Electronic Journal of Applied Statistical Analysis
EJASA, Electron. J. App. Stat. Anal.
http://siba-ese.unisalento.it/index.php/ejasa/index
e-ISSN: 2070-5948
DOI: 10.1285/i20705948v9n3p502

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Published: 2 November 2016

Electronic Journal of Applied Statistical Analysis
Vol. 09, Issue 03, November 2016, 502-519
DOI: 10.1285/i20705948v9n3p502

Estimation of the cost of the direct damage on human resources caused by water pollution

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Published: 2 November 2016

A set of simple models is proposed in this study to measure the cost of the direct effects of water pollution on human resources. Inductive reasoning is used while developing and applying the models on a hypothetical case to demonstrate the feasibility and practicability of the proposed models. By testing the validity and applicability of the proposed models, a professional accountant may recognize the accounting transactions tangibly in the financial statements of the polluted companies. This will improve the quality of companies' financial reporting.

keywords: Water Pollution Costs, Human Resources, Financial Reporting.

1 Introduction

The interaction between human beings and environment is a continuous and a dynamic reaction. The level of environmental pollution is increasing as the economies develop, industries grow, and scope of technology expands at both international and regional levels. The economic and social problems escalate if the economic systems and modern technologies result in emissions that exceed the permitted limits (Saal et al., 2007). Consequentially, the human activities will lead to damages of environment, including additional medical treatment, lost income, early death, depletion of natural resources, environmental pollution and abnormal climates. There is global consensus to promote sustainable development.

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ISSN: 2070-5948
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Many countries around the world have mandated enterprises to establish green accounting and to disclose environmental information for interested parties (Tu and Huang, 2015). Our study aims to propose a set of simple models to measure the cost of direct effects on human resources induced by water pollution.

The findings of the study serve to help and prepare the companies to recognize the accounting transactions in the financial statements tangibly which will improve the quality of companies' financial reporting.

The study is organized into seven sections.

- Section 2: Summarizes previous studies.
- Section 3: Pollution costs control from economic perspective.
- Section 4: Measuring cost of water pollution damages from an accounting perspective.
- Section 5: Estimation of water pollution damages using wealth approach.
- Section 6: Estimation of the cost of direct damages on human resources.
- Section 7: summary, conclusions, limitation, recommendations and future studies.

2 Literature Review

Although the potential benefits of industrial pollution control are clear in many developing countries, policy makers continue to worry about the costs (Freedman and Jaggi, 1992; Gray et al., 1995; De Gois et al., 2015). It has been difficult to address this concern explicitly, because little empirical evidence has been available. In addition, information about abatement costs would be extremely useful for the design of cost effective regulation (Dasgupta et al., 2001; Muller et al., 2011). Industrial air and water pollution worldwide have been major concerns for the last two decades. A recent assessment by the Chinese Research Academy of Environmental Sciences (CRAES) has identified industrial pollution as the source of approximately 70% of China's total environmental pollution. Current estimates of human health damage from urban air and water pollution are very high for some areas (Parris, 2011). Such high levels of damage are primarily due to the rapid growth of pollution-intensive industries, not to lack of effort by environmental regulators.

On other hand, many people die prematurely around the world every year because of water and outdoor air pollution. Many of these deaths and their related costs may be prevented with appropriate environmental policies. In fact, improving environmental conditions upstream to prevent environment-related health problems from developing can be far more effective than trying to treat health problems when they arise further downstream. That means significant cost savings for healthcare as well. Polluted air and water can cause acute illnesses, and can also lead to death. Although air and water pollutants are generally highly regulated, OECD countries are still significantly affected by these environmental health risks.

