COSTS ESTIMATION OF WATER POLLUTION IN AGRICULTURE, FISHERIES, LIVESTOCK AND BIRDS

Attiea Marie♣
Al Falah University

Sameer Albarghouthi
Al Falah University

ABSTRACT

This study proposes a set of simplified quantitative models to estimate the cost of water pollution in agriculture, fisheries, livestock and birds, which causes numerous damages 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 cost of pollution tangibly in the financial statements of polluted companies. This will improve the quality and transparency of companies' financial reporting.

Keywords: Water Pollution Costs; Agriculture; Fisheries; Livestock; Birds; Quality and Transparency of Financial Reporting.

1. INTRODUCTION

Many countries around the world have made great strides in establishing green accounting and compelling enterprises to show environmental information for interested parties (Tu and Huang, 2015). As a result several models were proposed during the last two centuries to measure the cost of air and water pollution in descriptive way (Al Barghouthi and Marie, 2016). On other hand, by reviewing various sectors in developing and developed countries we found the companies' financial statements do not show environmental information in quantitative form. (Bayou & James, 1992; Bebbington, et al, 1994; Muller, Mendelsohn and Nordhaus, 2011; Jayanthi, 2015).

This was our motivation to think about a practical incentive for companies to show such important environmental information in its financial statements. Based on that, our research question is: How can different companies stimulate disclosure of environmental information in their financial statements?

The researchers believe that the answer of research question lies in the ability to proposed simple quantitative models for estimating and measuring the pollution effects on the elements of living wealth, on one hand, and reallocate it to its sources of emissions on other hand.

To achieve our objective, we proposed in a previous research paper simple quantitative models for estimating and measuring the pollution effects on human resources (Al Barghouthi and Marie, 2016),

---

♣Corresponding author: Accounting professor in Al-Falah University, Dubai, UAE. Email: attiea.marie@afu.ac.ae; Tel: +971-04-23380621

this paper will focus on introduce simple set of quantitative models for estimating and measuring the pollution effects on agriculture, fisheries, livestock and birds, and the allocation of resulting costs to sources of pollution will be postpone to future research.

The study findings will help companies to recognize water pollution's cost effects on its financial statements; this will improve the quality and transparency of companies' financial reporting. The findings will also help Stakeholders control and force the companies' pollution emission to reduce it to the globally accepted limits.

The remainder of this paper is organized as follows:

➢ Section 2 is dedicated to discuss the earlier studies.
➢ Section 3 tackles the cost estimation of water pollution in agriculture, fisheries, livestock and birds.
  - Section 3.1 focuses on estimation of productivity lost in agriculture crops induced by pollution.
  - Section 3.2 examines the estimation of productivity lost in fisheries induced by pollution.
  - Section 3.3 will focus on estimation of pollution cost in livestock and birds.
    a. Section 3.3.1 discusses the cost estimation of pollution diseases in livestock and birds.
    b. Section 3.3.2 discusses cost estimation of deaths in livestock and birds induced by pollution.
    c. Section 3.3.3 cost estimation of productivity lost in livestock and birds induced by pollution is considered.
➢ Section 4 includes study conclusions, limitation, and recommendations of future studies.

2.   LITERATURE REVIEW

Without agriculture the world would suffer from famines as it is a necessary means of human survival as well as fisheries, livestock, and birds. For thousands of years, traditional agriculture was a harmless practice that did not damage or deplete the land it was performed on. However, the harmful modern farming and agricultural operations have gradually led to agricultural pollution. These harmful operations and the modern day by-products of agriculture have managed to cause degradation of not only the eco-system, but also the land and environment. Pesticides and fertilizers, soil erosion and sedimentation, polluted water, livestock, weeds, pests among others are some of the primary causes of agricultural pollution.

