

Environmental Pollution in the *Ta'nach* and in the *Talmud*

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Rachel Carson's book, *Silent Spring*, published in 1962, brought the environmental hazards that stem from exposures to pesticides to the attention of the American public. Since then, much legislation was passed to control the deleterious impact of human activities upon the environment. President Richard Nixon proposed the establishment of the United States Environmental Protection Agency (U.S. EPA), which became operational on December 2, 1970. The U.S. EPA was charged with protecting the environment and human health from various chemical, physical, and biological hazards transmitted and deposited into the air, soil, and water. Before the establishment of the U.S. EPA, who was concerned with protecting the public from pollution? Apparently, the Rabbis of the Talmud were cognizant of pollution, and established laws to protect the public from environmental hazards; these laws are briefly mentioned in the Talmud. In the Talmudic era, the types of pollutant emissions were much simpler than those of today (synthetics, such as polychlorinated biphenyls (PCBs), polybrominated biphenyls (PBBs), BPA (bisphenol A), DDT, *etc.* were not manufactured), the sources of the toxic emissions were much less complex than of today (*e.g.*, family-run factories versus mega-industrial complexes), and the knowledge of the subtle health effects (*e.g.*, cancer) of pollution were unknown. Thus, legislation developed by the Rabbis was directed to prevent the nuisances of pollution to the public, rather than to protect the public from the adverse health effects of pollution [1].

Air pollution

Air quality has a profound effect on human health. Epidemiologic evidence has identified an association between outdoor air pollution and increased risk for several major chronic diseases, including respiratory and cardiovascular diseases, cancer, skin diseases, eye irritation, neuropsychiatric complications, cognitive impairment, and decreased longevity. The major air pollutants include particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead [2, 3]. The nature of a specific deleterious health effect is dependent upon the nature of the particular air pollutant. For example, there is a direct association between exposure to poor air quality due to fine particulate matter (0.1 to 2.5 micrometers in diameter), and an increasing rate of mortality and morbidity due to cardiovascular and respiratory diseases, including lung cancer [4]. Conversely, lowered concentrations of airborne fine particulate matter, as mandated by regulatory actions, are associated with an increase in life expectancy [5].

Ramban understood the potential deleterious effects of polluted air on human health, and suggested a causal relationship between ambient air pollution and longevity (Bereishis 5:4), specifically, that outdoor air pollution accounted for the progressive reduction in longevity noted in the early history of humans. Before the flood, the human lifespan was extremely long.

When the flood came upon the land, the atmosphere deteriorated for them, and their days of life gradually decreased. After the flood the approximate life span of the three generations that followed Shem was 400 years. After the Dispersion in the days of Peleg, the change of atmosphere had a further effect on shortening longevity to about 200 years. By the time we get to the patriarchs, although they lived longer (Avraham, 175 years; Yitzchok, 180 years; and Yaakov, 147 years), the life of ordinary people was 70-80 years.

Schoental [6], however, suggested that the decrease in longevity following the flood was related to the proliferation of microfungi, whose growth was favored due to the high humidity following a world-wide flood. These microbes excrete secondary metabolites, termed mycotoxins, which are poisonous chemicals usually associated with diseased or moldy crops, such as grains and seeds. Ingestion of some food-borne mycotoxins cause acute ailments that appear very quickly while the ingestion of other mycotoxins causes longer term chronic or cumulative effects on health, including the induction of cancers, immune deficiency, and decreased longevity.

A common air pollutant in ancient times was smoke, which is a collection of airborne impurities consisting of solid particulates, liquid droplets, and a variety of gases emitted when a material undergoes combustion or burning. The visible particles emitted from a fire are commonly termed "smoke"; the unaided eye can detect particle sizes greater than 7 micrometers. Soot (composed of carbon) is a component of the visible particulate matter in smoke. The invisible constituents of smoke are referred to as gases. Smoke typically contains hundreds to thousands of different chemicals. The chemical composition of smoke varies, depending upon the material undergoing burning and the conditions of combustion - *e.g.*, the availability of oxygen and the temperature of combustion [7].

