Journal of Environmental Impact Assessment, Vol. 23, No. 5(2014) pp.323~336
http://dx.doi.org/10.14249/eia.2014.23.5.323
ISSN 1225-7184

Research Paper

A Study on Economic Evaluation of Beneficiary Pays Principle in Water Resource Management*

- The Case of Namyangju in Korea -

Jaehyun Yoon
KDI School of Public Policy and Management

수자원관리 부문에서 수혜자부담원칙 경제적 평가에 관한 연구*

- 남양주시 사례분석 -

윤 재 현
KDI 국제정책대학원

요 약 : 본 연구는 헤도닉가격기법(hedonic price method)을 활용한 경기도 남양주시의 2012년도 지가 분석을 통해 수질보호구역으로 인한 경제적 손실을 추정하고, 한강 하류지역에 수혜자부담원칙에 의해 부과되는 물이용부담금 제도에 대한 평가 의견을 제시한다. 분석결과 Double-log 모델이 수질보호구역으로 인한 영향을 추정하는데 보다 적합한 모델인 것으로 나타났으며, 본 연구에서 사용된 Double-log 모델에 따르면 남양주시에 대한 적정 총 보상액은 약 8.6조원으로 추정되었다. (95% 신뢰구간: 약 4.4조-12.4조원) 또한, 영구연금지급방식에 따른 남양주시에 대한 연간 보상액은 약 0.9 조원으로 추정되었으며 (95% 신뢰구간: 약 0.4조원-1.2조원), 이는 추정된 적정 연간 보상금이 2012년에 징수된 한강수계에 대한 물이용부담금 총액 (약 0.5 조원) 보다 높다는 것을 보여준다. 특히, 팔당지역의 국유지를 제외한 수질보호구역의 면적이 (약 2,572 km^2) 남양주시의 수질보호구역 면적의 (약 140 km^2) 18 배가 넘는 점을 고려할 때, 한강상류지역의 재산권 침해에 대한 적절한 보상을 위해 수혜자부담원칙에 따라 하류지역에 부과되는 물이용부담금의 인상이 필요할 것으로 판단된다.

주요어 : 수혜자부담원칙, 물이용부담금, 생태계서비스 지불, PES

Abstract : Using hedonic price method, this paper analyzes the impact of restriction for water quality protection on property value with the officially announced price of reference land in the city of Namyangju in 2012 to evaluate Water Use Fee, based on beneficiary pays principle, levied on the downstream area of the Han River in Korea. The results from the regression analyses of the models

* This paper is based on the author's Master's thesis (Yoon, 2014) in partial fulfillment of the requirements for the degree of Master of Development Policy at KDI School of Public Policy and Management.

Corresponding Author: Jaehyun Yoon, KDI School of Public Policy and Management, 85 Hoegiro, Dongdaemun, Seoul, 130-722, Korea
Received : 14 June, 2014. Revised : 13 August, 2014. Accepted : 18 August, 2014.

used show that the double-log model is the preferred model in the case of Namyangju. Using the double-log model, the total compensation for the city of Namyangju is estimated to be 8.6 trillion won with 95% confidence interval between 4.4 trillion and 12.4 trillion won. Under the perpetuity compensation scheme at the discount rate of 10%, the estimated annual compensation is 0.9 trillion won with 95% confidence interval between 0.4 trillion and 1.2 trillion won. This is more than Water Use Fee collected in 2012 for the Han River, which is approximately 0.5 trillion won. Considering the size of the restricted area of the Paldang area, which is more than 18 times of that of Namyangju, the rate of Water Use Fee, which is based on beneficiary pays principle and imposed on the residents of the downstream area, needs to be increased to sufficiently compensate the economic loss caused to the upstream areas of the Han River in Korea.

Keywords : Beneficiary pays principle, water use fee, payment for ecosystem services, PES

I. Introduction

Beginning in 1999, Korea has adopted Water Use Fee for the upstream region of the Han River, which is Korea's major river and crosses the country's capital, Seoul. The principle behind the fee is beneficiary pays principle, which levies the surcharge on the residents of the downstream area, who benefit from the freshwater supplied from the upstream area in order to compensate the loss caused to the residents of the upstream area, who are restricted to develop their areas due to the water quality protection. In fact, Water Use Fee is collected to form Han River Watershed Management Fund, which is used to provide financial assistances to the residents in the upstream areas and to support the purification of contaminated water.

Despite the clear logic of beneficiary pays principle, the fee levied on the residents of the downstream area is still in question as there is no direct method to value the cost associated with the services of freshwater using direct market prices. In specific, unlike commodities or financial products, there is no market for freshwater from the river, and market prices are not readily available for the freshwater. This means the cost of the ecosystem services of freshwater cannot be calculated using a direct valuation method based on market prices.