There is a huge amount of major environmental issues that the world is facing today, and factory farming is one of the major causes of pollution (Schaffner, et al., 2011). A scientific research carried out on factory farming's methods found that the increase in animal production in confinement in warehouse-like building before killing them, and mass-producing cows and chickens meat along with dairy and eggs causes an unacceptable level of risk to public health and damage to the environment (Aftab, 2017). Yet, several governments endorse this unsustainable industry, in spite of its significant social and ecological costs, to supply for the growing worldwide "meat" market which is predicted to double in 33 years (Moreira and Bravo-Ureta, 2010; Parris, 2011).

Several studies use hedonic analysis to assess the impacts of reduced water clarity on home values in Maine; they found water clarity was a significant variable impacting home prices, with lower clarity resulting in lower home prices (Michael et al. 2000; Poor et al. 2001 and Gibbs et al. 2002).

Walsh et al. (2011) assessed the impacts of multiple pollutant concentrations on home values within 1,000 meters of lakes in Orange County, Florida. They estimated the implicit price associated with a 17% change in concentrations of total nitrogen, total phosphorus, chlorophyll, and trophic state index (a composite of the three other nutrient pollutants). The authors note that the impacts were much higher for waterfront homes, with the impacts diminishing with distance to the beach.

Huang et al. (2010) estimated the lagged effects of hypoxia on commercial harvests of brown shrimp in these water bodies. The authors used bio-economic modelling, assuming that the environmental effects associated with a hypoxia event accumulate over a 60-day period. They found that between 1999 and 2005, the brown shrimp harvest declined by 13.1% due to hypoxia in the Neuse River.

Key & Sneeringer (2014), mentioned the potential effects of climate change on the productivity of US dairies. Pan, et al. (2016), they said farmers have been using animal excrement as a crop fertilizer for over millennia, however; factory farms generate far more waste than the soil can take in.

To our best knowledge, extrapolation good number of earlier studies reveals that they did not offer quantitative models to estimate the cost of water pollution's harmful effects on agriculture, fisheries, animals and birds.

To illustrate the problem more clearly, let us start with sources causes' water pollution that can be divided into two categories: the pollutants that belong to a single source such as wastes released from factories into the water, and the pollutants released from multiple sources**.** [1] In general, the causes of water pollution are summarized as follow: (Dasgupta et al., 2001; Pascoe, 2007; Weiss, et al.,2007; Sneeringer, 2009; Hoagland, et al., 2009; Morrison et al., 2010; Wheeler, 2013; Engel, 2016):

1. Industrial waste: Many industries do not follow responsible waste disposal methods and simply release the waste into fresh water which would then flow out into rivers, canals and sea.
2. Mining activities: Mining has serious environmental impact and causes water pollution as it generates metal waste and sulphides from the rocks which can be very harmful for the water.
3. Marine dumping: The improper disposal of paper, aluminum, rubber, glass, plastic and food in the sea does not only cause water pollution but also threatens marine life and wildlife.
4. Accidental oil leakage: Oil spill can be a major form of pollution if a large amount of oil gets released into sea.   Hence oil spill poses a significant threat to local marine life and wildlife like fish, birds.
5. Burning of fossil fuels: when fossil fuels such as coal, oil and natural gas get burnt, substantial amount of fly ash is produced. The particles of the fly ash contain toxic chemicals that can result in acid rain harmful to agriculture, marine life and wildlife.

---

[1] Water pollutants also include both organic and inorganic factors. Organic factors include volatile organic compounds, fuels, waste from trees, plants etc. Inorganic factors include ammonia, chemical waste from factories, discarded cosmetics etc. The water that travels via fields is usually polluted with all forms of waste inclusive of fertilizers that it swept along the way. This infected water makes its way to our water bodies and sometimes to the seas endangering the fish, livestock and humans.

6. Chemical fertilizers and pesticides: for years farmers have used chemical fertilizers and pesticides to protect their crops from pests and bacteria. However, these chemicals are harmful not only on plants, but also on livestock and birds.
7. Leakage from sewage lines: damaged pipes in sewage lines lead to leakage of untreated waste, which escapes into groundwater, resulting in damage to agriculture, marine life and wildlife.
8. Global warming: global warming is a result of gradual heating of Earth's surface, oceans and atmosphere due to greenhouse effect. This increase in water temperature results in death of aquatic animals and marine species which eventually leads to water pollution.

