

# Laying a Foundation for Peace? A Quantitative Impact Evaluation of the United Nations Operation in Cote d'Ivoire

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## *TECHNICAL APPENDIX*

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## I. Introduction

This technical appendix provides details on the data and methods used in our quantitative evaluation of UNOCI's impact. We provide details on the sampling design, weighting adjustment methods used to account for potential non-response and non-coverage problems, the characteristics of the raw and adjusted sample, and methods used in the analysis.

## II. Sampling Design

The sample design was intended to achieve equal probability of selection at the level of households for civilians, and at the level of individuals (or perhaps units) for former civil war combatants. We succeeded in this regard with respect to civilian households. The combatants sample however was seriously compromised by instability in the country at the time of surveying as well as non-cooperation from relevant authorities. Details are below.

### A. Target and Survey Populations

Considering the objectives of the survey, the *target population* of the survey includes all individuals potentially exposed to the conflict and ONUCI operations within Cote d'Ivoire. Practical limitations prevent the *survey population* from including all members of this target population. It is necessary to be clear about whom is excluded as a result of such limitations. The following provides those details:

**Adults** The survey population was restricted to adults aged 15 years or older. This corresponds to definitions of adulthood operative in Cote d'Ivoire.<sup>1</sup> As of summer 2008, individuals aged 15 years and older constituted 10,945,110 of the the population of 18,373,060 (i.e. 59.6%).<sup>2</sup>

**Current residents** The survey population was restricted to current residents of Cote d'Ivoire. UNHCR currently reports to be assisting 22,232 refugees whose origin is Cote d'Ivoire (UNHCR 2008). This figure includes both adults and children. UNHCR reports minors proportions ranging anywhere from about 1/3 to 2/3 across Africa, thus a rough guess at the number of refugees of Cote d'Ivoire origin that fall within the target population is between 7,400 and 15,000. Based on an adult population estimate of 10,945,110, this implies that a within-country sample frame would fail to cover between 0.07% and 0.14% of the target population. We consider such coverage problems to be negligible.

A distinction was made between "combatants," who were members of either the national army (FANCI) or one of the major rebel groups during the war, and "civilians," who were members of neither the army nor a rebel group during the war. As we describe below, we were able to obtain a representative civilian sample, but the combatant sample was severely limited.

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<sup>1</sup>In Cote d'Ivoire, the legal age of majority (i.e. the age at which one is considered an adult before the law) is 21, the age of sexual consent under the law is 15, and the basic minimum working age set by the Ministry of Labor is 14. U.S. Department of Labor Bureau of International Labor Affairs (<http://www.dol.gov/ilab/media/reports/iclp/sweat/cote.htm>), UNICEF ([http://www.unicef.org/knowyourrights/know\\_oldenough.html](http://www.unicef.org/knowyourrights/know_oldenough.html)), and Wikipedia, "Age of Majority" ([http://en.wikipedia.org/wiki/Age\\_of\\_majority](http://en.wikipedia.org/wiki/Age_of_majority)). All were accessed June 18, 2008.

<sup>2</sup>CIA World Factbook entry on Cote d'Ivoire, available at <https://www.cia.gov/library/publications/the-world-factbook/print/iv.html>. Accessed June 18, 2008.

## B. Sample Selection

The sample includes 1,206 individuals who were not combatants during the civil war (i.e. “civilians”). The civilian sample was drawn using geographic strata defined by Cote d’Ivoire’s *Institut National de Statistiques* (INS) (see INS et al 2006, p. 183). We recombined INS’s 21 regional strata into 4 regions—Center, North, West, and South—plus (i) the city of Abidjan and (ii) localities in boundaries of the former Confidence Zone. Each of the 4 regional strata were divided into urban and rural substrata. This yielded 10 geographic strata for the civilian sample. We used INS’s data on population totals and distributions (estimates based on 2002 population enumeration) to allocate clusters across strata to approximate a proportional stratification. We used INS’s *districts de recensement* (DRs) as our primary sampling unit (PSU). DRs were sampled from INS’s database within each of the 10 strata with a probability proportional to size selection mechanism. We randomly selected a total of 68 DRs. Each DR was mapped by INS’s cartographic section. Fixed numbers of households were then chosen from within each DR (18 on average, although the fixed allocation was adjusted to ensure that deviations from equal probabilities of selection were not too large). Households were selected using one of two techniques: (i) where possible, physical identification and mapping of all the households in a DR before a random selection of households was taken; and (ii) when population density made such mapping impractical, enumerators were positioned in random starting locations, pointed in a randomly selected direction, and then selected households at a specified interval. Within households, a “Kish grid” and random number table were used to select subjects for interview.

