**Oil in the Soil: How Ecuador's Contaminated Soil Affects Food Security**

Located in the Northwest part of South America, covering 109,484 square miles, Ecuador is a vast and ecologically diverse country. It is a constitutional republic government run by a unitary president with an average population of 18 million (Worldometer, 2024). The average climate of Ecuador is temperate in mountain valleys and subtropical in lowland rainforests and coastal areas. Being directly on the equator makes Ecuador hot year-round, creating rainy and dry seasons. Ecuador's economy is primarily based on petroleum production, followed by agricultural exports, and although the backbone of their economy comes from oil production and mining, these industries have hurt Ecuadorian agriculture due to their effect on groundwater (Travel Document Systems-Ecuador,2024). Large mining productions produce acid runoff, which ruins groundwater used for farming. Oil operations have also created toxic groundwater which can lead to a variety of health issues including cancer. Both of these industries have taken a toll on Ecuador's food security. Through the use of oil pit containment and removal, construction of groundwater treatment plants, and natural cleanup methods, we can decrease Ecuador's malnutrition problem and drastically reduce the country's food insecurity problem.  
  
 The typical Ecuadorian lifestyle and family are widely different from the average American household. The average Ecuadorian Family consists of around four members (“Ecuador average Household,” 2012). Most families live in poverty, averaging an income of around $520 a month (“Ecuador Gross,” 2024). The cost of living in Ecuador is dramatically lower than costs in the U.S. The average cost of living for a single person in Ecuador is $538, without rent, which is already greater than the average monthly income. This is in stark contrast to the U.S. where the average monthly cost of living for one person is $1174 with a monthly income of around $4478 (Numbeo, 2024). Education systems are implemented and available in Ecuador but face problems such as physical and linguistic barriers. Rivers and mountains make transportation to school unsafe and difficult, and most teachers speak Spanish instead of the native Kichwa language (Education in Ecuador, 2024). Health care is available and affordable but suffers from a lack of qualified medical personnel and outdated technology (Facts About Ecuador's Health Care System, 2024). The Ecuadorian diet consists of vegetables like corn, beans, and potatoes and proteins like eggs and meats. Imports of cheap grains like rice and wheat have also become intermixed in Ecuador's diet. Both of these crops, especially rice, require large amounts of water to grow, but because of groundwater contamination, most children face malnutrition.  
  
 A large proportion of Ecuador's population is involved in agriculture, both crops and livestock, which both rely heavily on clear water. Common local crops include corn, beans, potatoes, and cassava. Money crops in Ecuador include bananas, coffee, and cacao, which play a large part in Ecuador's foreign exchange and GDP. Small airports in Ecuador have also made delicate crops, such as roses and cut flowers, profitable crops to grow and export. The country's use of irrigation has increased, dramatically aiding Ecuador's farmable land. New irrigation systems allow water to reach the highlands and coastal areas, causing an increase in banana, cacao, and rice paddy cultivation. In the highlands of Ecuador, cattle farmers raise sheep and dairy cattle, while farmers in the lowlands raise mostly beef cattle. Smaller livestock include goats, pigs, and guinea pigs, but only ranges in small parts of Ecuador (Qamar, 2013). Forest reserves and wildlife habitats claim much of Ecuador due to it being part of the Amazon, meaning industrialization and farming practices are prohibited in those areas. This causes a clash of the agricultural industry with the mining and oil industry for usable land area.  
  
 Ecuador sadly faces challenges of poverty and malnutrition. This stems from the country's low-income rates and ability to farm. Families struggle to buy the needed vitamin-rich foods, resulting in childhood malnutrition. Environmental and agricultural problems also hinder food security in Ecuador. Portions of the land in Ecuador have been contaminated with metals and oil from large mining and petroleum industries. Contaminated soil results in poor crop growth or even land loss altogether. Most families rely on their crops or cattle as their source of income or food. The damage or loss of crop yield results in a loss of income. This makes Ecuadorian families struggle to make a living and earn enough to survive (Yates, 2023).  
  
 Ecuador's food security is being threatened by mining and petroleum industries. From 1964-90, Texaco oil drilled and damaged the Ecuadorian Amazon. This resulted in dumping over 16 billion gallons of toxic wastewater into open pits. Over nine hundred known opened and unlined pits were found across the Ecuadorian Amazon (Yates, 2023). Three hundred seventy-four clean water sources used by the indigenous people and farmers were affected by ground leaching of contaminated cancer-causing water. With nearly 85% of Ecuador's population living below the poverty line and most surviving off of agriculture, the actions of the petroleum industry have devastated Ecuadorian people. The ecocide brought upon by Texaco resulted in a lawsuit where they agreed to clean the waste products they produced. Texaco has done little to clean or help remedy the effects of its oil waste. The few pools they did “clean” were only covered by a small layer of dirt. The covered pits have now become exposed due to erosion or solidified in the ground. Locals say that wells near the pits have become poisoned, and fruit trees can't grow or bear fruit near the pits. The contaminated groundwater and soil have prohibited farming and living near any of the pits due to the cancer-causing and toxic properties of petroleum (Baquero, 2023).