Anderson et al. (2007) examined the environmental perceptions, behaviors and awareness vis-à-vis water and water pollution in South Africa by analyzing the results from the 2004 South African General Household Survey. They looked at the similarities and differences between African and non-African households pertaining to the perceptions, behaviors and awareness of programs related to water and air pollution. They found that water pollution is perceived as a community problem by Africans and those with lower socio-economic status; educational attainment is not pertinent to this perception. When water pollution is perceived as a problem, environmental education is an effective way to help implement proactive strategies to treat water for drinking and food preparation. Parris (2011) inspects the latest trends and economic costs of agricultural water pollution. The most recent Organization for Economic Co-operation and Development (OECD) policy experiences in tackling the issue of water pollution in agriculture, and the medium outlook for pollution across OECD countries are inspected as well. He also explores ways forward toward sustainable management of water quality in agriculture.

American Auditing Association (AAA) formed four committees during 1972- 75 for measuring the efficiency of social programs, determining the systematic conduct on the environment, measuring the social cost and determining cost concept (AAA, 1975; Ananda and Hampf, 2015). The American Institute of Cost Public Accountants (AICPA) and Accountancy Committee of National Accountancy Association (NAA) constituted committees for measuring social performance of business firms (Ackerman, 1973; Sheikh, 2010; Weaver III and Simmons, 2012).

In England, Standard Committee, which emanates from Chartered Accountants Complex in England and Wales, recommended amendment of fiscal reports in order to reflect the cost and benefits of social performance in addition to the economic performance. In France, Professional Societies for Accountancy (PSA) issued recommendations concerning the expression of social performance in the projects' fiscal lists, in order to acquaint with its social fulfillment (Bebbington et al., 1994; Ananda and Hampf, 2015). A series of conferences dedicated to discuss and reflect on the current environmental pollution problems in the United Arab Emirates and Arab Republic of Egypt have been organized and many periodicals by professionals and competent ministries were issued. Drawing on the above mentioned literature we reached the following conclusions (Freedman and Jaggi, 1992; Bayou and Nachtman, 1993; Färe et al., 2001; Färe et al., 2012; Ananda and Hampf, 2015; Tu and Huang, 2015):

a. Many researchers' findings suggest that air and water pollution costs should be taken into consideration while preparing schedules of production and cost for companies.

b. Recently there has been increasing research interests in measurement and disclosure of social and economic performance of the economic activities for securing the commitment in regional and global standards.

c. As it is not feasible to completely prevent the pollution damages that affect the society (as a result of undertaking economic and social activities), certain levels of pollution damages are acceptable without violating the environmental balance.These permissible levels are determined by internationally specialized nonaligned entities.

d. The social cost may be measured by damages to the total economic wealth induced by pollution emission beyond the globally permissible levels.

e. The cost charged to pollution emission sources may be estimated as the costs of tools and equipment needs to maintain emission within globally permitted levels.

f. From an accounting profession perspective, whether this commitment is voluntary or compulsory, it is to be considered as a cost item of economic activities.

g. Due to difficulty of measuring pollution damages in financial terms, other quantitative or qualitative methods may be used in accordance with the nature of the pollution damage

3 Pollution Costs Control from Economic Perspective

As a result of difficulty of estimating the cost of water pollution, economists have resorted to alternative methods to achieve the balance between private cost and social cost of pollution (Abbott and Cohen, 2009; Abbott et al., 2012):

a. Imposing taxes on pollutant sources in accordance with the extent of damages from such events.

b. Negotiating between pollution emission sources and the society for evaluating the extent of damage.

c. Using Pareto method for achieving equilibrium between society and sources of pollution.

These methods are based on multiple assumptions. The possibility of monetary evaluation of pollution damages and the possibility of achieving partial balance on emission sources in addition to evaluating the marginal pollutant effects, while Pareto method was justified by the International Council Report are some of the assumptions. In general, from economic perspective, the optimal level of controlling pollution occurs at a point where marginal cost of pollution control ΔC is equal to the marginal social benefit of pollution control αT (Barbera and McConnell, 1986). Graphically illustrated in Figure 1.