Smoke-induced eye irritation may explain, in part, the dimming of the eyesight of Yitzchok. Chronic exposure to smoke can initiate various ocular pathologies, including the

formation of cataracts and the induction of macular degeneration. A cataract is the clouding or loss of transparency of the lens in the eye as a result of tissue breakdown and protein clumping. The causes of cataracts include aging, trauma, diabetes, and chronic exposure to smoke [8]. Macular degeneration, a medical condition typically occurring in older people, is characterized by blurred vision or by loss of vision, making it difficult to recognize faces [9]. Chronic exposure to smoke, more specifically to the oxidants in smoke, induce oxidative stress that damages the proteins of the lens of the eye and the macula of the retina [8, 10].

It came to pass when Yitzchok was old and his eyes were too dim to see, that he called Esav his elder son and he said to him, “My son,” and he said to him, “Here I am” (Bereishis 27:1).

This introduces the incident whereby Yitzchok bestowed the blessing upon Yaakov, instead of Esav. Biblical scholars have offered many opinions regarding the nature and cause of the dimming of the eyesight of Yitzchok. Rashi offered three possible explanations, one of which was that Yitzchok’s eyesight lessened due to chronic exposure to the smoke emanating from the burning of the sacramental incense offered by Esav’s wives to their idols. Smoke is an eye irritant (Mishlei 2:10). Incense burning inside the home, a common practice in Arabian Gulf countries, was identified as a significant source of indoor air pollutants. Analyses of the indoor airborne pollutants arising from the burning of incense included particulate matter, carbon monoxide, sulfur dioxide, nitrogen oxides, formaldehyde, and carbonyls, including pentanal and glyoxal [11]. Possibly, Yitzchok already had the beginnings of cataracts and age-related macular degeneration, pathologies which were aggravated in the presence of the smoke emanating from the burning of incense by Esav’s wives as an offering to their idols [12].

In *Pirkei Avos* (5:7) mention was made of ten miracles performed in the *Beis HaMikdash*, one of which is that the smoke emanating from the sacrificial offerings on the Altar (*Mizba’ach*) rose in a vertical column, so as not to discomfort the eyes of the *kohanim*. The *Mizba’ach* stood in the Inner Courtyard (*Azarah*) of the *Beis HaMikdash*. As there was no roof above the *Mizba’ach*, potentially, smoke emanating from the *Mizba’ach* could have polluted neighborhoods surrounding the *Beis HaMikdash*. However, even on windy days, the smoke emanating from the burning wood pile on the *Mizba’ach* miraculously did not disperse downwards to discomfort the *kohanim* (Yoma 21b). In addition to smoke being an eye irritant, wood smoke creates particulate pollution that may evoke a spectrum of health effects, including asthma attacks, diminished lung function, upper respiratory illnesses, heart attacks, and stroke [13]. Thus, vertical movement of the

smoke alleviated a potential and serious health hazard to the *kohanim* and to the citizens in the neighborhoods surrounding the *Beis HaMikdash*.

When smoke comes into contact with the surface of any substance or structure, the chemicals contained within it are transferred to and absorbed into the substance or structure. Among the ten regulations enacted on entering *Eretz Israel* was one which, in order to preserve the amenities of *Yerushalayim*, proscribed the erection of kilns (furnaces used for processing limestone or to make pottery). Such furnaces emitted smoke and which potentially could blacken the walls of the surrounding buildings (Bava Kamma 82b).

Although the overt rationale for eliminating smoke from *Yerushalayim* was esthetic, there is an inherent covert health benefit, which is best understood by comparisons to cigarette smoke. For cigarette smoke, a distinction is made between first-hand smoke from second-hand smoke. First-hand smoke is the smoke that is inhaled by the individual smoking the cigarette, whereas second-hand smoke is the smoke that is passively or involuntarily inhaled by someone who is not smoking. Exposure to second-hand smoke increases the risk of various diseases, such as coronary heart disease, asthma, and cancer, in individuals not directly exposed to first-hand smoke. A relatively new concept is that of third-hand smoke, which is the residual contamination from cigarette smoke after a cigarette is extinguished. It consists of the pollutants from second-hand smoke that settle onto surfaces, such as clothing fibers [14], and can be re-emitted into the air and inhaled or ingested, even months later. Third-hand smoke contains carcinogens [15]. Thus, the disallowance of kilns in *Yerushalayim* eliminated the deposition of smoke on the surfaces of buildings, which would have been a source of third-hand smoke pollution and a potential health hazard.