From the above we conclude that there are several sources of pollution each of which imposes serious environmental hazards that affect plants, livestock, birds, fish and humans. This necessitates cooperation and coordination between all the concerned actors authorities and stakeholders to find quick and effective solutions for these pressing environmental issues.

Among these actors governments and the various sources of pollution emissions in addition to the pivotal role of accountants in the simplification of accounting procedures and methods of calculation and accounting for pollution, which leading to ease the application of implementing rules of policies, laws and reflected transparently of reports and financial statements in companies as an integral part of their operations.

3. COST ESTIMATION OF WATER POLLUTION IN AGRICULTURE, FISHERIES, LIVESTOCK AND BIRDS

In addition to its impact on humans, water pollution also causes material damages in agriculture, fisheries, livestock, and birds among others. In our previous paper (Al Barghouthi & Marie, 2016) we have differentiated between pollution cost control from economic perspective and accounting perspective. We also introduced a set of simple models to estimate the cost of water pollution's direct effects on human resources, such as; additional cost of medical treatment and income loss among others.

This paper addressed one of the previous paper's shortcomings; cost estimation of water pollution's indirect effects on humans, which includes agriculture, fisheries, livestock and birds.

3.1. Cost Estimation of Productivity Lost in Agriculture Crops

Sustainable agriculture is one of the major challenges we face today. Sustainability entails more than just securing a sustained food supply, but also acknowledging the effects of agricultural practices on the environment, socio-economics and human health when national development plans are designed.

As discussed above, water pollution affects the productivity of planting areas which in turn affects various traditional crops such as wheat, rice and corn, as well as several types of fruit like apples, plums, peaches and apricots. The accountant's role is to formulate a simple model to be used in estimating the losses in crops' productivity induced by water pollutants. This proposed simple model is:

$$E(TC_1) = \sum_{i=1}^{m} (AG_i)(\Delta PRQ_i)(P_i)(S_i) \tag{1}$$

Where,

AG$_i$ = Cultivated areas of polluted crop of type i, measured in acres.

m = Crops types affected by water pollution (1,2…...m).

ΔPRO$_i$ = Change in crop's productivity of type i at polluted and clean areas

P$_i$ = Probability of productivity loss is due to pollution

= [1- {(crop productivity at a polluted area) ÷ (crop productivity at a clean area)}]^2

S$_i$ = Market selling price per ton of crop (i).

To illustrate the applicability of model 1, assume there are six polluted types of crops that are planted on two areas; A.01, A.02. A.01 is planted with wheat (WH), rice (RI), corn (CO). A.02 is planted with apples (AP), plum (PL), and peaches (PE). Where cultivated areas measured by acres is referred to as (Ki). Acres productivity for each type of crop (m) at relatively clean areas is referred to as (PRO$_c$) while at polluted areas as (PRO$_{p)}$, and the selling market price per ton for each type of crop is (Pi)

Based on the above parameters, table (1) represents the estimation of productivity losses in agricultural crops induced by pollution.

Table 1: Cost Estimation of productivity lost in agricultural crops [Model (1)]

Planted Areas	Type of crop	K$_i$ (acres)	PRO$_c$ (Ton)	PRO$_p$ (Ton)	ΔPRO (Ton)	P$_i$	S$_i$ ($/Ton)	E(TC$_1$) ($)
A.01	WH	4,000,000	18.00	10.00	8.00	0.444	1,200	17,049,600,000
	RI	3,500,000	22.00	15.00	7.00	0.318	1,400	10,907,400,000
	CO	5,000,000	15.00	11.00	4.00	0.267	900	4,806,000,000
Subtotal								**32,763,000,000**
A.02	AP	250,000	40.00	25.00	15.00	0.375	2,000	2,812,500,000
	PL	150,000	12.00	7.00	5.00	0.467	1,800	630,450,000
	PE	200,000	14.00	8.00	6.00	0.429	2,100	1,081,080,000
Subtotal								**4,524,030,000**
Total								**$7,287,030,000**