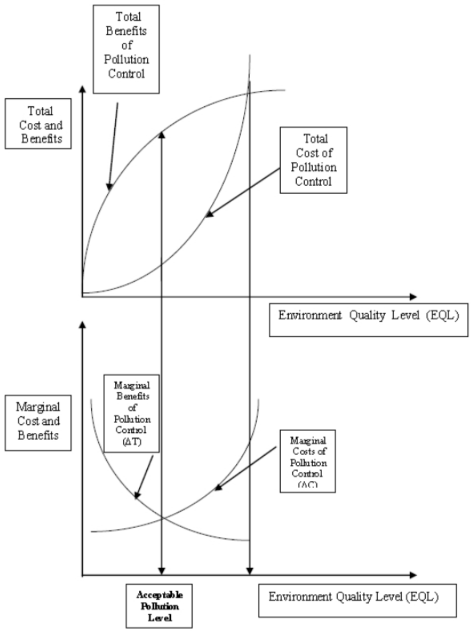

Figure 1: Equilibrium Point between Benefits and Costs of Pollution Control

4 Measuring Cost of Water Pollution Damages from an Accounting Perspective

In the absence of available data to measure water pollution costs objectively, researchers resort to the following accounting approaches (Bayou and Nachtman, 1993; Bebbington et al., 1994; Dasgupta et al., 2001; Costa and Kahn, 2004; Anderson et al., 2007):

a. Property value approach.

b. Wage differential approach.

c. Specific damages approach.

d. Wealth approach.

The first two approaches assume that the society knows the importance of maintaining environmental equilibrium with willingness to pay to keep environmental pollution level to a minimum. In addition, the first approach relies on property value at non-polluted vacant areas relative to similar values of the property located at the polluted areas. The second approach is based on employees' desire to shift to clean areas with lower wages than work in polluted areas even with higher wages. The third approach requires classifying effects of water pollution as (Anderson, 1976; Reddy and Behera, 2006):

a. Damages that can be measured directly in financial terms. It includes pollution damages which lead to productivity loss of human resources,plants and livestock, and increase in costs of maintenance and replacement of productive assets.

b. Damages appear later on economic resources.

c. Damages cause early loss of life and total or partial disability.

d. Increase ratios of injuries in work and decreasing workers' productivity.

e. Damages that can be derived from the comparative analysis between two groups of residents, one living in polluted area and the other living in a clean area.

Although the above classifications are useful for defining various effects of damages induced by pollution, they cannot be used in determining the relation between damages and different types of society wealth such as: human resources, agricultural production and livestock. Therefore, the research efforts are directed to the fourth approach to estimate water pollution costs.

5 Estimation of Water Pollution Damages Using Wealth Approach

Under this approach, the effects of water pollution on human wealth can be classified into direct and indirect damages. Direct damages represent the extent of damage in human wealth by direct exposure to water pollutant and it is reflected in the cost of medical treatment, decrease of employees' income, productivity loss, and cost of early loss of life. Indirect damages represent the extent of damages in human wealth as a result of damages to agricultural production and livestock.

6 Estimation of the Cost of Direct Damages on Human Resources

In this part of our study, we introduce simple yet logical models to estimate the cost of direct damages on human resources induced by water pollution. These costs include additional cost of medical treatment, and the cost of loss of income among other effects.

6.1 Estimation of the Additional Cost of Medical Treatment

The medical treatment can be viewed as the costs of resources and services utilized or consumed in the treatment of individuals affected by water pollution. Similar to the production costs classification, the medical treatment costs of diseases can be classified as follows: (Anderson et al., 2007; Costa and Kahn, 2004).

a. Direct cost: includes the cost of medicine, soft equipment, medical services, wages of doctors and nursing and any other costs related to a patient treatment from diseases, and

b. Indirect cost: includes costs of general services utilized by the patient during medical treatment and follow up period.