The objective of this paper is to estimate the cost of the services from freshwater of the Han River and to evaluate beneficiary pays principle in the case of the Han River. For the estimation, due to the fact that there is no market price available for the freshwater from Lake Paldang, this paper will utilize hedonic price method using officially announced price of reference land of the city of Namyangju, which is attached to Lake Paldang, in the year of 2012. In fact, Lake Paldang is an artificial lake created by a dam in the Han River and is the main water resource for the residents of the downstream area, and the area around Lake Paldang is subject to heavy restrictions in order to protect the water from contamination.

Through the analyses on the land price of the city of Namyangju, the economic loss caused by the restriction for water quality protection will be analyzed, and the current beneficiary pays principle for the Han River, which is funded through Water Use Fee, will be tested. In fact, the city of Namyangju has both restricted area (42.6%) and unrestricted area (57.4%) within its administrative district (Government of Gyeonggi Province, 2013), and the analysis on Namjangju allows a cross-sectional analysis using hedonic price method to compare the land prices with respect to restriction for water quality protection.

The results of the cross sectional analysis on the city of Namyangju suggest that there is statistically significant evidence for the economic loss caused by water quality protection. In addition, the total amount of compensation estimated by the results of the cross sectional analysis suggests that the current Han River Watershed Management Fund is not sufficient, and Water Use Fee needs to be increased.

II. Research Method and Results

1. Research Method

In order to test the economic impact of restriction for water quality protection in the city of Namyangju, a hedonic price method, derived from the works by Lancaster (1966) and Rosen (1974), is used in this paper. Among the valuation methods for non-market valuation, which include travel cost method and contingent valuation method, hedonic price method is chosen due to the availability of land price data in Namyangju. The land price can be utilized to estimate the difference in willingness-to-pay (WTP) between the restricted and the unrestricted area. The difference can lead to the estimation of appropriate compensation for the restricted area. In the past, hedonic price methods are used to estimate the impact of air pollution (Chattopadhyay, 1999; Murdoch and Thayer, 1998; Zabel and Kiel, 2000), noise (Lake I. R. et al., 2000), view (Benson et al., 1998; Kendree and Rauch, 1990; Rodriguez and Sirmans, 1994; Wolverton, 1997), and neighboring facilities (Kim and Jung, 2012; Sirpal, 1994).

For comprehensive analyses, this paper presents both descriptive and regression analyszes on the land prices and independent variables that affect the land prices and estimates the land price difference caused by the restriction for water quality protection. In addition, a customized border analysis on the samples around the borderline between the restricted area and unrestricted area will be conducted. For the regression analyses, STATA/IC 11.1 is used.

For the land price, which will be the dependent variable, the officially announced prices of reference lands of Namyangju in the

Table 1. Hedonic price models used

Type	Function	Remarks
Semi-log model	$\ln(Y) = \alpha + \beta_1 X_1 + \sum_{i=2}^{7} \beta_i X_i + \sum_{i=8}^{20} \beta_i X_i + \varepsilon$	Y: dependent variable (land price) a: constant X1: independent variable (restriction for water quality protection)(dummy variable) Xi (i= 2, 3, ⋯, 7): independent variables (accessibility and land size variables) Xi (i= 8, 9, ⋯, 20): independent variables (isolation and land type variables)(dummy variables)
Double-log model	$\ln(Y) = \alpha + \beta_1 X_1 + \sum_{i=2}^{7} \beta_i \ln(X_i) + \sum_{i=8}^{20} \beta_i X_i + \varepsilon$	

Table 2. Definitions of the variables used

Variable		Attribute	Measurement
Dependent Variable			
Land price		Officially announced price of reference land	won/m²
Independent Variables			
Restriction variable			
Restriction		Development restriction for water quality	If restricted =1, If not restricted = 0
Accessibility variables			
Primary school		Distance to the closest primary school	km
Hospital		Distance to the closest hospital	km
Convenience store		Distance the closest convenience store	km
Seoul		Distance to the center of Seoul	km
Road		Distance to the closest road	km
Isolation		The sample land does not have direct access to road (the land cannot be accessed by automobile)	If yes = 1, If no = 0
Land size variable			
Land size		The land size of the sample	m²
Land type variables			
In comparison to building site	Dry field	The type of land is dry field	If yes = 1, If no = 0
	Factory	The type of land is factory site	If yes = 1, If no = 0
	Forest	The type of land is forest land	If yes = 1, If no = 0
	Gas station	The type of land is gas station site	If yes = 1, If no = 0
	Orchard	The type of land is orchard	If yes = 1, If no = 0
	Paddy field	The type of land is paddy field	If yes = 1, If no = 0
	Pasture	The type of land is pasture	If yes = 1, If no = 0
	Religion	The type of land is religious site	If yes = 1, If no = 0
	River	The type of land is stream area	If yes = 1, If no = 0
	Sports site	The type of land is sports site	If yes = 1, If no = 0
	Warehouse	The type of land is warehouse site	If yes = 1, If no = 0
	Misc.	The type of land is miscellaneous land	If yes = 1, If no = 0

year of 2012 are used, and the two types of hedonic price models, semi-log model and double log model, are chosen as described in Table 1.

