October 2020 Research # 131

Executive Summary

A Methodology to Determine Israeli Values for External Costs of Water Pollution

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המשרד להגנת הסביבה
الوزارة لحماية البيئة
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The Fellows Program is a non-partisan. It is funded, in part, by the Milken Institute and other leading philanthropic organizations and individuals in the United States and Israel.

The Ministry of Environmental Protection defines environmental external costs to determine monetary grounds for internalization of those costs. The external costs represent the monetary value of the losses to social welfare caused by pollution. Every year since 2012 the ministry has published the external costs of air pollutants, which represent the cost of damage per unit of pollution, i.e. – per one ton of pollution. The external costs published by the ministry regarding air pollution are calculated using the "Benefit Transfer" method, which facilitates the adjustment of monetary values calculated for different countries, to local values.

In addition to pricing the external costs of air pollutants, for the first time the ministry plans to price the external costs of water pollutants in Israel, and to express these costs as a monetary value per pollution unit, i.e. – per one kg/ton of pollution.

In light of the ministry's innovative initiative, this paper examines the various methodologies which may be employed to price the external costs of water pollutants as monetary values per pollution unit, while taking into account the unique characteristics of the Israeli water market.

Water market management in Israel imposes several costs, comprised of water usage and management combined with the costs attributable to the different stages of supply – production, distribution and transmission. Cost-type mapping suggests that there are also un-internalized or external costs within the current pricing by the Israeli water market. These external costs include damage to recreation activities, human health, natural habitats, and to biological diversity of water sources.

In order to price these external costs in Israel, this paper examines methods of water pollution pricing in different countries, in the hope of identifying external costs formulas that may be used to calculate the relevant values in Israel. Furthermore, this paper proposes parameters for application of the Benefit Transfer calculation in Israel.

The focus is on major pollutants originating in treated wastewater, urban sewage and industrial sewage, which are poured into streams[1] and into the sea[2] (with or without

[1] According to Public Health Regulations (Wastewater Quality Standards and Sewage Treatment Rules), 2010, which set threshold values for wastewater and sewage quality.

permission), and on pollutants which must be reported to the Pollutant Release and Transfer Register (PTRT).[3]

A review of the literature was conducted to determine applicable international sources for Benefit Transfer. Most of the reviewed studies estimate the value of individual water bodies as an overall value, without calculating the monetary value per pollution unit, (per one kg/ton of pollution), and are therefore not suitable as a source of Benefit Transfer for Israel. Only two studies were found which discuss monetary damage value per one kg of pollution. The first is the Environmental Prices Handbook, which lists more than 200 water pollutants and is published by the Dutch CE Delft research and consultancy organization, which specializes in environmental economics studies.[4] The second study was conducted by the EXIOPOL environmental accounting framework, funded by the European Commission.[5] This project has undertaken several analysis studies regarding the external costs of major Environmental Effects in Europe, including of water nutrients (phosphorus and nitrogen). The external costs valuation made in the Delft and EXIOPOL studies are based on the Impact Pathway Model, which examines the path of a pollutant, starting from the instant of its production, continuing through the changes it causes to air, water or soil quality, and culminating in its end-effects, such as the influence on human health, before it is expressed in monetary cost and benefit terms. It should be noted that, as far as we know, the Delft study is the most comprehensive and up-to-date and has gained recognition and been lauded for its functionality throughout the EU and beyond, including in Israel, regarding air pollution.[6,7] In contrast, the EXIOPOL study is older, and with regard to water focuses on only two pollutants (phosphorus and nitrogen) within a limited set of regions. In the Delft study, the value of water pollutants is calculated according to their effect on two endpoints: human health and biological diversity. **For pollutants possessing a value that skews toward damage to human health, the Delft model is considered the most**

[2] According to Marine Pollution Prevention Regulations from Terrestrial Sources (levies intended to prevent marine pollution), 2011.
[3] According to Environmental Protection Law (Emissions and Transfers to the Environment - Report and Register Requirement), 2012.
[4] CE Delft (2018).
[5] Soes Hansen & Skou Andersen, 2009.
[6] See: Green Book: Estimating and Measuring External Costs of Air Pollution and Greenhouse Gas Emissions
[7] Note that an additional examination is required for practical application of Delft's external costs calculation for water pollutants.

reliable. The monetary damage to human health was calculated using a well-known method from Health Economics, applicable to the Benefit Transfer method, similar to the external costs of air pollutants published annually by the ministry.

Primary Pollutants by Delft (calculated mainly according to their effects on human health)

	Pollutant Name	CAS Number	Damage Rate Attributed to Effect on Human Health	Damage Rate Attributed to Effect on Biological Diversity
1	Zinc	7440-66-6	99.3%	0.7%
2	Arsenic	7440-38-2	99.2%	0.8%
3	Benzene	71-43-2	92.45%	7.55%
4	Dichloromethane DCM	75-09-2	99.80%	0.2%
5	Tetrachloroethylene PERC	127-18-4	98.92%	1.08%
6	Trifluralin	1582-09-8	88.93%	11.07%
7	Chloroform (Trichloromethane)	67-66-3	99.16%	0.84%
8	Mercury	7439-97-6	99.06%	0.94%
9	Lead	7439-72-1	91.96%	8.04%
10	Cadmium	7440-43-9	76.05%	23.95%
11	Naphthalene	91-20-3	69.04%	31.96%

The application of the Benefit Transfer method to these pollutants would necessarily include adjustments based on differences in GDP, in population density, and in currency

and price index, using a Benefit Transfer method similar to that used for external costs of air pollutants.

