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Treating the Symptoms and Not the Cause:

Analysis of the Environmental and

Social Costs of the Drug War in

Colombia

Abstract: This paper is an exploration of complaints that the use of glyphosate in aerial eradication of coca in Colombia negatively impacts the environment and human health. It was shown that aerial eradication impacts other land classes beyond targeted coca crops, including food crops and native forest. There is anecdotal evidence that wildlife is impacted and that people experience symptoms of poisoning, but it is not established that these effects come from glyphosate. Results showed that alternatively, negative environmental and health effects may be attributed to the harsh chemicals and widespread deforestation associated with coca production. There is a lack of empirical evidence for contamination of coca-related chemicals in the field, although in the lab these chemicals are more toxic than glyphosate. Although the rate of deforestation associated with coca cultivation was high, a recent study showed that presence of coca does not predict deforestation as strongly as low economic status population, suggesting that presence of coca may not be a cause but rather a symptom of economic inequality and impoverishment. Expanding on this result, I looked at the factors that drive coca related deforestation, focusing on aerial fumigation and armed conflict, and confirmed that poverty is a dominant underlying factor. In light of this, I hypothesize that funding for eradication efforts would be better directed towards alleviating poverty.

*“What I tried to do was to focus on every aspect of the problem. I tried to empower the Colombians for example to do more militarily and police-wise because I thought that they had to. Thirty percent of their country was in the hands of the narcotraffickers… Well obviously, if the expected results was that we would eliminate serious drug use in America and eliminate the narcotrafficking networks — it hasn’t worked.”*

* Bill Clinton

Introduction

Colombia, a country of almost 1 million indigenous people and about 10 percent of the world’s biological diversity, is also the world’s top producer of cocaine. Plan Colombia began under the Clinton administration with the goals of combating cocaine production, and by extension helping Colombia control the drug supported Marxist insurgencies occupying its jungles since the Cuban revolution. The primary method used to eradicate coca crops is through aerial fumigation. Coca production and the methods used to eradicate coca are taking place in precisely the remote and relatively isolated areas of the Andes Mountains and Amazonian jungles where indigenous people have been able to survive to date, relatively intact (Brain et al, 2009). Although native people have used coca medicinally for thousands of years, its recent commercialization has had a devastating impact on them. There have been extensive reports of negative impacts on the environment and human health in regions where coca production and eradication occur, and most have been attributed to the chemical used in aerial eradication.

Environmentalists, NGO’s, and indigenous people have protested the use of aerial fumigation to eradicate coca on the basis of several claims. Some of the main objections to aerial fumigation appear to be that 1) aerial fumigation is non-specific, inaccurate and defoliates an area beyond the targeted coca crops, including basic food crops and native forest, and that 2) the herbicide used in aerial fumigation is a toxic compound that contaminates land and waterways, resulting in both environmental damage, and adverse effects on human health. The methods I will use to investigate these claims are literature analysis, land cover and satellite images, government reports, published studies on chemical analysis, anecdotal evidence and published interviews with indigenous people. This analysis would not be complete without expanding upon the results found in order to gain a comprehension of the probable underlying causes of the environmental and health impacts experienced in these regions.

**Aerial Fumigation**

The aerial spraying program is conducted by the National Police Antinarcotics Directorate (DIRAN). They spray any land that has coca, including protected regions, indigenous territories, and municipalities. The DIRAN sprayed 103, 302 hectares in 2011, especially focusing on the southwestern departments of El Pacifico, Putumayo and Caquetá (UNODC, 2011). The chemical defoliant used in this process is glyphosate, commonly known as Roundup. This non-selective herbicide was approved by the EPA for general use in 1974 (Messina et al., 2006). However, iHowen Colombia, it is mixed with an adjuvant, Cosmo flux, which increases its toxicity and ability to permeate the waxy coca plant. Interestingly, this formula of Roundup used in Colombia has not been approved for use within the United States. The herbicides used against coca crops in Colombia are both more concentrated and applied in greater doses than maximum levels approved by the EPA (Oldham et al., 2002). Although the EPA-approved label states that the aerial application should not exceed 1 quart per acre, in Colombia the rate is over 4 times that amount (Oldham et al., 2002). The herbicide mixture is very effective at destroying the plant on which it is applied. In 2011, the Commission of National Verification of Spraying Operations estimated a percentage of 98% of effective death of plants per field sprayed (UNODC, 2011).

