The Dioxin Effect of Barrel Burning in St. Lawrence County

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The goals of this project are to model emissions, fate, and transport of dioxins from burn barrels in St. Lawrence County and to estimate health risks from human exposure via inhalation and ingestion. Because detailed information is not available on the operation and locations of burn barrels in the county, several scenarios will be modeled to investigate a range of potential outcomes. The modeling will provide preliminary results and expose knowledge gaps for a more extensive future study.

Barrel burning is today the biggest source of dioxin emissions. The barrel burning practice provides the optimal conditions needed to produce dioxins, including a lack of oxygen during combustion, a general temperature range about 500°F, availability of carbon and chlorine, and availability of transition metal catalysts. In addition, the trash of today contains many components which help to generate dioxins readily. Before 1960, trash did not contain so many plastics, and consumable items were not as disposable as they are today. Thus not only has trash composition changed, but also the amount of trash per person has increased. Given these new conditions, the levels of dioxins released in barrel burning of today is much higher than the levels released a century ago. With modern trash disposal institutions, it may seem unnecessary to need to burn trash, but in rural areas, the burden of trash disposal on residents is greatly increased. Most rural areas require the residents to transport the trash in addition to paying for its disposal. From the burdens caused by trash disposal, many rural residents choose to burn their trash in burn barrels because it is the easiest option. From recent studies done by the EPA and other research groups, approximately 100 kg of trash from households (number depends on whether the people recycle or do not recycle) that burn trash release as many dioxins as a 200 ton per day Municipal Waste Incinerator.

Polychlorinated dibenzo-*p*-dioxins (PCDD) are a group of hydrophobic (aromatic) compounds, which are known to be toxic and carcinogenic. Ranked among the PCDD's for similar characteristics, are polychlorinated dibenzo furans (PCDF) and polychlorinated biphenyls (PCB). These compounds gained a much greater awareness in the 1970's and 1980's when the harmful effects of these products being dumped into the environment was discovered. With the recent times of stricter environmental laws and a better understanding of how harmful these compounds are, their deposition into the environment has reduced drastically (but not completely).

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The polychlorinated compounds can be formed from simply burning chlorinated plastics, such as polyvinyl chloride (PVC). Without special filtration or flue gas cleaning these toxic dioxins, furans, and biphenyls can be scattered into the atmosphere and into the local community. The optimal conditions for generating these compounds are: sub-stoichiometric amounts of oxygen available during combustion, low temperatures (between 300-700°F) for combustion, a source of carbon and chlorine (PVC is a good source for both), and a transition metal catalyst for the reaction (catalysts like lead or copper can work).

Because dioxins are hydrophobic, they are most likely to be found accumulating in fats and oils. They are also known to have a very long half-life (on the order of seven to thirty years), so they can bioaccumulate for a long time before they are eliminated. The dioxins accumulate in the fatty tissues of animals and reside for a long time, causing potential harm during the time they reside in the tissue. They will also persist in food products that contain a high percentage of fat (e.g. fatty meats, milk). Therefore, exposure routes for dioxin include direct inhalation as well as ingestion as shown in Figure 1. The possibility of having food sources contaminated with this toxin puts all consumers of these products at risk.

