Integration of Different Data Bodies for Humanitarian Decision Support: *An Example from Mine Action*

Aldo Benini, Charles Conley

Lebanon conducted an agricultural census in 1999. This peaceful scene of a shepherd and his flock is actually near a minefield; and most of the 980 contaminated areas in the country are in or near farms and pastures.

Abstract

Geographic information systems (GIS) are increasingly used as a platform for integrating data from different sources and substantive areas, including in humanitarian action. The challenges of integration are particularly well illustrated by humanitarian mine action. This sector has developed an advanced data model. Its main information management application, tightly integrated with its GIS, is recognized as a de-facto international standard. Also, it has enlarged its strategic and operational decision-making from a purely technical approach to the inclusion of socio-economic criteria.

In practice landmine impact surveys have rarely overcome institutional obstacles to external data acquisition. A positive exception occurred in Lebanon, where the landmine impact survey had access to agricultural census data. The integration of this data was not straightforward. The auxiliary assumptions made, and the technical steps taken, in order to bring it into a common analytic framework, are detailed as a case study in GIS-aided integration.

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Humanitarian emergencies and data integration

Introduction

Geographic information systems (GIS) have the capacity to link data from various sources that are of concern to responders to humanitarian emergencies. Thereby they help improve the quality of decision making. Kaiser et al. 2003 report on an example of practical data and program integration from the 1999-2000 Ethiopian famine; decision-makers were given maps combining food distribution and nutrition survey results. From more tranquil non-emergency settings, Tanser and le Sueur (2002) review GIS applications to public health problems in Africa. From both kinds of environments, one comes away with the impression that applications that truly integrate data from different sources and sectors are rare. High cost and high levels of required expertise deter the wider use of GIS technology. Obviously, the balance between cost and the value added of more and more diverse information is a concern in spatially targeted interventions, in both emergency and development settings.

This paper offers a case study of some of those issues from one humanitarian sector – mine action. Humanitarian mine action is particularly suitable to illustrate such integration issues. On one side, it may well be the sector within humanitarian action that has built the most cogent and internationally recognized data model of that segment of reality which concerns its practitioners. The Information Management System for Mine Action (IMSMA)[1], developed at the Technical University of Zurich, Switzerland, is the sector information management tool recommended by the United Nations (UNMAS 2003), enjoys de-facto recognition as an international standard, and is tightly integrated with a GIS application. This consensus situation contrasts with the diversity of frameworks admitted in other humanitarian sectors such as food security (Jaspars and Shoham 2002).

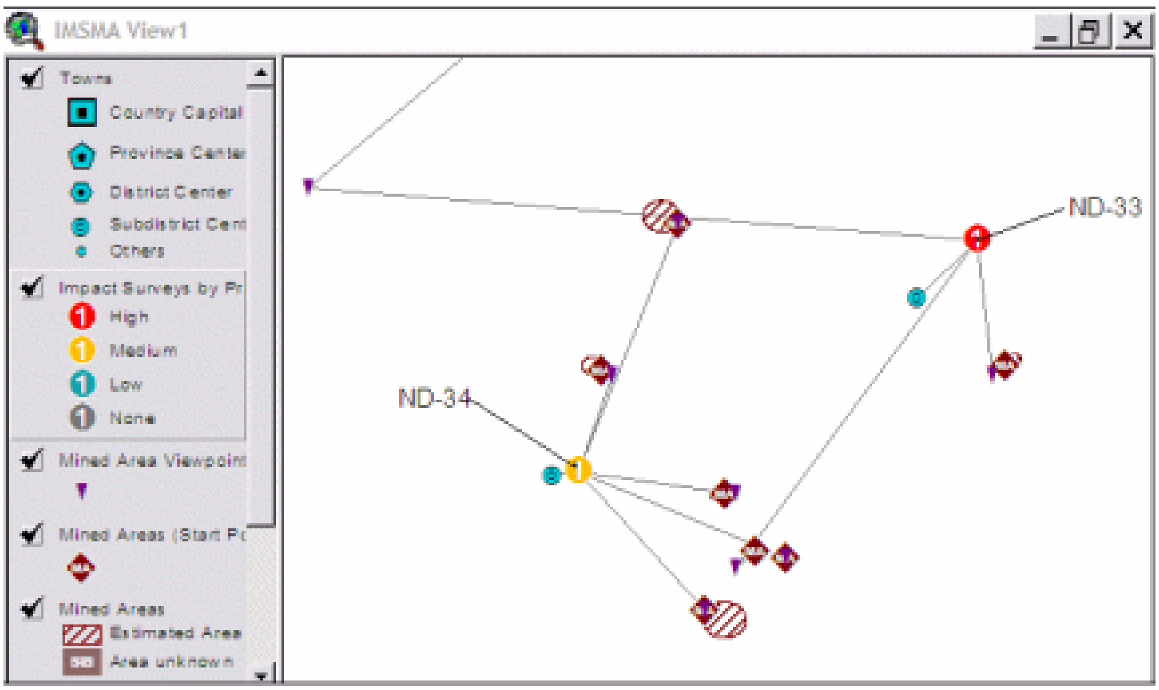
On the other side, information behavior in humanitarian mine action is increasingly rationalized in the light of funding and intersectoral concerns. This $ 240 million-a-year global industry seems to have reached a funding plateau (ICBL (ed.) 2002) that brings out issues of competition and collaboration more sharply. A trickle of cost-benefit studies into mine clearance has appeared (Harris 2000, challenged by Paterson 2001; Harris 2002; Byrd and Gildestad 2002). Cost-saving alternatives to mine clearance, where appropriate, are being discussed (van de Merwe 2002).

Such decisions, however, often call for broader informational bases. This in turn can create fears of spiraling complexity. Linkage with external authorities who do not understand the landmine issue and yet are requested to supply socio-economic data on affected communities is difficult, and the timeliness and

[1] For documentation see http://www.imsma.ethz.ch/en/support/documentationCat.asp.

value of the information is often unpredictable. While the management of standard information from within the mine action sector may no longer be an issue, there are no recognized stopping rules in the search for information that will enhance its decision making with considerations from other sectors. The point of this article is that integrating data from other sources and sectors can indeed produce valuable new insights for policy and decision support. Both the production and the use of such knowledge entail costs before they yield gains, and if the value added is negative or very uncertain, the efforts to acquire external data should remain closely circumscribed.

Figure 1: IMSMA and GIS



The IMSMA GIS provides a direct spatial view of the contents of the database. From the distance and directions reported by members of the community, the relationship between adjacent mined areas becomes immediately apparent in the GIS. In this case, it is likely that a single mined area was reported by two communities (see lower center of figure at right). – Source: Mark Yarmoshuk, Mines Advisory Group.