1. Unintended Defoliation

Although the US government claims that only large-scale coca cultivation is targeted, one of the criticisms about aerial spraying is that it is considered effective at defoliating more than the intended coca crops. If aerial eradication efforts are inaccurate and spray indiscriminately, I would expect to find evidence of defoliation in land classes beyond coca crops. From 2001 to 2006, over 6,000 official complaints of wrongful fumigations were submitted to the Colombian government, although only 28 were offered compensation (Embassy, U.S., 2012). Reports include the destruction of basic food crops, such as yucca, avocados, maize, plantains and farm animals including livestock, poultry, and fish of nearby impoverished subsistence farmers (Messina et al., 2006; Oldham et al., 2002). For example, an inspection in a municipality in Putumayo reported the destruction of 20,239 acres of food crops and 171,643 adversely affected farm animals after herbicide spraying (Oldham et al., 2002). A Putumayo indigenous community member attests to the damage beyond targeted areas: **"The spraying has affected the entire area of upper Putumayo. Our tomatoes, beans, and our banana plants died, and our traditional medicine sources ran out completely. At first we didn’t know why all our plants were dying, but then we learned that this was a result of the fumigations in lower Putumayo, and that the effects were spreading to us. This is why all of our plants died" (Edeli et al., 2002).** Even programs specifically intended to provide poor farmers with economic alternatives to drug crop production are not immune. The Human Rights Ombudsman reported in 2001 that the aerial spraying had destroyed crops in eleven government-sponsored crop substitution and alternative development programs (Oldham et al., 2002). Defoliation has also been reported in Ecuador, from glyphosate that drifts over the heavily sprayed areas near the border (Messina et al., 2006). A confounding issue is that farmers often inter-crop coca production with their basic food crops in order to avoid detection and spraying (Messina et al., 2006). The consequences of food and livestock contamination by glyphosate is often ultimately severe food crisis (Pineda, 2011).

**Study on Defoliation**

Evidence of defoliation occurring outside of targeted areas is often anecdotal. In an effort to understand the validity of these claims, a study from the Department of Geography at Michigan State University used remote land cover images to analyze the effect of defoliation in the Putumayo, an aggressively targeted region in south-western Colombia along the borders of Ecuador and Peru (See Figure 1). They analyzed two fumigation efforts in 2000 and 2001, and they classified the affected land into numerous categories such as dense forest, secondary forest, pasture, agriculture, and coca-producing. They found that about 31% to 40% of areas that were nearly completely defoliated included non-coca lands. Over half of the areas that were over 50% defoliated included land classes that were not coca producing in both the first (57%) and second (63%) efforts of fumigation. As can be seen in the graph in Figure 1, with perfect spraying the “classes represented” line should be strongly negative, with most heavily sprayed areas containing mostly coca. Instead the line is fairly constant across all classes with only a slight reduction in classes represented with over 50% defoliation. Although the United Nations Drug Control Program reported this event as a reduction in coca of 71,891 hectares, the study found that 106,178 hectares of land had been impacted- an unexplained difference of 34,287 hectares. They concluded that aerial fumigation has the unintended consequence of defoliating “not only coca but also contiguous and interspersed native forest and food crop parcels” (Messina et al., 2006). They added that while the research should not be used to indict the UN or the organizations that spray, it should “serve as a warning that the published reports on drug war results are open to interpretation and that some of the anecdotal, and usually dismissed, claims of misapplication of spraying may, in fact, be true” (Messina et al., 2006).

Although this was not addressed in the study, when I showed these images of the fumigation aftermath to a friend he noticed that the pattern of defoliation appeared to have a sharp and defined line on one side, and exhibiting an irregular and undefined edge on the opposite side (Figure 1). This pattern suggests that the effect and direction of wind in spreading the sprayed defoliant may also be visible through this kind of imaging. This may be due to the fact that planes often fly at higher elevations in order to avoid being shot down, allowing more possibility for wind to affect the direction of the spray, contributing to the collateral damage on unintended plants.

