Computer Simulation as a Means of Dialogue between Local Committees and Relief Agencies: A Case from Southern Sudan

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Computer simulations, using modest equipment — a portable computer with a familiar spreadsheet programme — can facilitate dialogue between local committees and relief agencies in the management of disasters. An example is given from the southern Sudan in which the outcomes of different relief strategies, some urged by the donors, were simulated. This helped the local committee to defend difficult choices and the donors to realise that the decision-making autonomy of the affected community should be respected.

THE PROBLEM

Over the past 20 years, the international community has become increasingly responsive to large-scale disasters and increasingly organized to take relief to the victims. Conversely, communities which have suffered, or been threatened with, repeated disasters have included appeals to relief agencies amongst their own strategies for coping with such crises. Apart from the uncertainties which the disaster produces for the local community, however, it must also face the uncertainties inherent in donor relief. Notably, perceptions of the disaster and of relief priorities may differ between the local community, the relief agencies and the donors. There may also be disagreement over the appropriate uses of the relief once it does materialise.

Both sides may fear that the existence of vastly different assessments and strategies will threaten the relief process itself and they may be keen to minimize the differences. This may result, for example, in the local community accepting agency recommendations and closely following agency-imposed methods of accounting and reporting. The community may also choose to argue its case more actively by providing types of report that go beyond traditional concepts of accountability and through deliberate experiments that compare the merits of various ways of delivering the relief. This may take the form of practical field experiments or (more feasible in an emergency) of "thought experiments" in which a number of critical factors, some controlled and some not controlled by the local community and the relief agencies, are systematically varied. In its simplest form, the thought experiment is hardly distinguishable from the deliberations of, say, the

local relief committee, but more sophisticated approaches are possible.

With minimal programming effort, personal computers can be used to simulate the outcomes of disaster scenarios. Simulation may not narrow the range of insecurity that torments the various actors in relief, but it obliges them to spell out their basic assumptions and objectives and at the same time enables them to produce more persuasive reports. Such reports may be used across several tiers of organizations, including local committees, relief providers and donors, and may help them to work towards mutually acceptable strategies and to defend difficult choices.

The case described here concerns the timing of relief distributions in a pre-famine situation. It is set in Wau, one of the major towns in southern Sudan, where I was working with the International Committee of the Red Cross. There were two relief agencies in the town. One used its food stocks for vulnerable groups of persons that were more or less fixed in size. The other received considerable new stocks of relief food for groups yet to be seriously affected by the worsening food situation. Its donor agency urged that the food be distributed over the next few months whereas local wisdom recommended stockpiling for the lean season later on. The different strategies were discussed in meetings bringing together most of the local decision makers in relief. The discussions were supported with graphs of several scenarios which I formalized using a familiar spreadsheet programme.

THE AFFECTED COMMUNITY

Wau is the capital of Bahr-el-Ghazal Region, one of the areas severely affected by the long drawn-out civil war in southern Sudan. The town is shelter to several tens of thousands of persons displaced by hostilities and by the utter lack of services and goods in the countryside. At the same time, large numbers of its original inhabitants have moved to the north of the country, fleeing from hunger and war. The years from 1986 to 1988 were particularly hard on the people of Wau, with fighting within the gates of the town and starvation claiming a heavy toll of deaths. Attempts to airlift food were aborted and, throughout the year 1988, church organizations were the only relief providers in place, trying to mitigate a severe famine with inadequate relief stocks that had reached them through irregular overland convoys. In 1989, the International Committee of the Red Cross (ICRC) was able to improve conditions greatly with massive airlifts and distributions of food to large numbers of families. The airlift was suspended in November 1989, to be resumed only in May 1990. The depletion of stocks and the lessened needs put an end to large food distributions in early 1990. This led to a new series of problems. The Regional Government and the ICRC clung to grossly different estimates of displaced persons in Wau. Also the consequences of the war had impoverished old residents as much as recent arrivals. The resultant matrix of distress was so complex and dynamic that adequate interventions far exceeded the mandate of the ICRC as a life-saving organization for immediate war victims.

Happily, the ICRC's monopoly in relief was broken when the Lutheran World Federation (LWF) started airlifting food from Nairobi to Wau in October 1990. Its consignee, the local office of the Sudan Council of Churches (SCC) was, however, in a moribund state and, with such a large consignment (1,800 mt of food), there was a need to revive, as the responsible local organization, an inter-denominational body known as the Allied Relief and Rehabilitation Services (ARRS). Subsequently, the roles of the various actors were better defined. A concurrent vaccination survey done by UNICEF and the Ministry of Health helped by producing the first credible

population estimate since the 1983 census. According to this estimate, some 50,000 persons were living in the town, besides 6,000 in four camps for displaced persons. While the improved definition of roles (worked out chiefly through informal coordination between ICRC and ARRS) and population estimates considerably narrowed down the uncertainties of the relief task, food availability and nutritional status remained major unknowns.