The sample also includes 253 combatants, all of whom are members or former members of the FAFN. We were not given access to members of FANCI for surveying. Sampling of combatants was complicated by the fact that we had no access to detailed information on their distribution over locations in Cote d’Ivoire. We planned to use state-of-the art respondent-driven sampling methods that have been developed in the United States to sample hard-to-find populations.<sup>3</sup> However, ongoing political unrest associated with the demobilization process preventing us from implementing this plan. The combatant sample is thus a “convenience sample,” drawn from localities in Man, Bouake, and where the situation allowed us to work.

## III. Implementation

### A. Implementation Team

The local population survey was implemented by Eric Mvukiyehe and Cyrus Samii, both affiliated with the Department of Political Science at Columbia University, in the summer of 2008. They worked in partnership with the Ligue Ivoirien des Droits de l’Homme (LIDHO)—a local Human Rights organization with representation across the national territory. The researchers were supported by a locally-recruited team of 20 enumerators and a Project Coordinator. The enumerators went through an intensive week of training in human subjects issues and survey techniques before being deployed to the field for 21 days to carry out the actual survey. Enumerators were organized into four teams of 5 members each (4 regular enumerators and 1 supervisor). To make things more manageable logistically, we grouped the 68 or so localities sampled into four operational sectors and each sector was assigned to one team. Team 1 conducted surveys in the center-West (or the Man areas), which encompasses the localities of Man, Biankouman, Logouale, Zeo, Zou, Douekoue,

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<sup>3</sup>Refer to the documentation at [www.respondentdrivensampling.org](http://www.respondentdrivensampling.org) for details.

Kouibly, Facobly, Nidru, Sangouine, and Bagohouo). Team 2 conducted surveys in the Center and Upper North (or the Korhogo, Ferke, and Bouake areas), which encompasses the localities of Korhogo, Ferke, Sinematiali, Kani, Katiola, Bouake, Sakassou, Djebonoua, Toumodi-Sakassou, Tien-dienkro and Brobo. Team 3 conducted surveys in the South-East (or the Adzope area), which encompasses the localities of Rubino, Aferry, Adzope, Betie, Boungouano, Arrah, Transua, Tanda, and Taoudi. Team 4 was assigned to the South West (or the Daloa sector), which encompasses, Daloa, Sinfra, Gboguhe, Issia, Diegonefla, Oume, Zoukougbeu, Soubre, and Sassandra as well as Dania and Gohitafla. Team 1 and Team 2 also worked on demobilized combatants and actual military elements from the FAFN sampled in some of the localities they operated in. Team 3 and Team 4 conducted surveys in the 10 DRs sampled in the city of Abidjan. Data entry was carried out by two assistants recruited at INS.

## B. Survey Instrument

A common survey instrument was used for both civilians, combatants and demobilized combatants. The survey instrument was developed from questions used by the researchers in post-conflict surveys in Burundi and the Democratic Republic of Congo, but adapted to the Cote d'Ivoire context. This adaptation was done after 12 focus groups conducted in various and diverse regions of the country. The surveys were administered in French or in a respondent's language of choice through on-spot translation by enumerators.

## IV. Adjustment Methods

### A. Poststratification Adjustment

We used methods incorporating design information and poststratification adjustment to deal with potential non-coverage problems owing to non-response or non-availability of certain types of respondents.<sup>4</sup> First, we determined how individual probabilities of selection may vary because of the sample design. The design-induced individual sampling probabilities for individuals were proportional to  $1/h_i$ , where  $h_i$  is the number of eligible adults in  $i$ 's household. Second, in order to deal with potential non-coverage, we defined poststratification categories that we will use for further weighting adjustment. We determined that age group, gender, education level, income level, and region were useful for poststratification. This determination was based on evaluating differences in sample distributions compared to the best estimates available of population estimates, as well as an analysis of the correlates of non-response (discussed further below). The best-available auxiliary data on population distributions for our case was a 2005-6 demographic and health survey (DHS) conducted by the Cote d'Ivoire's national statistics institute (INS et al 2006). That survey, which had nearly 10,000 respondents in a national sample, was itself adjusted based on 1998 census data, the latest census data available. We label population density value in poststratification cell  $s$  as  $\delta_s$ .