3.2. *Cost Estimation of Productivity Lost in Fisheries*

Since Fish are assumed to be a biological and natural renewable resource and one of the most valuable sources of food for humans, it protecting fish stocks and the marine environment from resource depletion and water pollution is now a major issue. Thus, a common fisheries policy (CFP) for overseeing the fisheries in the water was introduced by the European Union. This policy which was implemented on January, 1st of 2014 intends to encourage environmental, economic and social sustainable uses of common resources including aquaculture production. Its initial goals include: Increasing productivity; Sustainable exploitation of resources; Protection of the environment; and Safeguards for a high level of human health protection.

Despite the threat the described pollutants pose, these goals has proven to be rather difficult to achieve in reality. The quality and productivity of fish is also affected by:

➢ Heavy metals in water and fish tissues: Pollution of the aquatic environment by inorganic chemicals has been recognized as one of the major serious threats to the health and survival of

---

[2] For example, if wheat productivity per acre at a polluted area is 10 ton and its productivity at clean area is 18 ton, then the probability of productivity lost is due to pollution (p$_i$) = 1- 10/18 = 0.444

fish. The agricultural drainage water can enhance the concentration of chemicals generated from agricultural wastes like pesticides, and fertilizers as well as industrial effluents that pass into the biotic elements of the ecosystem to varying degrees (Anderson et al., 2007; Ananda, 2014).

➢ Temperature zone: Temperature does not only affect the survival rate and distribution of fish, but also, affects the growth performance of fish, activity, reproductive processes and susceptibility to diseases (Jayanath & Benjamin, 2015).

Accordingly, we proposed model (2) to estimate the cost of fish productivity lost.

$$(TC2) = \sum_{i=1}^{m} (K_i)(PRO_i)(P_i)(S_i) \qquad (2)$$

Where,

K_i	= Cultivated areas of polluted fish of type (i) measured in acres.
m	= Fish types affected by pollution.
ΔPRO_i	= The change in fish productivity of type i at polluted and clean areas.
P_i	= Probability of productivity loss is due to pollution
	= [1- {(fish productivity at a polluted area) ÷ (fish productivity at a clean area)}]^3
S_i	= Market selling price per ton of fish of type (i).

To illustrate the applicability of model 2, assume there are three polluted types of fish; Shrimp (SH), Sea Bass (SB), and Tilapia (TI) which are planted on artificial lakes (or farms); A.01, A.02., planted with fish of type (m_i). Where cultivated areas are measured by acres K_i, acres productivity for each type of fish m_i at relatively clean areas is referred to as PRO_c while at polluted areas as PRO_p, and the selling market price per ton for each type of fish is P_i.

Based on the above assumptions, table (2) represents the estimation of productivity loss in fisheries' production induced by pollution.

Table 2: Cost Estimation of fisheries' productivity lost [Model (2)]

Planted Areas	Type of fish	K_i (acres)	PRO_c (Ton)	PRO_p (Ton)	ΔPRO (Ton)	P_i	S_i ($/Ton)	E(TC$_1$) ($)
A.01	SH	9,800	10	6.5	3.5	0.350	1,500	18,007,500
	SB	14,500	30	20	10	0.333	950	45,870,750
	TI	50,200	50	24	26	0.520	250	169,676,000
Subtotal								**233,554,250**
A.02	SH	8,400	9	6	3	0.333	1,500	12,587,400
	SB	16,300	28	21	7	0.250	950	27,098,750
	TI	40,000	45	20	25	0.555	250	138,750,000
Subtotal								**178,436,150**
Total								**$411,990,400**

3.3.   *Cost Estimation of Pollution in Livestock and Birds*

As noted above, water pollution has a great effect on the productivity and quality of agricultural crops and fish. This section will focus on cost estimation of pollution in livestock and birds. It is recognized

---

[3] For example, if shrimp productivity per acre at a polluted area is 6.5 ton and its productivity at clean area is 10 ton, the probability of productivity lost is due to pollution (p_i) can be calculated = 1- 6.5/10 = 0.35

that pollution affects livestock and birds by increasing the extent of herds affected by diseases and deaths, in addition to reducing its productivity.