The ICRC had carried out repeated nutritional surveys of the camp population. In September 1990 a slight deterioration was noted in some of the camps. The ICRC had run a temporary food support program for needy families in the town during the lean summer months. This helped to map out poverty in the various neighbourhoods and to identify local structures that could take responsibility for distributing relief to the needy. The programme did not, however, provide accurate measures of the changing nutritional situation as none of the agencies was equipped to carry out nutritional surveys in the town. The exercise did, however, lead to the conclusion that between 3,000 and 5,000 families could not meet their basic food requirements when the price of the staple food, millet (known as dura), was a favourable SDP 200 per 12 kg, and that disproportionately high numbers would be deprived as it rose. In fact, the price of dura appreciated by 20 per cent during the harvest period, when it should have fallen. Clearly, more and more people were going hungry.

THE FOOD SYSTEMS

Wau depends on several sources of food. Families grow part of their requirements in home gardens and in public spaces. A swath of fertile alluvial land is farmed mostly by senior government officials. To the west, a large cultivated area expands and contracts with changes in the security situation. The 1990 rainy season was a disappointment and security developments interfered with weeding and harvesting. As a result, only about two months' worth of food needs were stored by the average family.

The government, as well as private traders, brought food from central Sudan before the rains closed the only road that links Wau with the north and west of the country. After the last convoy arrived, the government had another 1,200 mt of dura waiting for onward shipment in Raja, western Bahr-el-Ghazal. Meanwhile, the government had disposed of most of its stocks in Wau through "fair price" shops. Commercial stocks were also believed to be unusually low, although information about them was shrouded in secrecy and they were hoarded for later use when prices would skyrocket. Food shortages in the country's main food-growing areas created a very pessimistic outlook for the importation of food by traders in early 1991 and security conditions made it doubtful that the regional government could collect grain from Raja.

Wau has an advantage over other garrison towns in the South in that it has access to a nearby agricultural surplus area, the so-called Bagari Loop, a collection of villages some 10–50 km to the southwest. The marketing arrangements for this surplus are rudimentary, and supply is relatively inelastic due to transportation constraints and to incomplete market information. Food is moved on bicycles by farmers when they need cash or by townspeople who go out to buy in their home villages. Nevertheless, the Bagari Loop acts as an important, even critical, source of food when other sources dry up or become prohibitively expensive.

There remain the relief agencies that airlift food to Wau. The ICRC had stopped the famine by January 1989. It continued its massive airlifts, only to see them suspended for security reasons for several periods. Its relief stocks in Wau had been dwindling since August 1990 and were entirely com-

mitted to continuing minimum food assistance for vulnerable groups in the camps, some institutions and through the Sudanese Red Crescent. The local community greeted very warmly, therefore, the somewhat unexpected relief sent by the Lutheran World Federation. The newly formed ARRS was quick to reach a consensus that most of this food should be stockpiled for emergencies, although it was ready to distribute rations of modest amounts, grafted onto the ICRC temporary food support programme, to needy families.

THE CASE FOR SIMULATION

On November 13, 1990, the local SCC office received instructions from its headquarters in Khartoum to proceed immediately with the distribution of the food in stock. The message stated categorically that "no stockpiling for emergencies" was permitted.

The order came as a bolt from the blue to those concerned with relief in Wau. The ARRS committee members resolved that they had a moral duty to resist it for the good of the people who would starve in dire times when the food was not there. But clearly, the ARRS was at a loss to read the minds of the SCC head office, the LWF, and of the donors behind the scenes. Had the LWF solicited aid by depicting an acute famine in Wau and was it therefore under an obligation to prove its point through massive distributions? Was the LWF positive that it could send more once the already approved 1,800 mt had been given out? The ARRS had no means of discussing this complex issue with distant head offices, and speculation would not help. But a redeeming factor was that the telex from Khartoum included an invitation to enrich the distribution reports with market surveys and crop data.

In reviving the ARRS and in liaising between it, the ICRC and the Regional Government, a very important role was played by the United Nations advisor to Wau, a veteran of cooperative relief in the Sudan. He had been volunteering reports and explanatory notes on the ARRS reports to the SCC and LWF and felt that the ARRS must now use better arguments for deferring major distributions to the lean season. In particular, the donors had to be warned about the disaster that would befall Wau if two events coincided: the early depletion of relief stocks and the failure of the government to bring its grain from Raja. The first would be determined by the tenuous situation of the ICRC and the ARRS distribution policy; the second by major uncertainties over security.