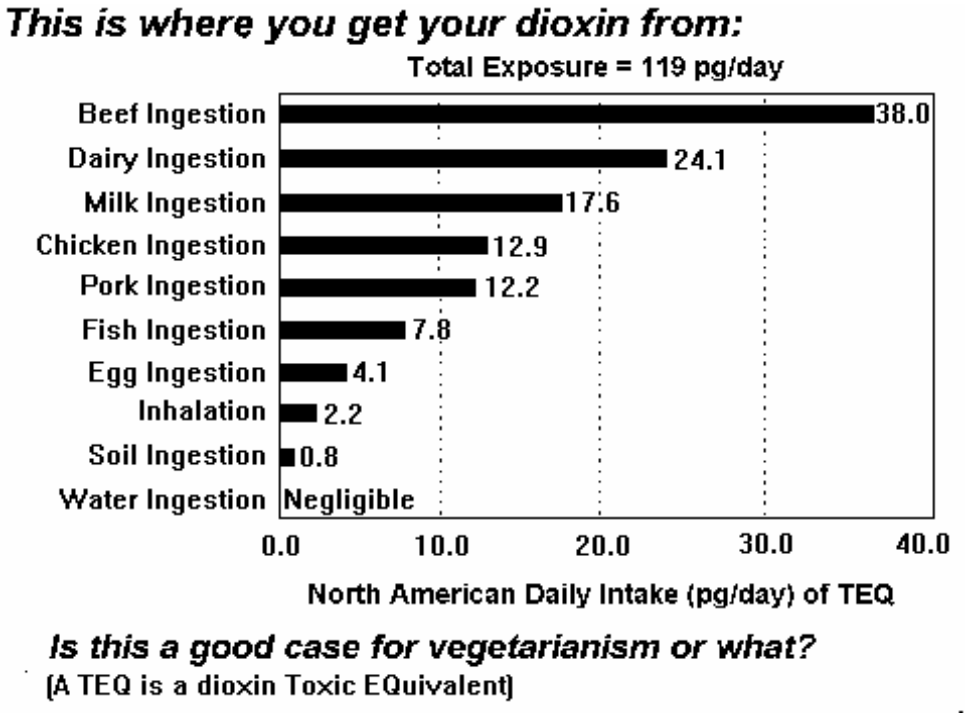

Figure 1: Comparison of Dioxin Exposure Through Different Types of Foods and Pathways (http://dioxinthreat.tripod.com/dioxin_chart.gif)

The carcinogenicity of dioxins is relatively high. It only requires a tiny constant exposure of about 0.0001 pg/kg body weight (bw)/day for cancer to develop in about one person out of a million

people. A lethal dosage of the most toxic dioxin, 2,3,7,8-tetrachlorine dibenzo-*p*-dioxin (2,3,7,8-TCDD), is less than some other comparable toxins (e.g. lead, mercury). Dioxins also cause many other health problems to the heart, reproductive system, nervous system; although one of the more important problems this toxin can cause is developmental problems for children.

St. Lawrence County is a major manufacturer of milk in the United States. It is important to know whether this product is being contaminated with dioxins. Unfortunately, because this is a rural area with a relatively high cost of trash disposal, barrel burning is a common practice among many families. The burn barrel issue is rather heated among many people in the county, and some families see it as a tradition they refuse to part with while others are skeptical of government intervention in the issue. New York State law prohibits trash burning in any village, town, or location where the population is above 20,000 people, but is this enough to stop the problem at hand? Most areas in St. Lawrence County have a population less than 20,000 people. Also, burning takes place in the very rural areas where the population is too small to have a trash service. Currently, dioxins are being emitted and are depositing around the St. Lawrence County from the families that still burn trash. Because 25% of the land in St. Lawrence County is used for agriculture (which includes silage for cow feed) it is possible that the local milk production has a relatively high concentration of dioxins in the milk due to the cows ingesting dioxins that have deposited on the grass or other agricultural products that are grown here.

Through an extensive literature review, several knowledge gaps have been identified for accurately estimating dioxin deposition onto soil and vegetation, runoff of dioxin with soil during rain events, and uptake by cows. Using available information, a simple well-mixed air box model was formulated to estimate the average person/animal exposure to dioxins from barrel burning. Information obtained about St. Lawrence County was obtained through several papers, interviews with people running the open burn awareness campaign in St. Lawrence County, and internet searches. Preliminary analysis of dioxin concentrations in the soil was also conducted using a runoff model source (although not specifically formulated for dioxin, RUNQUAL by Dr. Doug Haith). Using hydrology information of St. Lawrence County, soil and grass trends were predicted for the rain cycle, where it is assumed the rain washes away 90% of the dioxin that was deposited on the grass. Knowing the average deposition on grass is important in estimating how much dioxin may be ingested by cows. With the formulated data, a risk assessment was performed to analyze the risk for residents of St. Lawrence County.

