabilities in the Kemerovo region are shown in Table 1. Table 1 demonstrates that the mining, chemistry, and ferrous and nonferrous metallurgy sectors have mainly caused the environmental liabilities.

The Tom River serves as Kemerovo city's main source of drinking water and, thus, its water quality is the main determinant of the quality of the tap water. Data on water quality in the Tom River near Kemerovo show that in 2004–2008, three types of contaminants—namely, nitrite nitrogen, phenol, and oil products—exceeded the Russian water quality standards. For example, the concentration of oil products in 2008 was 1.8 mg/liter, whereas the environmental standard requires a concentration of 0.05 mg/liter (Kemerovo Region Committee of Natural Resources 2009).

The recent statistics of the Kemerovo Region Department of Russian Consumer Supervision (2009) indicate that the quality of drinking water that residents use in their households did not meet quality standards in 2008. Iron concentration was 9.6 ml/liter, whereas the maximum allowable concentration of iron under Russian standards is 0.3 mg/liter (*ibid*). Manganese concentration was 2.9 ml/liter but the

---

[1] The research did not use the data on citizens' perceptions of the environmental liabilities that might influence the preference information, because the citizens' perceptions of the environments are invisible for the government, which are not helpful for planning rehabilitation. Moreover, population surveys conducted in the Russian Federation revealed that there was little difference in the attitudes toward environmental issues between generations (18–35-year-olds, 35–50-year-olds, and over 50s) in the surveys conducted in 2001, 2005, and 2007 (Russian Public Opinion Fund 2001; 2005; 2007).

[2] More locational information on the survey site is provided in Kalugin et al. (2010).

Russian standards specify 0.1 mg/liter (*ibid*). These figures indicate that water contamination is a serious issue.

A plausible explanation for the low quality of drinking water is that various dangerous chemicals are emitted from the facilities and sites with environmental liabilities. A well-known site with environmental liabilities and a notorious environmental hazard in Kemerovo city is the former Aniline and Dye Plant (ADP), which occupies 20 ha of land in immediate proximity to the Tom River in the Kirovsky district. The operation of the plant was stopped in 2004 after more than 60 years of operation, and it is currently the cause of significant environmental problems. According to Perfilieva (2006), the ADP site is characterized by the large amounts of wastes being stored on the site of the closed plant. The total amount of sodium phosphate, boric anhydride, bromine, broken glass in wooden containers, flexible containers, scrap iron, steel barrels that had lost their use properties, construction wastes, and unsorted waste from welfare spaces accumulated equals to 6,603.5 tons (Perfilieva 2006). Mortality risks from the consumption of vegetables in Kemerovo city are estimated to affect 340,000 persons (Perfilieva 2006). In addition to the serious soil contamination, there is a great risk of the Tom River being contaminated from the destruction of waste storage facilities. Perfilieva (2006) estimated that the 132,000 m^3 of hazardous waste would flow into the Tom River in the case of a sludge collection accident. The ADP is the source of soil contamination, an indirect source of river contamination, and it has further potential risks for drinking water pollution in Kemerovo city.

Questionnaire Design

A household survey based on the choice experiment was conducted to derive the estimates of respondents' preferences for the environmental quality improvements in December 2009. All of the five districts (Centralny, Zavodsky, Leninsky, Rudnichny, and Kirovsky) in Kemerovo city were targeted. To elicit representative answers of the households, the households' heads, or the spouses of the households' heads, were requested to answer the questionnaire. The survey was conducted on a door-to-door visit basis, which enabled the respondents to provide detailed responses. A total of 300 samples have been collected as part of the main survey.

Prior to the main survey, a focus group was organized, involving 15 persons with different socioeconomic characteristics, living in different city districts, to elicit opinions on the current environmental situation in the city in respect to the environmental liabilities. These meetings with experts who have longer experience of the environmental liabilities in Kemerovo enabled the development of precise and apprehensive questionnaires. Further, a pilot survey involving 30 respondents in all of the cities' districts was conducted to detect potential problems in the questionnaire, as a result of which minor modifications were made before the main survey.

The questionnaire contained information on drinking water quality and the environmental liabilities in Kemerovo city, as well as the choice experiments design to elicit information on preferences, and questions on the sociodemographic characteristics of the respondents. In the choice experiment, respondents were presented with a series of alternatives and asked to choose the most preferred option. A baseline alternative, corresponding to the status quo, was included in the scenario to indicate the current situation.