3.3.1. *Cost Estimation of Pollution Diseases in Livestock and Birds*

Costs estimation of diseases in livestock and birds require counting affected cases classified by diseases, probability of infection due to pollution, and average cost of treatment within herd (i) with a specific disease (d). Model 3 described the relationship between these parameters as follows:

$$E(TC_3) = \sum_{d=1}^{D}\sum_{i=1}^{G}(Q_i)(T_i)(P_i)(P_{id}) \tag{3}$$

Where,
D   = Number of diseases affecting livestock and birds.
G   = Kind of livestock and birds herd affected by diseases.
Q_i = Number of livestock and birds affected within the herd (i) by a specific disease (d).
T_i = Average cost of treatment within herd (i) by a specific disease (d).
P_{id} = Probability of infection due to pollution
        = [1- {(number of affected livestock and birds at a relatively clean area) ÷ (number of affected livestock and birds at a polluted area)}][4]

To illustrate the applicability of model 3, assume there are five kinds of livestock and five kinds of birds affected by pollution: Camels (CA), Buffalo (BU), Cow (CO), Lambs (LA), and Goats (GO), Ostriches (OS), Turkey (TU), Rabbits (RA), Ducks (DU), and Chicken (CH) respectively. Assume

Table 3: Cost Estimation of Diseases in Livestock and Birds [Model 3]

Diseases "D"	Livestock/Birds "G"	Q_i (Quantity of herd)	T_i ($)	P_{id}	E (TC_3) ($)
Flu	CA	400,000	20	0.80	6,400,000
	BU	700,000	15	0.60	6,300,000
	CO	1,100,000	10	0.90	9,900,000
	LA	3,000,000	8	0.70	16,800,000
	GO	2,000,000	5	0.75	7,500,000
	OS	600,000	4	0.50	1,200,000
	TU	900,000	3	0.65	1,755,000
	RA	750,000	1	0.75	562,500
	DU	1,000,000	1	0.55	550,000
	CH	5,000,000	1	0.90	4,500,000
Subtotal					**55,467,500**
Smallpox	OS	800,000	10	0.80	6,400,000
	TU	700,000	8	0.60	3,360,000
	RA	700,000	5	0.40	1,400,000
	DU	400,000	3	0.20	240,000
	CH	2,000,000	2	0.85	3,400,000
Subtotal					**14,800,000**
Total					**$135,317,500**

---

[4] For example, if we have 70 camels affected at a relatively clean area and 100 camels affected at a relatively polluted area, then the probability of diseases was due to pollution (p_i) = 1- 70/100 = 0.3

that pollution is causing poisoning, flu, and smallpox to livestock and birds. Based on these assumptions and the model's parameters, table 3 explains the applicability mechanism of model 3.

3.3.2. Cost Estimation of Deaths in Livestock and Birds

Estimating such costs requires counting the amount of dead livestock and birds (Q_i), the expected market price per unit of each herd (S_i), and probability of death due to pollution (P_i). The probability of death can be estimated as follows:

{1- {(death cases in clean areas (Q_{ic})) ÷ (death cases in polluted areas (Q_{ip}))}[5]

Based on the above parameters, the suggested model for estimating costs of livestock and birds due to death is:

$$E(TC_4) = \sum_{i=1}^{G}(Q_i)(P_i)(S_i) \tag{4}$$

To illustrate the applicability of model 4, assume that pollution is causing death of three types of livestock; Cows (CO), Lambs (LA), and Goats (GO), and five types of birds; Ostriches (OS), Turkey (TU), Rabbits (RA), Ducks (DU), and Chicken (CH).

Based on the model's parameters and assumptions, table 4 represents the applicability mechanism of model 4.