Plan of the article

The plan of this article is this: We briefly describe the Global Landmine Survey as the current sector response to demands for socio-economically based action priorities and summarize the landmine situation in Lebanon as apparent from a recent impact survey following this format. Used in isolation, the survey data seems to confirm the claim that landmines in Lebanon created "a lack of land for agriculture" (Ahmed 2001). This claim, made by mine action coordinators as well as by many community key informants our survey workers interviewed, is one of the premises for the programs that have cleared large tracts of contaminated land, most of it by commercial firms.

When combined with agricultural census data, the survey produces a qualified tableau of the reality of affected communities – one that may recommend less clearance and more infrastructure investment if there is a choice. We describe the segment of the census data used for this exercise and the GIS operations needed to conform it to the different format of the community survey data. We present a statistical model of the influence that landmine impacts and years since the end of hostilities have on agricultural land use, controlling for the local agro-climatic environment. The results are open to the interpretation that the major problem of landmine-affected communities in Lebanon is not blocked farmland, but the fact that many of them belonged to regions of long-standing hostilities that delayed their transition to a service-oriented local economy or to more capital-intensive forms of agriculture.

While the analysis of integrated data sets can produce fresh insights, integrated models necessitate auxiliary assumptions. We spell out some of ours in order to demonstrate the additional uncertainty as one of the possible downsides of such models. Moreover, the acquisition of outside data, its processing and the dissemination of new results entail costs. We describe some of the hidden costs for mine action. By and large, external data acquisition is unpredictable, posing a kind of “make-or-buy” dilemma. The cooperation with the Agricultural Census Office was akin to “buying”; for contrast, we briefly report on a “make”-experiment in a different country.

We conclude with some reflections on the capacity for data integration and analysis in the wider humanitarian action.

The case study

The Global Landmine Survey

Within humanitarian mine action, progress in integrating information is manifest chiefly by the way the traditional array of survey activities have been reformed. Following the 1997 Ottawa treaty to ban anti-personnel mines, several mine action NGOs and the United Nations Mine Action Service launched the Global Landmine Survey, a multi-country survey project. This initiative has helped to institutionalize the collection of social and economic data, along with contaminated area data, to enhance the overall management of mine action programs worldwide, and in that sense has achieved a paradigm change over the erstwhile purely technical approach to mine clearance[2].

Socio-economic impact surveys have since been completed in several countries and have been certified by the United Nations. More are ongoing or in planning. In

[2] For a comparative perspective with other impact assessment approaches, see Harpviken et al. 2003.

addition to establishing countrywide inventories of communities affected by landmines and/or unexploded ordnance (UXO), the surveys classify communities by the severity of socio-economic impacts. The classification relies on an internationally standardized scoring system that combines, for each affected community, types of munitions, blocked resources as well as recent victims, using weights that national stakeholders may adjust within limits. Technical information at the contaminated-area level and demographic data on incident survivors is also generated and is available to national mine action coordinators through the IMSMA look-up, mapping and reporting facilities. One of the key outcomes is the designation of a small segment among the identified affected communities (usually 10 – 20 percent) as high-impact communities deserving priority attention for technical surveys, clearance, victim assistance and mine risk education.

This information does not come cheap. The impact surveys of Yemen, Chad and Thailand, for example, each cost between $ 1.5 and 2 million. This expense is justified with the gains from more judicious clearance decisions, the effect on donor mobilization and the value of the equipment and skills that the survey implementers leave with national mine action organizations. As one observer of the Yemen survey quipped: *"So, you identified 14 high-impact and 84 medium-impact communities* [out of 592 that the survey detected]. *Was it worth the money?"* Not surprisingly, then, ideas are traded from time to time to make cost savings by substituting existing mine survey information for part of the new impact survey requirements (a concept known as "retrofitting") or to enhance the value of the impact survey by supplementing it with existing external data bodies.

The impact survey in Lebanon, conducted by the British charity Mines Advisory Group in collaboration with the Lebanese National Demining Office between March 2002 and August 2003, went one step in the latter direction. Beside its own data, it used a segment of the national agricultural census data.

This for the first time has allowed for some systematic, although limited, comparison between affected and non-affected communities. The normal impact survey format, while sampling unsuspected communities for false negatives, does not collect substantive information on non-affected ones, and rather focuses on a full census of affected communities. This is a classic case of "selecting on the dependent variable." It has made it difficult to put landmine impact findings in perspective with other issues of reconstruction and development. The further a country finds itself from past conflict, the more critical the inclusion of other substantive data sets because communities have had time to adapt to the contamination.

However, such an ambition was beyond the original intent and design of the Global Landmine Survey, limited, as it was, by financial and design consensus concerns. The extended scope of the Lebanon survey has come as a windfall opportunity when additional data was made available at no extra direct cost.

The landmine situation in Lebanon

Landmines were used extensively in Lebanon's 25-year history of armed conflict; in addition many areas remain polluted with unexploded ordnance (UXO) (Wie 2002, Ahmad 2001). The impact survey identified 306 affected communities in five out of six provinces; only the sixth province, Beirut, has been completely cleared. An estimated 1,087,000 persons live in the affected communities; however, particularly in the large suburban communities of Mount Lebanon, just outside Beirut province, only a fraction of the residents are exposed to the hazard. During the two years prior to the survey, mine and UXO incidents had happened in 54 of the affected communities, killing 11 persons and injuring 97. At an estimated 9.9 new victims per year per 100,000 persons living inside contaminated communities (Spurway et al. 2003), the hazard for the population at risk is at similar level with Yemen (10.8), but considerably lower than, say, in Thailand (34.5) and Chad (59.5). However, victim rates are distributed very unequally across provinces, with the southern provinces and the Bekaa suffering rates several times those reported for the north and Mount Lebanon.

The survey also identified 980 distinct areas of suspected landmine or UXO contamination[3]. Despite the largely urbanized and service character of the Lebanese economy, most of the affected communities complained of blockages of some of their farmland and pasture. Blocked public infrastructure or residential areas were reported only by a small minority of communities, reflecting the fact that most of the remaining contamination is outside built-up areas. Using the standard impact scoring method and a set of weights approved by the National Demining Office, the Impact Survey classified 114 (37 percent) of the 306 affected communities as low-impact communities, 164 (54 percent) as medium-impact of the total, and 28 communities (nine percent) as high-impact.

In May 2000, the Israeli army withdrew from southern Lebanon. Vigorous clearance has since taken place in the formerly occupied area under a program known as "Operations Emirates Solidarity", for which the United Nations, the National Demining Office and the United Arab Emirates operate a joint coordination center in Tyre. By June 2003, most affected communities between the Litani River and the so-called Blue Line, which runs along the southern border, had been cleared. The impact survey revealed a number of problems that are preventing land from being returned to productive uses – most commonly lack of capital to redevelop the land and the paucity of access roads, water and power supplies.