Along with this, Ecuador's soil has also been contaminated by metals left behind from gold mining operations. Heavy metals like zinc and lead can be found in the southern Ecuadorian Amazon. Mercury has become one of the biggest heavy metal threats to Ecuadors' soil and groundwater. Many types of plants, animals, and people are being threatened by mercury and other heavy metals leached from mining operations. The effects of heavy metal and oil runoff have caused acres of Ecuadorian land to be unusable for living and farming both crops and livestock alike (Karáth,2023).  
  
 Ecuador now faces food insecurity because most agricultural land in the country is affected by toxic chemicals and heavy metal leaching. Most Ecuadorians rely on agriculture to make enough money to buy food or survive off their farms. For Ecuador’s food security to improve, soil quality must first be rectified. To improve the quality of Ecuador's soil and water supply, the contaminated water pits left behind by Texaco have to be cleared out first. Excavating soil containing petroleum and collecting contaminated water would be the first step in helping Ecuador's environmental conditions. This would require the water to be collected, properly contained, and disposed of. The remaining land can be filled with a mixture of topsoil and manure, produced by local cattle farms, to restore fertility to Ecuador's soil and make it suitable for farming once again. Additionally, the construction of groundwater treatment plants in lowland areas near the contaminated pits should be implemented. This geographic placement would allow any rainwater or groundwater contaminated in higher areas to be intercepted and cleaned before it reaches any large bodies of water. This clean water can then be used as drinking water for the indigenous people or irrigated and used on local farms.

In areas minorly affected by heavy metal and oil runoff, it would be cleaned in a different, less industrialized way. Research shows evidence of native plants' capability to hyperaccumulate metals and hazardous material from soil. New research shows how native Ecuadorian plants, such as Miconia sp. and E. Polymnioides, can absorb these hazardous materials and cleanse the soil. Both of these plants are considered Hyperacumulators, meaning they have the potential to hold more than the average amount of metals or metalloids in their tissues. Miconia sp. has cadmium and zinc phytostabilization abilities in soil and E. Polymnioides has phytoextraction capabilities for both these elements, meaning it can fully remove the contaminants from the soil. Both of these plant species can phytostabalize mercury, the main heavy metal affecting Ecuador’s groundwater and soil (Probanza, 2023). Because these species are native to Ecuador, there are no concerns of potential invasiveness or negative ecological repercussions, in fact there would be ecological benefits supporting local fauna. When the plants reach maturity, they can be harvested and used for a form of biomass fuel and turned into energy. If these species are planted and harvested repeatedly in affected areas, they can, over time, remove contaminants that have been plaguing the Ecuadorian people and return farmland to a usable state.

Due to Ecuador's current economic standpoint, the construction of multiple groundwater treatment plants would be unrealistic. Because of this, funding would come from the original source of the problem, Texaco. They have yet to fix their devastation, even after the lawsuit. If Texaco, a two hundred eight billion dollar industry, now merged with Chevron, refuses to help in the full cleanup of oil contamination, a secondary lawsuit should be filed because of their acts of environmental racism and negligence to fix their pollution problem on Ecuadorian land. Other forms of support can come from foreign aid organizations. Although most citizens couldn't help financially, they can play their part by raising awareness and creating movements to gain internal government and foreign support. With the help of Texaco and other organizations, both industrial and biological methods can be used to purify groundwater and return Ecuador to the agricultural country it once was.

Ecuador's food insecurity spawns from large oil and mining industries ruining farmland with contaminated runoff. Toxic oil pits and heavy metals left by petroleum and mining companies resulted in the leaching and contamination of the country's land and groundwater. This caused hundreds of acres of not only farmland to become unusable, but also hurt local forests and wildlife. The hindrance of small farms causes families in Ecuador to go into poverty. Low income and wages results in the inability to buy healthy foods causing an increasing malnutrition problem in the country. Once the water and soil quality is returned to the state it once was, Ecuador can begin to rebuild their agricultural lifestyle. Ecuador has already begun taking great steps in fixing their water sanitation problem. In 2023 Voters were able to win a case which completely banned oil drilling in the ecuadorian amazon showing that change is possible and ecuador can save their environment and agricultural lifestyle (Donziger, 2023). This groundwater and soil cleaning plan will allow families in Ecuador to have clean drinking water and healthy sustainable farms greatly reducing the country's food insecurity.

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