The dependent and independent variables that are used in the hedonic price models of this paper are defined in Table 2 as follows:

"Land price" represents officially announced price of reference land measured in the Korean won per square meter (won/m²) in 2012 and is the dependent variable. "Restriction" is a dummy variable that shows whether the sample observations are under development restriction for water quality protection, and the value of variable is 1 if the sample is a land sample that is under restriction for water quality protection and is 0 if the sample is not under the restriction; the restricted area includes Water Source Protection Area, Water Source Special Policy Area (Area I and Area II), Water-pollutant Buffering Zone, and Nature Protection Area. The coefficient of this variable will be used to estimate the loss rate that shows the difference in land price between the restricted area and the unrestricted area.

The accessibility variables used in this paper show the distance from a sample land to facilities, infrastructure, and city that affect the land price. "Primary school" is direct distance between a sample land and the closest primary school. The data are as of end of 2012 and are the public data announced by Ministry of Education of Korea. "Hospital" shows the direct distance between a sample land and the closest hospital. The hospitals include upper-level general hospitals, general hospitals, dental hospitals, dental clinics, oriental hospitals, and oriental clinics. The data are the public data announced by Health Insurance Review and Assessment Service (HIRA), and the ones used in this paper are updated in 2012. "Convenience store" is the direct distance between a sample land and the closest convenience store. The convenience stores in this paper include the stores of major convenience store franchises in Korea: Seven Eleven, Buy the Way, CSPACE, CU, Ministop, and GS25. The data are collected from the websites of the above mentioned convenience stores and Korea Association of Convenience Stores, which are updated as of the end of the year 2012.

"Seoul" represents the direct distance from the center of Seoul to the sample points. The coordinates of the center of Seoul in this paper have the latitude of 37.573 degree and the longitude of 126.985 degree. Seoul is the capital and the largest city in Korea. In addition, Seoul is the economic center of Korea. In this regard, it is assumed that the distance to Seoul affects the land price of the areas around it. "Road" demonstrates the direct distance between a sample land and the closest road, which is key infrastructure.

"Land size" represents the size of the sample lands. The data are announced by Ministry of Land, Infrastructure and Transport of Korea. "Isolation" is a dummy variable that shows whether a sample land is directly connected to a road. If the sample land is directed connected, the value is 0, and if not, the value is 1. In addition, there are 13 dummy variables according to the types of land. The types of land include dry field, factory, forest, gas station, sports site, orchard, paddy field, pasture, religion, river, building site,

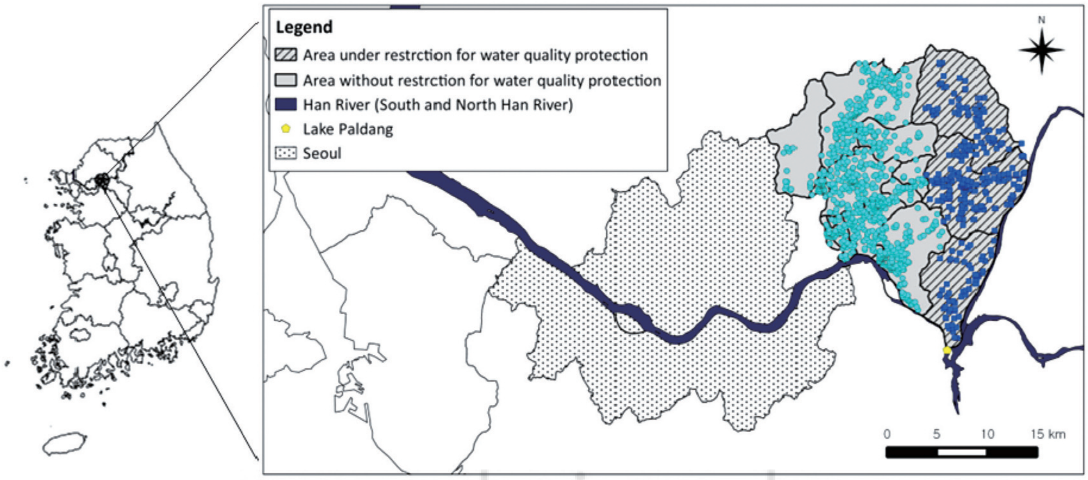

Figure 1. Sample map of Namyangju

Table 3. Number of sample observation

	Restricted area	Unrestricted area	Total
Number of sample observation	286	795	1,081