Evidence that air quality affects the health of humans is relatively recent, as “medicine of early times lacked the necessary tools to provide the Jewish and non-Jewish scholars with data about health danger and thus we find hardly any reference to this point” in the Talmud [1]. Many cases of Talmudic air pollution centered on smoke and latrine odors. “A man may not open a bakery or a dyeing shop under another’s storehouse, nor open a cattle shed underneath a storehouse” (Bava Basra 2:3). A bakery and a dye shop in which dyes are boiled for soaking of fabrics generated sufficient smoke to cause a deleterious effect on grain or oil in his neighbor’s storehouse. Similarly, the manure in cattle shed emanated unpleasant odors to cause a harmful effect on grain or oil in his neighbor’s storehouse. Examples of Talmudic legislation include, [a] anyone who sets up a kiln must do it at least 50 cubits (*amot*) away from the city (Bava Basra 23a); [b] on

account of their obnoxious odors, animal carcasses, cemeteries, and tanneries should be located at a minimal distance of 50 cubits outside the city (Bava Basra 25a); and [c] a threshing floor should be 50 cubits in all four directions from houses, because the chaff produced by winnowing flax is injurious to humans and, upon its decomposition, acts as compost to generate excessive heat which adversely affects sown fields (Bava Basra 26a). Rambam (*Hilchos Shechenim*, 11:1) extended this law to any industrial activity that emits airborne dust or ash that could harm people or damage vegetation.

Mamane [16] contrasted the solving of air pollution problems in Talmudic times versus today.

When compared with today's problems, one could say that the main difference is in the scale, in the magnitude of the problems, as well as the solutions. The number of air pollution source categories in the Mishnah time was limited, although not the number of individual sources within a town. Factories were small and family operated. Thus distances of 50 cubits were considered a sufficient distance to minimize the impact of a family factory on a neighborhood. In severe cases, distance alone was not sufficient, but the 'industrial source' had to be located downwind of the town, along the prevailing wind.

In the midst of a discussion on healthful dietary habits the Talmud (Berachos 40a) mentioned *ketzach*, either fennel or a type of unspecified seed cultivated in Arabia. Rabban Shimon ben Gamliel said that "one who sleeps to the east of its (*i.e.*, *ketzach*'s) storage area has his blood on his own head." Apparently, *ketzach* generated a volatile chemical poison. Moist, heavy winds blowing off the Mediterranean Sea carried the volatilized poison to people sleeping to the east of the storage, thus explaining "one who sleeps to the east of its storage area has his blood on his own head." This is somewhat similar the red tide blooms off Florida's central gulf coast. *Karenia brevis*, the marine dinoflagellate causing Florida's red tide, produces chemical toxins that adversely affect the central nervous system of fish and other vertebrates, resulting in their death. Disruption of the dinoflagellates by wave action causes the airborne liberation of chemical toxins, which, when carried onshore by winds, may induce respiratory irritation in humans. At such times, beachgoers with respiratory conditions who are hypersensitive to red tide irritants, such as those with emphysema and asthma, are asked to leave the immediate area [17].

Discussions of various circumstances causing death of an intended victim are presented in Sanhedrin (77a). One such case involved a person who brought another individual into an airtight marble chamber, and subsequently lit an oil lamp. The burning fuel caused the air to "foul", resulting in the death of the trapped

individual. Apparently, as the chamber was airtight, the burning fuel consumed the oxygen, leading to death of the imprisoned individual.

Water Pollution

In the Talmud, there was less concern about water pollution, either because it was very rare, or because people were careful about their water supply. A person who dug a cistern or water hole for public use may wash his face, hands, and feet therein, unless there is mud or dung on his feet. If the cistern or water hole provided drinking water, he may not wash himself at all (Tosefta, Bava Metzia 11:14). Water left overnight without a cover should not be drunk, since harmful matter may have contaminated it (Avoda Zara 12b, 30a,b).

