The War on Drugs:
A Failure in (Operational) Thinking

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Abstract

We suggest that the currently recognized failure of the so called “war on drugs” is an opportunity to explore how academics and policy-makers fail in operational thinking, that is, they fail in thinking in terms of “how things really work”. We illustrate this failure with certain modes of reasoning that seem to underpin the way in which the war on drugs has been debated in Colombia. We selected various studies and policies that show a way of thinking anchored in a cause-and-effect rationality that leaves out the very actions that produce and explain the performance of the social system that those studies and policies deal with. Systems adapt, systems respond to our actions. Policies that exclude such decisional nature of a social system are doomed to fail. Operational thinking means, among other things, to recognize, first, that a social system is a system driven by actors, that is, decision makers whose sequences of actions and decisions form intricate and complex networks of accumulations and feedback structures that can better be understood with the help of computer simulation.

Keywords: operational thinking, war on drugs, system dynamics

1. Failures

In 1971 president Richard Nixon declared drug abuse the "public enemy number one" and started what he called the “war on drugs” (Brownstein, 2014; Hawken & Kulick, 2011). This so-called war usually refers to the prohibition, control and combat of the production, distribution, and consumption of illegal psychoactive drugs. Lately, the number of people that declare the failure of such a “war on drugs” has been increasing:

> *Change is coming because the ‘war on drugs’ is being convincingly won by drugs* (The Economist, 2013).

> *A colossal failure... and a deadly set of unintended consequences... It's like trying to put out an electrical fire by dousing it with water* (Baird, 2012, p. 28).
>
> *Over 45 million people have been arrested, and there are now more people in US prisons for non-violent drug offences than were imprisoned for all crimes in 1970... The war on drugs shatters lives, corrupts the supposedly incorruptible, and causes untold collateral damage* (Mold, 2012, p. 1983).
>
> *Wherever I went, everyone involved—prisoners, cops, judges, jailers, wardens, medical experts, senators—all described to me a system out of control... [we need to] restore sanity to the criminal justice system* (Jarecki, 2012, p. 6).
>
> *The war on drugs has been 'far worse' than a failure...a self-perpetuating and constantly expanding policy disaster... 43 years of drug prohibition, millions of arrests and an estimated $1 trillion spent on law enforcement and incarceration have failed to put a dent in drug supplies or their purity, price and rate of use or the explosion in associated crime... the most devastating single destructive social policy since slavery* (Zullo, 2014, quoting Jack Cole, a retired narcotics detective and a co-founder of Law Enforcement Against Prohibition).

In Colombia things are not different. Colombia also declared its own "war on drugs" at the end of the 1980s (Camacho & Lopez, 2000), a war that has been driven by the $7 billion, US-designed "Plan Colombia", an anti-narcotics and military aid at a cost of an estimated 28,000 Colombian lives a year (Baird, 2012). And Colombia has not been able to declare "victory" either. For example, since 2005 the United Nations Office on Drugs and Crime (UNODC) and the Colombian Government regularly publish studies on the production and yield of coca leaf. The latest report reveals the lack of real effectiveness of the Colombian war on drugs: although in 2012 the Colombian Government manually eradicated 34.486 hectares, and sprayed 100.549 hectares of coca fields, 135.000 hectares were still affected by coca at some point, there was also an increase in the price of fresh coca leaf (+9.9%), and the prices of basic paste, cocaine base and cocaine hydrochloride remained rather stable—variations of -0.4%, +3.9% and -2.4% respectively (UNODC/SIMCI & Government of Colombia, 2013).

Such a failure represents an opportunity to explore certain modes of thinking that have underpinned this "war". We must clarify that we start from the working assumption of policy makers: illegal drugs must be combated and hence they focus their efforts in interdiction and law enforcement. Different assumptions, such as legalization, are out of the scope of this paper. Here we address the type of reasoning behind specific policies that have sustained such war on drugs; in particular we will focus on the the policies of eradication of illicit crops in the Colombian "battlefield". We show the way in which certain modes of thinking are elusive for tackling problems. A cause and effect way of thinking inspires such a war, which means a failure in recognizing the operations of actors as the drivers of the performance of a system, that is, a failure in "Operational Thinking".

The document starts with the concept of "operational thinking" in order to address central characteristics of social systems. The next section reveals failures in operational thinking through four policy works whose author's mental models exclude the dynamic structure of the system aimed to be improved leading to wrong inferences on proposed policies. Finally, we introduce a dynamic model that includes operational structures in the very conceptualization of the respective social system, which we believe leads to a more reliable way for designing effective policies.

2. Operational Thinking

The Colombian war on drugs is grounded on two assumptions (Camacho & Lopez, 2000): i) the problem originates with the supply of illicit drugs; ii) in order to put an end to the demand it is necessary to eliminate the source (aerial spraying, manual eradication and substitution of illicit crops such as marijuana, coca, and poppy plants). Figure 1 shows such rationality.

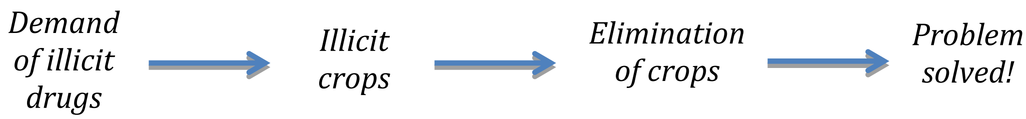

Figure 1. *Dominant rationality of the War on Drugs in Colombia*

To suggest that this is a problem of rationality seems rather trivial. However, there are different types of rationalities. It is common to call for a more "scientific" rationality for dealing with this problem and design effective policies, e.g. "rationality and economic reasoning alone fail to persuade politicians to end existing policies [of the drug war]" (Scherlen, 2012, p. 67). But economic reasoning shows also important shortcomings. We suggest that operational thinking, a distinctive type of engineering thinking, permits to get closer to tackle "organized complexities" produced by social systems. Barry Richmond (1993) coined the expression "operational thinking" to denote the skill of thinking in terms of "how things *really* work", for him this skill is "the unique essence of system dynamics" (Richmond, 1994, p. 140) and consists in "seeing key arrangements of stocks and flows, with an occasional wire thrown in to make an information link. Stocks and flows are very profound building blocks...They form the infrastructure of a system... Without the infrastructure, there can be no feedback system" (p. 143). In turn, to think in terms of operations in a social system means to think in terms of decision making processes of actors that form a complex network of interrelated decisions that unfolds through time (Olaya, 2012). In particular we will concentrate on four elements that surge from thinking in terms of "how things really work": the identification of actors as the first task to do, the awareness of bathtub dynamics for having effective impact, the relevance of feedback structures, and the necessity of the support of computer simulation.

Actors

The empirical version of science indicates to think in terms of *observations* since the main task of this type of science is to explain phenomena (*that which appears or is seen*). This attitude usually leads to the identification of aspects, factors, attributes, in short, data and variables that form the "empirical basis" which in turn becomes the source of knowledge and the basis to generate theories. However, to think in terms of "how a social system really works" is a different story, it means to recognize, in the first place, that operations of actors drive the performance of the social system that they form through their mutual interactions and processes of exchange of information and material. Then, the questions on actors are not easy: who are the actors that (can) impact the performance of the system? Who are affected? How do these actors decide? What information do they use? How? The answers to these questions form a special type of "data" that is very different from measurements of observed events or factors.

