Persistance in the Political Economy of Conflict
The Case of the Afghan Drug Industry

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Abstract
Links between licit and illicit economies fuel processes of conflict in countries mired in irregular warfare. We argue that in case of conflict in Afghanistan engaging in poppy cultivation and drug trade provides stability to farmers who lack alternative livelihoods and security necessary to access markets and face the unintended consequences of haphazard developmental efforts. Drug trafficking also provides a stable source of income for the crime-insurgency nexus and funds corruption, in turn foiling attempts to establish a unified governance body. We show how individual rationality, market forces, corruption and opium stocks accumulated at different stages in the supply chain can counteract the effects of any single counternarcotics policy. To that end, we use initial results from an agent-based model of agricultural economy of Afghanistan. We define physical, administrative, social, cultural and infrastructural environments in the simulation; outline objectives and inputs for decision making and the structure of actor interactions.

Statement of the Problem
We start by recasting the post-2001 insurgency in Afghanistan as a complex adaptive system (CAS) and lay out the components of a country-scale, multiagent model that captures persistence and resilience as the key properties of the current conflict in Afghanistan.

Post-2001 Conflict in Afghanistan as a CAS
The current insurgency in Afghanistan, like that against Soviet occupation during 1979–1989, is rooted in resistance to external intervention, unlike conflicts before the Soviet invasion that generally stemmed from internal ethnic and economic divisions. The country is populated with rural and urban households, a medley of opportunist armed groups and criminal gangs led by local strongmen, the government and International Security Assistance Force (ISAF), and the insurgents. Adaptive and “strategic” interactions among actors that have determined the emergent course of the current conflict are informed by individual attitudes, kinship considerations and tribal affiliations on multiple scales through weakly-coupled, nested systems enabled by the remoteness of population settlements, lack of transportation and communication infrastructure and scarcity of manpower.

A Multiagent Model of Conflict in Afghanistan
In this paper we examine the Afghan drug industry as a component of the current conflict in Afghanistan by building a country-scale, multiagent model of the agricultural economy that enables us to represent subset of elements of conflict that turn it into a CAS. As listed in Table 1, full representation of Afghan conflict will include population livelihood, kinship and attitudes and government security and development policies along with an intricate set of institutions that determine how households render support to the government, ISAF or the insurgents depending on the flow of resources they receive. Figure 1 shows how these components, called modules, interact with one another. For example, the livelihood module situates abstract kinship networks in physical space, for instance a village.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livelihood</td>
<td>Farming and trading crops; geography, climate</td>
</tr>
<tr>
<td>Kinship</td>
<td>Marriage and procreation; kinship networks</td>
</tr>
<tr>
<td>Attitude</td>
<td>Positions on political actors and events</td>
</tr>
<tr>
<td>Security</td>
<td>ISAF and government security policies</td>
</tr>
<tr>
<td>Governance</td>
<td>Flows of resources up and down</td>
</tr>
</tbody>
</table>

Table 1: Modules of the full model of conflict in Afghanistan.

Using completed version of the agricultural economy module, we show that engaging in poppy cultivation and drug trade provides stability to farmers who lack alternative livelihoods and security necessary to access markets and face the unintended consequences of haphazard developmental efforts. It also provides a stable source of income for the crime-insurgency nexus and funds corruption, in turn foiling attempts to establish a unified governance body. Therefore, the decision to participate in the drugs supply chain at any stage is rational from the point of view of risk averse, but boundedly rational, individuals. That is why eradication, even if it succeeds in significantly reducing proportions of land devoted to poppy cultivation, is insufficient to discourage farmers from growing poppy. Market forces, corruption
and opium stock accumulated at different stages in the supply chain counteract the effects of eradication. To that end, we outline the physical, administrative, social, cultural and infrastructure environments; objectives and inputs for actors decision making, and the structure of actor interactions.

![Diagram](image)

Figure 1: Interactions among components of the model of conflict in Afghanistan.