2. Toxicity of Glyphosate

The results from the above study appear to confirm the anecdotal evidence that aerial spraying directly impacts different categories of land other than coca. The primary direct effects are clear, but does aerial spraying have secondary effects associated with systemic contamination of the environment? The impact of fumigation programs has been controversial, and there is evidence to both support and contest its negative impact on human health and the environment.

**A. Impact on Environment/ Wildlife**

Several environmental groups have expressed concern about the environmental impacts of spraying, especially considering that the Colombian government allows defoliants in protected areas. The EPA warns that spraying can affect “plants up to 600 feet from the target, will temporarily destroy animals’ habitat, and could contaminate water” (Davalos, 2011). According to the World Wildlife Fund, aquatic ecosystems are particularly sensitive to glyphosate. Wildlife, especially frogs, birds, and insects, are especially susceptible to chemical exposure and are easily affected by disruptions in their environment (Davalos et al., 2008; Walcott, 2002). Glyphosate can reduce larvae survival and may cause DNA damage in tadpoles, leading to population declines (Davalos et al., 2008). The Cananguchal palm tree is not only an indigenous staple crop used for food, clothing and roofing material, but also sustains other plants and animals. Water contaminated with glyphosate that reaches the tree causes it to lose its useful sponge-like properties and dry out, which in turn impacts the eco-system and people that depend on them (Messina et al., 2006; Walcott, 2002). According to the American Bird Conservancy, aerial spraying could impact the survival of Colombia’s birds, including 500 species in the Putumayo region alone. An indigenous leader from Putumayo describes what he sees happening to the birds as “strange”: "They fall sick at six o’clock in the morning, and by six o’clock in the afternoon, they are dead. We never had anything like this before" (Walcott, 2002).

**B. Impact on Human Health**

Although it is difficult to find concrete proof, NGOs and indigenous people insist that spraying the toxic herbicide causes illness and death in local populations. Glyphosate has been reported to cause skin ailments, eye problems, dizziness, gastrointestinal complications, vomiting, and diarrhea (Landel, 2010; Pineda, 2011). In a study carried out in rural parts of Colombia in 2003, they found that over 80% of the 403 people they interviewed had experienced a health problem such as digestive tract complications, skin irritations, and eye problems within a month after an aircraft sprayed near their homes or workplaces (Pineda, 2011). In 2001, a commission from the European Network of Brotherhood and Solidarity reported finding “skin conditions (rashes and itching caused by the skin drying to the point of cracking) in both children and adults who were exposed directly to spraying while they worked their land or played outside their homes” (Oldham et al., 2002). Even in neighboring Ecuador, communities near the Colombian border have reported illnesses including skin and eye irritation, vomiting and diarrhea after aerial spraying was conducted on the Colombian side (Oldham et al., 2002).

**The Roundup Warning Label**

Although we do not have scientific evidence from the field that glyphosate is the source of these illnesses, the findings appear to be consistent with the information that is generally available about glyphosate. The World Health Organization states that glyphosate is “poisonous if swallowed, and may cause diarrhea, vomiting, and stomach cramps.” Any part of the body that comes into contact with the chemical should be washed with clean water immediately because it may irritate the eyes and skin” (Oldham et al., 2002). Colombia does not use the herbicide in accordance with the US approved label instructions, but even the EPA approved safety recommendations for Roundup warn that it can cause:

“skin and eye irritation in people who are sprayed directly or contaminated by drift, or who come into contact with sprayed crops immediately after crop dusting; · illness and gastrointestinal irritation in people or animals if they ingest large quantities of the crops or other contaminated materials shortly after spraying; fish kills and ecological harm to aquatic ecosystems that are contaminated or sprayed; and death of non-target plants, and associated environmental damage” (Oldham et al., 2002)

The warning also includes adverse effects on local populations and ecology:

“Roundup will kill almost any green plant that is actively growing .... Take care to spray Roundup only on the weeds you want to kill- don't allow the spray to contact plants you like or they may die too .... Roundup should not be applied to bodies of water such as ponds, lakes or streams as Roundup can be harmful to certain aquatic organisms .... After an area is sprayed with Roundup, people and pets (such as cats and dogs) should stay out of the area until it is thoroughly dry.... We recommend that grazing animals such as horses, cattle, sheep, goats, rabbits, tortoises and fowl remain out of the treated area for two weeks ..." (Oldham et al., 2002).