The simple air box model assumed a well mixed volume of air above St. Lawrence County that is at steady state with respect to dioxin concentration. From calculating emissions of dioxins from burn barrels and estimating an approximate concentration of dioxins from the upwind county, steady state concentrations of dioxins in the air were calculated for St. Lawrence County. The upwind county

(Jefferson County), based on the prevailing wind direction, was assumed to have a typical concentration of dioxins in the air based on literature data (approximately 0.1 pg/m^3). Figure 2 shows an estimate of the dioxin concentration in how St. Lawrence County varies with the number of burn barrels that are used in the county.

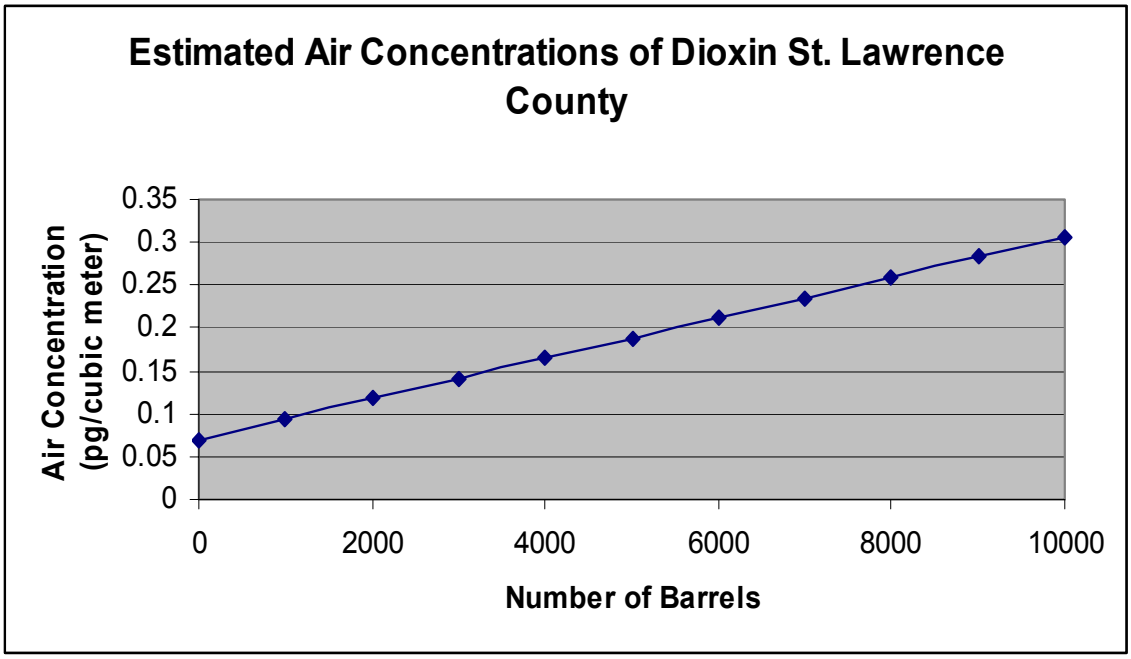

Figure 2: Estimated Dioxin Air Concentrations versus Number of Burn Barrels Used

The soil runoff model, takes all the dioxin predicted to deposit in St. Lawrence County, and predicts what will be ingested by cows eating the grass and what will be in precipitation runoff. Under the assumption that all dioxin is adhered to particulate matter and assumptions provided by the RUNQUAL model by Dr. Doug Haith, dioxin accumulation trends are predicted for the grass and soil. With pasture grass and silage agriculture being consumed by cows, it is important to predict the average concentration of dioxins that are consumed. From applying values of human mother consumption versus mammary gland accumulation, milk concentrations of dioxin are predicted. From knowing the consumption of dioxins by cows, human exposure can be estimated from ingestion. With the values obtained from the analysis of both models, a risk assessment was performed to predict the amount of dioxins a person can be exposed to in St. Lawrence County from drinking local milk.

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