Industrial effluent, albeit on a smaller scale than today, was recognized. A pond used for steeping flax should be distant from a neighbor's vegetable garden, as the water runoff could damage the vegetables (Bava Basra 25a). The Talmud is referring to the process of flax retting. Flax, *Linum usitatissimum*, is a plant whose fiber is used to make textiles, such as linens. The plant grows as tall, slender stems. In the process of natural water retting, bundles of flax stalks are submerged and weighted down in ponds. The water penetrates into the central stalk portion, swelling the inner cells, and bursting the outermost layer of the stalk, thereby increasing absorption of water and allowing access by decay-causing bacteria. These bacteria dissolve the cellular tissues surrounding the fiber bundles, thereby facilitating the eventual separation of the fibers from the stem. The flax's soaking in a pond lasts for several days. Apparently, in the process of water retting, toxic chemicals from the flax plants were released, carried in runoff water, and caused harm to nearby vegetation [18]. To prevent damage to crops, these soaking ponds must be distanced from those areas in which a neighbor grew vegetables.

The most extreme example of water pollution was event in the first plague, in which *HaShem* turned the waters of the Nile River into actual blood or into a blood-like substance [19]. The reddened waters of the Nile River were suitable neither to irrigate the fields nor to drink; the Egyptian economy was crippled. The fish died (Shemos 7:20, 21; Tehillim 105:29) and their decomposition by aquatic bacteria of decay emitted a stench that permeated the atmosphere of Egypt. The appearance of dead fish floating upon the surface of an aquatic system or washed onto the shore is termed a fish-kill. Today, it is not uncommon, and the main causes of fish-kills are pollution (poisoning), suffocation (insufficient dissolved oxygen), and disease. In 1994 in St. Helena Bay, South Africa, a large bloom of algae formed in an estuary and extended into the open sea more than thirty kilometers out from the shore. The

bloom sank and decomposed, forming an aquatic area with almost no oxygen and lethal levels of hydrogen sulfide. Approximately fifteen hundred tons of dead fish and sixty tons of dead rock lobsters were washed ashore [20]. The fish-kill in the polluted Nile River was of a greater magnitude and resulted in extensive water and air pollution.

Soil pollution

An interesting incidence of soil pollution is noted in *Shoftim* (chapter 9). Gideon, a judge, married many women who produced 70 sons; he also sired a son, Abimelech, from a concubine. The seat of power of this family was in Shechem. After Gideon's death, Abimelech usurped the power from his half-brothers; he killed 69 of them, while one half-brother escaped. Abimelech's maternal relatives initially agreed to accept his leadership. A short time thereafter, Gaal the son of Ebed (probably, a non-Jew), entered Shechem with his army and mobilized the citizens to rebel against Abimelech. In the resulting battle, Abimelech was victorious; to punish the people, "he broke down the city and sowed it with salt" (*Shoftim* 9:45). This ritual of spreading salt on conquered cities was practiced in the Near East as a curse to anyone who dared to rebuild the city (Wikipedia). Plants normally live in soil environments that are hypoosmotic relative to the osmotic pressure of their cellular cytoplasm. In such hypoosmotic environments, water moves from the soil solution into the plants cells. By adding much salt to the soil, Abimelech changed the osmolarity of the soil solution to be hyperosmotic relative to the cytoplasm of the plant cells, thereby causing water to leave the plants. In such hyperosmotic environments the plants wilted and died.

Noise Pollution

Noise pollution refers to the generation of excessive noise that is deleterious to human activity or health. Consistent exposure to elevated levels of sound is associated with hearing impairment, cardiovascular disease, and hypertension. In the society of today, outdoor noise pollution is caused by machines and by transportation systems, such as trains, aircraft, and motor vehicles, whereas indoor noise pollution may be caused by loud music [22]. The noise pollution experienced at Jewish weddings by the extremely loud sounds is a potential health issue, manifested by pain perception, headache, ringing in the ears, and short-term hearing loss. An interesting solution was established in Israel, in which catering halls are required to install decibel meters to automatically monitor noise levels. When the noise level exceeds 85 decibels, electricity is automatically cut. Prior to this law, the average noise level at a Jewish wedding was greater than 100 decibels [23].