Lebanese agriculture

These obstacles to economic rehabilitation tie in with general conditions of Lebanese agriculture. The war did tremendous damage to this sector. Many of the irrigation systems, storage facilities, farm buildings and roads were either

[3] For language economy, we will only use "landmines" in the rest of this article even tough impact surveys are about communities affected by "landmines and/or UXO."

destroyed or gravely neglected, and vast agricultural areas were abandoned. Particularly in the South, the war uprooted entire communities. As they resurfaced to peaceful conditions, farmers found their incomes eroded between high production costs and competition by cheap produce imported from Syria, Jordan and Egypt. Many left farming. The agricultural environment is one of the reasons why the "government's attempts to return wartime internally displaced people to their villages have largely failed" (Mekdachi 2001: 26). On the other side, recent years have seen large-scale investment in milk production and the rapid growth of high value products like strawberries, watermelon, and exotic fruits.

The 1999 agricultural census

In order to improve the informational basis of its agricultural sector policies, the government of Lebanon, with the help of the UN Food and Agriculture Organization, conducted a census in 1999. Data was collected on a variety of aspects of 194,829 farming entities for the farming year 1997-98. FAO also assisted with spatial data management tools (Latham 2000) resulting in a census database which is, at least in part, geo-referenced.

At the request of the National Demining Office, the Agricultural Census Office shared land use data on 1,633 census tracts[4] with Mines Advisory Group to support the impact survey analysis. Quantities of interest include actively farmed land[5] (251,721 hectares total), irrigated land (as part of the actively used land; 105,381 ha), and abandoned land (54,015 ha)[6]. The census defined abandoned land as parcels that had lain fallow for the five years prior to the census interview. For comparison, the 980 suspected areas recorded by the impact survey cover an estimated 13,748 hectares (experience with technical surveys suggests that the actually contaminated area will be much smaller, but for the use or non-use of land, it is the social perception that matters).

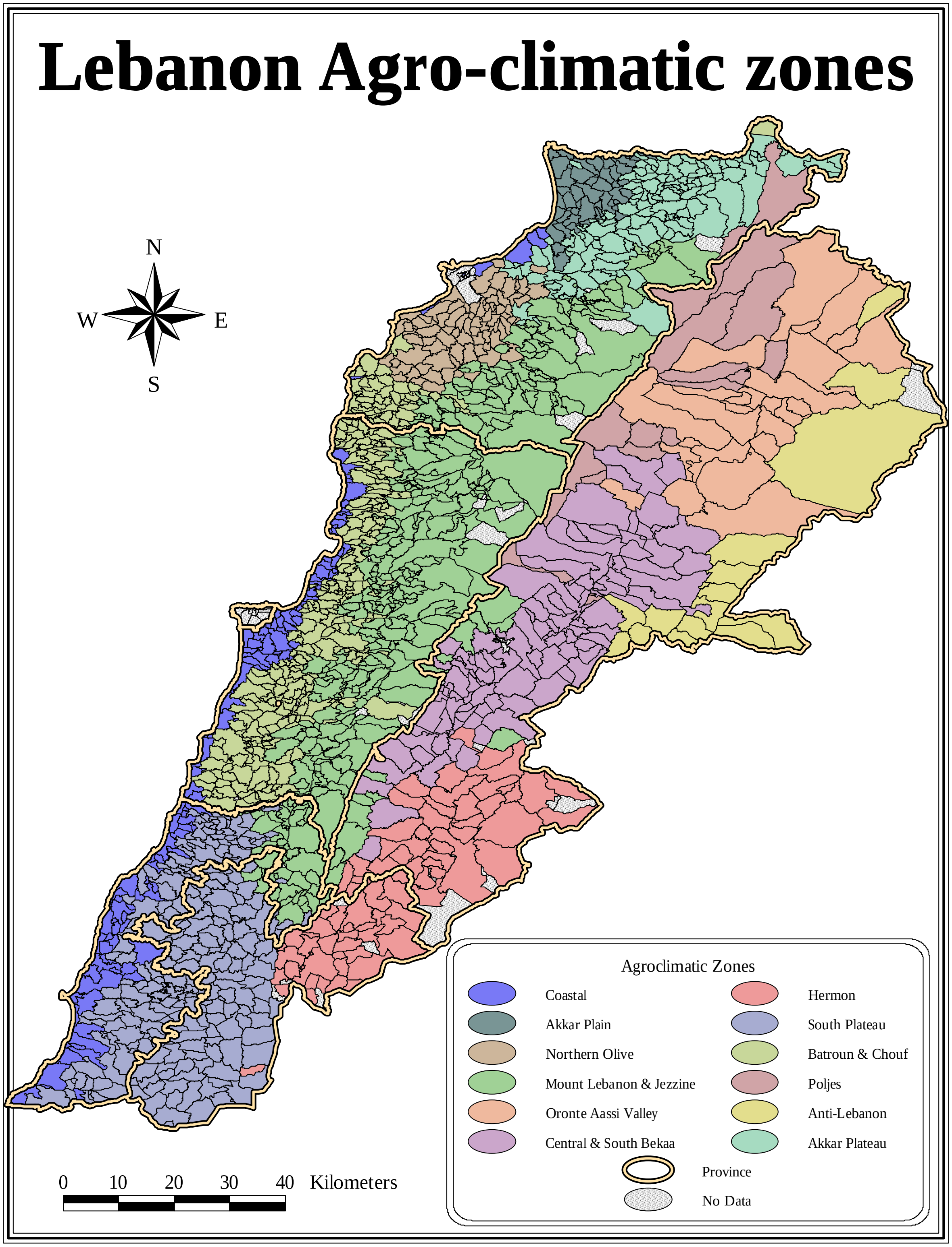
We use the active land use ratio (= 1 – abandoned land / (abandoned + actively used)) as a proxy indicator for the economic viability of local farming. We use the irrigation ratio (= irrigated land / actively used land) as proxy for the capital intensity of farming[7]. These concepts are important because, first, land abandonment is shaped by market forces and is larger than the surfaces taken out by landmines and UXO. Second, a reversal from irrigated to rain-fed farming or even to pastoralism during the war years fits in with the hypothesis that war leads to a shift of economic activity towards forms which "are relatively less sensitive or vulnerable to the disruptions caused by such strife" and, because they are less capital-intensive, "could be associated with a significant reduction in the growth

[4] In the French-language census terminology, the census tracts are called "circonscriptions foncières", which is closer to "cadastral districts".
[5] "Surface utilisée activement" in the census terminology
[6] These figures, calculated from data tables, differ minimally from those published earlier by the census office (Mansoor and Azzabi 2000: 21).
[7] Technically, it would be more appropriate to talk of proportions rather than ratios. But "proportions" not only is linguistically more cumbersome, but also suggests identical denominators, which is not the case for the two quantities in point.

potential" (Deininger 2003: 14, who refers to a more general conjecture by Collier 1999). In other words, these two ratios characterize the agro-economic environment of landmine-affected (and other) communities and ultimately determine the chances for cleared farmland to be returned to profitable use.

One other set of variables from the agricultural census is important for our analysis. The census assigns each tract to one of twelve agro-climatic zones following a typology created by a French geographer in the 1960s. These zones define the natural and traditional environments for particular forms of farming and types of crops.