To ask first about actors and not about (observed) data is a distinctive task. It means to pay attention to the sequences of decisions and actions which occur in the modeled system. It means to recognize explicitly information flow channels. It means to examine the decision criteria that actors employ.

Forrester already suggested to trace "the motivations, hopes, objectives and optimism of the people involved" (Forrester, 2003, p. 341). More precisely, he suggests that the question about decisions of actors refer to "the control of an action stream. Such an action stream may be the time devoted to sleeping in response to one's physical state, the effort to improve products in response to market information about product acceptance, the change in interest rates in response to money supply, the change of prices in response to a worldwide commodity shortage, or the rate of consumption of rabbits as a response to the size of the coyote population" (Forrester, 1968, p. 402).

It is common to make wrong inferences on how a system might work. Forrester suggested that the origin of this problem is due to the counter-intuitive behavior of social systems, since the decisions made by actors generate reactions and effects that are not previously considered. In this sense, political resistance is framed within the difficulty of humans to identify elements of feedback operations of social systems, which seem to work differently than human logic assumes. Hence, the exclusion of the actions and reactions of different actors may explain the policy resistance (Sterman, 2000) that social systems show when interventions are implemented, such resistance may end up defeating them.

Bathtub Dynamics

The "note to the Faculty Research Seminar" that Jay Forrester (2003) wrote in 1956 sketched the foundations of system dynamics with a strong criticism to economic models. Its very first point stated that "one of the striking shortcomings of most economic models is their failure to reflect adequately the structural form of the regenerative loops that make up our economic system. The flows of money, materials, and information feed one another around closed re-entering paths" (p. 332). Forrester added that the behavior of such loops is determined by characteristics which are usually omitted from such models. One of this characteristics is the presence of accumulations, stocks that absorb the difference between inflows and outflows creating disequilibrium dynamics that are easy to underestimate (Sterman, 2000; Sweeney & Sterman, 2000).

Resources accumulate. People accumulate. Perceptions and beliefs that are the basis for acting, accumulate. Reservoirs of material change only through the decisions of actors. The operations of an actor, the outcomes of his decisions, usually operate on accumulations. Decisions affect also other decisions made by other actors. The sequences of decisions and actions form a stock-and-flow "infrastructure" that provides the operational ground for a social system. But inflows and outflows are affected by dissimilar actors. The accumulations absorb these differences and consequently behave unexpectedly. The unawareness of this fact and the lack of understanding of the dynamics associated with accumulations is one of the typical characteristics of the reasoning of policy makers. Within this static way of thinking, a policy maker would expect, for instance, that illegal crops should decrease as long as eradication and aerial spraying efforts increase. But rates of change should be compared with (other) rates of change: the only way for crops to decrease is to guarantee that the operations on all outflows should be faster or stronger than the operations on all associated inflows.

Feedback

Human beings tend to explain what they observe phenomena in terms of causes. We all have our "laundry list" (Richmond, 1993), that is, our list of "causes" that explain what we observe:

$$Y = a_0 + a_1X_1 + a_2X_2 + \cdots + a_nX_n$$

Where

Y = phenomenon to explain
a_i = weights or "importance" of each cause
X_i= causes or factors

However, actors make decisions that affect the world which in turn is examined for making new future decisions. Forrester noted that "the action resulting from the decision stream affects the state of the system to which the decision stream itself is responding (Forrester, 1968, p. 402). The recognition of a social system as a system of actors leads to feedback-based rationalizations of the behavior of the system according to the way in which such actors, processes and activities, are arranged and organized (Figure 2).

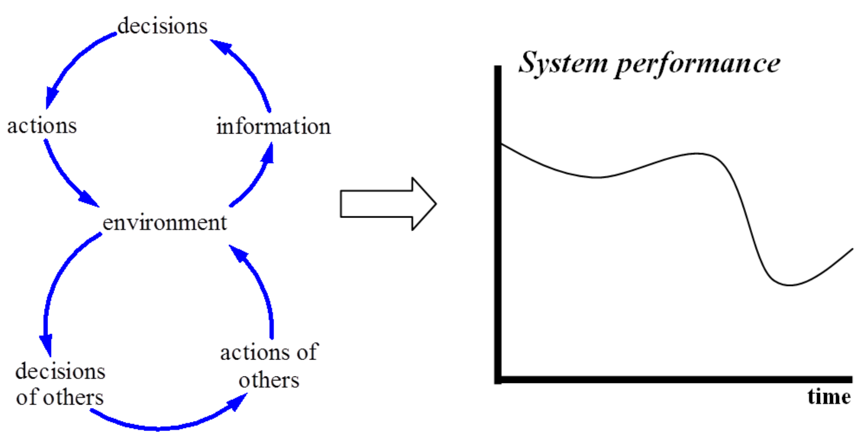

Figure 2. *Decision processes generate feedback structures that explain the performance of a social system*

Hence, the awareness of the presence of feedback loops mean to have a dynamic view of a situation, the action of an actor is produced *after* his (and other's) previous actions. Moreover, feedback loops provide the learning structures that permit actors to improve and to get closer to their goals. Human actors are learners, they act better as long as they act, they learn by doing. But feedback structures are decisive sources of complexity (Sterman, 2000). Hence, to omit them is to exclude not only time but also the possibility of having an appropriate account of the performance of any system.

Simulation

Human beings hardly understand basic concepts related to dynamic complexity, even if they are highly educated people with training in mathematics and calculus, people have incorrect beliefs about the relationships between stocks and flows (Sterman, 2000; Sweeney & Sterman, 2000); this is a pervasive problem in human reasoning unrelated to particular domains of action, disciplines or background (Cronin & Gonzalez, 2007). Static mental models (Moxnes, 1998; Sterman, 2000) ignore or adjust insufficiently for the complex dynamics that a stock presents, even simple tasks can be elusive, e.g. a stock can decrease even if the outflow is increasing. And yet, policy makers usually assume that "the more eradication, the less coca plants".

The strength of computer simulation rests on the capacity for conducting *experiments* (Rohrlich, 1990). Our mental models contain what we believe is the organization of a system. To simulate these beliefs through experiments gives us the opportunity to challenge and to improve our mental models (Sterman, 2000). Forrester (1975) is eloquent:

> We stress the importance of being explicit about assumptions and interrelating them in a computer model… The most important difference between the properly conceived computer model and the mental model is in the ability to determine the dynamic consequences when the assumptions within the model interact with one another. The human mind is not adapted to sensing correctly the consequences of a mental model… The computer model…is a statement of system structure. It contains the assumptions being made about the system...Generally, the consequences are unexpected (pp. 213-215).

Sterman (2000) reviews these limitations of the human mind that lead to erroneous inferences about the complex dynamics of social systems. To simulate "how things really work" means for any modeler a powerful option to test his mental models about the complex operations of social systems.

So far, it has been shown operational thinking includes many elements. We have signaled four: the identification of actors, the awareness of "bathtub dynamics", the relevance of feedback structures, and the necessity of the support of computer simulation. We will explore the presence or absence of these elements in various studies and policies that address the Colombian war on drugs.

3. Failures in Operational Thinking

Operational thinking is usually absent in the policies and initiatives for diminishing coca crops in Colombia. Academic and governmental frameworks exclude basic principles of operations, accumulations, learning and feedback. Instead, they use elaborated theories that have been developed on the basis that reality can be understood and modeled through static causal relations based either on historic data or on law-like theories. These elements can be shown from at least three different sources: theoretical and academic papers, national development programs, and evaluation and implementation reviews. Here, we briefly examine four examples. Three of them are academic studies, the other one is a governmental program.