**Toxicity of Glyphosate?**

These parallels have lead indigenous leaders to conclude that environmental changes and new illnesses are related to aerial spraying. The government officials of the United States and Colombia have hesitated to agree. For example, an official has pointed out that “low coffee yields and smaller mangos…are not likely caused by herbicide spraying,” but admits that “some of the symptoms reported by farmers are consistent with pesticide poisoning” (Walcott, 2002). The evidence appears clear that the environment is contaminated and the health problems are symptomatic of poisoning, but how do we know what the actual poison(s) is/are? What they argue is that, although the symptoms are evidence of poisoning, that doesn’t mean it comes from glyphosate. A more likely explanation, they argue, is that the Colombian drug traffickers’ own large quantities of herbicides and pesticides used to clear the jungle for coca fields, and dangerous chemicals used to produce cocaine may be to blame for the environmental and health damage.

This viewpoint is supported in a study by scientists Brain and Solomon, who published in the *Journal of Toxicology and Environmental Health* their analysis of the hazards posed to amphibians in Colombia. Using worst case assumptions for exposure, they analyzed the toxic effects of glyphosate + Cosmo-Flux on frogs, and compared them with that of other pesticides used in coca production. They found that several other pesticides used for coca production, including  **“**mancozeb, lambda cyhalothrin, endosulfan, diazinon, malathion, and chlorpyrifos, were up to 10- to 100 times more toxic to frogs and larvae than the Glyphos–Cosmo-Flux mixture.” They cited insecticides as a particular concern, because of its selective targeting of the primary food source of amphibians. The greatest hazard they found for amphibians, however, was habitat loss due to deforestation, which they attributed to coca production. They admitted that glyphosate and Cosmo-Flux do have a mild toxic impact on amphibians, but concluded that it pales in comparison to the “cumulative impacts and risks of coca production” (Brain et al, 2009).

Scientists came to similar conclusions in their studies comparing glyphosate and other chemicals on human health. In a report prepared for the Inter American Drug Abuse Control Commission in 2005 and a 2007 study in *the Journal of Toxicology and Environmental Health*, they examined the possible human health and environmental effects of glyphosate the way it is used in Colombia (See Figure 2). They concluded that the risks to human health and the environment from glyphosate and Cosmo Flux were minimal. They found that acute toxicity to laboratory animals was very low, and the likely exposures were also low. The risk to human health was deemed to be much greater from the unregulated use of other pesticides, many of which are so toxic, the effects of glyphosate are considered negligible (Solomon et al., 2007). I noticed that the study also mentioned that the likelihood of accidentally off-target spraying is small and estimated it to be less than 1% of the total area sprayed, which is in contradiction with the Messina (2006) study of defoliation through remote sensing.

Discussion

The findings of this research are limited in that they measure the effects of these pesticides at an estimated “worst-case scenario,” a controlled situation that is a different context than the field in which they occur in reality. There is no empirical research that can tell us exactly how these chemicals respond when they are released into the environment. It is interesting that indigenous people strongly blame only fumigation efforts and not coca producers for the environmental and health damages they experience. Could this be simply because the planes flying overhead dropping gallons of herbicidal spray are so visually striking, they automatically assume a causal relationship? Perhaps they have understandable anti-government sentiments, and closer allegiance with coca producers who often are the only ones to an economically viable option? It may be useful to explore the evidence presented that chemicals and deforestation from coca production may be a comparatively greater hazard to the environment and human health than glyphosate.

**Chemicals Used in Coca Production**

What are the agrochemicals and liquid effluents used in coca production, and how prevalent are they? Colombian coca growers use several pesticides and herbicides in the cultivation of coca. It is estimated that coca growers use approximately 210 million pounds of chemical fertilizers and about 3 million pounds of herbicides in their fields annually (Davalos et al., 2008). Processing coca leaves into cocaine requires the use of chemicals such as sodium bicarbonate, gasoline, sulfuric or hydrochloric acid, potassium permanganate, ammonia, and acetone or ether. In 2003 alone, drug traffickers used 9.6 million gallons of gasoline and 460,000 liters of acid for the production of 460 metric tons of cocaine (Embassy, U.S., 2012). Since the chemical reagents are dumped onto the soil and watercourses without treatment, they pose a high risk endemic species in terrestrial and aquatic habitats. Although these agrochemicals are highly toxic to mammals and may have significant environmental impacts, the absolute and relative magnitude of these damages is unknown because of the lack of empirical research (Alvarez, 2007). The figures are calculated based on purchases or seizures of chemicals and cannot replace field studies. The effects of agrochemicals may be a significant factor, but the greatest hazard identified in the studies was that of deforestation caused by coca production.