Figure 2: Agro-climatic zone map



Source: Author Charles Conley

Integrating the census data

This data does not immediately conform to the set of landmine-affected (306) and landmine-free (1,585) communities which together form the set of all communities (1,891) in the government gazetteer[8]. Agricultural census tracts have known areas; in the GIS they are represented by polygons. Communities have known center points; their GIS representations are point coordinates. Each community, therefore, is included in an agricultural census tract, at least in theory; each tract may contain zero, one or several community center points. In practice, a one-to-one relationship exists for approximately half of all tracts and of all communities. Almost a quarter of the tracts contain no community center points. The following table details the inclusion frequency:

Table 1: Communities by agricultural census tracts

Communities per tract	Agricultural census tracts	Communities
1	881	881
2	264	528
3	74	222
4	20	80
5	7	35
6	2	12
7	4	28
8	2	16
14	1	14
15	1	15
Agric census tract information missing		60
No community inside tract	377	
Total	**1,633**	**1,891**

This leaves 1,831 communities whose center points are within some agricultural census tracts. In order for these communities to inherit the agricultural information,

[8] The state of the "Spatial Data Infrastructure" in Lebanon contrasts with that of other landmine-affected countries. Mines Advisory Group did obtain the community gazetteer from a government office, but it was a local commercial company that catalyzed use of common spatial data in the country. As a result, various government departments have strong GIS capabilities. When foreign development projects have conducted surveys, they have effectively partnered with government agencies (as was the case of FAO in this agricultural census). In most other countries where landmine impact surveys were conducted it has been much less frequent for a common spatial referent to exist, and where it did it was usually maintained by foreign bodies. The relatively strong condition of Lebanon's spatial data infrastructure was a significant enabling factor, which is often not present in post-conflict environments. Even in countries such as Iraq where some other infrastructure approaches or meets western standards, the military sensitivity of spatial data has meant that there is no appreciable civilian spatial data maintenance capacity.

a number of simplifying assumptions are needed. We assume that communities have land use and irrigation ratios similar to those of the tracts that contain their center points and that they belong to the same agro-climatic zones as the surrounding tracts. Since the degree of similarity cannot be estimated, we set the ratios for communities equal to those of their surrounding tracts, assuming that, while this procedure does introduce some error, it does not create systematic bias. In tracts that embrace several community center points, all member communities inherit the same ratios and the same agro-climatic zones.

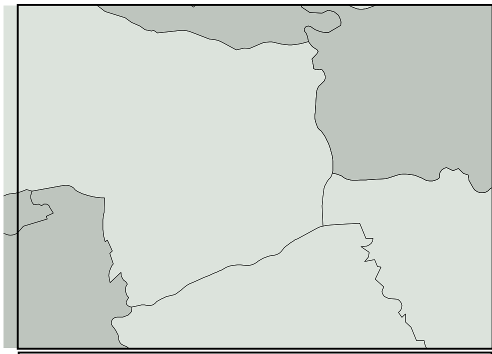
Another auxiliary assumption is needed given the agricultural census reference period. We assume that land use and irrigation ratios in 2003 are similar to those of the farming year 1997-98. This, clearly, is a strong assumption; the Israeli withdrawal took place between those years, and the political environment for Lebanese agriculture changed in part of the country very markedly. This change may bias the estimates in unknown degrees.

The actual mapping of the agricultural tract values to the communities was done in the GIS application, using an operation known as spatial join. We did one further geography-based operation requiring a simplifying assumption: The impact survey established the last year during which each landmine-affected community was exposed to hostilities, ranging from 1976 as the earliest return to peace all the way to 2003 for some communities exposed to very recent shelling. The year of exiting the war is important because it defines the number of years that local communities have enjoyed for economic and social growth unhampered by violence. For non-affected communities, the years are not known. Given the strong local clustering of communities with similar exit years, we assume that non-affected communities returned to peace roughly at the same time as their landmine-affected neighbors. We set the exit year for non-affected communities as the median exit year of all affected communities in their respective districts.

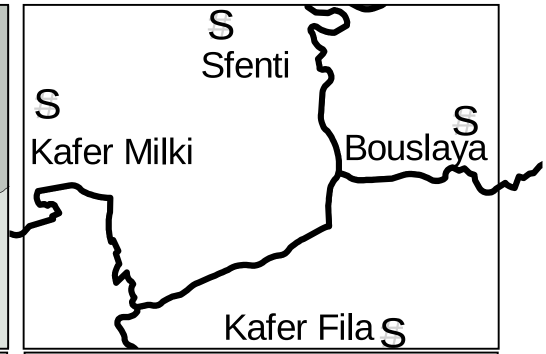
The schematic on the next page graphically expresses some of the relationships between agricultural census tracts, districts and communities and the operations of assigning agricultural census tract and district variables to communities. They set the stage for the combined analysis.

Figure 3: Relationships among census tracts, districts, and communities
[See next page]
[Source: Author Charles Conley]

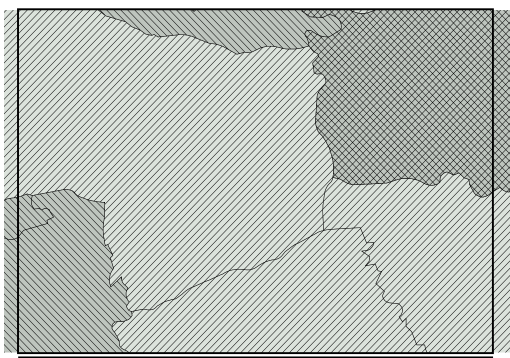
Agricultural Census | **Landmine Impact Survey**



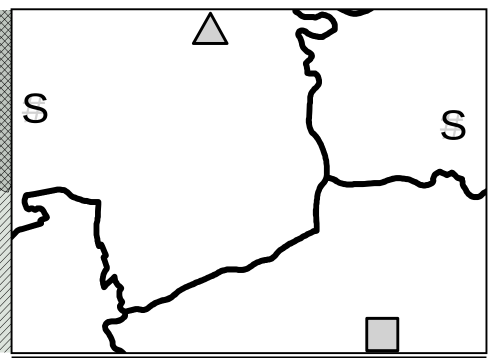
1a. Agro-climatic zones are filled with agricultural census tracts.



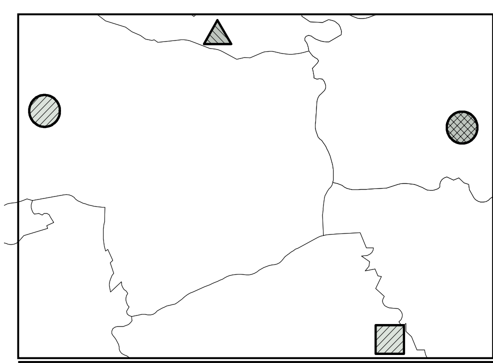
2a. Districts are filled with communities represented by point coordinates.