Example 1: 'The War Against Drug Producers' (Grossman & Mejia, 2008)

Grossman and Mejia (2008) propose a sequential model of a war against drug producers to reduce the supply of hard drugs. In the model, the government and drug producers compete for control of arable land. The government devotes resources to prevent illegal farming and to destroy illegal crops while the drug producers try to maintain control over the land, farm the land for coca crops, and export their supply for drug sales. We will indicate some points that show the lack of operational thinking in such a model.

First, the model establishes functions for its main parameters relative to conflict over arable land, eradication and interdiction, and maximization of income for relevant actors. These functions do not consider learning and feedback processes even though they are nonlinear and concave equations. Instead, these equations depend on exogenous variables and hence, it can be concluded from a mathematical point of view, that there is no relation among the solution of the equations and the use of past information, as well as the interactions among variables. Rather, the problem is addressed with a general equilibrium model:

Fraction of arable land i the state controls	Fraction of drugs the drug producer successfully exports
$P_i = \begin{cases} \frac{Z_i}{Z_i+\phi X_i} & X_i > 0 \\ 1 & X_i = 0 \end{cases}$	$q_i = \begin{cases} \frac{\phi x_i}{\phi x_i+z_i} & z_i > 0 \\ 1 & z_i = 0 \end{cases}$

Where:

- Z_i and X_i are the resources that the state and the i^th drug producer, respectively, allocate annually to their conflict over arable land
- z_i are the resources that the state allocates annually to eradication and interdiction efforts
- x_i are the resources that the i^th drug producer respectively allocate annually to counter-attack the state's efforts
- ϕ is a parameter of relative effectiveness of the resources the drug producers allocate to the conflict compared to the efforts made by the government

These formulas imply that resources used in the model are exogenous and static over time. This relation can be expressed graphically in the following way:

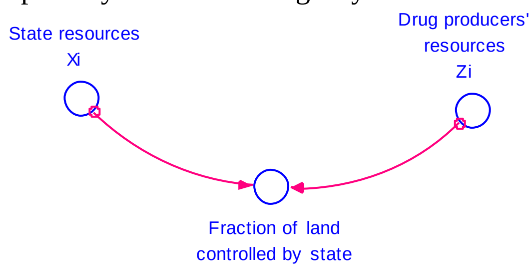

Figure 3. *Constant resources*

In this case, resources are handled as constant variables. Les us briefly check if this approach contemplates how things *really* work. We will explore just two issues: accumulations and feedback.

What actually we see in the operations of the system is that resources behave like *stocks* that depend on funding and income *inflows*, and on *outflows* due to expenses. These latter outflows in turn depend on the stocks of available resources, which create a feedback-based accumulation process. Figure 4 shows this operational concept.

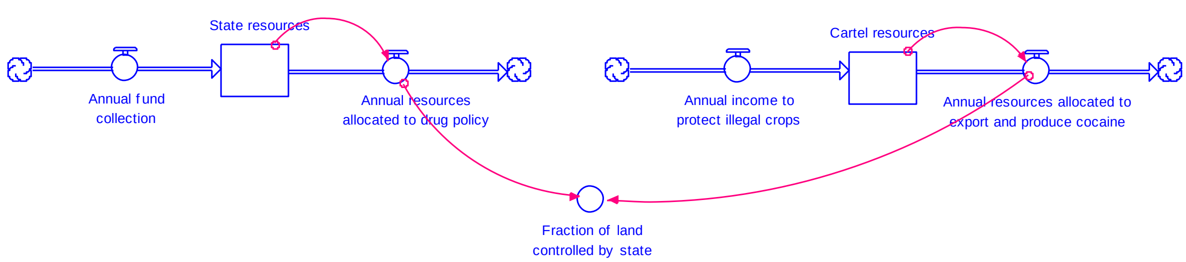

Figure 4. *Resources as stocks*

A first problem to notice is that resources, in the "real" system, present a behavior that is neither invariant over time nor a regularity because they come from dynamic decision-making processes of collection and expenditure of money and other assets. The continuous operation of those processes generates the accumulation and de-accumulation of material, as the *stock* is affected simultaneously by inflows that add material and outflows that subtract it, certainly at different rates. The exclusion of such dynamics produces a misperception of the actual situation and, more importantly, leads to errors about the dynamics of the fraction of land controlled by the State since such fraction depends on the stocks of resources.

Second, the model lacks feedback structures. Even though it is calibrated through two periods—before and after Plan Colombia—it does not include decisions and reactions from one point of time to the next one, then it doesn't allow for understanding the consequences of inter-connected decision-making process that unfold through time. Similarly, policy resistance might arise as interventions can be defeated as a response of the system against the intervention itself. This limitation is unmistakable since an actual real time frame is not considered and thus, it is not possible to explore how actors respond according to the state of the world and to the possible solutions that the model suggests.

Example 2: **'*An Econometric Analysis of Coca Eradication Policy in Colombia' (Moreno-Sanchez, Kraybill, & Thompson, 2003)***

The objective of this document is to statistically evaluate the effectiveness of supply reduction policies for cocaine in Colombia. According to that, the following model is established:

$$H_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 PP_{t-1} + \beta_3 E_{t-1} + \beta_4 O_{t-1} + \varepsilon_t$$

Where H is the number of hectares of cultivated coca in Colombia, P is the farm-gate price of coca, PP is the farm-gate price of plantain (a major crop substitute), E is the number of hectares of coca eradicated in Colombia and O is the number of hectares in Bolivia and Peru. The model is estimated using Ordinary Least Squares.

A first characteristic of this study is that actors are not explicitly included. As a consequence, the study excludes the decision-making processes of actors that actually build and recreate the behavior of the system through their decisions.

Secondly, causal thinking sustains the hypothesis that the study tries to prove. The model presents its "laundry list" and looks for the 'origin' of increases in coca cultivation in Colombia. Learning structures are not considered because the dependent variables are assumed to be affected by exogenous parameters and not from feedback processes of the system.

Third, the variables related here have different dynamic nature. Actually, the coca plantations behave like stocks while prices do not necessarily have a process of accumulation and can be modeled as rates. However, the model establishes a linear relationship that combines different types of variables, which leads to erroneous inferences about the impact that they have on the dependent variable. Policy resistance is very likely to happen since the study excludes the interactions among decision makers that react to possible interventions, let alone the complex accumulation dynamics that are left out as well.

Fourth, even though a time horizon is taken into account, the model is still static. While it seeks to create an association between two time periods (t and t-1), it neglects the systemic relationship between the variables as well as the operational structures between them, e.g. the coca selling price, the plantain selling prices, the eradication of coca hectares, and so on. Such variables behave as the outcome of decisions of different actors, decisions that repeat in time according to contingent conditions like the changing state of system, the changes in preferences and goals, and the outcomes of previous decisions. Moreover, these relations could be simulated to explore the consequence of these assumptions. The truth is that there seems to be no awareness about the real implications of using linear models. In fact, differences between linear regressions and dynamic models are so significant that they deserve to be explained in a more detailed manner. The next example highlights important issues derived from the lack of operational thinking.

