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A Contaminated Groundwater: A Transgenerational greek Tragedy: A Book Review of Regulating Chemical Accumulation in the Environment: The Integration of Toxicology and Economics in Environmental Policy-making

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Contaminated Groundwater: A Transgenerational Greek Tragedy

A Book Review of

REGULATING CHEMICAL ACCUMULATION IN THE ENVIRONMENT: THE INTEGRATION OF TOXICOLOGY AND ECONOMICS IN ENVIRONMENTAL POLICY-MAKING[1]

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Despite the location in the maize-growing Po River Valley in northern Italy, this case study, comprised of 10 chapters by 13 contributors, is still recognizably a modern Greek tragedy with universal implications for the human condition in the twenty-first century. The drama unfolds in the final chapter on legal instruments by Michael Faure and Jûrgen Lefevere. The Hydrologicus brothers, Aquarius and Agricola, are brought shackled together before a local magistrate. Aquarius, CEO of the water supply company, is accused of selling drinking water that is contaminated with pesticides, contrary to the European Economic Commission Directive on Drinking Water Quality.[2] Agricola, his older brother, who inherited the extensive family estate, is accused of using a pesticide that is prohibited in his region. The case study, complete with occasional appearances of a Greek chorus to give an ethical interpretation to the tragedy, is a skillful integration of the environmental chemistry and toxicology, economics and politics that landed the Hydrologicus brothers in court. For those of us who are not simultaneously familiar

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1 REGULATING CHEMICAL ACCUMULATION IN THE ENVIRONMENT: THE INTEGRATION OF TOXICOLOGY AND ECONOMICS IN ENVIRONMENTAL POLICYMAKING (Timothy Swanson & Marco Vighi eds., 1999) [hereinafter Regulating Chemical Accumulation].

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2 Council Directive 80/778 Relating to the Quality of Water Intended for Human Consumption, 80/778/EEC, 1980 O.J. (L 229) 11.

with all these subjects, Professor Marco Vighi, Carolina Sbriscia Fioretti, and Professor Timothy Swanson have produced a comprehensive and highly readable preface, and Professor Timothy Swanson wrote an accessible description of the problem and the layout of the various chapters in the volume.

There is, strangely, no account in the case study of when maize started to be grown in the Po Valley or whether it is used for human consumption or for livestock feed, but in the 1950s, herbicides began to be used to control the weeds because about a third of the yield was being lost. And in the mid-1960s, the selective herbicide, atrazine, was introduced as a pre-emergence spray to control a variety of weeds that affected maize production. This was followed by a variety of other compounds that were used in different combinations and for post-emergence applications. Two problems gradually became apparent. First, the weeds began to develop strains that were resistant to the herbicides, so new herbicides had to be introduced. Second, groundwater began to be contaminated with pesticides and, in the 1970s, analytical chemists started reporting detectable concentrations in groundwater supplies not only in the Po River Valley, but also throughout the European Community, that for centuries, had been used, untreated, as sources of drinking water by the general population.

The response of the European Economic Community (EEC) was to issue a Council Directive in 1980 establishing a policy of zero tolerance for the presence of pesticides in the natural environment and in drinking water.[3] This must have been the point at which the Greek chorus asked how this was to be implemented because it is difficult to demonstrate that something is not there. One approach was to set a level that corresponded with the limit of analytical detection that happened at the time to be 0.1 μg/l for an individual pesticide and 0.5 μg/l for the 'cocktail' of all pesticides. The second approach was to set water quality objectives based on the existing toxicology, resulting in a value for atrazine of 1.0 mg/m^3, that had been produced by the

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3 *Id.*

Scientific Advisory Committee on Ecotoxicology and Environment, of the European Community. Similarly, the World Health Organization (WHO) proposed a drinking water guideline for atrazine of 2 μg/l based on rat carcinogenesis experiments and the derivation of an acceptable daily intake. The question posed by these different values that reflect different philosophies is whether they represent "acceptable" concentrations or prohibited levels.

The chapter on environmental toxicology, by Professor Marco Vighi, Richard Lloyd and Carolina Sbriscia Fioretti, is a useful overview of the methods used for assessing the risks of compounds released into the environment, with consideration not only of the potential toxicity of the compound, but also the likely environmental fate and distribution. The modern Greek chorus might be excused expressing its concern at the revisionism in the second introductory paragraph that states, "Organisms over a wide area could be exposed to low concentrations of [DDT and later PCBs] for a long period of time. Ecotoxicologists then began to search for very sensitive biological responses in order to detect the effect, if any, of these low concentrations."[4] There should be an immediate dissonance in the mind of the reader between this account and the extensively documented record, known by all students of environmental toxicology, of the discovery of the extirpations, in the 1950s and 1960s, of populations of several birds of prey, such as the peregrine falcon, on the North American and European continents and the subsequent investigations to unravel the relationship to specific organochlorine pesticides and industrial compounds.