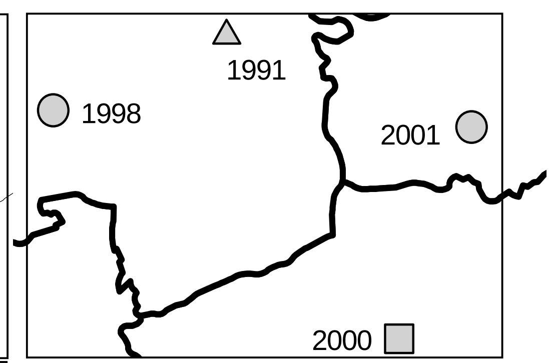
1b. Tracts have different combinations of land use and irrigation ratios.



2b. Communities have different landmine and UXO impacts.



1c. Communities inherit agricultural indicators from tracts surrounding them.



2c. Communities take years when local hostilities ended from the survey or inherit the district's median year.

Land use and irrigation in response to landmines and exit-from-war years

Initially, believing that landmines indeed caused a lack of farm land, and more so in the southern regions that had exited the war late, we anticipated that more severe landmine impacts and shorter recovery periods (i.e. later exit from war) would both work to depress agricultural ratios. We anticipated these negative effects on active land use (proxy for the viability of local agriculture) as well as on irrigation (proxy for capital intensity and growth potential). In terms of a regression model, we expected four significantly negative coefficients (land use and irrigation ratios each on impact score and end-year of hostilities) after controlling for the natural environment influences via the agro-climatic zones.

Readers not interested in the statistical approach may skip the remainder of this section and go directly to the next. The fact that this integrated data model calls for less well known statistical procedures, however, is of interest in itself as a cost element in such an approach and will be discussed later[9].

Descriptives for the two ratios of interest – our dependent variables – and for landmine impact scores and exit-from-war years are given in the appendix, together with the distribution of communities over the agro-climatic zones. Both land use and irrigation ratios are very non-normally distributed. This rules out OLS regression. Instead, we partition each ratio distribution into four levels and use ordered logit regression ("ologit" in STATA 2003). Zero gives the first level; non-zeros are divided into three equal quantiles. Ranges and frequencies are also given in the appendix. In addition, ordinary two-outcome logit is used for the highest vs. all other levels. While the first procedure estimates coefficients such as to best predict ratio levels, the second identifies the factors that send communities up to the top rung of agricultural vibrancy. For both procedures, the agricultural census tract ID is used as the cluster ID because ratios for communities within a tract are set identical.

Controlling for the natural environment, we use 7 out of 12 agro-climatic zones as dichotomous variables. The union of the other five forms the reference category. This is necessary because of the way affected communities are distributed across the twelve zones. Importantly, each of the three zones bordering on Israel (Coastal Plain, Hermon, and South Plateau) is included as its own variable; and each intersects with clusters of widely different exit-year communities. Otherwise the

[9] We exclude from our model 60 communities in southern Lebanon whose territories lie entirely inside the so-called Operation Emirates Solidarity (OES) areas #1 – 4 (The communities of Beirut province were already excluded because the agricultural census was not conducted there). Most of these had been cleared prior to the survey, and although the impact survey was later extended to 17 others not yet completely free by 1 June 2003, we have no way of estimating the severity of the earlier impacts.

models would founder on collinearity or would be seen as irrelevant given the persistence of this particular conflict.

The results are summarized in the following table. Coefficients and p-values are displayed, Confidence intervals are left out for space reasons. P-values smaller than .10 are grayed.

Table 2: Regression results

	Active land use				Irrigation intensity			
	Four-level ologit		Highest level vs. others logit		Four-level ologit		Highest level vs. others logit	
N	1513		1513		1511		1511	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Explanatory variables:								
Landmine impact score	-0.02	.224	-0.07	.007	-0.03	.117	-0.06	.030
Year conflict ended	0.04	.029	0.05	.012	-0.08	< .001	-0.08	< .001
Controls: Agro-climatic zones								
#01: Coastal region	-0.26	.447	-0.47	.224	1.90	< .001	1.81	< .001
#03: Northern olive zone	0.05	.881	-0.12	.740	-2.54	< .001	-3.68	< .001
#04: Mount Lebanon and Jezzine	-2.37	< .001	-2.43	< .001	-0.20	.451	-0.13	.660
#05: Oronte Aassi Valley	-1.70	.001	-1.74	.013	-0.96	.147	-0.83	.171
#07: Hermon	-2.25	< .001	-2.11	< .001	-2.51	< .001	-2.10	< .001
#08: South Plateau	-1.75	< .001	-1.87	< .001	-0.86	.012	-1.19	.010
#09: Batroun and Chouf	-1.99	< .001	-2.08	< .001	-0.86	.001	-0.83	.009
Auxiliary quantities:								
Constant [logit]			-105.24	.012			151.51	< .001
_cut1 [ologit]	62.41				-168.46			
_cut2 [ologit]	68.62				-165.40			
_cut3 [ologit]	70.28				-163.61			
Fit:								
Prob (_score = 0 & _year = 0)		.063		.004		< .0001		.0001
Pseudo-R2		.09		.13		.14		.19

Findings and implications

The key quantities for this section are the coefficients and p-values for the explanatory variables in the last table. They express a mixture of the trivial and the surprising.

As expected, higher landmine impacts tend to depress both active farm land use and irrigation intensity – all the coefficients for the impact score are negative. However, they are so at a statistically significant level (i.e., $p < .10$) only for the question whether a community should be at the highest level of land use and irrigation[10] or not. In other words, once a community is using its farmland and irrigating it below the highest levels, landmine impacts no longer have a statistically significant effect of depressing agricultural ratios any further. Landmines must be particularly badly interfering with the local farm economy in communities that, if unaffected, would be pre-disposed (e.g. by their agro-climatic setting) to use farmland and irrigation to very high levels. Ahmed's observation that landmines created a lack of farmland (see page 6) is not tenable as an across-the-board claim.

By contrast, the year when the local communities exited the war has a statistically significant influence on the ratios in all the models. Communities which exited earlier and thus have enjoyed longer recovery periods tend to irrigate more of their farmland. That is common sense and is expected also under the Collier-Deininger hypothesis (page 11) that longer strife promotes less capital-intensive production.

The real surprise is in the effect that exit from war has on active farm land use. Contrary to all expectation, and across all levels, communities that exited the war late tend to be at *higher* active land use levels (the coefficient is + 0.04, i.e. the odds of being at higher versus lower levels are about four percent higher for each added year; this is significant at $p = .03$). The causal mechanism can only be conjectured – the communities in the South that were in the conflict zone until the Israeli withdrawal in 2000 have had less time to participate in the transition from an agricultural to a service-dominated economy. Their residents, for lack of investment and jobs, may have remained stuck in low-income farming livelihoods. If correct, this interpretation would also imply that obstacles other than landmines are more important in the context of recovery and growth – the coefficient for the effect on irrigation, which we take as a proxy for capital investment, is stronger for exit years than for landmine impacts. What these obstacles are this data does not tell us, but more investment in landmine clearance in communities that came out of hostilities recently may not remove them since they already tend to use more of their land while irrigating less of it.