For simplicity purposes, let us assume that hectares of cultivated coca in Colombia are explained by the following model: $H_t = \beta_0 + \beta_1 P_{t-1} + \varepsilon_t$. Then, using historical data based on UNODC annual reports on coca leaf prices and hectares of coca cultivation from 2001 to 2012, the relation between farm price and hectares can be explained by the formula in the following graph, showing a negative relation between lagged price and hectares:

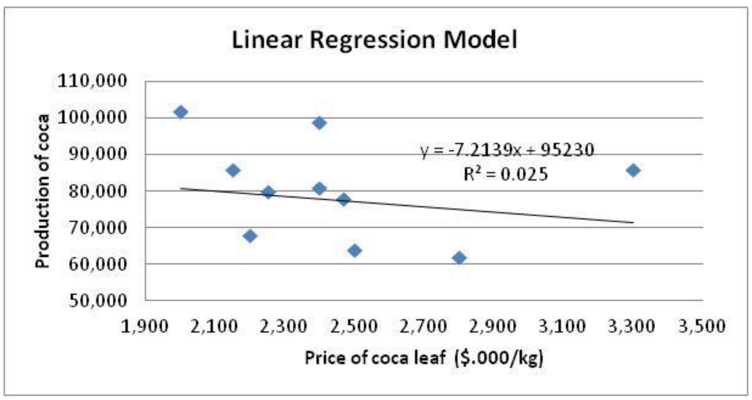

Figure 5. *Linear regression model between production of coca and its price*

If the same situation is modeled using operational thinking we obtain the simple model of Figure 6, which highlights important dynamic aspects of how coca crops "really work". This model relates variables according to their operational and decisional nature along with the resultant feedback relations that unfold through time. Moreover, the stock of productive crops is *directly* and *uniquely* related with its inflows and outflows. Figure 6 immediately shows that there is no way that a direct relationship between prices and crops can be established since crops simply vary according to sowing, death, eradication and spraying. And for sure price does not impact crops death.

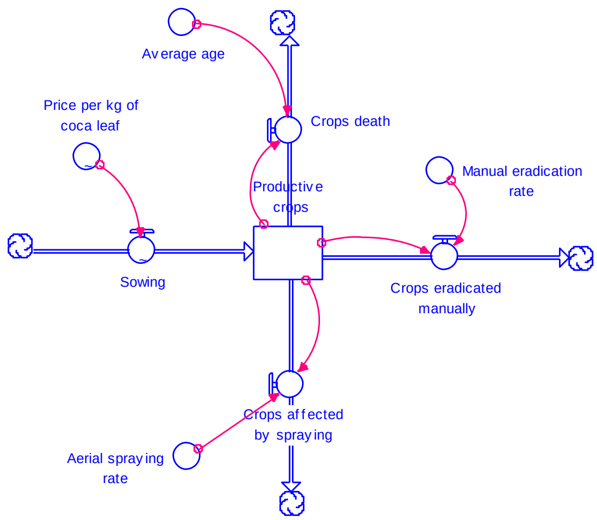

Figure 6. *Simple Stock and Flow model of how crops really work*

Depending on how those flows perform, the hectares will behave accordingly. Such is the case that the negative relation found in the above regression does not always hold and it can be easily shown by evaluating several scenarios that apply for the same relation in the dynamic model. Diverse scenarios are shown below to illustrate how results might change depending on how the model is understood under the same structure:

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Aerial spraying rate	0.3	0	0	0	0.4
Average age	30	30	30	15	30
Manual eradication rate	0.2	0.2	0	0	0.3

Table 1. *Scenarios with different values for selected variables*

Results associated with the scenarios mentioned above are shown in Figure 7.

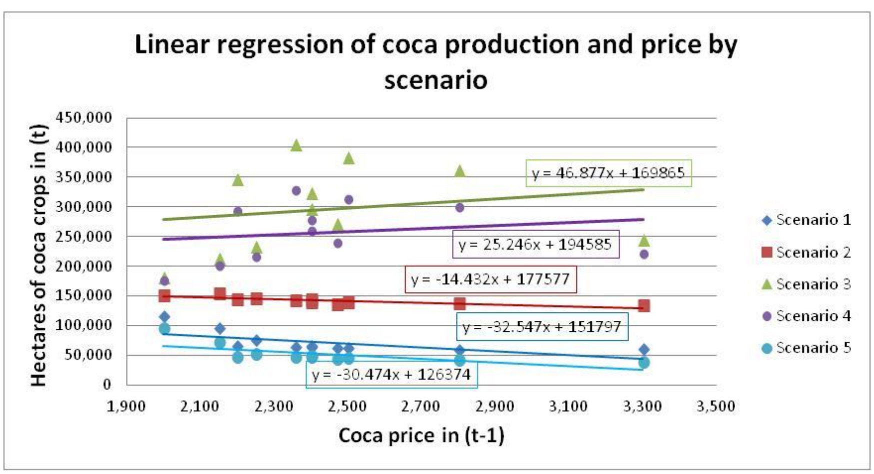

Figure 7. *Linear regression model between production of coca and its price by scenario*

Figure 7 shows that depending on how hectares (stocks) are affected by the net change flow (the resultant force from relative inflows and outflows), the linear regression model will be different when relating to prices. Specifically, as can be seen in the figure, the relation can be positive as well as negative.

The previous analysis shows the criticism of Forrester (1961) to economic models:

> In economics, models have often been constructed working backward from observed total system results. Even as a theoretical goal, there is no evident reason to believe that the inverse process of going from total-system behavior to the characteristics of the parts is possible... The routine, clerical collection of numerical data is unlikely to expose new concepts or previously unknown but significant variables (pp. 54, 57).

Stocks are only affected through their flows and they are not *operationally* related to other variables (such as price). Stocks have memory and inertial properties produced by the accumulating dynamics of the operations of inflows and outflows. The momentum associated with accumulations, the important delays, and the permanent disequilibrium of the system mean that an analysis correlating different variables will hardly get closer to the actual way in which such a system works. In this case, to establish a direct relation between price and the coca crops is incorrect from an operational thinking point of view: crops are not determined solely by price, the operational concept that Figure 6 shows, reveals this fact straightaway.

Example 3: 'New Approach of Programs Against Illicit Crops' (DPCI, 2012)

The governmental agency "Direction of Programs Against Illicit Crops" (DPCI) leads the "Consolidation Strategy" that emerges as a means to generate greater support from Colombian institutions in places where there have been problems of illicit crops and illegal groups. In this regard, the government has "implemented a flexible intervention model in the short term, and guidelines for development in the medium and long term. The intervention model develops actions in four main components: eradication, post eradication, containment, and sustainability" (DPCI, 2012, p. 15).

Under this approach, the program considers two fundamental elements from a dynamic point of view. First, it addresses the interaction among stakeholders (state and farmers) through monitoring programs that measure the effectiveness of implemented policies. This generates learning and reaction processes which are translated into feedback among these actors, but exclude possible scenarios when other stakeholders (like drug producers) that react and generate new actions to counteract current policies.

Second, it takes into account that major guidelines will not be implemented instantly but instead, they need a time horizon in order to effectively make an impact on the objective population. Even though this is a good initiative, the time horizon proposed to evaluate the program is very close to one year. In order to see the overall effect on the system of the feedback process, it would be necessary to extend the time horizon to evaluate and possibly redesign the previously implemented policies. Otherwise, policy resistance may arise and thus effectiveness of policies might be defeated. Another important shortcoming is that this program does not use operational modeling or simulation in order to examine the consequences of its design. In fact, the model is written as a guideline for decision makers but it is not supported with modeling techniques or simulation tools to provide a confident understanding on how the system may react given the current recommendations.