The average cost of treatment for a set of diseases (d) due to water pollution is estimated by counting the number of individuals (N) affected with a certain disease (i) in a polluted area, and assuming that the medical treatment of this disease requires an average period of time (Ay), as well as an average cost of medical treatment and follow up per day (Ac), along with the probability that the disease (i) is due to water pollution (P_i). The cost is estimated as:

$$E(TC_1) = \sum_{i=1}^{d} N_i AY_i AC_i P_i$$

The number of affected individuals with a certain disease (Ni) can be obtained from health records maintained at the Ministry of Health. The probability of diseases due to water pollution (Pi), can be computed as the difference between the number of medical cases of diseases in a polluted area (N_{pa}) and the number of diseases in a clean area (N_a) expressed as a percentage of (N_{pa}) : $P_i = (N_{pa} - N_{ca})N_{pa}$ The average period of time (Ay), and average cost of treatment and follow up (Ac), can be obtained from the patients' registers at medical centers.

To illustrate the applicability of model (1), a hypothetical case of individuals who live in a city that is affected by three types of diseases D.01, D.05 and D.09 caused by water pollution is used; the estimated costs of the medical treatment of these individuals are shown in Table 1).

Table 1: Estimated additional cost of medical treatment: Model.1

Code. No.	N_{i}	AY_{i}	AC_{i}	N_{ca}	N_{pa}	P_{i}	E(TC1)
D.01	25,000	18	150	100	200	0.50	33,750,000
D.05	50,000	4	50	300	400	0.25	2,500,000
D.09	60,000	12	35	250	600	0.58	14,616,000
Total							50,866,000

6.2 Estimation of the Cost of Income Loss

Human resources accounting, which is an independent branch of accounting, measures human resources by the cost of appointment, training, planning and controlling its utilization effectively and efficiently (Alberini et al., 1997). The human resources' economic value is estimated by the present value of tangible services loss to be performed in the future, while its social value is estimated by opportunity loss in birth, growth, education and training induced by water pollution. Many researchers suggest that the human capital value of employees, from an organization point of view, can be measured by the present value of expected income during their working lives in the future which requires an estimation of death probabilities prior to reaching retirement age from life tables (Dawson, 1994; Gray et al., 1995; Johanson and Nilson, 1996; Mabon, 1996; Kodwani et al., 2007).

This suggestion however overlooks the possibility of transferring workers within the organization and the possibility of leaving their working places. Other researchers suggest relying on the experience of mobility and shifting through which the individual can shift to many situations in the organization. However, the proposed model for this purpose is inadequate since it focuses on the individual value not the value of the expected revenue.

Therefore, the researcher's efforts are directed towards another approach that allows us to discuss the logical relative values concept of benefits, rarity, replacement possibilities, and availability of employment chances (Chen et al., 2013). Under the stability assumption of relative rarity, it is possible to distinguish between three values of human resources: from the perspective of the organization, individual and society. These values become equal only under competition and static equilibrium. The suggested comprehensive surrogate model is as follows:

$$\sum_{i=1}^{n} \sum_{t=u_i}^{T} W_i(u_i)(1+r)^{(-t)}(P_{is})(P_{ie}) + \sum_{i=1}^{n} \sum_{t=u+1}^{T} \Delta W_i(t)(1+r)^{(-t)}(P_{is(t)})(P_{ie(t)})$$
$$------X----;-------Y----------$$

Where

- E(TC2) = Expected present value of employees' income.
- X = Elements marked X represent present value of base income (of affected employees) due to water pollution
- Y = Elements marked Y represent present value of the additional training cost to compensate employee's productivity loss.
- ui = Age of an employee (i) at the beginning of evaluation period, $t > u$.
- Wi (Ui) = Income of employee (i) at the age of (u).
- R = Discount rate
- Pis = Probability that an employee (i) at the age of (u) remains alive till retirement age (T).
- Pie = Probability that an employee (i) at the age of (u) remain working till retirement age (T).
- Wi (t) = Incremental income of an employee (i) as a result of learning and training during work.