**Modeling the Afghan Drug Industry**

Poppy cultivation and opium trafficking have since 2001 influenced the course of the Afghan conflict (Buddenberg and Byrd 2009) by financing insurgent operations and sustaining rural, Afghan households. Although detailed field studies show that lack of security and alternative economic opportunities drive Afghan farmers to cultivate poppy (Mansfield 2007; 2008), multiagent models of drugs supply chain (Watkins, MacKerrow, and Merritt 2010) and macroeconomic structural equation models of drug exports (Buddenberg and Byrd 2009; Lind, Moene, and Willumsen 2009) have failed to incorporate the objectives that players in the Afghan drug industry pursue and the biophysical, geographic and resource constraints they face. These failures are partly inherent to reasoning about interactions among heterogeneous groups with dynamic memberships on multiple scales and contexts and partly caused by available data produced by sources with varying credibility. The model we present in this paper includes both the physical and the behavioral layer of the Afghan drug industry.

**Method**

To overcome difficulties mentioned above, we have pursued the following workflow:

1. Produce a unified dataset of rural Afghanistan by merging remote sensing data and local surveys.
2. Initialize a multiagent simulation model with 1.5M rural households, 40K small-scale traders, 1K drug traffickers and 50 major traffickers.

**Recovering Data for Model Instantiation**

The first challenge to modeling the Afghan drug industry is to unify disparate datasets to inform model building. In order to create a population of rural households and fill in all of their attributes, we implemented a procedure described in (Rizi, Latek, and Geller 2010). Our approach takes open-source data listed in Table 2; creates a population of farmer households, each of which assigned a particular size and a set of land lots with physical properties by an iterative preferential attachment procedure through which a village is more likely to receive a new household if it has a higher percentage of unassigned land, while preserving (a) district level population counts; (b) regional availability of land and land types; and (c) the joint distribution of household size and wealth, conditioned on village wealth.

In (Rizi, Latek, and Geller 2010) we validated our procedure with the ORNL LANDSCAN dataset (Oak Ridge National Laboratory 2009) and showed that it guarantees a reasonable degree of fidelity. The key properties of rural households and their placement in villages are shown on Figure 3. We adopted a similar approach to create agricultural traders:

<table>
<thead>
<tr>
<th>Source</th>
<th>Data</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSO</td>
<td>Population</td>
<td>Rural household population</td>
</tr>
<tr>
<td>AIMS</td>
<td>Population</td>
<td>Urban household population</td>
</tr>
<tr>
<td>NGIA</td>
<td>Villages</td>
<td>Distribution of rural population</td>
</tr>
<tr>
<td>AIMS</td>
<td>Land quality and irrigation</td>
<td>Distribution of rural population</td>
</tr>
<tr>
<td>FAO</td>
<td>Land surveys</td>
<td>Properties of rural households</td>
</tr>
<tr>
<td>USGS</td>
<td>Elevation and roads</td>
<td>Transportation costs</td>
</tr>
</tbody>
</table>

Table 2: Data layers fused into initial conditions for the drug industry model.

3. Introduce insurgent actions: government, ISAF and development agencies policies.
4. Define behaviors and reactions of farmers and traders to changes in local market and security conditions.
5. Validate the model with historical data on climate, security and policy against a spatial panel dataset of trade volumes and prices of selected crops.

Currently, we are working on steps 3 and 4.
we turned adjacent villages into sets of markets and assigned them to agricultural traders. We use the transportation time layer to ensure that traders do not exceed realistic time constraints required to visit the markets they are assigned to. We designed different classes of traders by using the time constraint layer and the markets that traders monitor: small-scale sedentary traders monitor a cluster of neighboring villages; medium traders a set of clusters and a city or two; large-scale opium traffickers and wheat wholesalers cities, provincial capitals, and international markets. This process situates a mixture of traders in a hierarchy of markets that provide lateral liquidity, see Figure 4.

For validation purposes, we have gathered data on historical, village-level climate data conditioned on local irrigation infrastructure, security conditions, developmental and counternarcotics policies from 2000 to 2010. After inputing these data, we plan to replicate historical price time series for selected regional markets (MCN 2010; MAIL 2010) and spatial distributions of crop cultivation (Taylor et al. 2010).