Despite the Council Directive, the extent and severity of pesticide contamination has been increasing in European groundwater placing the EEC in a dilemma. Should they allow the local authorities to raise the permissible limit as long as it was within toxicologically acceptable levels, and should local and eventually national bans be placed on the use of certain substances? Detailed maps of the geographic progression of specific bans on the use of atrazine in the

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4 REGULATING CHEMICAL ACCUMULATION, *supra* note 1, at 75.

Po Valley are provided to show the extent of the Italian regulatory response. Analytical chemists monitoring groundwater had shown that concentrations were frequently above the EEC Council Directive of 0.1 μg/l, but generally not above the WHO guideline of 2 μg/l. This is commented on in the last two concluding paragraphs of the environmental toxicology chapter that state, "[T]he total national ban [on atrazine] was the consequence of an emotional situation, determined more by public fear than by sound scientific evaluation[,]" noting that "conditions of real risk for human beings were sporadic and limited to restricted areas."[5] The chapter ends with a call for "sound agronomic, environmental and economic grounds" for controlling weeds on maize.[6] The difficulty with this chapter on environmental toxicology is that it excludes consideration of recent advances in endocrine disruptors and developmental effects at very low doses and the possibility of synergistic effects, and so the concluding certainty has a tinge of hubris. As the introductory chapter states, the toxicological procedures for deriving an acceptable daily intake are well established and are not under examination in this volume.

As an entree into the literature on economic aspects of groundwater contamination, there are two valuable chapters that, respectively, review methods of valuation of health risks, and methods for estimation of benefits of groundwater protection. Magnus Johannesson and Per-Olov Johansson introduce the concept that undertaking a human activity for some benefit will involve a change in the probability of the survival of the individual and that a monetary value can be put on this change in the risk of death. One method is the human capital approach which relies on the estimation of a person's future earnings. The willingness-to-pay approach overcomes many of the ethical dilemmas posed by the human capital approach that does not take into account the preferences of an individual for buying a reduction in risk for money. The willingness-to-pay

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5 *Id.* at 98.

6 *Id.*

can be indirectly estimated by studying wage differentials since some workers are willing to work for less money in a safer environment. Alternatively, workers can be asked directly, using the contingent valuation method, what money they are willing to pay for a reduction in risk. Results of application of these methods can be compared using the concept of the value of a statistical life. The review of the extensive literature indicates that this value is about US $2.2-2.5 million, with a suggestion that the value increases by about a third when altruistically estimating for the safety and welfare of other people. The chapter ends with a discussion of the results from application of these techniques to a variety of situations involving the contamination of groundwater.

The second applied economics chapter is a detailed report of a "pioneering" contingent valuation study, undertaken by Jane Press and Tore Soderqvist on the benefits of groundwater protection in Milan. Previous work had addressed an economic problem of social efficiency concerning whether the standard of 0.1 μg/l in the EEC Directive corresponded with the concentration at which the marginal cost of reducing the concentration of atrazine in drinking water was equal to the marginal benefit from having reduced the concentration. That work had shown that there was almost no economic information on benefits. The chapter starts from the premise that although the "health risks caused by observed atrazine levels in Italian groundwater reserves are virtually zero ... people may perceive the matter differently and be willing to give up some wealth for accomplishing decreased concentrations of pesticides in groundwater."[7] The costs of reducing the concentrations by substituting more expensive herbicides or by treating the water are well characterized. The chapter includes a description of the available valuation methodologies, the process of choosing the contingent valuation method as the appropriate technique, the development of a questionnaire, and the presentation and discussion of the results.

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7 *Id.* at 122.

There are large aquifers under Milan that are recharged from the hinterland. But a combination of industrial as well as agricultural activities has resulted in contamination of the groundwater with solvents as well as pesticides. If one aquifer has become seriously contaminated, it can be closed (a process known as "pollution prevention") and groundwater from the less contaminated of the 582 wells in the 31 distribution zones in Milan can be mixed to ensure that the resulting drinking water meets the standards. Based on the results of the survey, the researchers found that the willingness of the people of Milan to pay for protection of the groundwater was unpredictably high. The discussion addresses reasons for these anomalous results in terms not only of a high value placed on non-consumptive benefits of groundwater, but also the perceptions of the people of Milan about the quality of drinking water based on "exaggerated" media reports and on advertising for mineral water. At this point the Greek chorus might question whether the people of Milan might, despite the scientific rationalism, be justifiably fearful of the cocktail of known and unknown chemicals in their drinking water and whether, in the 1950s and even the 1960s, their parents and grandparents would have chosen these agricultural and industrial technologies if they had known that they would result in groundwater contamination and consequent contamination of drinking water.