The probability of survival (Pis) of an employee (i) up to retirement age can be found in life insurance companies mortality tables. These tables are built on the statistical analysis of companies' experience over an extended period of years. A variation between countries exists because life expectancies differ from one country to another according to variations in socio-economic and environmental variables.

To illustrate the calculation of the Pis's for a hypothetical employee's population, we will use a table of mortality suggested by Simpson et al, 1969; Harald 2012 and Christopher, 2012. This table contains the following information:

x: Gives the age in years, from 10 to 95.

1_x: The number of people alive at age x.

d_x: The number of people dying between x and $x+1$.

q_x: The probability that a person of age x will die within one year, $q_x = \frac{d_x}{x_1}$

Px : The probability that a person aged x will live at least one year; P_x = 1 - q_x = $(1_x + 1)(1x)$

We are interested in the probability that an employee aged x will live at least to age t; t = x + 1, x + k = T; T retirement age. This can be found from the table using: tPx = 1x + t / 1x. For example, if an employee is aged 25, the probability of him/her remaining alive, at least till the age of 55, can be computed from the table as follows: 30P 25 = (125 + 30) (125) = 64563 / 89032 = 0.725 On the other hand, the probability of continuing employment not only varies from one country to another but also varies from one firm to another according to the level of employee's satisfaction and morale. We consider the firm's turnover ratio a reasonable indicator of such probability which may vary over time for any firm. For simplicity, we assume a constant average turnover ratio over expected life of employees work. For example, given an overage turnover ratio of 2% per year, the probability of continuing employment (Pie) for any employee can be calculated as follows:

Pie (1) = 1 0.02 = 0.98 for the first period of employment as of beginning of first period.

Pie (2) = 0.98 (0.02 x 0.98) = (1 0.02) (1 0.02) = (1 0.02)2 for two period as of beginning of first period.

Pie (k) = (1 0.02)(1 0.02) = (1 0.02)k for k periods as of beginning of first period of employment. Accordingly, if turnover ratio is to be (v), we can say:

Pie (k) = (1 v)k For k periods as of beginning of first period.

For an estimation of human resources income, it is suitable to determine the discount rate (r) by internal rate of return used in material resources investment decisions, or by market interest rate on long term loans. It is preferable to use the market interest rate for comparison and achieving equity between human resources and long term resources which are financed by borrowing. By multiplying model (2) by coefficient (e), it is possible to estimate the employee's income loss induced by water pollution. Where (e) is refers to probability of expected decrease in employee's income due to water pollution. It is thus possible to estimate the decrease of employees' income E (TC3) as follows:

$$E(TC3) = E(TC2)\ e. \quad (3)$$

To illustrate the applicability of models (2 and 3), we assume a hypothetical company whose organization chart is summarized in Table 2).

Table 2: Summary of Organizational Chart.

Level	No. of employees	Job title	Code No.
A. Top Management	1	General Manager	A.01
B. Intermediate Mgt.	2	Manager	B.01 - B.02
C. Supervisory	4	Supervisor	C01 - C04
D. Technical Work	16	Technician	D. 01 - D.16
E. Non-technical Work	36	Worker	E. 01 E. 36
	59		

Assume that the company started its business in January 2011, and wanted to estimate the income of its human resources on economic basis as of January 2016. On January 2016, the basic pay scale of the employees, the current pay scale, and the annual rates of pay increase are shown in Table 3. Assuming that upward mobility between levels is allowed on a selective basis i.e., when the current pay of employees at the lower level reaches the annual basic pay of employees at the next higher level on the scale, then the annual rate also increases as per the rates for higher levels. Further, we presume that going from level C to B and from level B to A, requires on-the-job training to be equipped for the job in addition to on-the-job orientation required for all levels. Suppose that the average annual turnover ratios at various levels were: A = 0, B = 0, D = 1%, E= 2%.