Although the health effects of continuous exposure to loud noise were not known in Talmudic times, loud noise was acknowledged, not so much as "pollution" but rather as an "annoyance." The Rambam (*Hilchos Shechenim*, 11:4) noted that each person is entitled to enjoy quietness, undisturbed by activities of his neighbors. For example, "If a courtyard resident set up a store in the courtyard, one of the residents can block him by claiming, "I cannot sleep due to the noise of your customers who go in and out of the courtyard." Noise of the customers' occasional arguments was disturbing to the sleep of the residents. In such cases, the storekeeper can be prevented from continuing his business. An exception, however, was made for a Torah school. Albeit children are noisy, a leniency was applied to allow the children to learn Torah (Bava Basra 2:3). Concern for those hypersensitive to noise was also acknowledged. Rav Yosef was easily bothered by noise. Blood-letters would practice under his palm trees. The spillage of blood attracted crows, which consumed the blood and flew to rest on the palm trees. Resting upon the branches the crows smeared blood on the dates and made much noise. Rav Yosef screamed, "Rid me of this crowing." Because of his hypersensitivity to noise, the blood-letters relocated their business (Bava Basra 22b, 23a). Milestones are another ancient source of noise pollution. Grindstones vibrate and emit loud noise and, therefore, must be distanced three *tefachim* from a neighbor's wall, as both could damage the integrity of the wall (Bava Basra 20b).

Excessive and continuous noise was characterized by the plague of *zfar'dea* (frogs). According to Rav Avigdor Miller, [19] two types of frogs were involved in the plague; one group of frogs croaked in the morning and continued throughout the daylight hours, and a second group of frogs croaked only a night.

The Egyptians could not sleep; and in the morning when the night croakers desisted and the Egyptian put his throbbing head on his pillow in hope to snatch some sleep, just then the day croakers began with their din. The constant raucous cries from all sides all day long sickened the people of the land. The chorus of frogs and toads can be deafening even in normal times. But at the command of HaShem the frogs caused a pandemonium in the land. As the ominous din from the river shattered the nerves of Egypt, they cursed the once revered Nile and wished it to become dry in order to cease supplying the multitudes of nauseating and cacophonous creatures that continued to swarm out of the contaminated waters.

Rav Miller's elaboration on the noise aspect of the inundation of frogs adds much to the understanding of the dynamics of the second plague.

Concluding statements

The scope of pollution in the time of the Mishnah and Talmud was much different than of today. For example, consider the magnitude of today's industrial complexes and the type of pollutants of today, *e.g.*, PCBs, PBBs, BPA, and DDT, versus mom-and-pop industries and wood smoke of 2,000 years ago. Apparently, water and soil pollution were not health issues, possibly as people of those generations were intimately connected to the land and understood the need to refrain from spoiling these environments. Air pollution seems to have been the main concern, albeit the health hazards from undesirable air were only understood on a simple level. For example, when R' Yehudah HaNasi became ill in *Beis Shaerim*, which was in a valley and had a hot climate, he was taken to *Tzippori*, which sat atop a mountain where the air was cool and crisp (Kesubos 104a). In Talmudic times, the focus on

pollution abatement was rather simple, as both the nature of the offending toxicants and subsequent the health hazards were minor, as compared to environmental issues in the 21st century.

Readers are directed to the articles by Attia and Attia [24], Carmell [25], Kottek and Seligman [26], Mamane [16], and Sichel [1] for additional information on pollution as viewed by *halakab*.

Acknowledgments

Appreciation is expressed to Rav Yisroel Reisman, Agudath Yisrael of Madison, Brooklyn, NY for reviewing the Torah content of this manuscript and to Charles Hochman, my *chavrusa* in the 5:30 A.M. *Daf HaYomi*, Agudath Yisrael of Madison, for reviewing the overall content of this manuscript.

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