As opposed to the above-mentioned pollutants' values, which mostly represent damage to human health, the external costs calculated by Delft for phosphorus and nitrogen represent damage to ecological systems, measured by impact on biological diversity. Delft's biological diversity impact measurement is based on a meta-analysis study, founded on willingness-to-pay studies, conducted mainly in Europe and North America. The high variance value of the different ecological systems in each source makes it difficult to generalize the values to a single value for biological diversity. As the researchers themselves note, this method embodies significant uncertainty. Moreover, external costs values, based on utilities from habitats that are geographically distant from Israel, are not an appropriate Benefit Transfer source. Therefore, it is recommended that the Delft study not be relied upon to calculate the external costs of phosphorus and nitrogen in Israel. Still, it is noteworthy that in a correspondence with Delft it was mentioned that the company conducts work for the World Bank on the subject of a Benefit Transfer mechanism for ecological systems' services evaluation so that the possibility should be explored of using it in the context of water pollution.

Since it is deemed unwise to rely on Delft's external costs of phosphorus and nitrogen, the option of adapting the EXIOPOL research was considered. The EXIOPOL values were calculated for sea and lake water separately, using a hedonic model, which yields an estimate of the monetary value of environmental hazards based on shifts in prices of the nearby real estate In this case, it was the water clarity caused by eutrophication. The sources for EXIOPOL's calculations were sites in Denmark, England and Norway. EXIOPOL's calculations include a combination of emission-dispersion and dose-response models, and a premise extrapolated from a study about New Hampshire which assumes a 3.3% drop in the real estate market as the result of a high level of water clarity.

An examination of EXIOPOL's methodology raises several reservations. First, it is not possible to rely on the actual values in the form of €/Kg-emission (not even after a conversion to local currency and a 2020 price index), because they represent ten-year-old real estate prices in Europe. One could, theoretically, apply the EXIOPOL premise (3.3% change in assets' price) to the Israeli real estate market. However, this would be

methodologically weak, because the percentage was calculated only for the New Hampshire market back in 2002. Second, EXIOPOL's emission scenarios include only unplanned dripping caused by changes in the environment's agriculture activity, and not by a direct surge into water sources, such as in flow levy. Therefore, the pure values obtained from EXIOPOL are not reliable for the purpose of Benefit Transfer.

Considering these findings, it is recommended that an original study be conducted to estimate the external costs of phosphorus and nitrogen.

Most of the studies estimating the benefits from water sources which were examined within the review of the literature, were conducted using the stated preferences method, while the above-mentioned EXIOPOL study was conducted according to the hedonic model, which is revealed preferences method.

EXIOPOL's research methodology may be of use for an original Israeli hedonic prices study and would provide guidelines for an assessment procedure which would facilitate application of a monetary value to an emission scale unit. EXIOPOL suggests useful statistical models for emission-dispersion estimation, as well as formulas for calculating coefficients for the interdependence between a pollutant's concentration and water turbidity decline (dose-response), and a formula for weighting these variables into a specific value per one scale unit of pollution. Therefore, implementing this methodology requires three types of studies; (1) a study of the pollutants' emission-dispersion interdependence in Israeli water sources; (2) a study the pollutants' measured quantity and changes in water clarity dependence; and (3) a monetary estimate of water turbidity incline using the hedonic prices method.

Recommendations

While the Delft and EXIOPOL studies provide monetary values for specific pollutants, they do not include pollutants' species groups or indexes for identifying different pollution levels, whereas an understanding of their monetary values might be useful to the ministry. Therefore, with respect to these pollutants and other major pollutants which lack a source for Benefit Transfer, it is recommended that a local study be conducted in Israel, to assess their monetary value:

Pollution Indices

- BOD – Biochemical Oxygen Demand
- TOC
- E. coli
- TSS

Other Pollutants[8]

Pollutant Name	CAS Number	On Delft?
Ethylbenzene	100-41-4	No
Aluminum	7429-90-5	No
Boron	7440-42-8	No
Iron	7439-89-6	No
Beryllium	7440-14-7	Yes
Vanadium	7440-62-2	No
Total Phosphorus	7723-14-0	Yes
Total Nitrogen	7727-37-9	Yes
Toluene	108-88-3	No
Chlorine	7782-50-5	No
Chloride	7447-40-7	No
Chromium	16065-83-1	No
Lithium	7439-93-2	No
Molybdenum	7439-98-7	No
Manganese	7439-96-5	No
Copper	7440-50-8	Yes
Nickel	7440-02-0	Yes
Sodium	7440-23-5	No
Selenium	7782-49-2	No
Total Organic	irrelevant	No

[8] The pollutants in the table appear in the Public Health Regulations and in the Marine Pollution Prevention Regulations from Terrestrial Sources. However, Delft cannot be used as the Benefit Transfer source for these pollutants, since either they are not included in Delft, or they mainly damage the biological diversity, rather than adversely affecting human health.

Carbon		
Fluoride	1333-83-1	No
Phenol	108-95-2	No
Cyanides	Cyanide Hydrogen 74-90-8 Cyanide Sodium 143-33-9 Cyanide Potassium 151-50-8 Cyanide Calcium 592-01-8	No
Cadmium	7440-43-9	Yes
Cobalt	7440-48-4	No
Xylene	1330-20-7	No
Mineral Oil	8042-47-5	No

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