What can be concluded is that the program has a somewhat strong view in the sense of operational thinking but it needs to develop additional key factors. Even though it is a very aggregate program, it should consider additional elements of operational thinking such as the inclusion of all relevant decision-makers, the analysis of long-term relationships and possible policy resistance according to how the system reacts.

Example 4: After Plan Colombia: Evaluating "Integrated Action," the next phase of U.S. assistance (Isacson & Poe, 2009)

Isacson and Poe (2009) evaluate a strategy known as Integrated Action (hereafter IA) within the framework of Plan Colombia. The document gives a review of the policies elaborated in recent decades to show recommendations on new strategies.

According to Isacson and Poe, instead of attacking the problem of almost total absence of the state in regional areas like Putumayo (where a large part of coca leaf is produced), drug squad campaigns for aerial spraying and crop eradication prevailed in IA as being part of a strong militarization plan. In order to counterbalance this intervention, there were later proposed a series of recommendations that included demilitarization, coordination, improving land ownership warranties as well as to focus on a timeframe beyond two years.

Both the apparent solution and the proposed set of policies are coercive initiatives. At first glance, the problem is seen from a cause-and-effect framework, trying to identify the main drivers causing the lack of effectiveness on IA. Secondly, a list of independent policies is shown to help solving the problem but there is not a study on how to implement those policies in a period of time that may guarantee the success of the policy and that includes the implications and reactions of implementing the proposed intervention. There are no signs of considering the dynamics of crops accumulations, moreover, policies will add complexity to the problem and relevant actors indeed reacted according to their decision processes.

Since the authors do not consider interactions among actors and their reactions according to their interests and decision rules, then it is hard to guarantee that these combined effects may actually improve the situation of affected people. The use of a simulation tool could help to evaluate scenarios and policies as it will generate a better understanding.

Finally it is important to emphasize even though the cited document is more an assessment about what has happened and how effective Plan Colombia has been, causal thinking keeps dominating the way this problem is understood. The fact that it is thought that militarization is the main reason of the lack of effectiveness in Plan Colombia reflects a simple cause and effect view in which the complexity of the network of decision-making processes carried on by diverse actors, is excluded.

The previous examples along with the respective presence or absence of operational thinking elements are summarized in Table 2.

Aspect	Theoretical and academic papers		National development programs	Evaluation and implementation reviews
	GROSSMAN & MEJIA	MORENO, KRAYBILL & THOMPSON	DPCI	ISACSON & POE
Relevant Actors	✓	χ	✓	χ
Learning structures	χ	χ	✓	χ
Policy resistance	χ	χ	χ	χ
Bathtub Dynamics	χ	χ	χ	χ
Feedback and time horizon considerations	χ	χ	✓	χ
Simulation tools	χ	χ	χ	χ

***Table 2**. Examples of operational thinking elements included* (√) *or excluded* (χ) *in four policy suggestions on the war on drugs in Colombia*

4. Operational Possibilities

This section seeks to provide an operational example for conceiving public policies aimed at the reduction of coca cultivations in Colombia. We will show what happens when we think in operational terms. A model was constructed under the focus of how the State acts to decrease the amount of coca cultivations, while drug producers try to increase them, encouraged by the demand for cocaine. There are different understandings on this issue so the purpose of this exercise is not to generate a single numerical result about which parameter(s) should be modified or changed, but to show what means to think in terms of how such a system (might) work.

Actors and accumulations

The identification of relevant actors and the accumulations that they affect, is a key operational step for building a model. The first question deals with asking which agents have an impact on the production of coca crops in Colombia. In that sense, there are two actors that directly affect the availability of resources for coca production: the state and the drug producers. Other agents take other decisions that end up affecting the production as well: the demanding population for processed cocaine and farmers who move between legal and illegal work. The second question addresses a 'Bathtub Dynamics' point of view. It is essential to identify variables behave like stocks and which ones not.

Relevant actors learn from the system while they are affecting it at the same time. Such is the case that information moves across the system but it might not be instantly known and on the contrary, delays appear due to asymmetries of information and channels of communication. Since information about the real level of crops is not instantly known but on the contrary, it takes a while to discern real data, perceived crops will resemble the actual hectares grown and should also be taken into account in the model as actors take decisions based on such perceived situation. In this case information delays are related to the perception about the current level of coca cultivated in Colombia. Figure 8 shows this information delay.

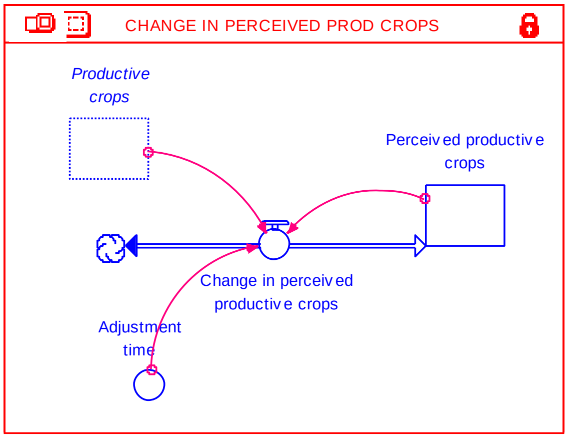

Figure 8. *Productive coca crops' information delay*

Coca crops cultivated and productive must be conceptualized as (separated) stocks. This is done in order to evidence the growing process of the plant and the associated material delay involved in producing coca leaf. Once productive crops are identified as a tock, it is possible to incorporate the effects of eradication, aerial spraying, and crops' death, as they are direct outflows to such crops. Moreover, crops grow, which is formulated with a first-order material delay. This is shown in Figure 9.

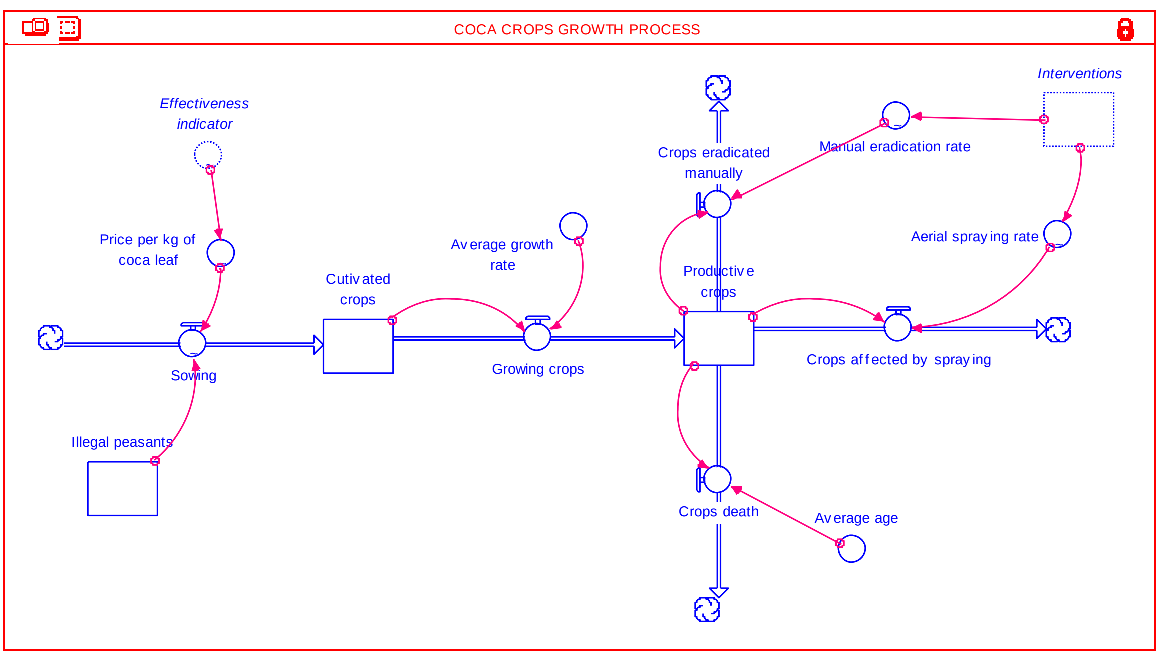

Figure 9. *Productive coca crops involving material delays*

Finally, State's intervention can be represented as a material delay as well, on the basis that new interventions are gradually incorporated into the system, and after an average period of time, they start to have lower impact due to the changing conditions. This is shown in Figure 10.