**Agency in the Model**

In addition to representing the physical environment explicitly, the model consists of three main agent types of farmers, traders and the government. The ISAF and insurgents are absent in the computational experiments whose results we are reporting in this paper.

**Farmers** Farmers choose what crops to cultivate and when to sell and buy more of crops they have cultivated and buy...
those they have not. Each farmer household is endowed with plots of land chopped into *jeribs*, a traditional measure of land in Afghanistan equal to 0.2 of a hectare. Each lot is characterized by a land type that has a specific yield for any combination of potential crops and climate conditions. Some land types are irrigated, so climatic conditions do not influence their yields much. Some crops, for example poppy, are rather resistant to weather conditions regardless of whether they are cultivated on irrigated land or not. Farmers allocate crops to the land they cultivate in order to maximize their expected annual income, satisfying the following constraints:

- Historically smoothed local prices of different crops;
- Expectation of climatic conditions;
- Government policy: if farmers choose to grow poppy, they account for eradication risk and bribes to avoid it;
- Availability of farm labor provided by family members or rented out from locals;
- Household food consumption.

For example, if a farmer with a large family expects imminent drought when poppy prices are high enough, he may decide to forgo grain cultivation and plant only drought-resistant, labor-intensive poppy, hoping to buy wheat from the market with opium income later. Similarly, some farmer households may decide to fallow some of their land lots and offer accessory labor for farm wages to other households. Detailed surveys of farmer behavior are provided by (Maletta and Favre 2003; Mansfield 2004; Kuhn 2009; Chabot and Dorosh 2007).

**Traders**  Traders are households themselves: farmers are traders. Each trader has a desired stock of each crop. Minimally, this corresponds to grains needed to sustain the household for a year. By adjusting this vector, we differentiate between opportunist, small-scale traders and the more specialized opium traffickers and wheat wholesalers. The decision cycle for traders is the following:

1. Monitor a set of markets. Collect available buy and sell offers and determine the most lucrative trade opportunities;
2. Post a buy or sell offer depending on the level of the household stock of crops;
3. The offer consists of a price and a volume. The offer price is based on risk-adjusted, historically smoothed prices for a crop in the markets monitored by the trader. The volume is based on the household budget constraint and a trader’s reluctance to risk too large a portion of the household total wealth in a single trade.

Farmer households adjust risk based on the following factors:

- Transportation costs;
- Risk perceptions: losing crop shipments to bandits or government interdiction and the necessity to pay bribes if caught with illicit crops;
- Urgency to replenish the stock of each crop to the desired level.

Markets clear via a double-auction mechanism that represents all physical shipments. The detailed surveys of trader behavior which have informed our assumptions can be found in (Byrd and Jonglez 2009).

**Government**  The government allocates forces to districts and to poppy eradication and trade interdiction as counternarcotic policies. The probability that a poppy-growing farmer and poppy-shipping trader run into an eradication
and interdiction team respectively depends on the relative frequency of a given illicit activity versus the manpower devoted to policy enforcement. We model endogenous district-level bribery markets where farmers and traders can pay for protection from policy enforcement. In the version of the model presented here, the presence of insurgents does not limit the government in allocating forces to counternarcotic policies. Discussion of counter-narcotic tools available to ISAF, Government of Islamic Republic of Afghanistan and international community is included in (Clemens 2008; Goodhand 2008; Byrd 2008). Interactions between corruption and effectiveness of governance in Afghanistan has been subject of a recent workshop (Starr 2010).

The Effectiveness of Poppy Eradication

Figure 5 presents a dashboard for a poppy eradication scenario. First, we let the system run for 5 years in order for it to stabilize and dispose of the effects of the initial money and crop stocks and artificial prices used to initialize markets. This process takes around 3 years. It starts by farmers overreacting to initial prices and a wave of ferocious trading when all actors try to adjust their target stock levels, recorded on Figures 5(c) and 5(e). The yearly cumulated harvests of different crops are recorded on Figure 5(a).

Details of trading dynamics are recorded in Figures 5(b) and 5(f) where we plot the total volume of crops traded and the number of outstanding buy and sell orders. Oversupplied buy or sell orders create unrealized supply or demand for crops where prices demanded do not match prices offered. While unmatched orders expire after some time specific to each trader, they provide other traders information and influence what orders are placed in the meantime.