**Coca and Deforestation**

Since the pace of deforestation in Colombia has accelerated significantly over the last 20 years, and this coincides with the explosion of coca cultivation, several analyses have suggested coca cultivation directly and indirectly drives deforestation in Colombia’s forested frontier (Davalos et al., 2011; Brain et al, 2009; Alvarez, 2007). Estimates vary considerably regarding the total area of primary forest loss due to this activity. Drug cultivation and transport is proposed to be responsible for over half the forest loss during the 1990s reaching about a half a million hectares by 2004 during times when drug trafficking rates were sky-rocketing (Davalos et al., 2008; Brain et al., 2009). The Colombian government estimates the spread of illicit crops destroyed 1.6 million hectares of forest in the past ten years (Embassy, U.S., 2012). In the southern department of Caquetá, deforestation partly linked to coca production reached 4.1% per year during the 1990’s, which ranked among the highest in the world and was “equivalent to clearing eighty thousand football fields annually” (Davalos et al., 2008). The most reliable data are provided from satellite imagery from the Colombian government and United Nations Office on Drugs and Crime (UNODC) , although as we saw in the study there appears to be a wide margin for error. According to the UNODC, in the period between years 2001-2011, 583,926 hectares have been cultivated with coca at some point, and 245,382, (nearly half), of these hectares were formerly covered by forest. Although recently the rate of land planted with coca has remained stable, 21% of the existing coca fields in 2011 were created from the felling of primary forests that had existed in 2010.

**Is Correlation Causation?**

Although it seems we can draw a clear causal effect by looking at the rates of coca cultivation and deforestation, the relationship may be more complex. A study that analyzed forest cover data for the 2002-2007 period in Colombia, confirmed that there is a relationship between proximity to new coca plots, greater area planted with coca plots, and forest loss. However, presence of coca cultivation did not predict forest loss. Instead, presence of new coca cultivation was an indicator of municipalities where increasing population led to higher deforestation rates. They explain that gains in rural population density relate to higher deforestation rates because “most or all economic activities that absorb immigrants, or used to occupy emigrants, require forest clearing”(Davalos et al., 2011). They hypothesized that coca expanding in these regions because they are underdeveloped, rather than the converse. In light of this, coca is therefore a “symptom rather than the ultimate cause of deforestation, and structural features such as socioeconomic inequality, failed agricultural development policies, and armed conflict are the large-scale drivers of deforestation” (Davalos et al., 2011).

**Mechanisms of Deforestation**

If coca cultivation is a symptom of poverty, will this be evident by analyzing the mechanisms that drive coca-related deforestation? If so, then what are the mechanisms with which coca causes deforestation? The immediate and direct drivers of deforestation are obviously for the clearing of an area to plant the coca plant itself. The actual area of primary forest cleared due to coca cultivation is greater than the area being directly cultivated for this purpose. According to the narcotics police, each hectare of coca planted implies the clearing of four hectares of forest (Alvarez, 2007). Coca producers also clear land for subsistence farming, lab sites, campsites, and landing strips (of which more than 100 exist at any one time) (UNODC, 2011). However, the more influential drivers of deforestation through coca may be more indirect.