Environmental improvement scenarios were described by a bundle of attributes and the choice experiment format was designed in a way that required respondents to state their preference over these hypothetical situations.

Table 2 describes the final attributes and the levels used in the questionnaire. The attributes for “Pollution in Drinking Water” relate to the drinking water quality in Kemerovo. The value 0.96 indicates the current water quality measured by the iron concentration in 2007 (Kemerovo Region Department of Russian Consumer Supervision 2009), and the research hypothesized that the concentration quality would become 0.3 mg/liter (Russian Environmental Standards) if water improvement activities are implemented. The middle ground between the status quo and the environmental targets is indicated by 0.6 mg/liter. The attributes “Soil Contamination and Potential Cancer Risk” represent the benefits of a clean-up of the facilities with environmental liabilities. According to Perfilieva (2006), the chemical contamination of vegetables grown in suburban areas poses individual cancer incidence risks for 340,000 people in Kemerovo city. As the number of affected people is expected to decrease as a result of remediation of the facilities, the research hypothesized that rehabilitation projects could decrease the mortality risk to 140,000 persons, or even to as low as 40,000 persons if greater rehabilitation efforts occur.

The two attributes described above (“Pollution in Drinking Water” and “Soil Contamination and Potential Cancer Risk”) implied different environmental improvement scenarios arising from different degrees of clean-up efforts in relation to the environmental liabilities in Kemerovo. The improvements in water quality involved comprehensive improvements of the facilities and sites with environmental liabilities, although long-term efforts would be required to solve the problems because a number of facilities and sites with environmental liabilities (potentially) have affected the water quality of the Tom River. By contrast, comprehensive ADP clean-up measures would reduce soil contamination and possibly reduce the water pollution of the Tom River, and would result in more obvious effects for residents. The contrasts presented between these issues were intended to highlight the overall citizens’ preferences in relation to the initiatives on the environmental liabilities.

The attributes for “Medical Check Aimed at Reducing Cancer” describe the medical checking required to decrease the cancer risk. Currently, the cancer risk from water resources in Kemerovo is $2.8*10^{-4}$, indicating that if 100,000 people reside in Kemerovo for their lifetime, 28 of these people will suffer from cancer as a result of the water pollutants (Zaitcev and Mikhailuc 2001).[3] The medical treatment programs would be expected to decrease cancer risks, and the attribute captures the broader understanding of health risks by the respondents.

---

[3] The value of the cancer risk would be underestimated because the research uses the value from water pollution only. As we could not obtain other reliable figures to indicate the cancer risk of Kemerovo city residents, the cancer risk indicated by Zaitcev and Mikhailuc (2001) was cited.

The final attributes relate to the additional tax required for project implementation. The research referred to the previous research studies that elicited the WTP for water quality improvements, but the final lists of the levels were determined following discussion among the experts and the pilot survey.[4]

The structure of the choice experiment is presented in Table 3. The experiment took the form of a series of choices between two hypothetical plans for environmental quality improvement, with one representing the current situation (the status quo). Respondents were asked to state whether they would choose “Plan 1”, “Plan 2”, or “Current”. Hypothetical scenarios, named “Plan 1” and “Plan 2,” indicate the improvement scenarios from the status quo, but imply an additional financial burden for citizens, indicated as “additional tax.” Each respondent was requested to answer three times.

The attributes and levels of the profiles were developed using orthogonal main effects design, which enables elimination of multicollinearity among the attributes, yielding nine possible choice sets. Three versions of the questionnaire were developed; each includes three possible choice sets. Each respondent was requested to consider three choice sets of one given version of the questionnaire.

Table 4 describes the socioeconomic profiles of the respondents who were included in the final sample. The final sample size was 160, after removal of respondents who could not understand the contents clearly or who were protest bidders. The category of respondents’ characteristics includes the respondents’ age, sex, and educational attainments. The average respondents’ age is 43.6 years, and the samples are biased towards female respondents. The educational attainments are relatively high; more than half of the respondents had obtained bachelor degrees. If the research can reveal a statistically significant relationship between respondent age and the profile attributes, it would indicate the effect of the respondents’ generations on the environmental improvements.