Third, we used the design-induced selection probabilities to define inverse-probability weights ( $= h_i$ ), and used these weights to compute the selection-probability-corrected distribution of the sample over the poststratification cells. The selection-probability-corrected sample density within cell  $s$  is given by,

$$d_s \equiv \frac{\sum_{i \in s} h_i}{\sum_j h_j}.$$

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<sup>4</sup>See Lee and Forthofer (2006) for details.

Fourth, an adjustment factor for each poststratification cell  $s$  is computed as  $r_s \equiv \delta_s/d_s$ . Adjustment factors show us which strata are over-represented ( $r_s < 1$ ) in the sample and which are under-represented ( $r_s > 1$ ). These are shown in Table 1. The factors along the bottom and right of the adjustment factor grid show average adjustment factors over strata.

Finally, the survey weight for individual  $i$  is computed as,

$$w_i \equiv h_i r_{s[i]} \frac{N}{\sum_t \sum_j h_j r_{t[j]}}$$

where  $N$  is the population size.

Our post-stratification weighting adjustment compensates for non-response and non-coverage in the civilian sample so long as the following holds: remaining differences in the likelihood of non-coverage or non-response will either be small once we have accounted for the demographic and regional attributes used in the weighting scheme, or these differences can be accounted for by conditioning on other variables available in the survey data when conducting analyses. We studied the extent to which this held with respect to observed non-response. The rate at which enumerators failed to contact any potential respondents in a selected *household* was extremely low—2.3%. Within households, a “Kish grid” was used to randomly select a respondent from among all eligible adults. The overall rate at which selected adults were unavailable or refused to be interviewed was 12%. This non-response rate varied systematically with regional strata, as shown in Table 2, although the post-stratification weighting compensates for such regional variation. We examined the relationship between non-response and variables not directly used in the post-stratification weighting. We found no systematic relationship with ethnicity, a local insecurity index constructed from the data, or urban/rural respondent locality. Once region and the demographic information of the associated respondent was controlled-for, no significant relationship was found with economic variables.

We treat the combatant sample differently than the civilian sample. As already mentioned, practical difficulties prevented us from implementing our design for combatants. We sought ways to correct for coverage problems in the combatant sample. To do this well, we required good data on combatant demographics. But no such data was furnished to us by agencies involved in the DDR and army integration process. Thus, the combatant sample is not adjusted at all, and we make no claims that the findings associated with the combatant sample are representative.

## B. Missing Data

Random regression imputation was used to complete data vectors essential for the computation of adjustment weights. Refer to Allison (2002) for details. Variables that were treated with this process include measures of monthly income, ethnicity, household size, and whether primary education was completed or not.

## C. Auxiliary Data

We combine our survey data with data from multiple external sources. Self-reported information is sometimes subject to error and possible bias. For example, self-reported information on peace-keeping deployments, past conflict events, and aggregate characteristics of communities may not always be reliable. Thus, it is useful to have auxiliary data to help pin things down. We augmented our survey data with the following data:

Table 1: Adjustment factors by demographic and regional poststrata

|   | 1.Nord-Ouest,<br>Nord,<br>Centre-Nord | 2. Ouest | 3.<br>Centre-Ouest,<br>Sud-Ouest | 4.Centre,<br>Nord-Est,<br>Centre-Est | 5.Sud,<br>Abidjan | <i>Marginal</i> |
|---|---------------------------------------|----------|----------------------------------|--------------------------------------|-------------------|-----------------|
| 1. Male,<br>no edu compl.,<br>15-25 yrs.        | 0.55                                  | 0.22     | 0.77                             | 0.67                                 | 1.06              | 0.66            |
| 2. Female,<br>no edu compl.,<br>15-25 yrs.      | 1.53                                  | 0.78     | 2.06                             | 3.42                                 | 10.77             | 3.71            |
| 3. Male,<br>primary edu compl.,<br>15-25 yrs.   | 0.20                                  | 0.35     | 0.24                             | 0.49                                 | 0.63              | 0.38            |
| 4. Female,<br>primary edu compl.,<br>15-25 yrs. | 0.35                                  | 0.54     | 0.77                             | 1.39                                 | 1.92              | 0.99            |
| 5. Male,<br>no edu compl.,<br>25-40 yrs.        | 0.59                                  | 0.33     | 0.75                             | 0.81                                 | 2.10              | 0.91            |
| 6. Female,<br>no edu compl.,<br>25-40 yrs.      | 1.05                                  | 0.86     | 2.93                             | 1.00                                 | 3.50              | 1.87            |
| 7. Male,<br>primary edu compl.,<br>25-40 yrs.   | 0.20                                  | 0.32     | 0.24                             | 0.25                                 | 0.58              | 0.32            |
| 8. Female,<br>primary edu compl.,<br>25-40 yrs. | 0.28                                  | 0.55     | 0.84                             | 0.45                                 | 1.88              | 0.80            |
| 9. Male,<br>no edu compl.,<br>40+ yrs.          | 0.23                                  | 0.23     | 0.34                             | 0.23                                 | 1.13              | 0.43            |
| 10. Female,<br>no edu compl.,<br>40+ yrs.       | 0.71                                  | 0.30     | 1.27                             | 0.56                                 | 2.80              | 1.13            |
| 11. Male,<br>primary edu compl.,<br>40+ yrs.    | 0.10                                  | 0.20     | 0.09                             | 0.12                                 | 0.33              | 0.17            |
| 12. Female,<br>primary edu compl.,<br>40+ yrs.  | 0.40                                  | 0.24     | 0.42                             | 0.21                                 | 1.87              | 0.63            |
| <i>Marginal</i>                                 | 0.52                                  | 0.41     | 0.89                             | 0.80                                 | 2.38              |                 |

Notes: Values less than 1 indicate over-representation in sample; values greater than 1 represent under-representation. Adjusted to INS et al (2006) results.

Table 2: **Non-response rates by regional poststrata**

| Regional stratum | 1st pick interviewed | 2nd or later pick interviewed |
|------------------|----------------------|-------------------------------|
| 1.NO,N,CN        | 177<br>(69%)         | 80<br>(31%)                   |
| 2.O              | 114<br>(96%)         | 5<br>(4%)                     |
| 3.CO,SO          | 225<br>(97%)         | 6<br>(3%)                     |
| 4.C,NE,CE        | 144<br>(82%)         | 32<br>(18%)                   |
| 5.S,A            | 285<br>(93%)         | 22<br>(7%)                    |
| Mil/demob        | 114<br>(99%)         | 1<br>(1%)                     |
| Total            | 1,059<br>(88%)       | 146<br>(12%)                  |

Notes: Pearson  $\chi^2_{[5]} = 140.7$ ,  $p \approx 0$ . Refer to Table 1 for full regional stratum labels.

- Nordas et al 2008. These data provide information on all major conflict events from 2002-2008 that could be culled from newswire reports. The conflict history data used in the study are drawn from these data.
- Bogetic and Sanogo (2005). We constructed a regional infrastructure index by extracting the first principal component factor from their measures of regional road density, postal service density, water service density, and access to health facilities.
- INS et al 2006. Information from this dataset was used to construct the adjustment weights to correct for uneven coverage and response patterns in our sample.
- UNDPKO deployment maps for Cote d’Ivoire. These maps were used to assign deployment force levels to localities.

## V. Sample Characteristics

Figure 1 shows how the sample respondents’ home areas were distributed geographically at the time of the survey in August 2008 and in the period just prior to the onset of the war in 2002. Each point is sized according to the final adjustment weight applied to that respondent. We display the confidence zone (CZ) on the map of current locations to highlight an area of special interest for this study. Sampling rates in this area were intentionally higher than other parts of the country to permit more precise comparisons between people in and out of the CZ. The weights take into account these different sampling rates.