Table 4: Cost Estimation of deaths in Livestock and Birds [Model (4)]

Code # G_i	Livestock /Birds	Q_I (Quantity of herd)	P_i	S_I ($)	$E(TC_4)$ ($)
G.01: Livestock	CO	145,500	0.33	650	31,209,750
	LA	268,700	0.54	180	26,117,640
	GO	155,800	0.50	120	9,348,000
Subtotal					**66,675,390**
G.02: Birds	OS	420,400	0.62	90	23,458,320
	TU	505,600	0.58	60	17,594,880
	RA	312,500	0.81	15	3,796,875
	DU	710,200	0.89	12	7,584,936
	CH	985,800	0.98	6	5,796,504
Subtotal					**58,231,515**
Total					**$124,906,905**

3.3.3. Cost Estimation of Productivity Lost in Livestock and Birds

Productivity reduction in dairy and meat is one of the major effects of pollution as it reduces the economic value of livestock and birds. Estimating the costs of such productivity reduction requires counting the quantity of livestock and birds affected by pollution (Q_i), the expected market price per ton of dairy and meat for each herd (S_i), productivity of dairy and meat for each herd in clean areas

---

[5] For example, if we have 67 Cows died   at a relatively clean area and 100 Cows died   at a relatively polluted area, then the probability of diseases was due to pollution (p_i) = 1- 67/100 = 0.33

(PRO$_C$) compared to polluted areas (PRO$_P$), and the probability that the pollution is the main reason of productivity reduction in livestock and birds (P$_i$). The probabilities are estimated for each herd (G$_i$) as follows:

{1- {(productivity in polluted areas (PRO$_P$), ÷ (productivity in clean areas (PRO$_C$))}[6]

Based on the above parameters, the suggested model for estimating costs of productivity lost in livestock and birds due to pollution is as follows:

$$E(TC_5) = \sum_{i=1}^{G}(Q_i)(\Delta PRO_i)(P_i)(S_i) \qquad (5)$$

Where,
G   = Type of herd (i,1…G).
Q$_i$ = Quantity of herd i, affected by pollution (i =1, 2….., G)
ΔPRO$_i$ = Reduction in herd's productivity measured in ton.
P$_i$ = Probability of reduction in herd's productivity due to the pollution
S$_i$ = Market selling price per ton of productivity.

Table 5: Cost Estimation of Productivity Lost in Livestock and Birds [Model (5)]

Productivity	Livestock /Birds G$_i$	Q$_i$ (Quantity of herd)	Pro.$_c$ (Ton/ piece of herd)	Pro.$_p$ (Ton/ piece of herd)	ΔPro. (Ton/ piece of herd)	P$_i$	S$_i$ ($/Ton)	E (TC$_8$) $
Dairy	CA	150,500	4.000	3.000	1.000	0.250	6,000	225,750,000
	BU	80,400	8.000	5.000	3.000	0.375	5,000	1,577,250,000
	CO	420,600	10.000	6.000	4.000	0.400	4,800	3,230,208,000
Subtotal								**5,033,208,000**
Meat	CO	50,800	0.400	0.200	0.200	0.500	10,000	650,800,000
	LA	00,000	0.120	0.075	0.045	0.375	9,000	121,500,000
	GO	300,000	0.050	0.030	0.020	0.400	8,500	20,400,000
Subtotal								**792,700,000**
	OS	410,700	0.100	0.060	0.004	0.400	15,000	9,856,800
	TU	80,200	0.010	0.008	0.002	0.200	7,000	2,744,560
	CH	2,850,000	0.003	0.002	0.001	0.333	2,000	1,898,100
Subtotal								**14,499,460**
Total								**5,840,407,460**

4. CONCLUSIONS, LIMITATION, AND RECOMMENDATIONS

4.1. *Conclusions*

The study discusses various reasons of water pollution and its harmful effects on crops, fruits, fisheries, livestock, and birds. To our best knowledge, extrapolation good number of earlier studies reveals that they did not offer quantitative models to estimate the cost of water pollution's harmful effects on agriculture, fisheries, animals and birds. The study has proposed a set of simple quantitative