Table 4. Sample area and actual area of Namyangju

	Restricted area	Restricted area (%)	Unrestricted area	Unrestricted area (%)	Total
Sample area (km^2)	3.0	42.6%	4.1	57.4%	7.1
Actual area (km^2)	194.9	42.6%	263.1	57.4%	458.1

Table 5. Descriptive statistics of sample data (excluding dummy variables)

Variable	Mean	SD	Min.	Max.
Land price (won/m^2)	511,882	755,479	1,300	6,150,000
Primary school (km)	1.1	0.8	0.1	3.8
Hospital (km)	1.1	1.0	0.0	4.9
Convenience store (km)	1.0	0.9	0.0	5.4
Seoul (km)	23.8	5.3	13.4	36.5
Road (km)	0.2	0.3	0.0	2.5
Land size (m^2)	6,593	32,373	73	869,225

warehouse, and miscellaneous. The mentioned 13 dummy variables are analyzed in comparison to the samples of which type of land is building site.

2. Descriptive Analysis

Using two hedonic price models, semi-log model and double-log model, the data analyses on the land prices of Namyangju were conducted. All the data used in this paper are those in the year of 2012. As shown in Figure 1, 1,081 data points were analyzed for this paper.

Among the total data points used, 286 represent the areas under restriction for water quality protection, and 795 represent the area without the restriction as described in Table 3.

The data points are randomly chosen in a way to represent Namyangju's proportion of the areas under the restriction and those without the restriction. The actual area and sample area are shown in Table 4 as follows:

The descriptive statistics of the total sample data analyzed are presented in Table 5 and Table 6 as follows:

Table 6. Descriptive statistics of sample data (dummy variables)

Dummy Variables	Number of variable with the value = 1	
	Number of Observations	%
Total Observations	1,081	100
Isolation	186	17.2
Dry field	210	19.4
Factory	39	3.6
Forest	150	13.9
Gas station	1	0.1
Orchard	2	0.2
Paddy field	232	21.5
Pasture	24	2.2
Religion	1	0.1
River	1	0.1
Building site	380	35.2
Sports site	4	0.4
Warehouse	1	0.1
Misc.	36	3.3

Table 5 shows that the range for sample land prices is between 1,300 won/m^2 and 6,150,000 won/m^2. The direct distances to the closest primary school are between 0.1 km and 3.8 km.

Table 7. Descriptive statistics of sample data sorted by restriction (excluding dummy variables)

Variable	Mean	SD	Min.	Max.
Unrestricted area				
Land price (won/m^2)	605,121	824,675	1900	6,150,000
Primary school (km)	1.1	0.7	0.1	3.6
Hospital (km)	0.9	0.8	0.0	4.2
Convenience store (km)	0.9	0.7	0.0	3.3
Seoul (km)	21.3	3.5	13.4	30.4
Road (km)	0.2	0.3	0.0	2.5
Land size (m^2)	5,142	17,949	73	293,713
Restricted area				
Land price (won/m^2)	252,703	420,084	1,300	3,850,000
Primary school (km)	1.3	0.8	0.1	3.8
Hospital (km)	1.5	1.2	0.0	4.9
Convenience store (km)	1.4	1.3	0.0	5.4
Seoul (km)	30.8	2.6	26.0	36.5
Road (km)	0.3	0.4	0.0	2.4
Land size (m^2)	10,627	55,242	93	869,225

Table 8. Descriptive statistics of sample data sorted by restriction (dummy variables)

Dummy Variables	Number of observations with the value = 1			
	Unrestricted area		Restricted area	
	Number of Observation	%	Number of Observation	%
Total Observations	795	100	286	100
Isolation	123	15.5	63	22.0
Dry field	150	18.9	60	21.0
Factory	25	3.1	14	4.9
Forest	102	12.8	48	16.8
Gas station	1	0.1	0	0.0
Orchard	2	0.3	0	0.0
Paddy field	176	22.1	56	19.6
Pasture	23	2.9	1	0.3
Religion	0	0.0	1	0.3
River	1	0.1	0	0.0
Building site	287	36.1	93	32.5
Sports site	2	0.3	2	0.7
Warehouse	0	0.0	1	0.3
Misc.	26	3.3	10	3.5

The main land types are building site (35.2%), paddy field (21.5%), and dry field (19.4%). 17.2% of the samples do not have direct access to road.

The descriptive statistics of the sample data sorted by restriction show that the mean value of the land price in the unrestricted area, which is a simple average value, 605,121 won/m^2, is more than two times greater than that of the restricted area, 252,703 won/m^2. For other variables including the direct distance to primary schools, hospitals, convenience stores, Seoul, and roads, the restricted area has greater values. Lastly, the

Table 9. Area-weighted average land price of the samples used (Unit: won/m²)

Total(both unrestricted area restricted area)	Unrestricted area	Restricted area
195,356	309,066	42,417

average land size of sample lands in the restricted area, 10,627 m² is more than two times greater than that of the unrestricted area, 5,142 m². The detailed data are shown in Table 7 and Table 8.