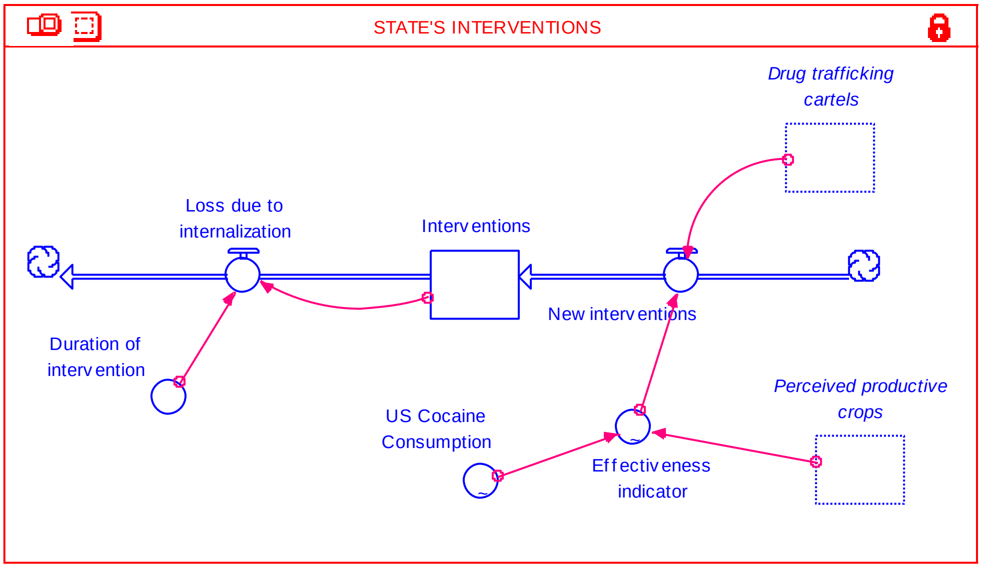

Figure 10. *State's intervention process*

It is also relevant to accumulate in separated stocks both legal and illegal farmers, because the model aims to understand the dynamics that occur between these two population groups. The state seeks to improve their living conditions, thus, a sound model must include their decision rules and how they react when they interact with the state and with drug producers. Drug cartels are naturally one of the most important actors, depending on the number of cartels in some areas, the intervention capacity of state agencies is more difficult. Then, their process of accumulation and de-accumulation is relevant for understanding the dynamics of the problem and for identifying possible balances to these effects. The way in which these actors are interrelated is shows in Figures 11 and 12.

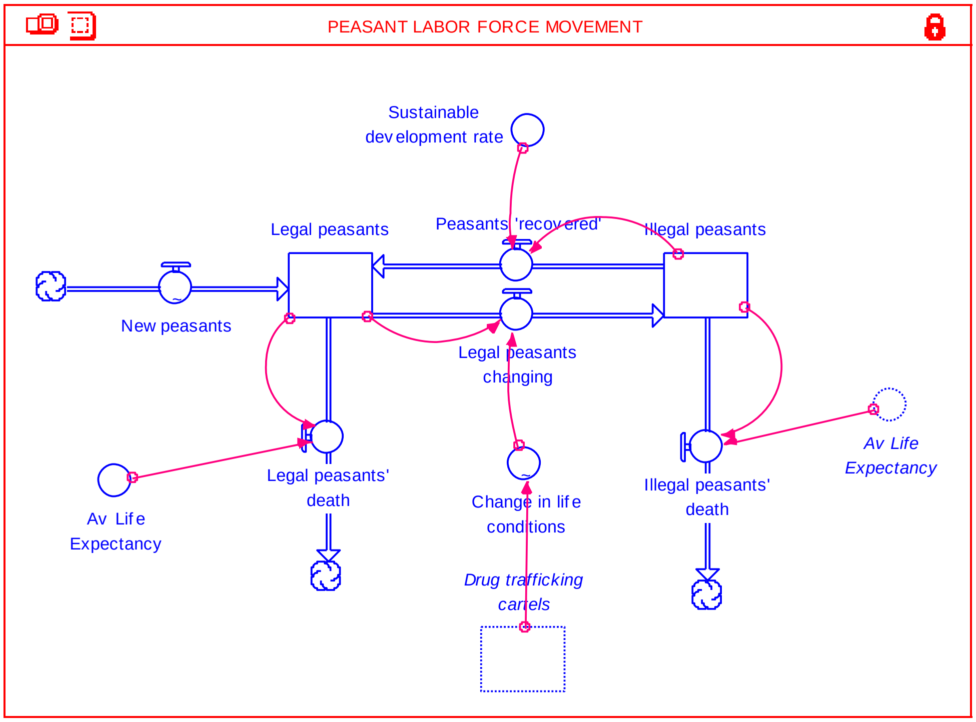

Figure 11. *Peasant labor force movement*

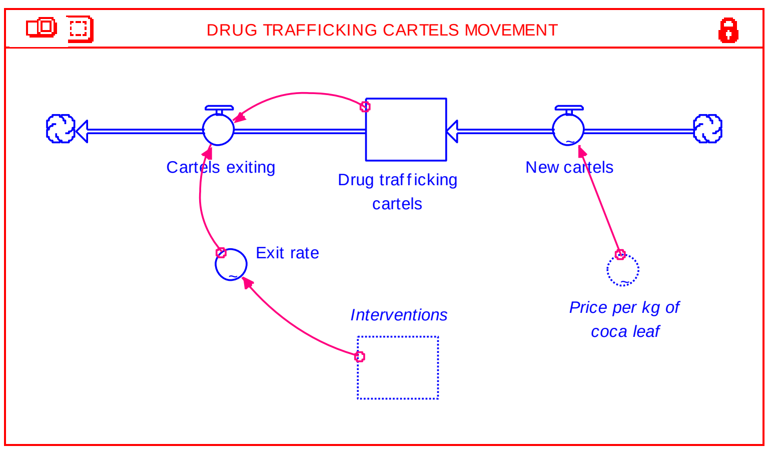

Figure 12. *Drug trafficking cartels movement*

Rate variables should be considered as well. The main variables under this category are: coca leaf price, cocaine consumption in most demanding countries, and policy effectiveness indicators, and, as can be seen, they affect how stocks behave though they make it through the inflows and outflows.