Table 3 shows the sample distributions over demographic factors. We note that men are very over-represented in the sample. This was not intentional, and suggests the non-response and non-availability were concentrated among women, an issue that we plan to investigate. For measures taken at the household level, the implications of this discrepancy are minor. For measures taken at the individual level, this discrepancy needs to be borne in mind. The civilian and combatant samples differ in marked ways in terms of demographics. But because we have not studied



the representativeness of the combatant sample, we would advise against making much of these differences.

Table 3: **Sample demographics**

| Demographic                         | Civilians     |                |                         |                         | Combatants    |                |
|-------------------------------------|---------------|----------------|-------------------------|-------------------------|---------------|----------------|
|                                     | No. in sample | Sample percent | Weighted sample percent | SE for weighted percent | No. in sample | Sample percent |
| Gender:                             |               |                |                         |                         |               |                |
| Male                                | 876           | 73             | 46                      | 2                       | 235           | 93             |
| Female                              | 330           | 27             | 54                      | 6                       | 18            | 7              |
| Ethnicity:                          |               |                |                         |                         |               |                |
| Mande                               | 334           | 28             | 26                      | 3                       | 134           | 53             |
| Gour                                | 102           | 8              | 8                       | 2                       | 35            | 14             |
| Krou                                | 293           | 24             | 22                      | 3                       | 67            | 26             |
| Akan                                | 460           | 38             | 43                      | 4                       | 16            | 6              |
| Other                               | 17            | 1              | 1                       | <1                      | 1             | <1             |
| Age:                                |               |                |                         |                         |               |                |
| 15-30 yrs                           | 612           | 51             | 62                      | 5                       | 118           | 47             |
| 30-50 yrs                           | 480           | 40             | 33                      | 3                       | 119           | 47             |
| 50+ yrs                             | 114           | 9              | 5                       | 1                       | 16            | 6              |
| Education:                          |               |                |                         |                         |               |                |
| No formal education completed       | 348           | 29             | 45                      | 5                       | 156           | 62             |
| Primary education or more completed | 858           | 71             | 55                      | 4                       | 97            | 38             |
| Urban/Rural:                        |               |                |                         |                         |               |                |
| Rural*                              | 676           | 56             | 43                      | 5                       | 13            | 5              |
| Urban*                              | 530           | 44             | 57                      | 7                       | 240           | 95             |
| Income:                             |               |                |                         |                         |               |                |
| No regular monetary income          | 724           | 60             | 64                      | 5                       | 180           | 71             |
| Regular monetary income             | 482           | 40             | 36                      | 3                       | 73            | 29             |

Notes: Total sample size is 1,206 for civilians and 253 for combatants.

\* The urban/rural classification refers to the respondent’s current location, and it refers to towns and other small population centers in addition to larger cities (e.g. Man or Abidjan).

## VI. Analytical Methods

### A. Identifying Impacts

In addition to measuring people’s attitudes, our study attempts to identify and measure *impacts* of UNOCI on peace process and peacebuilding dynamics. Doing so is made difficult by the fact that no baseline exists against which to compare outcomes in areas where interventions took place. By necessity, peacekeeping presence and tasks were assigned purposively to areas of need. There is no catch-all way to separate the effects of an intervention, on the one hand, from effects of the factors of an area that prompted the intervention there in the first place. To put it another way, what we really need to do to measure intervention impacts is (1) to compare *what actually happened in an area where there was an intervention to what would have happened in that same area had there been no intervention*, and (2) to compare *what actually happened in areas without an intervention to what would have happened had there been an intervention*. This ideal is known as “counterfactual comparison.” It is *not* the same thing as comparing areas with interventions to those without, because these two types of areas probably differ in important ways. Such naive comparisons, in the absence of the types of considerations discussed below, are usually biased.

The analyst can approach (but never fully attain) the counterfactual comparison ideal in a number of ways. She can go to places where there were interventions and ask people to explain what they *think* would have happened had there been no intervention, and vice-versa for places without interventions. This is usually best reserved for qualitative studies, because follow-up questioning and richer discussion is usually necessary to make sense of people’s counterfactual constructs. She can also do so by making comparisons *conditional* on the factors that are associated with both intervention assignment decisions and outcomes of interest. Such is the approach that we take in this evaluation.