**Aerial Eradication; Driver of Deforestation**

Much deforestation is driven as a consequence of the eradication program itself. Aerial eradication of coca crops causes coca growers to relocate, clear more forest, and replant to offset their loss. It is estimated that for every acre sprayed, three acres of rainforest are cut down by coca growers who are pushed deeper into Andean and Amazonian forests, infringing on indigenous territories (Walcott, 2002). Aerial spraying of fumigants is not considered very effective, destroying only one-fourth of the coca crop it sprays (Jackson, 2011). I wonder, does this correspond to the above statistic from last year’s UNODC report that about one-fourth of new coca fields originated in the clearing of new forest? Paradoxically, one of the arguments used to defend fumigation is to prevent the deforestation directly caused by coca cultivation… while indirectly caused by fumigation (Jelsma et al., 2001). For example, the study by Solomon previously cited, advises that since coca production is shown to be an environmental hazard, advises using methods to reduce coca including aerial eradication (Brain et al, 2009). Since aerial eradication destroys more than just coca crops, it is linked to economic crisis and food shortage. For many poor Colombians whose livelihood was destroyed by aerial eradication, the only economic alternative is to seek refuge among rebel groups and grow coca. According to a Human Rights Watch report on Colombian child soldiers, many children and youth join guerilla groups "simply ...out of hunger" (Pineda, 2011). To help visualize the unintended consequences of aerial eradication, refer to Figure 4.

Interestingly, the effect aerial fumigation has on relocating coca cultivation can be observed from the study on defoliation (Figure 1). In comparing the defoliated areas of the two events, it was a very noticeable trend that while the patterns of defoliation ran north to south, “the defoliated areas of event two shifted westward away from the areas in event one” (Messina et al., 2006). The shift in the area that resulted in defoliation suggests visual evidence of the shifting and replanting of coca after fumigation.

**Armed Conflict: Driver of Deforestation**

Armed conflict is another primary indirect factor in driving deforestation through coca because of its effect in generating refugees. In the past 40 years, between 1 and 2 million people have been forcibly displaced (Walcott, 2002). Of Colombia’s remaining forests, 33% are in municipalities with medium to high activity by armed groups, and 20% of them are in municipalities where both guerrillas and paramilitaries are present (Alvarez, 2007). These areas include indigenous territory, where insurgents fight for territory and implement a cleansing of all those inhabitants they believe to be non-sympathizers. Indigenous are compelled to serve as guides or informers, to cultivate illegal crops or to operate cocaine labs. The thousands of people that are forcibly displaced flee to areas that are barely able to meet their own needs, let alone take in refugees, resulting in more pressure on the environment. Some indigenous willingly grow coca because of economic need, and are provided loans by guerilla groups (Landel, 2010; Jackson, 2011).

**Poverty: the Underlying Link**

**The factors driving deforestation are non-exclusive and show a clear link between poverty, drugs, and growth of insurgents.** Although violence is the obvious factor driving the refugee problem, Plan Colombia’s efforts to crack down on drug traffickers are what causes the drug traffickers to move into new territory. Plan Colombia focuses on cutting off the insurgents’ source of income and ability to offer salaries to potential recruits, while failing to adequately employ a strategy to address the development of peasant and indigenous communities (Edeli et al., 2002). Indigenous argue that the money from Plan Colombia would do better to address the root causes of indigenous people’s willingness to accept recruitment by providing employment opportunities. Communities are often willing and eager to cooperate with manual eradication programs because it does not force a sudden loss of their means for survival, and ensures a more gradual transition with hope for aid in social development. Unfortunately, the government has often failed to keep promises to support local farmers in their transition to alternative crop production. For example, in 2001, a group of 62 international NGOs wrote a letter to US Secretary of State Colin Powell addressing this concern stating "six months after the agreements [pacts of recompensation for losses and support in alternating livelihood], residents had received no funds" (Pineda, 2011). Fortunately though, governments may have been starting to get the message in the last ten years, and this may have contributed to the recent decline in coca production. According to the 2011 report from the United Nations Office on Drugs and Crime, the government made substantial efforts to aim investments in areas focused on economic and social development. The area that received the greatest social investments, the Central region, was also the one that showed the greatest reduction in coca production for 2011. The same report includes a graph charting the rates of fumigation and manual eradication efforts alongside with coca cultivation. (See figure 3) It is visually apparent that there does not appear to be a correlation between fumigation efforts and coca cultivation.