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[10] A community is at the highest level of its active farm land use if the land use ratio of the surrounding census tract is higher than 93.2 percent. It is at the highest level of irrigation intensity if more than 50.8 percent of the actively used farmland in the tract is under irrigation. The levels were set by us for computational convenience. For a complete definition of the four levels, see page 28.

An illustration: Al Wazani village

The hypothesis of a livelihood trap – communities that are contaminated yet keep using a high portion of their land for low-value agriculture for lack of alternatives – is more understandable in the light of a mini-case study. The village of Al Wazani, in Marjeyoun district of Nabatiyah province, is instructive for this purpose[11].

This is a small village close to the border with Israel. It was occupied by the Israeli armed forces from 1978 to 2000. Al Wazani's registered population is 1,200, but the number of actual inhabitants is presently around 300 (50 households). Most of the original residents who fled in 1978 have not returned.

The families earn their living by raising livestock. Most also grow some crops, predominantly wheat, which they use for cattle feed and domestic consumption only. Some supplement their incomes with construction work. The village head owns and operates a cattle feed unit.

The community spreads over an estimated five square kilometers. This area is punctuated by three distinct mined areas. Two of these areas are relatively small, but the third area extends to the several neighboring villages and to estates of the Maronite church, with a total estimated 24 sq km of insecure land.

The community is obliged to graze animals in contaminated areas for lack of other suitable pasture. The mines in the largest area are chiefly anti-tank mines; the lighter and less valuable goats and sheep, rather than cows are taken there; nevertheless animal losses are frequent. Generally, people know how to avoid the mines. In the two years prior to the survey, only two persons came to harm; both were outsiders.

In order to cultivate wheat, the villagers rent land in nearby villages. They compete with big landowners from the Bekaa valley; rents have gone up. At the same time, the prices of wool and sheep milk are depressed. So are wages in construction, which have fallen by half amid the influx of Syrian workers. In 2001, the government opened a dairy factory in the nearby town of Al Khiam. This factory has since closed down. People of Al Wazani hope it will be re-opened, and that they will benefit both for the marketing of produce and for employment.

The surrounding agricultural census tract record showed 92 percent active land use but no irrigated land. Al Wazani may be typical of communities that came out of hostilities late, have low capital intensity in their farm operations, but have a surprisingly high active land use. For many people, poverty at home and emigration seem to be the only options. The mines are making things worse; at the same time, people have learned to co-exist with them.

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[11] Source: Spurway et al. 2003: 60 – 66; data tables (where the village name is rendered as "Al Kazzani")

Costs and benefits for mine action

Comparison with non-affected communities

The inclusion of agricultural census data achieved two benefits beyond the normal brief of a country landmine impact survey.

For the first time, some substantive comparison is made between landmine-affected and landmine-free communities. Previous surveys were able to contrast affected and non-affected communities only by geographic location; in other words, they identified clusters of affected communities and, conversely, clusters of non-affected ones about which mine action practitioners would not have to worry. By including non-affected communities, the analysis of landmine problems can be placed in a larger reconstruction and development perspective.

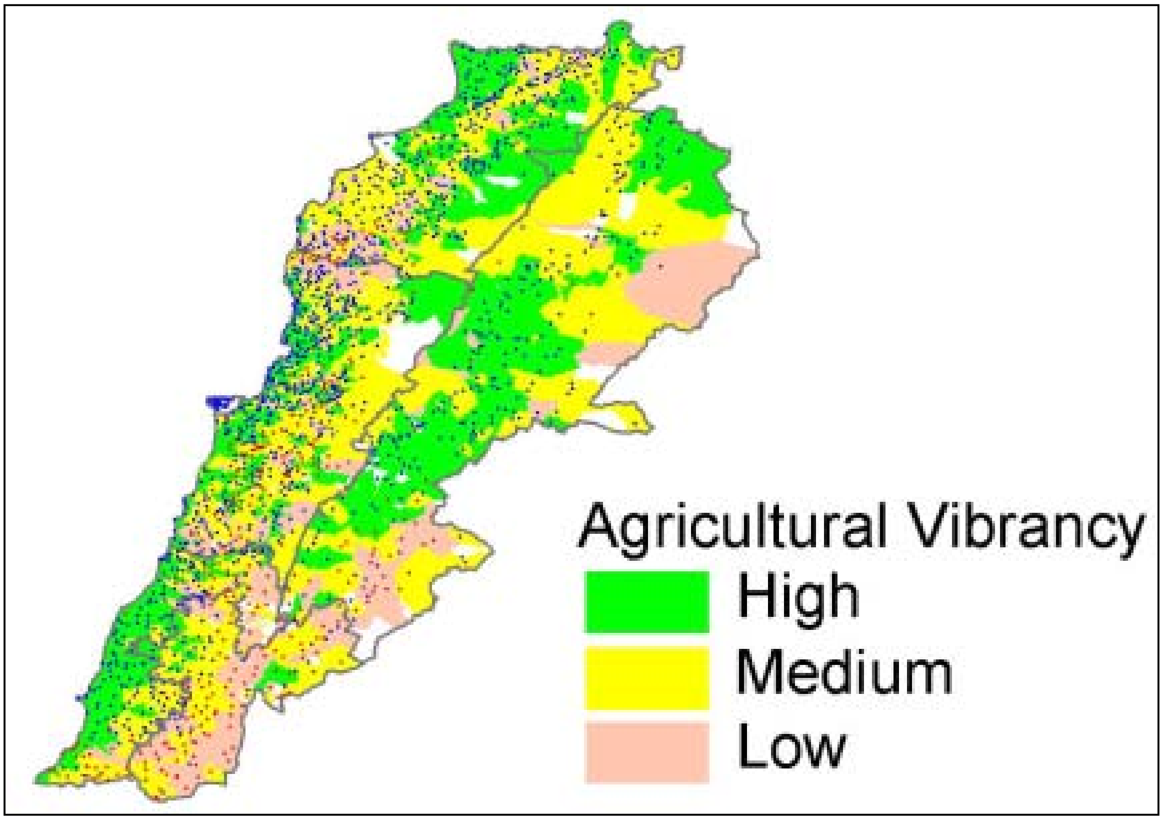
Detection of latent structures

The use of models integrating data from different sources also facilitates the discovery of latent structures and of unexpected connections that may take us beyond “mine action as we know it”. For example, “active land use” and “irrigation intensity”, imported from the agricultural census, are concepts that point also to the future uses of contaminated land that has been cleared or awaits clearance. Chances for profitable uses are determined by factors that are hardly measurable within the traditional, self-contained landmine impact survey.

Not every significant variable that integrated models identify can be translated straightaway into a policy variable. In statistical parlance, we may discover additional significant co-variates, but may not always be in the position to produce good predictions. In practical terms, we do know that the local agricultural environment determines whether cleared land will go back to active cropping, but we cannot simply plug into some equation the values of a local community and venture a forecast concerning the local clearance effects. What the discovery of such factors means is that in local assessments they should be carefully investigated and considered in the practical decisions.