---

[6] For example, if total dairy productivity of a Camel in polluted and clean areas are 3 tons and 4 tons respectively, then the probability of reduction in dairy productivity due to the pollution (p$_i$) = 1- 3/4 = 0.25

models to accounting for these harmful effects. Due to lack of primary and secondary data availability, the applicability mechanism of the proposed models was tested based on assumed mathematical and theoretical data. Accordingly our findings cannot be generalized in real-life unless the proposed models are tested based on actual data.

The availability of sufficient physical data to test the validity of the application of the presumed models, the results can be relied upon as a basis for formulating policies and plans to reduce pollution emission and encourage companies to explicitly disclose it in its financial reports. This will help all the concerned authorities and stakeholders to find quick and effective solutions for water pollution problems.

4.2. Limitations

Shortcomings in our study include the following points:
- ➤ The proposed models in our study cannot be circulated unless its validation and applicability are tested using realistic data.
- ➤ Our study was limited to estimating the cost of pollution damage in agriculture, livestock and fisheries and birds.
- ➤ The study did not address allocation of estimated costs of water pollution on its causative sources.

4.3. Recommendations

Accordingly, the study draws researchers' attention to address the shortcomings points in our study leading to continued improvements in water cost estimation models and their allocation to sources of pollution emissions

REFERENCES

Aftab, A., Hanley, N., & Baiocchi, G. (2017). Transferability of Policies to Control Agricultural Nonpoint Pollution in Relatively Similar Catchments. *Ecological Economics, 134*, 11-21. DOI: 10.1016/j.ecolecon.2016.11.004

Al Barghouthi, S., & Marie, A. (2016). Estimation of the Cost of the Direct Damage on Human Resources Caused by Water Pollution. *Electronic Journal of Applied Statistical Analysis, 9*(3), 502-519.

Ananda, J. (2014). Institutional Reforms to Enhance Urban Water Infrastructure with Climate Change Uncertainty. *Economic Papers: A Journal of Applied Economics Policy*, *33*(2), 123–136.

Anderson, B., Romani, J., Phillips, H., Wentzel, M., & Tlabela, K. (2007). Exploring Environmental Perceptions, Behaviors and Awareness: Water and Water Pollution in South Africa. Population & Environment, *28*(3), 133-161.

Bayou, M. E., & James, B. (1992). Costing for Manufacturing Wastes. *Journal of Cost Management, 6*(2), 53-62.

Bebbington, J., Gray, R., Thomson, I., & Walters, D. (1994). Accounting, Attitudes and Environmentally - Sensitive Accounting. *Accounting and Business Research*, *24*(94), 109-120.

Dasgupta, S., Wheeler, D., Huq, M., & Zhang, C. (2001). Water pollution abatement by Chinese industry: cost estimates and policy implications. *Applied Economics*, *33*(4), 547-557.

Engel, S., & Muller, A., (2016). Payments for environmental services to promote climate-smart agriculture? Potential and challenges. *Agricultural Economics*, *47*(S1), 173-184. DOI: 10.1111/agec.12307

Gibbs, J. P., Halstead, J. M., Boyle, K. J., & Huang, J-C. (2002). An Hedonic Analysis of the Effects of Lake Water Clarity on New Hampshire Lakefront Properties. *Agricultural and Resource Economics Review, 31*(1), 39–46.

Hoagland, P., Jin, D., Polansky, L. Y., Kirkpatrick, B., Kirkpatrick, G., Fleming, L. E., Reich, A., Watkins, S. M., Ullmann, S. G., & Backer, L. C. (2009). The Costs of Respiratory Illnesses Arising from Florida Gulf Coast Karenia brevis Blooms. *Environmental Health Perspectives, 117*(8), 1239-1243.