Household characteristics include the number of household members, the number of children, the number of elderly members, a dummy for location, and household income. Although there is no definition of the children, the number of children in this research is separated into three types: number of household members who are aged 0–4 years, 0–9 years, and 0–14 years. If statistically significant relationships are obtained between the number of the children in the household and preferences regarding environmental management, this may reflect perceptions on the risk for children as well as the bequest value for the younger generation. In the same manner, the number of elderly persons in the households was evaluated by the number of elderly persons who are equal to or older than 50 years, 60 years, or 70 years. If households with more elderly members are associated with the environmental preferences, we can observe the effects of the elderly’s ages on the environmental quality improvements. A dummy for location is included to

---

[4] As the project aims at eliciting the preferences for remediation of the environmental issues, a water fee may not be the appropriate payment vehicle. The research confirmed that the citizens could answer the questionnaire with tax as the payment vehicle.

observe whether the residents in Kirovsky,[5] where the ADP sites are located, have some particular preferences regarding the environmental liabilities.

Estimation Procedures

The research applied a random parameter logit (RPL) model to estimate the environmental preferences of the respondents. Compared with the conditional logit model, RPL models have two advantages related to the handling of the preference heterogeneity of the respondents' utility function and the independence of irrelevant alternatives. Conditional logit models hold only with strict assumptions regarding these issues (for details see Train 2009). NLOGIT 4.0 was used for the estimation (Greene 2007).

Here, we describe the estimation procedures of the RPL model.[6] The random utility function of the n respondents when selecting the alternative of i is denoted as follows.

$$U_{ni} = V_{ni}(\beta_n) + \varepsilon_{ni} = \sum_{j=1}^{J} \beta_{ij} x_{ij} + \varepsilon_{ni}, \qquad (1)$$

where $x_{ij}\left(j = 1,2,...J\right)$ are the attributes and β_{ij} indicates the marginal utility parameters.

Assuming that ε_i conforms to the extreme value type 1 (EV1) distribution, then the choice probability of selecting i, P_i for respondent n in the case of RPL is as follows.

$$P_{ni} = \int \frac{\exp(V_{ni}(\beta_n))}{\sum_{j=1}^{J} \exp(V_{nj}(\beta_n))} f(\beta \mid \Omega) d\beta, \qquad (2)$$

where $f(\cdot)$ is the probability distribution function of β and Ω is the distribution of the mean and variance of parameter β. This research applies to the normal distribution[7] for the parameter estimator β. The parameters with a positive Ω are denoted as random parameters because this indicates that the parameters are different among respondents. Fixed parameters will be $\Omega = 0$, because the parameters have no distribution.

As the research requested the respondents to provide answers three times, the RPL models are as follows.

---

[5] The population of Kirovsky is 58,000, which is 11% of the total population in Kemerovo city (Kemerovo City Government 2011). This research tried to cover all the districts but obtained samples are less than the proportion of the whole city.

[6] We referred to the descriptions by Kuriyama and Shoji (2005) and Train (2006).

[7] The distribution of the parameters can be the lognormal distribution, especially for the price parameters, to fix the sign of the variables. We specified the lognormal distribution for the variable tax and estimated the parameters, but we could not find convergence using the maximum likelihood estimation.

$$P_{ni} = \int \Pi_{t=1}^{3} \frac{\exp(V_{ni})}{\sum_{j=1}^{J} \exp(V_{nj})} f(\beta \mid \Omega) d\beta \qquad (3)$$

$t(t = 1, \cdots, 3)$ denotes the number of answers from the respondent, as there are three repeated scenarios presented to the respondents. As the integral calculus in equation (3) cannot be estimated by the maximum likelihood methods, it needs to be estimated using simulations (for details, please refer to Train 2006).

Furthermore, the MWTP has been estimated from the ratio of the utility parameters. MWTP is estimated from equation (4), where p indicates tax parameters and x denotes parameters of other attributes.

$$MWTP = -\frac{\beta_x}{\beta_p} \qquad (4)$$

Estimation Results

Table 5 presents the estimated values of the coefficients and statistics related to the three different models considered. Overall, the estimated models fit well in terms of the McFadden's Rho, which is the commonly used criterion of goodness-of-fit. The goodness-of-fit is measured by the comparison of the log likelihood of the estimation model (L) with the log likelihoods of the no coefficient model L_0 (assuming that all the coefficients are zero), which is referred to as McFadden's Rho $(1 - L/L_0)$ (Green 2007). Positive and significant alternative specific constants (ASC) that have been set for the hypothetical plans (Plans 1 and 2) imply that the respondents prefer the suggested environmental plans.[8]

Model 1 is the results from the variables related to the profile attributes. Negative coefficients for pollution in drinking water and soil contamination can be explained by the fact that the respondents are unwilling to have an increase of iron concentration in drinking water as well as increase of the mortality risk associated with consumption of vegetables. Indeed, the coefficients of tax variables are negative and significant, and the standard deviation of the tax variables is significant, meaning that citizens are not willing to pay for the increase of the tax, and their WTPs are normally distributed. However, the respondents did not show any significant responses on the carrying out of medical checks aimed at the reduction of cancer development.