We studied the relationship between deployment patterns and two such factors (known as “confounders”): (i) conflict incident history prior to the deployment of UNOCI and (ii) quality of regional infrastructure. We found a strong positive relationship between deployment levels and past conflict intensity in a locality (shown in Figure 2). However, considerable variation remained even after conflict history was taken into account. Indeed after conflict intensity reached a certain level (about 4 major conflict events in a locality), deployment levels seem to be based on entirely different considerations. This residual variation was not found to be associated with infrastructural quality, although our measure is quite coarse, varying only at the regional level. Thus, in assessing impacts we know that conflict history certainly needs to be taken into account, and so we always did so. Note that a locality’s conflict history is itself a function of many variables, including terrain, strategic importance, and political disposition vis-a-vis the war’s protagonists. Thus in “conditioning” on conflict history we are indirectly taking these important, but difficult-to-measure factors into account.

Sometimes, we can exploit the dynamic nature of peacekeeping deployments. Essentially, we compare outcomes in a given area before and after the arrival of peacekeeping forces. Doing so automatically conditions on all the features of the locality that do not change over time (e.g., infrastructure, accumulated conflict levels prior to a certain cut-off date, geographic location, etc.). We are limited here by the number of variables that the survey measured in a dynamic fashion. These include many of the measures of victimization, described below, and so we plan to conduct dynamic analyses of victimization for the final report.

## **B. Community-level Measurement**

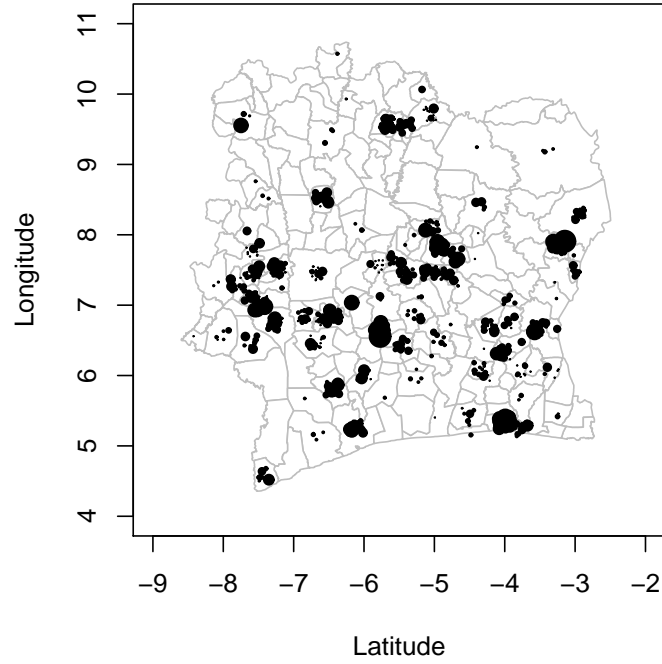
Because peacekeeping interventions generally varied at the level of localities, we used locality-level analysis, rather than individual-level analysis, regularly in the study. We employed hierarchical small area estimation methods to derive community-level measures, as demonstrated in Gelman and Hill (2007, especially pp. 301-310) and Rao (2003). These methods are superior to direct estimation of averages and totals for geographic localities when sample sizes within those localities are small. The process is to (1) fit an hierarchical mixed effects model on demographic factors and with varying intercepts for localities, and then (2) use the poststratification weights to compute weighted averages for localities.

## VII. References

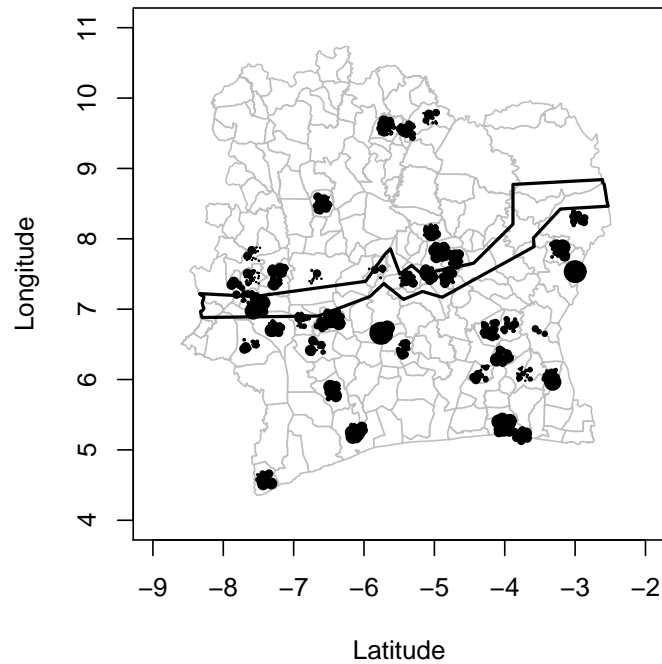
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Figure 1: Respondent Home Locations