Robin Mason has described respectively in two chapters the failure of the market and regulatory systems to correct the problem of groundwater contamination. Agricola was confronted with a wide array of mixtures of herbicides to control weeds on his maize and both efficacy and cost needed to be considered in deciding which to use. In contrast to the physico-chemical characteristics of insecticides that are designed to be hydrophobic to enter the bodies of organisms, herbicides need to be hydrophilic to be carried by the hydrologic cycle in the soil to the developing weed seeds. The second characteristic is the need for persistence, since there is no point in applying a herbicide if it is going to break down before it reaches the germinating target. As the Greek chorus notes, it is these two physico-chemical characteristics that pose the policy dilemma since the

herbicides with the most desirable characteristics for the farmer are the same as those that lead to contamination of the groundwater.

With the bans on atrazine, it was expected that herbicide manufacturers would start designing substances that would be less harmful to the drinking water resources. But the drama takes a "perverse" twist in the plot when Oligopolis, one of the small number of herbicide developers and manufacturers, ponders the significance of the bans for his patented products. Herbicides are proprietary compounds and the patents have a finite life. Oligopolis recognizes that the prospect of a ban on a particular substances could, from a strategic standpoint, be turned to his economic advantage since the useful patent life on his product is nearly expired. Compulsory removal of the product from the marketplace would ensure that his newly patented product, that is more expensive, can be efficiently introduced with less competition.

The Greek chorus discusses the way in which the ban on the herbicide should lead to the design of herbicides that are less persistent and have less affinity to water resulting in less groundwater contamination. Though Agricola does not choose the most persistent herbicides, because this would result in soil residues that might interfere with his options in crop rotation, he does continue to chose herbicides that are hydrophilic and with persistent tendencies because they are cost effective for him. And besides, the "externalities" of his maize production can be solved through Aquarius, as CEO of the water supply company, investing in water treatment facilities such as filtration through activated carbon.

Professor Timothy Swanson describes an economic method for influencing manufacturers in the design of herbicides through the imposition of a tax charge on the accumulation potential of each substance. Superimposed on this universal tax could be supplementary local taxes and regulations depending on the characteristics of the local soil conditions and the potential for movement of the pesticides into the groundwater. In the final chapter, Michael Faure and Jůrgen Lefevere ask "what is the problem that we want to solve?" and answer it by stating that the problem is the presence of potentially

dangerous substances in the drinking water of the EEC Member States. The Greek chorus would probably disagree and say that the problem is whether to grow maize in the Po River Valley and, if it is to be grown, how to grow it without frightening the populace that depends for their drinking water on uncontaminated groundwater. It is uncertain whether the various global and local tax incentives would be effective mechanisms or whether local administrative agencies might be captured by those regulated. After all, it was the implementation of the EEC Directive on drinking water quality using national legislation with criminal sanctions that netted Aquarius. And it was the decree of the zoning board enforced by criminal sanctions, concerning which pesticides could be used where, that netted Agricola. If these measures are unsuccessful, not only are the Hydrologicus brothers, Aquarius and Agricola, condemned to be shackled to each other for the length of their natural lives, but their children are condemned to play out the tragedy in the next generation.

This is an excellent volume for students and professionals involved in a wide variety of disciplines related to environmental contamination with persistent and accumulative substances. The piece that seems to be missing is alluded to in the first paragraph of the preface when noting that, "During the seventies a shift occurred from *a posteriori* control of chemical impacts to the prevention of this type of damage."[8] This case study of the use of chemicals for weed control in maize production in the Po River Valley could be regarded as a model of the societal costs and benefits from the modern use of chemicals in industry and in agriculture. After fifty years, there seems to have been little done to understand whether this practice has had any actual effects on health, particularly in terms of the subtle effects that may be occurring as a result of exposures to substances that are endocrine disruptors. At the international level there still seems to be the unanswered question of who is responsible for maintaining vigilance, through *a posteriori* investigations, to determine whether the predictions of the environmental chemists and toxicologists did

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8 *Id.* at xi.

actually prevent damage. Probably it cannot be a responsibility of industry. But should it be a responsibility of governments or of non-government organizations? The Greek chorus might close the curtain by noting the dangers of the marriage of science with big industry and big government. Who will guard the guardians themselves?