Model 2 includes the interaction terms among the household income and tax attributes, and is more improved than Model 1 in terms of the adjusted log likelihoods. Model 2 implies that the richer households tend to accept the tax increase.

---

[8] The estimation results in Model (1) are similar to that of Kalugin et al. (2010) in terms of the significance of the variables, but differ slightly mainly because of the smaller sample in the current analysis (160 respondents compared with 167 in Kalugin et al. (2010)).

Model 3 includes the interaction with age attributes in order to observe the intergenerational aspects of the preferences. The respondents' ages are positively associated with the tax, which shows that older respondents are relatively more willing to pay the tax. Moreover, the households with children who are 0–14 years old demonstrated a higher propensity to pay tax.

Based on the estimated parameters of Model 3, the MWTP for reducing pollution in drinking water and reducing soil contamination has been estimated. The average MWTP is 26.93 rubles per household per year for decreasing pollution in drinking water to 1 mg/liter, although a detailed analysis of the effects of respondents' age, number of children, and income is required. Table 6 presents the change in MWTP for decreasing pollution in drinking water for differences in the age of respondents and the number of younger children. As the richer households are willing to pay more tax, the MWTP was calculated for the following different income segments: 18,859 rubles/month, 12,500 rubles/month, and 27,500 rubles/month, which indicate the average income, the lower quartile (the lowest 25% of incomes) and the higher quartile (the highest 25% of incomes).[9] For example, if a respondent is 30 years old, has an average income, and his/her household does not have children (0–14 years old), then his/her household is willing to pay 21.56 rubles/year to decrease the iron concentration in drinking water by 1 mg/liter. By contrast, a 60-year-old respondent with two children is willing to pay 47.87 rubles/year. When the household income changes, the MWTP differs significantly; even if the age of the respondents and the number of children are the same, a difference in household income will have a large effect on MWTP.

Table 7 presents MWTP for reducing soil contamination. As the MWTP for reducing risks associated with soil contamination by one person is infinitesimal, the MWTP for reducing risk by 10,000 persons is presented. Average MWTP is 1.08 rubles per year per household for reducing risk by 10,000 persons through reducing soil contamination. Again, MWTP differs in terms of the age of the respondents, the number of children, and the household income. Table 7 shows MWTP for the respondents' age group and the number of children for each of the different categories of household income, i.e. 18,859, 12,500, and 27,500 rubles/month. For example, the respondents who are 30 years old, have an average income, and no children (0–14 years old), are willing to pay 0.86 rubles/year for decreasing risk by 10,000 persons.

Discussion

The present analysis has shown that the respondents demonstrate positive preferences for reducing both drinking water pollution and soil contamination. Environmental improvement initiatives aimed at removing iron concentration from drinking water and reducing soil contamination are positively associated with the citizens' preferences. The analysis also revealed that the attributes in the questionnaire are not fully capable of explaining the citizens' preferences because the models with interaction terms show a higher goodness-of-fit. The models that include the income, age, and the number of children of the respondents in the interaction terms show a significantly improved model fit (Model 3, Table 5). Thus, the present study

[9] Tables 6 and 7 omit the calculation in the case of the median income (17,500 rubles/month) because the median and mean are not greatly different.

clearly indicates the need to account for different preferences for managing environmental liabilities in Kemerovo.

The significance of the household income to the tax is related to affordability. As the households with higher incomes may have more disposable income, the government can request such households to pay a higher tax. Further, the elderly respondents are more willing to financially support environmental improvements. The results may reflect that elderly citizens feel a greater responsibility for the environmental issues that have arisen under the previous regimes because the older the respondent is, the more experience of living in the Soviet regime he or she has. There is a possibility that elderly respondents may consider their lower life expectancy compared with the younger respondents in formulating their preferences, but the results indicate that the effect of the recognition of responsibility outweighs that of lower life expectancy. As the nominated respondents are the decision makers of the households (the household head or his/her spouse) to elicit the households' decisions, then elderly respondents would place a high value on the environmental improvements for younger generations.

Moreover, the households with higher numbers of children are more willing to pay to reduce the health risks from water pollution and soil contamination. Although the children aged under 14 years may bear no responsibility for the environmental liabilities, these younger children, with longer life expectancies, are more susceptible to the associated health risks, which may induce respondents (that is, the parents of such children) to support the environmental improvement initiatives. In addition, there is a possibility that households with younger children want to preserve a better environment for the younger generation.