The sample data used for this paper show that area-weighted average land price of the city of Namyangju is 195,356 won/m². The weighted average land price of the unrestricted area and the restricted area are 309,066 won/m² and 42,417 won/m², respectively, as shown in Table 9.

The above calculations show that there is a significant land price difference between the restricted area and the unrestricted area. The area-weighted average land price of the unrestricted area is more than seven times higher than that of the restricted area. Since the price difference can be a result of various factors, using regression analyses, the following section will examine how much of the land price difference between the unrestricted area and restricted area is caused by the restriction for water quality protection.

3. Regression Analysis

In order to estimate the land value loss in the city of Namyangju caused by the restriction for water quality protection, the regression analyses were conducted using two hedonic price models, semi-log model and double-log model. The regression technique used in this section is ordinary least square (OLS) regression, and the result is shown in Table 10.

According to the regression results of the semi-log model, the model explains approximately 85.2% of the variation in land prices. In addition, the result shows that there is statistically significant evidence which suggests the land price difference caused by the restriction for water quality protection at the significance level of 0.05. The regression results of the double-log model show that it explains approximately 89.3% of the variation in land prices. Like the semi-log model, the result from the double-log model suggests statistically significant evidence that shows the land price difference caused by the restriction for water quality protection at the significance level of 0.001.

The conversion of the coefficient of the restriction variable (Restriction) suggests the loss rate which shows the difference in land price between the restricted and the unrestricted area. The conversion process, which shows the change in land price according to the value of the restriction variable, is as follows:

$\Delta \ln(Y) = (\beta_1)(X_1 = 1) - (\beta_1)(X_1 = 0)$,

$X_1 = 1$ if the sample is restricted (= 0 if not)

$\Delta Y = \exp(\beta_1)(1)$

Y = Land price (won/m²)

X_1 = Restriction variable

β_1 = estimate of X_1

Based on the conversion process described above, the loss rate can be calculated as follows:

Loss rate (%)= $1 - \exp(\beta_1)$

β_1 = estimate of X_1

The loss rate shows the land price difference between the restricted and the unrestricted area in terms of the land price of the unrestricted area. Following the equation above, the land price of

Table 10. Regression results for Namyangju (semi-log model and double-log model)

Dependent variable: ln(Land price)				
	Semi-log model		Double-log model	
Independent variables	Parameter estimates	Standard errors	Parameter estimates	Standard errors
Restriction Variable				
Restriction	**-0.162***	**(0.077)**	**-0.220***	**(0.058)**
Accessibility variables				
Primary School	-0.181***	(0.043)	-0.138***	(0.031)
Hospital	-0.120***	(0.032)	-0.148***	(0.017)
Convenience store	-0.165***	(0.034)	-0.125***	(0.024)
Seoul	-0.038***	(0.007)	-0.764***	(0.119)
Road	-0.652***	(0.072)	-0.188***	(0.014)
Isolation	-0.420***	(0.063)	-0.361***	(0.054)
Land size variable				
Land size	-0.000	(0.000)	-0.146***	(0.021)
Land type variables and constant				
Dry field	-0.988***	(0.058)	-0.623***	(0.056)
Factory	-0.458***	(0.110)	-0.130	(0.096)
Forest	-3.459***	(0.079)	-2.763***	(0.099)
Gas station	0.877	(0.646)	0.875	(0.549)
Orchard	-1.528***	(0.457)	-0.886*	(0.392)
Paddy field	-1.149***	(0.055)	-0.752***	(0.055)
Pasture	-0.777***	(0.137)	-0.396***	(0.120)
Religion	-1.118	(0.646)	-0.597	(0.551)
River	-1.705**	(0.645)	-1.146*	(0.551)
Sports site	-1.273***	(0.368)	-0.584*	(0.294)
Warehouse	-0.450	(0.645)	-0.275	(0.549)
Misc.	-0.281*	(0.113)	-0.141	(0.096)
_cons.	14.827***	(0.140)	15.877***	(0.378)
N	1081		1081	
R^2	0.852		0.893	

1) * p < 0.05, ** p < 0.01, *** p < 0.001
2) The parameter estimate refers to the midpoint of 95 percent confidence interval.

Table 11. Loss rates for the restricted area of Namyangju

	Semi-log Model	Double-log Model
Loss rate	15.0%	19.8%
[95% confidence interval]	[1.1%, 26.9%]	[10.0%, 28.5%]

the restricted area is approximately 85.0% of that of the unrestricted area under the semi-log model and approximately 80.2% under the double-log model. This suggests that the loss rate for the semi-log model is 15.0%[1] and 19.8%[2] for the double-log model.