In order to help the Lebanon impact survey stake-holders to assimilate such considerations, Mines Advisory Group improvised a map overlaying zones of differing agricultural vibrancy with the contamination status of local communities.

Figure 4: Agricultural vibrancy zones - map for stakeholders



Source: Aldo Benini, VVAF; Mark Yarmoshuk, Richard Shdeed, Mines Advisory Group

This map was shown in two meetings in May 2003 in which preliminary survey findings were shared with the stakeholders[12]. It uses a simple descriptive classification based on the agricultural census tracts. A tract is considered highly vibrant if both active land use and irrigation ratios are above the respective medians for all tracts. Medium vibrant tracts have one of the ratios above the median, and in low-vibrancy tracts both ratios are below the median. The vibrancy zones are overlaid with red dots for landmine-affected communities and with blue dots for landmine-free communities.

The outcome of the meetings was that Mines Advisory Group was invited to extend its impact survey to an area in southern Lebanon from which it had originally been exempted because of the advanced stage of clearance there. This region has been cleared chiefly by commercial demining firms, who were not party to the survey discussions, and who, for obvious reasons, have no incentive to foster debate on alternatives to universal clearance. In August 2003, however, the director of the National Demining Office showed one of us a map of demining work

[12] It is reproduced here as used in the PowerPoint show for the meetings, admittedly in less than well-edited format. Red dots stand for landmine-affected communities, blue dots for communities known or assumed to be non-affected.

underway all along the area designated for the Litani River pipeline project (Spurway 2003). This indicated that clearance in the South was already focusing more strongly on areas critical to the rehabilitation of major irrigation infrastructure.

Against those achievements, costs have to be taken into account. They are of two kinds, and each can be considerable.

The hidden cost of acquiring outside data

The search for relevant external socio-economic data bodies was arduous, in Lebanon as much as in other countries with landmine impact surveys. It absorbed a small, but not negligible part of the survey management's time. Worse, it introduced uncertainty as to what data to realistically expect in useful time, how far to push negotiations with apparent holders of relevant data, and what to gain for the landmine survey users if the data did come forth.

The experience of other landmine impact surveys has been similar, with some positive exceptions. In countries with authoritarian polities or self-assertive bureaucracies, the administrative culture generally discourages and obstructs data sharing. Access to outside data is easier in two types of other situations: in very poor countries, and in the wake of military interventions. In Yemen and Chad, for example, the community of researchers and of GIS users was small; moreover, both expatriate and national staff of the impact surveys used their closely-knit informal networks to obtain potentially useful data sets. In Kosovo, data bartering between the mine action coordination center, other UN offices, NATO units and consultancy firms was brisk; the mine action information managers had a strong hand because others had a safety incentive in cultivating them.

These institutional factors are not merely tangential to data integration concerns in humanitarian decision making. They shorten or lengthen the windows during which producers of information bases can usefully search for, acquire, process, and disseminate the implications of, external data.

Weak social science base

Second, the social science used in humanitarian landmine action is still weak. Although the socio-economic impact scoring has been elevated to an international standard, validation studies are rudimentary. The community of practitioners is still digesting the change from a purely technical approach to mine clearance to the inclusion of socio-economic criteria for prioritization. The IMSMA data model may be very advanced in data management terms, but the connect between community variables and policy is tenuous. Cost-benefit studies have produced wildly divergent rates of return to clearance that forbid universal conclusions. Patently, the studies that have come out of this sector are trailing far behind the validity and depth for which epidemiologically inspired public health or econometrically tested development debates are noted.

In this situation, surveys, studies and decision-support systems will not likely be welcomed when they expand their scope beyond consensus domains. Integration of outside data almost automatically involves some expansion of scope and perspectives if only because the meaning of the added variables has to be assimilated. As our use of agricultural census data demonstrates, integration may depend on auxiliary assumptions, some of which may be questionable. Also, we used statistical procedures that are not intuitive for average information users in mine action coordination centers. Fragile assumptions and exotic models feed the "plague of uncertainties" (Bressers and Rosenbaum 2000: 523) that bedevils policy and decision making, and of which landmine-stricken countries like Lebanon have more than enough.

"Make versus buy"

The cost issue forces "make vs. buy"-decisions on landmine impact surveys, just as much as it does on other types of information systems[13]. In most countries, "buying" outside data may not be a practical option. As a consequence, landmine impact survey designs cannot systematically incorporate variables for which data needs to be acquired from commercial markets or from different sector agencies. If it is available, designs and analysis plans can be modified ad-hoc, but this may entail, as discussed, hidden costs of various kinds even when the external data carries little direct cost.

The "make" option is more supportive of survey design changes and therefore eventually of innovation in the decision support system into which the survey data will be fed. If the landmine impact survey organization collects the additional data itself, completeness and integration issues may be milder, but this data comes at a direct cost. It may be affordable only on a highly selective basis. Such a "make" experiment is going on as part of the current impact survey in Bosnia and Herzegovina (Paterson et al. 2003). The classification that the impact survey provides on the basis of the estimated severity of impacts on local communities is used as a primary filter. Communities classified as high-impact – and only these – are revisited by survey teams skilled in economic assessment and technical aspects of mine clearance. They investigate the costs and benefits of clearing individual mined areas there, collecting for this purpose a much broader variety of information than the initial impact survey considers. This results in a community mine action plan. Communities with lesser impacts do not receive this attention, and the savings in cost and time are translated into accelerated and well-informed clearance projects for the benefit of the most deserving.

[13] There is a considerable literature on outsourcing of commercial information systems (e.g., Hirschheim et al. 2002), but we have not come across anything in social research or humanitarian *information* activities (as opposed to subcontracting the *delivery* of humanitarian relief, a phenomenon well documented in the field of donor – non-governmental organization relationships.

Data integration in the wider field of humanitarian action

We started out from a reference to GIS applications in humanitarian emergencies. We then provided a case study of how data from different sources can be integrated in a GIS project and demonstrated that the analysis of an integrated data set can produce non-trivial results. However, GIS is not the only feasible integration platform. Other research programs – e.g. the UNDP and World Bank-driven Living Standards Measurement Surveys (LSMS; see, for many others, Grosh 2000) as a tool for poverty alleviation strategies – have developed their strengths in joining data from different points of time – panel survey analysis is their best workhorse. Spatial covariates may be used, but are not fundamental for this kind of research. In methodological research, however, convergences between spatial and temporal models are growing stronger (Elhorst 2001, Anselin 2001); and some of this is being translated into applied research, such as in nature conservation. Vance and Geoghegan (2002), for example, combine satellite imagery from a 12-year period with data from a later household survey. Their integrated model allows them to estimate the varying risk of forest destruction over time and the factors that determine it[14].