In summary, the research results indicate that wealthier, older household heads (or spouses), and households with higher numbers of young children can receive more benefits from the remediation of environmental liabilities in Russia and, therefore, the government could levy higher taxes on such households. The allocation of the cost of managing environmental liabilities needs to be considered carefully as the remediation costs are finally covered by taxpayers. This research can provide advice on managing the cost allocation among the residents of the current generation.

The number of elderly persons (excluding respondents) has no explanatory power for preferences in relation to either water pollution or soil contamination. It is possible that the respondents consider the relatively high health risks of the elderly members and the environmental responsibility of the elderly members, but these effects might be cancelled out by the lower life expectancy of the elderly. Further research needs to be carried out to verify the contrasting effects.

The fact that medical checks aimed at decreasing cancer risk caused by the water pollution have no statistically significant impact on the citizens' preferences can be explained by the magnitude of cancer development. As we adopt the risk of cancer due to water pollution from Mikhailuc (2001), the value of the risks could be perceived as low (28 persons per 100,000, lifetime). The cancer risk would be higher if all the cancer risks from all the pollutants (water, soil, air, etc.) were summed. However, there was a lack of reliable data for determining more comprehensive cancer risks.

The present estimation results show no relationship among respondents' (households') characteristics and the attributes related to water pollution and soil contamination. This means that citizens do not put a priority on reducing either pollution to drinking water or soil contamination. For example, if statistically significant and negative relations were observed among the respondents' age and drinking water pollution, we could conclude that more elderly respondents pursue reductions in the health risks from water pollution. The results also show no interrelationships among the household size and preferences, even though the per capita tax will be lower for the larger-sized households. The respondents seem to place much emphasis on the number of children who are vulnerable to health risks, with their longer life expectancies. Those who live in the Kirovsky district did not show any preference for managing environmental issues compared with the residents in other districts. As the issues related to environmental liabilities spread beyond the focus districts, different taxation between districts is not desirable.

We should mention that relatively large numbers of protest bids were observed in the survey. The research considered responses to constitute a protest bid when respondents: (1) chose the current situation in all three questions; and (2) explained that their choices were attributed to a lack of faith in the project design. In total, 130 samples were considered to constitute protest bids, and the majority of these respondents (100 samples) indicated that they considered that the government should take all responsibility for instituting environmental improvement programs under the current budgetary schemes, and that respondents should not have any responsibility to pay additional taxes. Therefore, we note that governments should carefully design any schemes to improve the environmental liabilities, given that 33% of the respondents opposed the payment of additional taxes to tackle the facilities with environmental liabilities.

Conclusion

The main objective of this study is to examine the cost allocation for remediating environmental liabilities in Russia, where significant environmental damages, which have continued since the Soviet era, are presenting serious impediments to pursuing sustainable development. The research attempts to highlight citizens' preferences for remediating facilities and sites with environmental liabilities as well as to elicit the preference differences among the citizens, using choice experiment methods. Intergenerational issues are relevant to the environmental liabilities in transition economies because the causes and effects are spread among generations. Therefore, evaluating citizens' preferences provides a strong basis for policy implications for future remediation initiatives.

The econometric analysis reveals that respondents demonstrate positive preferences for the reduction of drinking water pollution and soil decontamination. The research also suggests that the households with higher incomes, older household heads (or spouses), and more young children have higher preferences to remediate environmental liabilities in Russia. The estimation results suggest that the government could levy higher taxes on the households from this segment of the population.

As indicated in the Introduction, no comprehensive inventories or overall impact assessment of environmental liabilities has been undertaken (World Bank 2007b), which has hampered detailed assessments of the health risks for the citizens of the environmental liabilities. Not only are there risks from consuming vegetable from contaminated soils or from drinking water that is iron contaminated, there are also other risks to citizens' health related to other chemical substances. It is crucial to organize comprehensive indicators to analyze the health risks derived from environmental liabilities. In doing so, it would be beneficial for policy makers to identify the sites with environmental liabilities requiring immediate initiatives.

Although this research is limited to the case of one city in Russia, the findings provide new insights on the cost allocation for remediating environmental damages in other places within the transition economies that suffer from the serious environmental legacies. Accounting for the voice of citizens in the form of calculating their preferences is one of the promising approaches to dealing with environmental liabilities in a democratic way. As this research found significant differences in preferences among the different generations and household income levels, there may be other factors that are relevant in the context of examining other issues related to the environmental liabilities. Further research should attempt to analyze how to construct the policy tools such that they maximize consideration of the citizens' preferences and reduce the damages caused by the environmental liabilities, while fully accounting for intergenerational equity in allocating costs.