**Further Research**

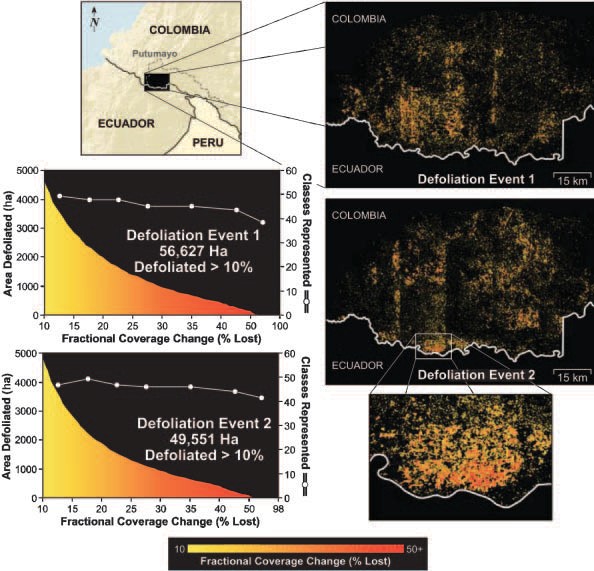
The ruling out of glyphosate as a potential contributor to the environmental and health problems experienced in Colombia does not provide a satisfactory explanation. In light of the observations of the extensive symptoms of toxic poisoning in the environment and in local health, it is important to determine not only that it is not glyphosate, but what it is that is causing these issues. There is a need for empirical research to be done in the field to discover and measure the environmental impacts of pesticides, herbicides, and other liquid effluents associated with coca production. It is important to find out how much of the pollutants reaches watercourses, what the persistence of pollutants is in the water and soil, what direct and indirect effects these wastes have on the fauna and flora, and any regional variance or adaptations. There is also a lack of data in how the chemical wastes and deforestation rates associated with coca compare to other legal causes of deforestation and pollution. If safety logistics is an issue, a suggestion might be to conduct analysis in Ecuadorian territory at the edge of the border with Colombia. However, upon examining Figure 1, it is evident that the part of the image that happened to catch part of Ecuador was deliberately blocked out in the study. This may suggest political ramifications if results were to find contamination spilling over from Colombia into Ecuador. Alternatively, I volunteer to collect data in Colombia under the pretense of joining the FARC.

Conclusion

Aerial fumigation is a controversial subject, believed by some to be extremely damaging and by others to be harmless and good for national security. In examining allegations that aerial eradication causes unintended negative impacts on the environment and health of local people, substantial evidence was found confirming the defoliation of non-targeted legal crops. Although the direct impact of fumigation is clear, its indirect effects on the environment and on health are not as clear. Plenty of anecdotal evidence clearly implicates glyphosate as the cause of environmental and health indications of toxic poisoning. There is scientific evidence that glyphosate is mildly toxic, but its effects are concluded to pale in comparison with the damage by chemicals and deforestation associated with cocaine production. Upon further examination of coca-related deforestation, it has been determined that several factors, including aerial eradication and armed conflict, contribute to a vicious cycle of environmental degradation and economic impoverishment (Figure 4). The most important underlying factor that appears to be most effective for controlling coca is social development and alleviation of poverty.

Figure 1

Defoliation and the war on drugs



“Collateral damage to agricultural and non-coca land cover types in Putumayo, Colombia. Using a common color ramp between the graphs and the maps (10% defoliated in yellow to 100% in red), the broad-scale vertical striping associated with aerial defoliation and the east–west shift in flight paths are displayed. Area defoliated and percent defoliation is shown with respect to the numbers of classes represented across the defoliation events. The ‘classes represented’ line data indicate the number of land cover classes (out of 90) that contain defoliated pixels in each defoliation class. As percent defoliated increases, a reduced chance that defoliation is occurring due to drift or runoff should exist as heavily defoliated classes should have been coca. With perfect spraying, the ‘classes represented’ line should be strongly negative with the most heavily sprayed areas containing only one spectral class.”