It is doubtful that humanitarian action can attain this level of data integration. The very nature of emergencies may militate against it. In backward view, emergencies disrupt institutional continuity, and previous information holdings may be lost or irrelevant. As a result, analysts and decision-makers may be limited mostly to cross-sectional data. In forward view, if the emergency is successfully resolved, humanitarian programs fold or are transferred to different institutions, which may not be able or willing to maintain and update databases from the emergency period. During the emergency, many information needs are short-term and one-time, and call for look-up facilities and basic summaries rather than in-depth analysis. Security concerns, too, privilege the spatial perspective over the temporal – typically the “where” of a threat is easier to assess than the “when”.

Recent institutional changes are making that less true. In regions of endemic complex emergencies, the international relief community has created centers with a mandate to collect and integrate basic data, again in a GIS framework. In all three recent Western military theaters – Kosovo, Afghanistan, Iraq – UN-led Humanitarian Information Centers supplied the relief community and the media with maps of diverse thematic content, and for Iraq a clearly pro-active approach to humanitarian information management was taken.

However, in countries with persistent emergencies or those farther advanced in post-war rehabilitation (such as Lebanon), the analytical demands on humanitarian information systems will grow. Maxwell and Watkins (2003) outline the logical components and linkages for such systems in complex emergencies. They detail seven requisite components, from baseline assessments to program

[14] For a well documented data model in nature conservation, see NatureServe (2003).

evaluation. It is an open question whether the needed analytical capacities are in step with the transfer of GIS technology and the aggressive acquisition of data. Even if only some of the components are to be meaningfully linked, the demands for data integration will be taxing.

Our case study illustrates challenges, costs and benefits of such an exercise. Despite the relatively benign environment in which it took place, they were far from trivial. As in the practical applications reviewed by Kaiser et al. and Tanser et al. that we cited in the opening paragraph, GIS was the key technology for us. However, in order to harvest benefits from GIS-enabled data integration, we borrowed tools from other fields, chiefly from analytical statistics. GIS is a wonderful integration tool, but it does not by itself expose, let alone resolve, the fragility of underlying assumptions or institutional frameworks. Humanitarian information management still needs to build a research program akin with those that gave wings to public health, poverty alleviation or nature conservation. Solutions for data integration challenges will be a big part of it.

Acknowledgements

The authors are grateful to the following persons; without their help we would not have been able to do this analysis.

At the National Demining Office in Beirut, Brigadier-General George Massaad initiated the formal request for a copy of the agricultural census data. Major Marwan Sakr liaised with the Agricultural Census Office.

At the Agricultural Census Office, Mr. Ezzedine Azzabi, Mr. Elie Choueiry, Mrs. Mantoura Yammine, and Mr. Hammoud Bou-Diab provided data and advice.

Ms Kim Spurway, Mr. Mark Yarmoshuk, Mr. Richard Shdeed, Mines Advisory Group negotiated access to the agricultural census data and co-authored a related working paper with us.

Dr. Larry Moulton, Johns Hopkins School of Public Health, Baltimore, provided advice on regression models.

Mr. Mike Kendellen, Survey Action Center, Takoma Park, provided documentation on the “Task Assessment & Planning” tool used in Bosnia and Herzegovina.

Mr. Dan Zimble, ESRI, Vienna, helped with nature conservation links.

The material for the Al Wazani case study, condensed on page 21, was collected by Ms Lina Mikdashi, Ms Nedaa Zein, MAG Lebanon, and Dr. Irshad Shaikh, VVAF.

Appendix: Statistical tables

Table 3: Descriptives of dependent and explanatory variables

Descriptive statistics are given for four important variables. These variables are now all at the community level. Landmine impact scores are originally community-level; non-affected communities have a score of zero. Exit-from-war years were collected for landmine-affected communities and were estimated for non-affected ones as the median year of the affected ones in the same district, as mentioned in the main body. Land use and irrigation ratios were inherited from the surrounding agricultural census tracts, as also mentioned.

		Active land use ratio	Irrigation ratio	Landmine impact score	Year local hostilities ended
N	Valid	1737	1735	1797	1566
	Missing	60	62	0	231
Mean		0.803	0.362	1.026	1990.3
Std. Deviation		0.194	0.330	2.630	5.758
Skewness		-1.154	0.598	2.785	0.285
Kurtosis		0.869	-1.059	7.905	-0.503
Minimum		0	0	0	1976
Maximum		1	1	19	2003
Percentiles	25	0.695	0.063	0	1987.5
	50	0.861	0.252	0	1990.0
	75	0.965	0.649	0	1991.5

Note the considerable number of communities with missing values for the year when local hostilities ended. This gap is primarily responsible for the lower number of cases in the regression models.

Table 4: Levels of active land use and irrigation intensity

Four levels are defined each for the land use and irrigation ratio distributions, in preparation of the ordinal logit regression estimates:

Active land use ratio:

Level	Range	Communities	Percent
1	x = 0	2	0.11
2	0 < x =< 0.758	598	33.28
3	0.758 < x =< 0.932	600	33.39
4	0.932 < x =< 1	597	33.22
	Total	1797	100.00

Irrigation ratio:

Level	Range	Communities	Percent
1	x = 0	67	3.73
2	0 < x =< 0.114	576	32.09
3	0.114 < x =< 0.508	577	32.14
4	0.508 < x =< 1	575	32.03
	Total	1795	100.00

Frequencies in the non-zero categories differ slightly because of ties.

Table 5: Communities by agro-climatic zone and landmine status

Census#	Agro-climatic zone Name	Non-affected	Affected	Total
#01	Coastal region	164	8	172
#02	Akkar Plain	46	0	46
#03	Northern olive zone	77	4	81
#04	Mount Lebanon and Jezzine	359	84	443
#05	Oronte Aassi Valley	47	3	50
#06	Central and South Bekaa	115	4	119
#07	Hermon (Hasbaya and Marjeyoun)	35	51	86
#08	South Plateau	160	51	211
#09	Batroun and Chouf	286	78	364
#10	Poljes region	46	2	48
#11	Anti-Lebanon	14	0	14
#12	Akkar Plateau	137	0	137
Total		1,486	285	1,771

This table excludes the 60 communities that fall totally inside the zone in southern Lebanon from which the survey was exemped originally (OES areas #1 – 4). N = 1,771 is smaller than the number of communities in the preceding table (1,797) because of some communities that lie inside tracts for which the census did not define an agro-climatic zone.

Zones #2, 6 and 10 – 12 have no or few affected communities. We use their union as the reference category in regression models that use the other zones as dichotomous covariates.

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Author addresses

Aldo A. Benini (Corresponding author)

Vietnam Veterans of America Foundation
1725 Eye Street, NW, Fourth Floor
Washington DC 20006-2412, USA
Phone: 202 557-7573
Fax: 202 483-9312
abenini@vi.org

Charles E. Conley

Vietnam Veterans of America Foundation
1725 Eye Street, NW, Fourth Floor
Washington DC 20006-2412, USA
Phone: 202 557-7569
Fax: 202 483-9312
cconley@vi.org