Acknowledgement

We would like to thank Dr. David Prentice of La Trobe University, and Dr. Taro Ohdoko of Kobe University for the helpful suggestions on an earlier version of this manuscript. This research is supported by the Grant-in-Aid for Young Scientists (B) (Number: 23710057), and the Global Environment Research Fund "Establishing of Methodology to Evaluate Middle to Long Term Environmental Policy Options toward Asian Low-Carbon Society (S-6)" from the Ministry of Environment, Japan.

Reference

Auer, M. R., Reuveny R., and Adler, L. (2001) Environmental Liability and Foreign Direct Investment in Central and Eastern Europe. Journal of Environment and Development 10: 5-34.

Bluffstone R. A., Panayotou T. (2000) Environmental liability and privatization in Central and Eastern Europe: toward an optimal policy. Environment and Resource Economics 17:335–352.

Bluffstone R. A. (2007) Privatization and contaminated site remediation in Central and Eastern Europe: do environmental liability policies matter? Ecological Economics 63:31–41

de la Motte, R. (2007) A Tale of Two Cities: Public participation and sustainability in decision-making on water systems in two Polish cities, Utilities Policy, 15: 134-142.

Boyd J. (1996) Environmental Liability Reform and Privatization in Central and Eastern Europe, European Journal of Law and Economics, 3: 39-60..

Dogaru D., Zobrist J., Balteanu D., Popescu C., Sima M., Amini M., Yang H. (2009) Community Perception of Water Quality in a Mining-Affected Area: A Case Study for the Certej Catchment in the Apuseni Mountains in Romania. Environmental Management 43: 1131-1145.

Gnedenko E, Gorbunova Z., Safonov G. (1999) Contingent Valuation of drinking water quality in Samara city, EERC Working Paper Series, 98-263e, 29p.

Green, W. H. (2007) NLOGIT 4.0, Econometric Software Inc.

Earnhart D. (2004) Liability for Past Environmental Contamination and Privatization. Environmental and

Resource Economics, 29:97-122.

Gnedenko E.D., Gorbunova Z.V.(1998) A Contingent valuation study of projects improving drinking water quality, Modern Toxicological Problems 3, Kiev.

IMF (International Monetary Fund) (2009) Representative Exchange Rates for Selected Currencies for December 2009, Exchange Rate Archives by Month. Available at http://www.imf.org/external/np/fin/data/param_rms_mth.aspx Retrieved on September 16 2011.

Kalugin A., Komatsu S, Kaneko S., Slozko O. (2010) Citizens' Perception of Past Environmental Damage and Liability in Countries with Transition: Evidence from Kemerovo, Russia, Transition Studies Review, 17: 763-776.

Kemerovo city government (2011) General Information about Kemerovo. Available at http://www.kemerovo.ru/gorod/english.html Retrieved on September 16 2011.

Kemerovo Region Committee of Natural Resources (2009) "State Report on the State of Environment and Environmental Protection in Kemerovo Region in 2008." Available at http://www.ecokem.ru/003/sod.html Retrieved on September 16 2011.

Kemerovo Region Department of Russian Consumer Supervision (2009) "State Report on Sanitary and Epidemiological Situation in Kemerovo Region in 2008", Kemerovo, 186pp. (in Russian)

Kuriyama, K. and Shoji Y. (eds.) Environmental Valuation of Recreation: An Application to the National Park Management. Keiso-shobo, 2005. (in Japanese)

Mikhailuts, A.P. and Mekush, G.E. (2006). 'The Influence of Past Environmental Damage Sites on Citizens' Health in Kemerovo Region', Eco-Bulletin InEca, 4, pp. 14-19 (in Russian)

Perfilieva, E. V. (2006) Past Environmental Liabilities in Kemerovo Oblast, (in World Bank (2007) Past environmental liability in the Russian Federation, Final Draft Report).

Russian Public Opinion Fund (2001). 'Ecological Problems'. Report of the nation-wide survey (in Russian). Available at http://bd.fom.ru/report/map/dd014424. Retrieved on January 14, 2011.

Russian Public Opinion Fund (2005). 'Ecological Situation in the Regions'. Report of the nation-wide survey (in Russian). Available at http://bd.fom.ru/report/map/dd052724 Retrieved on January 14, 2011.