Both the semi-log model and double-log model suggest the land price difference between the restricted and the unrestricted area caused by the restriction for water quality protection. The inclusion of variables related with accessibility, land size, and land type in the models implies that the coefficients of the restriction variables in the two models are independent of the impacts

1) Loss rate (%) = $1 - \exp(\beta_1) = 1 - \exp(-0.162) = 15.0\%$
2) Loss rate (%) = $1 - \exp(\beta_1) = 1 - \exp(-0.220) = 19.8\%$

Table 12. Estimated total compensation for water quality protection in Namyangju (Unit: trillion won)

	Semi-log Model	Double-log Model
Total Compensation	6.5	8.6
[95% confidence interval]	[0.5,11.7]	[4.4,12.4]

Table 13. Total Water Use Fee collected in the region of the Han River (Unit: billion won)

Year	1999	2000	2001	2002	2003	2004	2005	2006
Total Water Use Fee Collected	28	175	231	247	269	284	304	338
Year	2007	2008	2009	2010	2011	2012	Total	
Total Water Use Fee Collected	363	386	398	404	431	492	4,300	

Source: Ministry of Strategy and Finance of Korea (2013)

from the variables included in the models. From this point of view, the regression results suggest the loss rates for the restricted area of Namyangju, which are not affected by the economic impacts of the variables mentioned, as shown in Table 11.

Using the above rates, the total compensation for water quality protection in Namyangju can be estimated using the following formula:

$$TC = LP_U \times R \times A_R$$

TC: Total compensation
LP_U: Land price of unrestricted area
R: Loss rate
A_R: Land size of restricted area[3)]

The restricted area in Namyangju is approximately 140.4 km^2 after excluding the lands owned by the central government, local government, and military, and the total compensation estimated according to the results of the models used are shown in Table 12.

The total compensation for Namyangju is estimated to be 6.5 trillion won with 95% confidence interval between 0.5 trillion and 11.7 trillion won under the semi-log model. In the case of the double-log model, the total compensation is estimated to be 8.6 trillion won with 95% confidence interval between 4.4 trillion and 12.4 trillion won. The estimated values for the total compensation are much higher than Water Use Fee collected in the period from 1999 to 2012, which is approximately 4.3 trillion won as shown in Table 13

Table 14. Estimated perpetuity compensation for water quality protection in Namyangju[4)] (Unit: trillion won)

Discount rates	Semi-log Model	Double-log Model
3% [95% confidence interval]	0.2 [0.01, 0.4]	0.3 [0.1, 0.4]
8% [95% confidence interval]	0.5 [0.04, 0.9]	0.7 [0.3, 1.0]
10% [95% confidence interval]	0.7 [0.05, 1.2]	0.9 [0.4, 1.2]

Using a perpetuity compensation model, for the semi-log model, under the discount rates of 3%, 8% and 10%, the annual compensations are estimated to be 0.2, 0.5, and 0.7 trillion won, respectively. Under the double-log model, the annual compensations are 0.3, 0.7, and 0.9 trillion won, respectively, as shown in Table 14.

In fact, the annual collection of Water Use Fee in 2012 is approximately 0.5 trillion won as shown in Table 13. Considering the fact that Water Use Fee is collected for the entire upstream areas, the current Water Use Fee is not sufficient even under the perpetuity compensation scheme. From this point of view, the estimated

3) The restricted area excludes the land owned by the central government, local government, and military

4) Perpetuity compensation = total compensation × discount rate

compensations suggest that there should be a substantial increase in Water Use Fee in order to adequately compensate for the economics loss caused to the upstream region of the Han River.

III. Discussion

Despite the statistically significant evidence that supports the economic loss caused by water quality protection, this paper is still exposed to a number of limitations. First of all, the land price data used in this paper are officially announced prices of reference lands and thus are not the price data from actual transactions. Due to this reason, there may be difference between the results of this paper and those based on the actual willingness-to-pay for the lands in the city of Namyangju. However, the officially announced prices of reference lands serve as official bases for various taxes and surcharges. In addition, there is no reliable public institution in Korea that publicly announce actual transaction land prices on a regular basis. From this point view, based on officially announced prices of reference land, the results from this paper can provide a meaningful implication for Water Use Fee, which is a surcharge imposed on the residents of the downstream, who benefit from the clean water from the upstream area.

Secondly, this paper is based on cross sectional analyses. This implies that this paper assumes that the results of the regression analyses are constant over time. The factors that affect the land price might change over time, and thus the regression results may be affected by the potential changes in the future. From this point of view, the nature of cross sectional analysis should be carefully considered when interpreting the results of this paper.