Traders and markets activate with daily frequency, the same frequency with which we gather market statistics. Given the spatial heterogeneity of prices and supply, a single large trade may bias prices for the whole country for a day, corresponding to spikes on Figures 5(d) and 5(g) that present average trade prices at different nodes in the supply chain. We record prices at the farm gate, city and international markets for wheat and poppy. International prices correspond to four main clearing markets for opium and heroin in Quetta, Peshawar, Dushanbe and Zabol and to the wheat market in Karachi.

Years 3 and 4 represent the default dynamics of the system before eradication policy is introduced. In-country harvest of wheat stabilizes at 1.2 million metric tons, with around 2 million tons of wheat deficit imported from Pakistan. Unencumbered, farmers grow enough poppy to gather 10000 metric tons of opium. Farm gate wheat prices show annual seasonality and are higher than international prices by some 10 cents per kilogram. Seasonality is much weaker for opium that can be easily stored and is not consumed by farmers. The prices of opium show high differentiation depending on the level of the trader in the hierarchy. Major traffickers capture 80−90% of the whole value of the final product, charging 5 to 10 times more for the same opium equivalent as a farmer can demand.

In addition to differentiation according to market type and season, there is also high spatial heterogeneity in what crops are grown where and traded at what price. On Figure 6, we present the spatial distribution of the properties of trades taking place in a sample summer week in year 4, where it can be seen that without eradication poppy cultivation takes place mostly on the outskirts.

We introduce a massive eradication campaign after year 5. The government can dispatch 5000 specialized eradication teams, each capable of eradicating 2-3 poppy growing farms per week, to 328 districts. The teams are required to eradicate to their full capacity, but the order in which they pick poppy growing farms is arbitrary. In particular, the order can be influenced by bribes that farmers pay to delay eradication. When eradication happens, poppy fields are burned and the stock of dried poppy or opium on the farm is confiscated. Corruption causes eradication teams focus first on smaller and poorer farmers who cannot afford to pay large bribes.

Persistent eradication campaigns alter the volume of actual harvested poppy and lead to a slight increase in local poppy prices after some time. This process incentives farmers to devote more land to cultivating poppy at the expense of wheat, in turn causing the volume of the actual harvested poppy rebound after 8 years and bogging cities down in a creeping inflation of wheat prices. As keeping poppy stocks on farms becomes risky with 1500 metric tons captured each year as shown in Figure 5(b), farmers push poppy stocks to markets faster, inducing minor seasonality in poppy prices. These changes in farmer behaviors along with bribes paid to counternarcotics teams mute the effect of eradicating around 50% of poppy acreage on prices and volumes of poppy traded. The effect of eradication policy are further offset by large stocks of poppy, equivalent to about 2 years of production, accumulated by traders. These stocks slowly deplete, as shown on Figure 5(c), but the campaign would have to continue for much more than 5 years before this cushion is to be exhausted.

Summary

In this paper we presented preliminary results from a country-scale, individual-resolution model of the drug industry in Afghanistan, focusing on farmers’ choices between licit and illicit crops. Investigating the effects of a single eradication policy on the behavior of farmers and traders and dynamics of the whole system served as a proof of concept. Currently, we are working on expanding the set of available interventions, adding alternative governance and performing model validation against historical data.
Figure 5: Country-level outputs from a sample eradication scenario. All timescales are realistic where 1 simulated time unit equals 1 year. After 5 years of unperturbed dynamics, we endow the government with 20000 people to distribute among districts to eradicate poppy.
Figure 6: Spatial distribution of trades taking place in a sample summer week in year 4. The area of a dot is proportional to the logarithm of the volume of crop exchanged. Orange markets have the lowest prices while violet markets have the highest prices.

Acknowledgments

Funding for this work was provided in part by the Center for Social Complexity at George Mason University and by the Office of Naval Research (ONR) grant N00014–08–1–0378. Opinions expressed herein are solely those of the authors, not of George Mason University or the ONR.

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