The current age distribution of employees is assumed to be as shown in Table 4.

The evaluation of numerical case starts with the calculation of Pis (t) and Pie (t). Assuming that the retirement age is 60 years, we can get Pis (t) for ages of the nine groups as shown in Table 5.

In Table 5, the probability of survival decreases as the limiting survival expectation period increases. Given the previous assumptions, the probabilities of continuing employment Pie (t) are shown in Table 6.

Table 3: Basic Pay Scale and Current Pay

level	Salaries and Wages Scale		Code No.	Current Annual Pay	Annual Rate of Increase of Basic Pay
	Basic Annual	Maximum			
			A. 01		
			B. 01	$ 3300.0	
			B. 02	1733.4	10% base shift 5 Years
				1452.0	7% base
A	$ 2000		C. 01		shift 5 Years
B	1200		C. 02	1312.5	
		$6300	C. 03		
		3000	C. 04	1250.0	5% base
C	1000			1150.0	shift 5 Years
			D.		
		2200	01-		
			D. 10	756.0	
			D. 11		
D	600		D. 16	674.0	
					4% base
		1500	E. 01-	501.12	shift 4 Years
		1000	E. 20		
			E. 21-	464.0	
E	400		E. 28		
			E. 29-	432.0	4% base
			E. 33		shift 4Years
			E. 34-	400.0	
			E. 36		

We assume a discount rate of 8% per year. The higher the discount rate, the lower is the present value of the income stream. Thus, if the internal rate of return is higher than the borrowing rate it will result in a lower income for employees. Finally, to avoid the complication of inter-job mobility in the calculations, we adopt, for a start, the stability of employment over the whole period of analysis. When such mobility takes place in the future, appropriate adjustment to the value of employees income is required regarding two elements: (1 Table the training cost required for such mobility to take place, and (2) the wages or salaries differentials resulting thereof. The present value of such differentials is calculated by following the same methodology of finding the present value of ΔWi (t). Based on a hypothetical company data and previous assumptions, it is possible to calculate the value of employees' income by using model (2) x as shown in Table 7.

The values shown in Table 7 are calculated for each employment level for each age group, adjusted by the average probability of survival Pis (t), and the average probability of continuing employment Pie (t) for each level and age group as shown in tables 5 and 6.

Table 4: Age Distribution of Employees

Age	No. of Persons	Code Numbers
32	8	C. 01, C. 03, D. 04, D. 07, E. 03, E. 11, E. 15, E. 19.
35	4	B. 02, C. 02, D. 02, E. 02.
37	3	B. 01, C. 04, D. 01.
38	1	A. 01
39	9	D. 03, D. 05, D. 06, D. 10, E. 01, E. 16, E. 31, E. 34, E. 36.
42	10	D. 08, D. 09, D. 13, D. 14, E. 04, E. 07, E. 22, E. 28, E. 32, E. 35
43	2	D. 16, E. 10.
45	4	D. 15, E. 12, E., 23, E. 33.
46	16	All remaining in E level

Table 5: The Probability of X Surviving to Age t=33,34,,60=Lt Lx

Age Group	32	35	37	38	39	42	43	45	46
Average Survival Probability	.86	.87	.88	.89	.89	.90	.90	.90	.90

Table 6: The Probability of Continuing Employment to Age t

Level	Probability of Continuing employment for t Years hence; t = 1, 2, 3,., k													
	x+ 1	x+ 2	x+ 3	x+ 4	x+ 5	x+ 6	x+ 7	x+ 8	x+ 9	X 10	X+ 11	X+ 12	x+ 13	x+ 14	
D	.98	.96	.96	.95	.94	.93	.92	.91	.90	.89	.88	.88	.87	.86	
E	.96	.94	.92	.90	.88	.87	.85	.83	.82	.80	.78	.77	.75	.74	
	x+ 15	x+ 16	x+ 17	x+ 18	x+ 19	x+ 20	X+ 21	X+ 22	X+ 23	X+ 24	X+ 25	X+ 26	X+ 27	X+ 28	Average
D	.85	.84	.83	.82	.82	.81	.80	.79	.78	.77	.76	.75	.75	.74	.86
E	.72	.71	.69	.68	.67	.65	.64	.63	.61	.60	.59	.58	.57	.56	.77