Lastly, the regression analyses of this paper do not explain all the variations of the land prices. According the regression results, the semi-log model and the double-log model explain approximately 85.2% and 89.3% of variations in the land prices. This means that the coefficient for the restriction variable may change if the variations of the land prices are fully explained, and thus, the loss rates for the restricted area can be changed. Despite the possibility of omitted variable bias, the results of the models should be significant, considering R-squared values of the hedonic price models used (R-squared values for semi-log model and double-log model are 85.0% and 89.3%, respectively).

IV. Conclusion and Policy Implications

Based on the analyses on the officially announced price of reference land in Namyangju in the year of 2012, this paper demonstrates that there is statistically significant evidence that supports the land price difference between the restricted area and the unrestricted area of Namyangju, which is caused by water quality protection. In specific, under the semi-log model, the loss rate that the restricted area experience is estimated to be 15.0% of the land price of the unrestricted area. Under the double-log model, the rate is 19.8%.

The 95% confidence intervals of the loss rates from the models used suggest that the double-log model is more appropriate than the semi-log in estimating the compensation for Namyangu as it explains more land price variation and also provides narrower 95% confidence interval. This implies that the double-log model provides more precise estimations in the case of Namyangju.

Using the results from the regression analyses of the double-log model, which is more preferred than the semi-log model, the estimated compensation for the city of Namyangju is estimated to be 8.6 trillion won with 95% confidence interval between 4.4 trillion and 12.4 trillion won. This is much more than Water Use Fee that collected in the period from 1999, its inception year, to 2012, which is estimated to be approximately 4.3 trillion won (Han River Watershed Management Committee of Korea, 2013; Ministry of Environment of Korea, 2013). In addition, the previous analysis shows that under the perpetuity compensation scheme at the discount rate of 10%, the estimated annual compensation is 0.9 trillion won with 95% confidence interval between 0.4 trillion and 1.2 trillion won, which is greater than the Water Use Fee collected in 2012, approximately 0.5 trillion won. In fact, the restricted area of the Paldang area for water quality protection[5)], including Namyangju, is approximately 2,572 km^2; the restricted area in the Paldang area is more than 18 times of that of Namyangju, which is approximately 140 km^2. From this point of view, the results suggest that the rate of Water Use Fee needs to be substantially increased to sufficiently compensate the economic loss caused to the upstream areas of the Han River under Korea's current water management system.

The upward adjustment of Water Use Fee following the results of this paper would lead to the charge of multi-trillion won on the residents of the downstream areas of the Han River in addition to the current fees charged by the Korean government based on polluter pays principle. Considering the social cost associated with the compensation added to the cost based on polluter pays principle, this implies that in some cases, it would be more economical to adopt alternative policies for Korea's water resource management, which are based on market mechanism and allows to control the water quality at lower costs, rather than to stick with the current system that highly relies on the restriction areas imposed by the law.

The results of this paper further imply that the hedonic price method used in this paper can provide a meaningful guidance for payment schemes for ecosystem services that human well-being depends. Due to the lack of market prices for ecosystem services, in many cases, it is difficult to estimate the ecosystem services including those of freshwater, forest, etc. In fact, through the analyses on the land price of Namyangju, the estimated compensations of this paper can be interpreted as the cost associated with the provision of the ecosystem services of freshwater to the downstream area of the Han River, which is levied on the restricted areas in Namyangju for water quality protection. Based on the view that ecosystem services can be sustainable with appropriate payment schemes, the analysis method used in this paper can be utilized to estimate the cost associated with the ecosystem services and further assist in designing payment schemes and supporting policies for sustainability of various ecosystem services.

Lastly, the results of this paper provides implications for developing countries where environmental restrictions are often imposed by the central government without proper

5) The area includes the restricted areas in Namyangju, Yangpyeong, Hanam, Yeoju, Icheon, Yongin, Kwangju, and Gapyeong and excludes the land owned by the central government, local government, and military.

compensation schemes. With customization and refinement, the analysis method of this paper can be used in estimating the economic loss caused by environmental regulation, and the results could serve as a starting point for policy adjustment, which can contribute in formulating development policies that allow the countries to resolve environmental disputes at the same time to maximize both economic development and environmental conservation.

인용문헌

경기도. 2013. 2012년도 팔당백서.

국토교통부. 2013. 부동산공시가격 알리미, http://www.kreic.org/realtyprice (2013년 12월 10일 접속).

기획재정부. 2013. 2012년도 부담금운용종합보고서.

한강수계관리위원회. 2013. 한강수계관리기금통계.

환경부. 2013. 2013 환경통계연감.

Benson, E. D., Hansen, J. L., Schwartz, A. L. & Smersh, G. T. 1998. Pricing Residential Amenities: The Value of a View, Journal of Real Estate Finance and Economics, 16(1): 55-73.

Chattopadhyay, S. 1999. Estimating the Demand for Air Quality: New Evidence Based on the Chicago Housing Market, Land Economics, 75(1): 1-22.