Huang, L., Smith, M. D., & Craig, J. K. (2010). Quantifying the Economic Effects of Hypoxia on a Fishery for Brown Shrimp *Farfantepenaeus aztecus. Marine and Coastal Fisheries, Dynamics, Management, and Ecosystem Science, 2*(1), 232–248.

Jayanath, A., & Benjamin, H. (2015). Measuring environmentally sensitive productivity growth: An application to the urban water sector. *Ecological Economics*, *116*, 211–219.

Jayanthi, R. (2015). Green Accounting: A Study about Its Importance and Concept. *International Journal of Research in Commerce & Management, 6*(11), 76-80.

Key, N., & Sneeringer, S. (2014). Potential effects of climate change on the Productivity of US dairies. *American Journal of Agricultural Economics*, *96*(4), 1136-1156.

Michael, H. J., Boyle, K. J., & Bouchard, R. (2000). Does the Measurement of Environmental Quality Affect Implicit Prices Estimated from Hedonic Models? *Land Economics*, *76*(2), 283-298.

Moreira, V. H., & Bravo-Ureta, B. E. (2010). Technical Efficiency and Meta technology Ratios for Dairy Farms in Three Southern Cone Countries: A Stochastic Meta-Frontier Model. *Journal of Productivity Analysis*, *33*(1), 33–45.

Morrison Paul, C. J., Feithoven, R. G., & de O Torres, M. (2010). Productive performance in fisheries: modeling, measurement, and management. *Journal of Agricultural & Resource Economic, 54*(3), 343-360.

Muller, N. Z., Mendelsohn, R., & Nordhaus, W. (2011). Environmental accounting for pollution in the United States Economy. *American Economic Review*, *101*(5), 85-97.

Pan, D., Zhou, G., Zhang, N., & Zhang, L. (2016). Farmers' preferences for livestock pollution control policy in China: a choice experiment method. *Journal of Cleaner Production, 131*, 572-582. DOI: 10.1016/j.jclepro.2016.04.133.

Parris, K. (2011). Impact of agriculture on water pollution in OECD Countries: recent trends and future prospects. *International Journal of Water Resources Development*, *27*(1), 33-52. DOI: 10.1080/07900627.2010.531898

Pascoe, S. (2007). Estimation of cost function in a data poor environment: the case of capacity estimation in fisheries. *Applied Economics*, *39*(20), 2643-2654.

Poor, P. J., Boyle, K. J., Taylor, L. O., & Bouchard, R. (2001). Objective versus Subjective Measures of Water Clarity in Hedonic Property Value Models. *Land Economics*, *77*(4), 482-492.

Schaffner, M., Bader, H-P., & Scheidegger, R. (2011). Modeling non-point source pollution from rice farming in the Thachin River Basin. *Environment, Development & Sustainability*, *13*(2), 403-422.

Sneeringer, S. (2009). Does Animal Feeding Operation Pollution Hurt Public Health? A National Longitudinal Study of Health Externalities Identified by Geographic Shifts in Livestock Production. *American Journal of Agricultural Economics*, *91*(1), 124-137.

Tu, J-C., & Huang, H-S. (2015). Analysis on the relationship between green accounting and green design for enterprises. *Sustainability*, *7*(5), 6264-6277.

Walsh, P. J., Milon, J. W., & Scrogin, D. O. (2011). The Property-Price Effects of Abating Nutrient Pollutants in Urban Housing Markets. In H. Thurston (Eds.), *Economic Incentives for Stormwater Control* (pp. 127-145). Boca Raton, Florida: CRC Press.

Weiss, P. T., Gulliver, J. S., & Erickson, A. J. (2007). Cost and Pollution Removal of Storm-Water Treatment Practices. *Journal of Water Resources Planning and Management, 133*(3), 218-219.

Wheeler, T. B. (2013). Fish kills, toxic algae plague Northwest Creek in Stevensville. *The Baltimore Sun.* Retrieved from http://articles.baltimoresun.com/2013-08-26/features/bs-grtoxic-algae-shore-20130825_1_blue-green-algae-microcystis-fish-kills