It may be noted that we have treated the base payment (Wi (ui)) as a constant annual payment for a number of periods equal to the difference between the retirement age T and the current age u. Compound interest table [1 (1+r)t r] was used with r = 8% and t = Ti - ui for each age group. Table 8 shows the expected present value of increases in annual salaries. The calculations are shown in detail for A.01. The rest of levels B,

Table 7: Expected present value of employees' income as of January 2016 Model (2) x

Code No. of Work force	Age Ui	Wi(Ui)	T = 60-ui	1-(1.08)t/ 0.08	Pis	Pie	E(TC2) X $
A.01	38	3,300.00	22	10.20	0.89	1.00	29,959.40
B.01	37	1,733.40	23	10.37	0.88	1.00	15,818.32
B.02	35	1,452.00	25	10.67	0.87	1.00	13,478.77
C.01	32	1,312.50	28	11.05	0.86	1.00	12,472.69
C.02	35	1,312.50	25	10.67	0.87	1.00	12,183.81
C.03	32	1,250.00	28	11.05	0.86	1.00	11,878.75
C.04	37	1,150.00	23	10.37	0.88	1.00	10,494.44
D.04,.07	32	1,512.00	28	11.05	0.86	0.86	12,356.94
D.02	35	756.00	25	10.67	0.87	0.86	6,035.37
D.01	37	756.00	33	11.51	0.88	0.86	6,585.31
D.03,05,06,10	39	3,024.00	21	10.02	0.89	0.86	23,191.99
D.08,09,13,14	42	2,860.00	18	9.37	0.90	0.86	20,741.81
D.16	43	674.00	17	9.12	0.90	0.86	4,757.69
D.15	45	674.00	15	8.56	0.90	0.86	4,465.55
E.03,11,15,19	32	2,004.50	28	11.05	0.86	0.77	14,667.55
E.02	35	501.10	25	10.67	0.87	0.77	3,581.78
E.01,16,31,34,36	39	2,234.40	21	10.02	0.88	0.77	15,170.57
E.04,07,22,28,32,35	42	2,762.20	18	9.37	0.90	0.77	17,936.10
E.10	43	501.10	17	9.12	0.90	0.77	3,167.03
E.12,23,33	45	1,397.20	15	8.56	0.90	0.77	8,288.30
All remaining in E level	46	5,690.00	14	8.24	0.90	0.77	32,491.72
TOTAL							279,723.89

C, D and E can be calculated in the same manner. The annual increases are treated as an increasing up to maximum allowable, and from this point until retirement age as a constant annual payment.

$$PV^t = [1 - (1+r)^{-T}/r] - [1 - (1+r)^{-t}/r] = [1 - (1+0.08)^{-T}/0.08] - [1 - (1+0.08)^{-t}/0.08]$$

Table 8: The Expected Present Value of Increases in Annual Salaries Model (2)Y

Age x	Code No	t	Wi(t) of Basic	(1+0.08)-t	PV_{t}	Pis	Pie	E(TC2)Y $
		1	300	0.9259		0.99	1	275.0000
		2	600	0.8573		0.98	1	504.1152
		3	900	0.7938		0.97	1	693.0155
		4	1,200	0.7350		0.96	1	846.7544
38	A.01	5	1,650	0.6806	4.4541	0.95	1	1,066.8140
		6	2,100	0.6302		0.94	1	1,243.9550
		7	2,550	0.5835		0.93	1	1,383.7470
		8	3,000	0.5403		0.92	1	1,491.1420
		9-22	3,000	0.5002		0.83	1	11,090.7100
								18,595.2531

Table 9 shows estimates of the decreases of (or of reduction in) employees' income induced by water pollution. The calculations are shown in detail for A.01 and B.01. The rest of levels C, D and E can be calculated in the same manner.