Russian Public Opinion Fund (2007). 'Environmental in Russia: The Assessment of the situation'. Report of the nation-wide survey (in Russian). Available at http://bd.fom.ru/report/map/d073222 Retrieved on January 14, 2011.

Shahgedanova, M. and Burt, T. P. (1994) New data on air pollution in the former Soviet Union, Global Environmental Change, 4: 201-227.

Train, K. E. (2006), Discrete Choice Methods with Simulation, Cambridge University Press, New York, 2nd edition.

Vorobyov A. Y. and Zhukov S. V. (1996) Russian Economic Growth: Lessons from Liberalization, Medium-Term Constraints, and Ecological Challenges, World Development, 24: 359-371.

World Bank (2007a) Past environmental liability in the Russian Federation, Final Draft Report.

World Bank (2007b) Past environmental liability in the Russian Federation, Brochure. Available at http://siteresources.worldbank.org/INTECAREGTOPENVIRONMENT/Resources/10843-

Brochure3.pdf Retrieved on August 1, 2011.

Zaitcev V.I. and Mikhailuc A.P. (2001) "Hygienic estimation of environmental pollution caused by the long-term operation of concentrated chemical enterprises", Letopis publishing house, Kemerovo, 192p. (in Russian).

List of Tables

Table 1 Facilities and sites with environmental liabilities in the Kemerovo region

Sector	% of sites with environmental liabilities	Subjects of environmental liability and risks
Mining	25%	–Coal mines closed without performing proper environmental activities (43 mines, some of them drowned). Over 200 mining and concentration plants. –Square area of disturbed lands in Kuzbass is estimated to make up 91,700 ha, recultivation – 0.02% of disturbed land area.
Chemistry	20%	–Former defense industry plants in Kemerovo City: Progress and Kommunar. –22 chemical enterprises, including old operating plants. –Undeveloped landfills for hazardous chemical waste. –Old drug-producing plants in Anzhero-Sudzhensk and Novokuznetsk.
Ferrous and nonferrous metallurgy	18%	–Sludge collectors and ore dumping sites, waste landfills. –26 iron and steel plants, including old but operating ones. –Belovsky Zinc Plant.
Heat and power	16%	–49 power generating facilities, including old ones. –Sludge collectors and cooling ponds.
Municipal economy	14%	–Outdated sewage system without treatment facilities (discharge to the Tom River in Mezhdurechensk and Novokuznetsk). –Old domestic waste landfills. –Abandoned retention ponds, water bodies, old dilapidated dams of hydraulic structures.
Agriculture	7%	–Old pesticide storages, sometimes located in groundwater areas. –Old animal burials. –Abandoned farms with manure storages. –Old water wells in abandoned villages.

Source: Perfilieva (2006)

Table 2 Attributes and their levels

Attributes	Levels
Pollution in drinking water (iron concentration, mg/liter)	0.96 (status quo) 0.6 0.3 (Environmental standards)
Soil contamination and potential cancer risks (persons)	340,000 (status quo) 140,000 40,000
Medical check aimed at reducing cancer (number of people per 100,000)	28 (status quo) 14 7
Additional tax for the project implementation (rubles per household, yearly)	0 (only in the status quo option) 100 300 500

Table 3 Example of the choice sets

	Plan1	Plan 2	Current
Pollution in drinking water (iron concentration, mg/liter)	0.6 (Reduced by 0.36)	0.96 (No change)	0.96
Soil contamination and potential cancer risks (persons)	140,000 (Reduced by 200,000)	40,000 (Reduced by 300,000)	340,000
Medical check aimed at reducing cancer (number of people per 100,000)	7 (Reduced by 21)	7 (Reduced by 21)	28
Additional tax for the project implementation (rubles per household, yearly)	500	300	0
Circle the most desirable plan			

Table 4 Sociodemographics of the respondents

			Mean	Std. Dev.	Min.	Max.
Respondents' characteristics	Age		43.61	13.92	19.00	71.00
	Sex (male=1, female=2)		1.75	0.44	1.00	2.00
	Educational attainment (1=primary school (grades 1–3), 2=secondary school (grades 4–8), …, 5=university (bachelor), 6=graduate school)		5.01	1.09	2.00	6.00
Household characteristics	Number of household members		2.85	1.09	1.00	6.00
	Number of children	(0–4 years)	0.19	0.41	0.00	2.00
		(0–9 years)	0.31	0.53	0.00	2.00
		(0–14 years)	0.47	0.59	0.00	2.00
	Number of elderly members (excluding respondents)	(Aged 50 years or more)	0.83	0.88	0.00	3.00
		(Aged 60 years or more)	0.31	0.58	0.00	2.00
		(Aged 70 years or more)	0.09	0.29	0.00	1.00
	Dummy of location (1=Kirovsky, 0=others)		0.06	0.24	0.00	1.00
	Household income (rubles per month)[1]		18,859.38	8,843.71	0.00	47,500.00

Note: The number of observations is 160 for all of the estimation models, except for the educational attainment (sample size=157) and sex (sample size=159).