Now that the main actors, stocks and rates have been addressed, a series of non-linear relations can be proposed regarding some relations. The use of non-linear relations between variables, acknowledge the fact that the decision makers do not behave in the same way through their range of possibilities. When it comes to extreme situations, actors can become more conservative and prefer to stay close to certain values. Establishing linear relations might also eliminate effects such as economies of scale and growth limits. One example of this behavior is how legal farmers become illegal workers depending on changes in their actual living conditions, due to the pressure that drug trafficking cartels exert. Figure 13 shows that this relation, between the stock of drug trafficking cartels and the portion of farmers that become illegal workers, is not linear. What is shown is that even though the amount of cartels might change from its last two values in 35 units or 11% (from 315 to 350 cartels), changes in life conditions just have an impact of less than 1% (from 25.4% to 26.15). Normalization of this effect would be the next step for having a robust model.

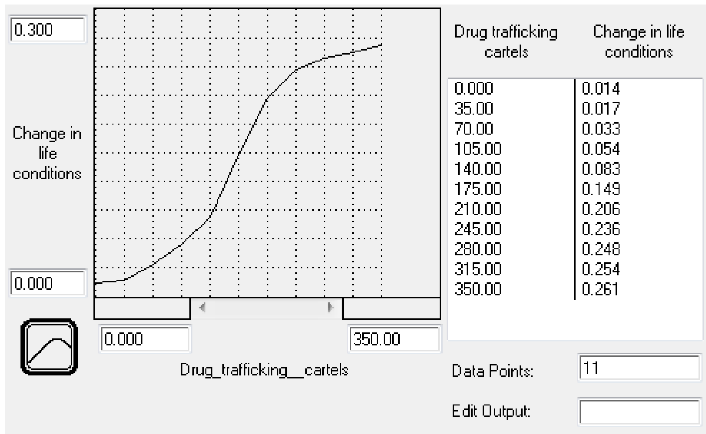

Figure 13. *Becoming illegal because of cartels*

Taking into account the previously elements, Figure 14 introduces a simplified Stock and Flows model that shows operational thinking.

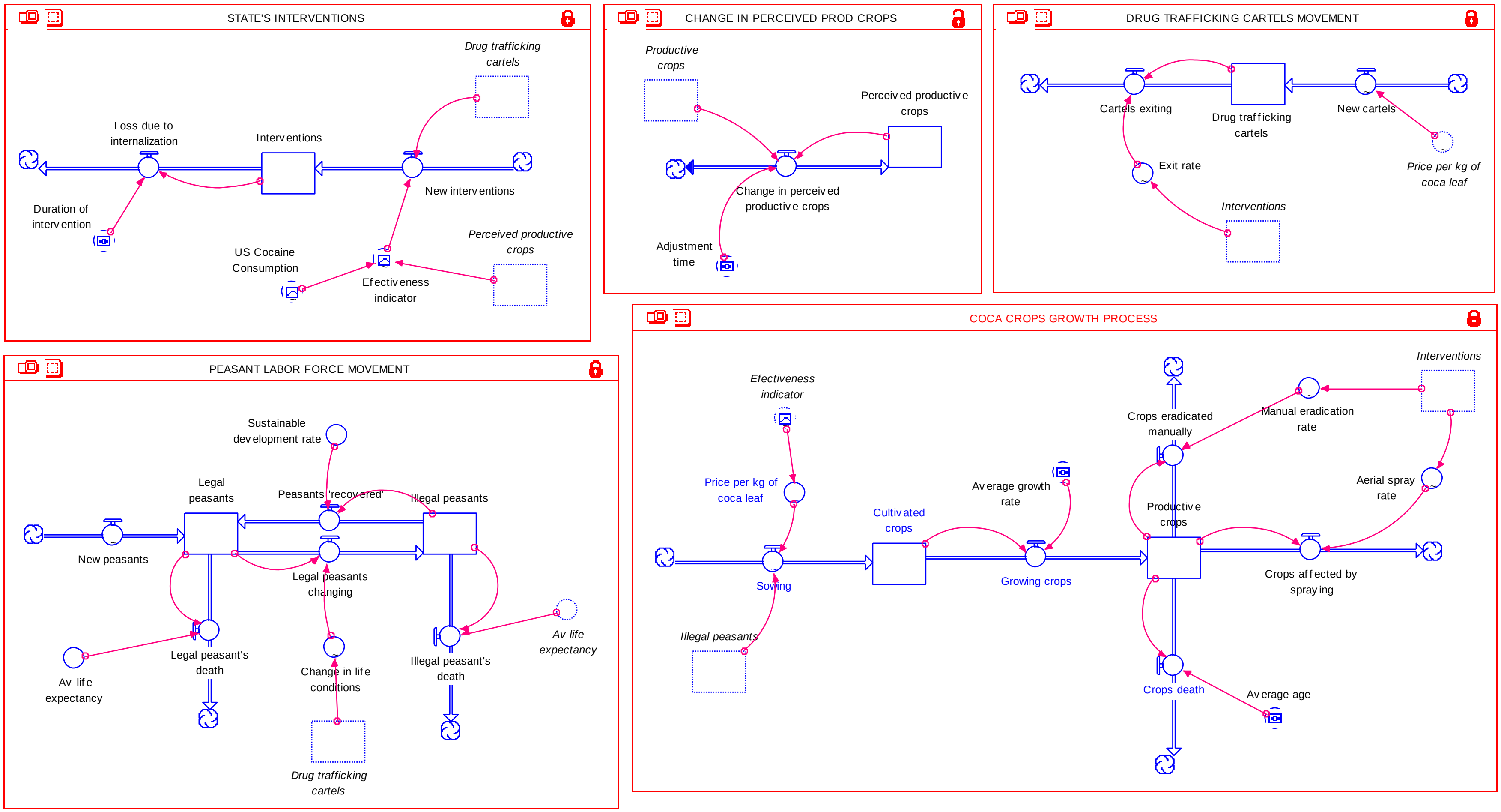

Figure 14. *Example of a possible operational model for Coca crops cultivation in Colombia*

The model shows how the government, through interventions and enforcement policies, tries to affect the ability of drug producers to increase sowing and production, as well as intimidating farmers in order to become illegal producers. From an operational thinking point of view, the model generates a network of dynamic decision processes embedded in a stock-and-flow infrastructure that will produce very complex behaviors.

Feedback and time horizon consideration

The capability of identifying feedback processes is central for developing a dynamic account of the behavior of such a system. As mentioned earlier, actors generate changes on the system and react to contingent conditions of such a system. The decisions of each actor affect their nearest environment and generate new (later) reactions from the system and so on. The next table shows the main reinforcing and balancing loops of the model and their effect according to the relations between variables they include. Figure 15 shows the corresponding Causal Loop Diagram.