(Messina et al, 2008)

Figure 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Impacts** | **Intensity**  **Score** | **Recovery**  **Time (Y)** | **Impact**  **Score** | **% Impact** |
| **Clear cutting and burning** | 5 | 60 | 300 | 97.6 |
| **Planting the coca or poppy** | 1 | 4 | 4 | 1.3 |
| **Fertilizer inputs** | 1 | 0.5 | 0.5 | 0.2 |
| **Pesticide**  **Inputs** | 2 | 0.5 | 1 | 0.3 |
| **Eradication spray** | 1 | 0.5 | 0.5 | 0.2 |
| **Processing and refining** | 2 | 1 | 2 | 0.7 |

Dr. Solomon et al., Potential Environmental Impacts of the Cycle of Coca or Poppy Production and the Spray Eradication Program

The table represents data from Figure 28 from the report prepared by Dr. Keith Solomon et al,

*Environmental and Human Health Assessment of the Aerial Spray Program for Coca and Poppy Control in Colombia*, 90. Of note from the report is the fact that, in the context of the environmental risks from the activities associated with the production of coca and poppy, the effects of the glyphosate spray itself are small. The major effects are attributed primarily to the uncontrolled and unplanned clearing of pristine lands in ecologically important areas for the purposes of planting the crop, and to a lesser extent, the chemicals used both as fertilizer for coca, and in the processing of coca paste.

(Solomon, 2007)

**Figure 3**

Total areas sprayed and total areas cultivated for years 2001-2011

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Total spraying** | **94,153** | **130,364** | **132,817** | **136,551** | **138,775** | **172,025** | **153,134** | **133,496** | **104,772** | **101,940** | **103,302** |
| Cultivated area  (hectares) | 145,000 | 102,000 | 86,000 | 80,000 | 86,000 | 78,000 | 99,000 | 81,000 | 68,000 | 62,000 | 64,000 |

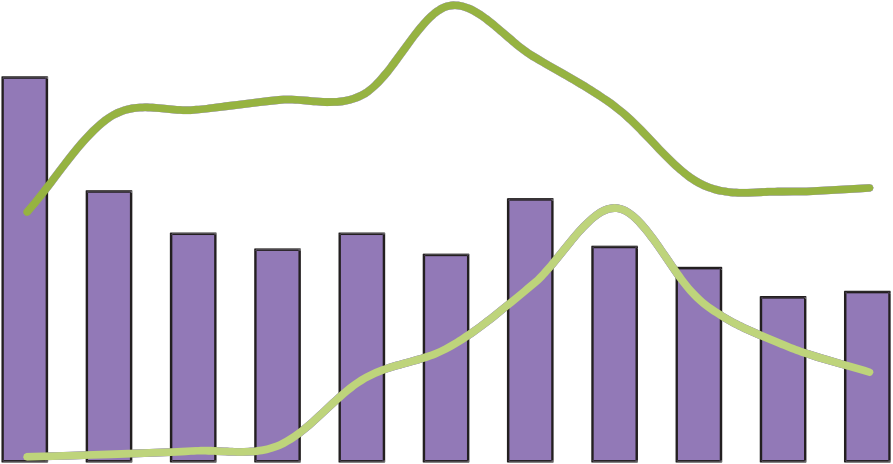
(UNODC, 2011)

**Comparison of coca cultivation vs. the accumulated areas sprayed and manually eradicated, 2001-**

**2011**

180,000

150,000



120,000

90,000

Hectares

60,000

30,000

0

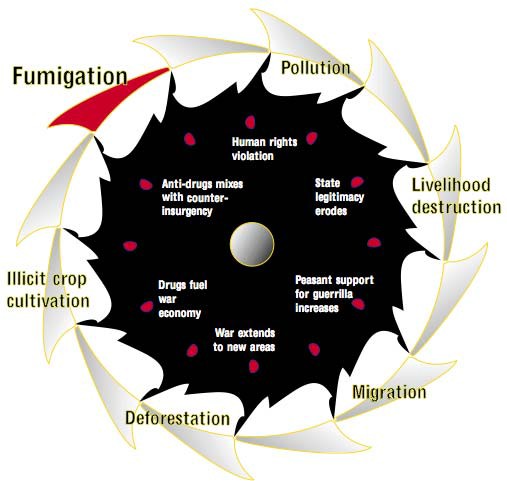
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

Coca cultivation Aerial spraying Manual forced eradication

*Source: PCI and UACT for eradication DIRAN for aerial spraying and SIMCI for coca cultivation.*

(UNODC, 2011)

Figure 4



Martin Jelsma Model for Visualizing the Unintended Consequences of Crop

Eradication

(Jelsma et al., 2001)

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