[1] 100 rubles was equivalent to 3.33 USD in 2009 December (IMF 2009).

Table 5 Estimation results

	(1) Models with profile attributes only		(2) Models with household attributes		(3) Models with age attributes	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Random parameters in utility functions						
Tax	$-2.83*10^{-2}$ ***	$4.75*10^{-3}$	$-3.94*10^{-2}$ ***	$7.74*10^{-3}$	$-6.82*10^{-2}$ ***	$1.35*10^{-2}$
Derived standard deviations of random parameters						
Tax	$3.32*10^{-2}$ ***	$4.68*10^{-3}$	$3.31*10^{-2}$ ***	$5.49*10^{-3}$	$3.74*10^{-2}$ ***	$6.71*10^{-3}$
Nonrandom parameters in utility functions						
ASC	4.55 ***	0.77	4.80 ***	0.84	5.22 ***	0.90
Pollution in drinking water	-0.75 **	0.35	-0.78 **	0.36	-0.85 **	0.36
Soil contamination	$-3.18*10^{-6}$ ***	$6.46*10^{-7}$	$-3.26*10^{-6}$ ***	$6.59*10^{-7}$	$-3.38*10^{-6}$ ***	$6.70*10^{-7}$
Medical check	$4.35*10^{-3}$	$1.48*10^{-2}$	$3.92*10^{-3}$	$1.51*10^{-2}$	$9.74*10^{-4}$	$1.56*10^{-2}$
Cross-terms with profile attributes						
Household income*tax			$5.45*10^{-7}$ ***	$2.04*10^{-7}$	$8.63*10^{-7}$ ***	$2.47*10^{-7}$
Age of respondents*tax					$4.21*10^{-4}$ ***	$1.48*10^{-4}$
Number of children (0–14 years old)*tax					$4.48*10^{-3}$ **	$2.14*10^{-3}$
Number of observations	480		480		480	
Number of samples	160		160		160	
McFaddens' Rho	0.268		0.273		0.280	

Note: The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 6 Marginal willingness to pay (MWTP) for reducing pollution in drinking water (MWTP for reducing iron concentration by 1 mg/liter, per year, per household)

–Households with average income (monthly income=18,859)

		Age of the respondent			
		30	40	50	60
No. of	0	21.56	24.15	27.45	31.79
children	1	24.34	27.69	32.11	38.21
(0–14)	2	27.93	32.44	38.67	47.87

–Households with lower quartile income (monthly income=12,500)

		Age of the respondent			
		30	40	50	60
No. of	0	18.92	20.88	23.30	26.36
children	1	21.02	23.47	26.58	30.62
(0–14)	2	23.65	26.80	30.92	36.53

–Households with higher quartile income (monthly income=27,500)

		Age of the Respondent			
		30	40	50	60
No. of	0	23.44	26.53	30.56	36.04
children	1	26.76	30.86	36.45	44.52
(0–14)	2	31.16	36.87	45.15	58.22

Table 7 Marginal willingness to pay (MWTP) for soil decontamination (MWTP to reduce risk by 10,000 persons, per year, per household)

–Households with average income (monthly income=18,859)

		Age of the respondent			
		30	40	50	60
No. of	0	0.86	0.97	1.10	1.27
children	1	0.97	1.11	1.28	1.53
(0–14)	2	1.12	1.30	1.55	1.91

–Households with lower quartile income (monthly income=12,500)

		Age of the respondent			
		30	40	50	60
No. of	0	0.76	0.83	0.93	1.05
children	1	0.84	0.94	1.06	1.22
(0–14)	2	0.95	1.07	1.24	1.46

–Households with higher quartile income (monthly income=27,500)

		Age of the respondent			
		30	40	50	60
No. of	0	0.94	1.06	1.22	1.44
children	1	1.07	1.23	1.46	1.78
(0–14)	2	1.25	1.47	1.80	2.33