Loop	Short description
R1	Vicious cycle for creating new cartels due to fumigation of productive crops
R2	Vicious cycle for creating new cartels due to manual eradication of productive crops
R3	Labor force movement due to legal and illegal crops' market
B1	Control of hectares of coca by the effectiveness of policies
B2	Balance of intervention level due to manual eradication
B3	Control of exiting cartels because of coca production perception
B4	Balance of farmers available through the price of coca leaf
B5	Control of interventions due to fumigation

Table 3. *Summary of feedback loops*

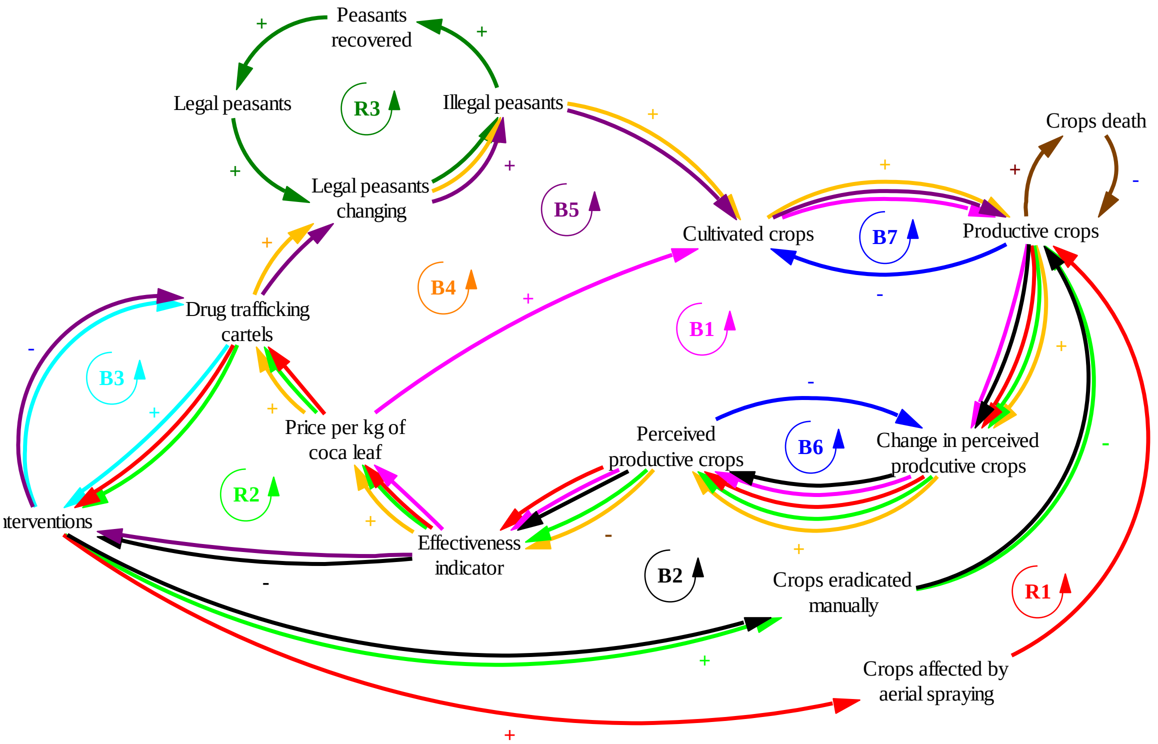

Figure 15. *Causal Loop Diagram*

This model necessarily implies the inclusion of a time horizon in which, given the state of time t, state t +1 is defined. The feedback-view allows the model to be indeed "dynamic". It also allows for considering possible strengths of the feedback loops. As relations among variables change over time, their relative influence on the system change as well. For example, due to a low intervention plan of the government in a certain point of time, drug producers might increase their harassment over farmers. However if the government later doubles its strength in its intervention plan, it might not get the double of people returning to legal crops. This ends up affecting related feedback loops and when drug producers or the state have higher power, their associated loops will have more strength. Such complexity cannot be properly understood without a simulation tool.

Simulation tools

We used the software iThink to explore how actors and their decision rules generate changes in a system of productive coca crops under a "war on drugs". We studied how the structure shown in Figure 14 generates the behavior of these crops over a ten-year horizon. Decision rules were investigated through historical information and expert knowledge. Figure 16 shows the results and a possible hypothesis that relates specific loops of Table 2with segments of the simulated behavior.

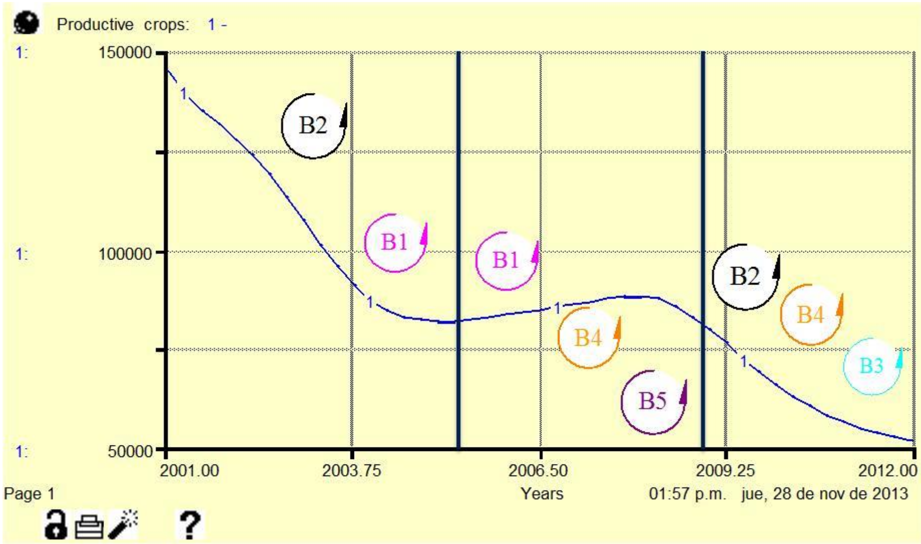

Figure 16. *Productive crops behavior based on feedback loops and learning structures on the proposed model*

The simulation shows how coca cultivation sharply decreases in the first part of the period studied, then increases from 2005 to 2008, and then decreases again. This pattern closely matches the actual behavior of crops during this time frame. But this is a minor issue. The major issue is that the model permits to explain how the system has behaved in terms of the dominant cycles identified to affect the performance of the crops. What can be seen here is that the understanding on the system is explained in terms of its relational structures and that the force of these cycles changes over time as a consequence of different reaction processes among the actors. That is, Figure 16 shows a possible explanation based on the actual human-made operations of the system. Any intervention designed from this point of view will necessarily include not only the complexity of accumulations dynamics but also the motivations and decisions of actors involved. Such elements are necessary for having policies that account for the operations of the system that those same policies seek to transform. The chances of real success (or of realizing that perhaps "a war on drugs" is not a good idea?) are, no doubt, greater.

5. Final remarks

The Global Commission on Drug Policy, a 22-person panel which analyzed the global War on Drugs, opened its central report this way:

> The global war on drugs has failed, with devastating consequences for individuals and societies around the world. Fifty years after the initiation of the UN Single Convention on Narcotic Drugs, and 40 years after President Nixon launched the US government's war on drugs, **fundamental reforms in national and global drug control policies are urgently needed**. Vast expenditures on criminalization and repressive measures directed at producers, traffickers and consumers of illegal drugs have clearly failed to effectively curtail supply or consumption (Global Commission on Drug Policy, 2011, emphases added)

The failure of the war on drugs can be explained from many points of view. Yet, it is unmistakable the simplicity that underpins such enterprise. To think in terms of how a system actually works, which means to recognize that motivations and decisions of diverse actors unfold through time, means to have a better chance of understanding why systems resist to our interventions. To build operational models of social systems allows for exploring our assumptions regarding the courses of actions that we develop.

We have highlighted several elements that help to develop an operational perspective. The inclusion of interested or affected parties is necessary to avoid a shortsighted view of a complex problem. But perhaps more importantly, the possibility of understanding a complex system using these types of tools can change the way policy-makers think their problems and hence, their solutions. Modeling and simulation tools are used mainly in academia. The development of real breakthroughs in the way that our society faces its more urgent problems is only possible when also governmental actors reflect on how actually the systems that they impact work.

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