Table 9: Estimates of the Decreases of Employees' Income Induced By Water Pollution Model (3)

Code No.	Age	T	Wi(t) $	(1.08)-t	Pis (x+1)	Pie (x+t)	E(TC2)Y $	E(TC2)X $	e	E(TC3) $
							275.00			
A.01							504.12			
							693.02			
		1	300.0	0.93	0.99	1				
							846.75			
		2	600.0	0.86	0.98	1				
							1,066.81			
		3	900.0	0.79	0.97	1		29,959.40		
							1,243.95			
		4	1,200.0	0.74	0.96	1				38,843.72
							1,383.75			
		5	1,650.0	0.68	0.95	1			0.80	
							1,491.14			
		6	2,100.0	0.63	0.94	1				
	38						11,090.71			
		7	2,550.0	0.58	0.93	1				
							18,595.25			
		8	3,000.0	0.54	0.92	1				
Subtotal							103.95			
		9-22	3,000.0	4.45	0.83	1				
B.01							190.56			
							261.96			
		1	113.4	0.93	0.99	1				
							390.64			
		2	226.8	0.86	0.98	1				
							456.56			
		3	340.2	0.79	0.97	1				
							508.98			
		4	553.6	0.74	0.96	1				
							549.34			
		5	706.2	0.68	0.95	1				
							579.27			
		6	859.2	0.63	0.94	1				
	37						600.22			
		7	1,012.0	0.58	0.93	1		15,819.93		25,269.78
							635.81			
		8	1,165.0	0.54	0.92	1			0.75	
							661.06			
		9	1,319.0	0.50	0.91	1				64,113.50
							4,510.76			
		10	1,525.0	0.46	0.90	1		45,779.00		
		11	1,732.0	0.43	0.89	1				
Subtotal							9,449.10			
		12-23	1,767.0	3.23	0.79	1				
TOTAL										
							28,044.35			

7 Concluding Remarks

7.1 Summary and Conclusions

The study proposed three accounting models to estimate the cost of the direct damages of human resources caused by water pollutions. The first one was used to estimate the additional cost of medical treatment for diseases caused by water pollution. However, the second and third models were used to estimate the value decline in earned income to employees as a result of water pollution. As a result of lack of access to actual data, these models are applied to a hypothetical case of a city to demonstrate the ease of applicability of the models to measure the water pollution costs under a simple, realistic and scientific assumptions to be practically applicable when actual data become available in quantifiable terms. The accounting profession could develop these assumptions using the framework for realistic projection of financial statements while considering new projects that are exposed to potential pollution hazards to reach minimum level of pollution damages and to ensure that the pollution emission is within permissible levels. Finally, the proposed models will help government and controlling authorities to impose tax and fees on sources of pollution, establish green accounting, and disclose environmental information in financial statements for interested parties

7.2 Limitations

Shortcomings in our study include the following points:

- Lack of actual data prevents testing the validity and applicability of proposed models in practice.
- Our study is limited in measure the direct damages of water pollution on human resources.
- The indirect damages on agricultural production and livestock are not covered by the current study.
- The study did not address how to allocate the damages' costs of water pollution on the causative sources.

7.3 Recommendations & future work

Accordingly, the main recommendation of this research is to draws attention of researchers to consider the proposed models to achieve the efficiency measurement and allocation of total costs of different damages induced by water pollution. Future research could explore accountancy articulation about pollution costs in the accountancy reports. This is considered as a next step in establishing the basis, rules and pattern of measurement and allocation to ensure consistency across all firms in the economy.

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