**Respondents' Prewar Home Locations (ca. 2002)**

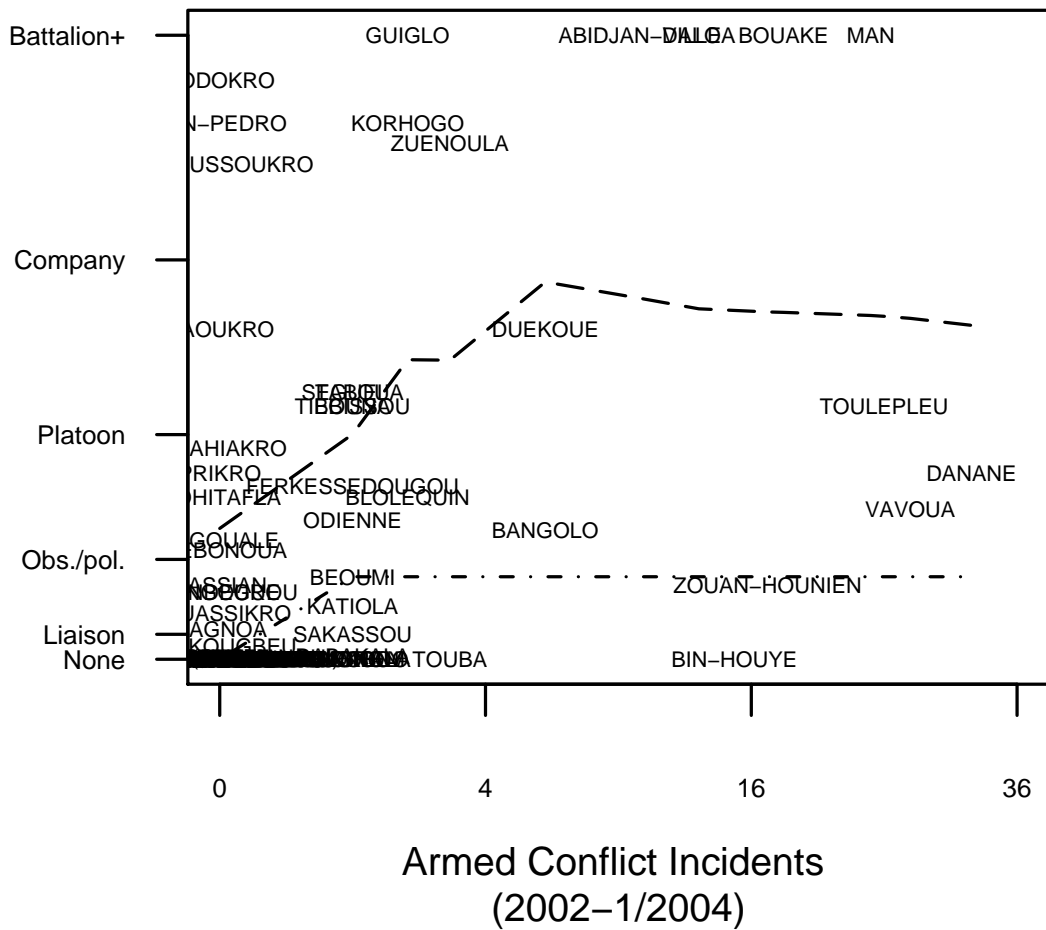


**Respondents' Current Locations (ca. August 2008)**



The size of a dot reflects weighting adjustment. The lower map also shows the zone of confidence as the area within the black lines.

Figure 2: Deployment Levels and Conflict History



The lower dashed line measures the deployment-conflict history relationship taking all cases into account. The upper line considers only those cases that actually received deployments. Both lines are lowess fits. The differences in the lines as well as their shapes are suggestive of a two-part decision-making process.