Kendree J. M, Rauch D. A. 1990. Toward a Theory on the Effects of View and Size on the Price of Real Estate, ARES annual meeting Lake Tahoe NV.

Kim and Jung. 2012. An Analysis of the Impact of Locally Unwanted Land Uses on Land Price in Ulsan City, The Journal of the Korean Urban Administration Association, 25(3): 161-175.

Lake, I. R., Lovett, A. A., Bateman, I. J., Day, B. H. 2000. Improving Land Compensation Procedures via GIS and Hedonic Pricing, Environment and Planning C: Government and Policy, 18(6): 681-696.

Lancaster, K. J. 1966. A New Approach to Consumer Theory, Journal of Political Economy, 74: 132-157.

Murdoch, J. and Thayer, M. 1988. Hedonic Price Estimation of Variable Urban Air Quality, Journal of Environmental Economics and Management, 15: 143-146.

Rodriguez, M. and Sirmans, C. F. 1994. Quantifying the Value of a View in Single-family Housing Markets, Appraisal Journal, 62: 600-603.

Rosen, S. 1974. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition, Journal of Political Economy, 82(1): 35-55.

Sirpal, R. 1994. Empirical Modeling of the Relative Impacts of Various Sizes of Shopping Centres on the Value of Surrounding Residential Properties, Journal of Real Estate Research, 9(4): 487-505.

Wolverton M. L. 1997. Empirical Study of the Relationship between Residential Lot Price, Size and View, Journal of Property Valuation and Investment, 15(1): 48-57.

Yoon, J. 2014. A Study on Economic Evaluation of Beneficiary Pays Principle in Water Resource Management: The Case of Namyangju in Korea, Master's Thesis, KDI School of Public Policy and Management.

Zabel, J. and Kiel, K. 2000. Estimating the Demand for Air Quality in Four Cities in the United States, Land Economics, 78: 174-194.

References

Benson, E. D., Hansen, J. L., Schwartz, A. L. & Smersh, G. T.1998. Pricing Residential Amenities: The Value of a View, Journal of Real Estate Finance and Economics, 16(1): 55-73.

Chattopadhyay, S. 1999. Estimating the Demand for Air Quality: New Evidence Based on the Chicago Housing Market, Land Economics, 75(1): 1-22.

Government of Gyeonggi Province. 2013. 2012 Paldang Whitebook (in Korean).

Han River Watershed Management Committee of Korea. 2013. Statistics on Han River Watershed Management Fund (in Korean).

Kendree J. M, Rauch D. A. 1990. Toward a Theory on the Effects of View and Size on the Price of Real Estate, ARES annual meeting Lake Tahoe NV.

Kim and Jung. 2012. An Analysis of the Impact of Locally Unwanted Land Uses on Land Price in Ulsan City, The Journal of the Korean Urban Administration Association, 25(3): 161-175.

Lake, I. R., Lovett, A. A., Bateman, I. J., Day, B. H. 2000. Improving Land Compensation Procedures via GIS and Hedonic Pricing, Environment and Planning C: Government and Policy, 18(6): 681-696.

Lancaster, K. J. 1966. A New Approach to Consumer Theory, Journal of Political Economy, 74: 132-157.

Ministry of Environment of Korea. 2013. 2012 Environmental Statistics Yearbook.

Ministry of Land, Infrastructure and Transport. 2013. Official Real Estate Price Guidance (in Korean), http://www.kreic.org/realtyprice (Accessed in 10 December 2014)

Ministry of Strategy and Finance of Korea. 2013. Comprehensive Report on Management of Surcharges in 2012.

Murdoch, J. and Thayer, M. 1988. Hedonic Price Estimation of Variable Urban Air Quality, Journal of Environmental Economics and Management, 15: 143-146.

Rodriguez, M. and Sirmans, C. F. 1994. Quantifying the Value of a View in Single-family Housing Markets, Appraisal Journal, 62: 600-603.

Rosen, S. 1974. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition, Journal of Political Economy, 82(1): 35-55.

Sirpal, R. 1994. Empirical Modeling of the Relative Impacts of Various Sizes of Shopping Centres on the Value of Surrounding Residential Properties, Journal of Real Estate Research, 9(4): 487-505.

Wolverton M. L. 1997. Empirical Study of the Relationship between Residential Lot Price, Size and View, Journal of Property Valuation and Investment, 15(1): 48-57.

Yoon, J. 2014. A Study on Economic Evaluation of Beneficiary Pays Principle in Water Resource Management: The Case of Namyangju in Korea, Master's Thesis, KDI School of Public Policy and Management.

Zabel, J. and Kiel, K. 2000. Estimating the Demand for Air Quality in Four Cities in the United States, Land Economics, 78: 174-194.