From this there arose the idea of formalizing and representing graphically various food supply scenarios and their outcomes. This made it necessary to define the principal goal of the relief more explicitly: namely, to avert the maximum number of famine deaths. Practically, that meant providing the maximum number of persons with food entitlements sufficient to prevent severe malnutrition, accepting periods of moderate malnutrition for many if the food saved could be used later on, or to feed the more severely malnourished. With this in mind, the objective of the ARRS and ICRC was to provide 10 kg worth of basic food items per month to as many needy persons as possible, for as long as possible. This worked out, given the population estimate, as a minimum food requirement of 560 mt per month. (A full diet, consisting of 17 kg of food per person per month, would require 952 mt.)

THE SIMULATED SCENARIOS

I simulated the monthly food consumption from November 1990 to October 1991 (a one-year harvest-to-harvest horizon), using a familiar spreadsheet programme making assumptions about stocks, receipts and the disbursment behaviour of the various food suppliers. At the core of the model was the price of the staple food, dura, formed by

unmet food requirements, trader stocks, and a speculation parameter. The resulting system of simultaneous and lagged equations yielded the stocks and flows in the food system, by major source, automatically responding to any changes in the modelled parameters, like a cobweb whose threads move to new positions whenever one of them is gently pulled.

Next, the model produced two estimates of the number of needy people, depending on the distributional efficiency of the relief. The first was calculated simply by dividing the unmet requirement *after* relief distributions by 10 kg, assuming that the relief would first go to the most needy. By definition, because of this direct effect, the number of needy was zero as long as relief stocks were permitted to supplement everybody's income for the basic 10 kg per month. The second estimate assumed only indirect effects, by relaxing the market price of dura. The number of needy was calculated as a quadratic function of the dura price.

The number of severely malnourished persons was calculated as a percentage of the sum of needy persons in the previous two months, i.e., as the outcome of a cumulative, lagged process. Similarly, famine deaths were assumed to be proportional to the sum of severely malnourished persons in the two previous months. With two different estimates each for the needy, the malnourished and for the famine dead, an index of disaster magnitude was constructed as the average of the two death estimates, scaled to 100 for the worst scenario. By this method, the impossibility of predicting absolute numbers of victims was acknowledged, but it was assumed that the magnitude of a disaster would be in rough proportion to the cumulative food shortages calculated under the various scenarios. Combining the different estimates in one index allowed for a less than perfectly efficient allocation of relief.

Five basic scenarios were run. Scenarios 1 to 5 varied the government's ability to move its grain from Raja to Wau and the ARRS distribution strategy. Scenario 5 reflected what the SCC instructions seemed to imply — distribute now; receive more later — with the catch that the government grain stayed in Raja and, consequently, food consumption in Wau fell into a trough before a second airlift had its effect. Table 1 summarizes the five scenarios.

Scenarios 3 and 5 are particularly relevant for some non-trivial findings. Scenario 3 suggests that, by deferring major distributions so that only the shortfall from the minimum requirement (560 mt tons per month) is covered, the ARRS can avoid 39 per cent famine deaths as against the worst scenario. Scenario 5 suggests that, even on firm promises of further airlifts, distributing the initial consignment early would be an extremely unwise policy. The arrival of another 1,200 mt of relief food, in summer 1991, would reduce the number of deaths by 9 per cent only.

Why should that be so? Let us look at the graph of monthly food disbursements by source for Scenario 5 (Fig. 1). Massive distributions of relief food between December and March drive the traders and the Bagari farmers out of the market. As relief stocks come to an end, prices skyrocket and traders dispose of their hoarded stocks. Also, the farmers respond with increasing food sales, but that is not sufficient to prevent effective total consumption falling into a deep trough. When the famine alarm is rung and donors respond with the second airlift, malnutrition in the Wau population has already gained enough momentum to kill almost as many people as in the scenario without any further airlifts (Fig. 2).

THE USES OF SCENARIOS

Local relief committees, governments and international agencies are all alike unconcerned with the number-crunching of com-

TABLE 1
The five scenarios

Scenario	Leading assumptions	% of basic food needs met over 12 months	Disaster magnitude (worst = 100)
I	Government takes grain from Raja to Wau; ARRS receives the full 1,800 mt and defers distribution, covering minimum shortfall only.	90	8
II	Government takes grain from Raja to Wau; ARRS receives the full 1,800 mt and distributes the food early (Nov. 1990–May 1991).	93	74
III	No food is imported from Raja; ARRS receives the full 1,800 mt and defers distribution, covering minimum shortfall only.	81	61
IV	No food is imported from Raja; ARRS receives the full 1,800 mt and distributes the food early (Nov. 1990–April 1991).	79	100
V	No food is imported from Raja; ARRS receives the full 1,800 mt and distributes the food early (Nov. 1990–April 1991); when food prices are shooting up, ARRS obtains another 1,200 mt and distributes it between August and October.	94	91

puter simulations. They want powerful reasoning and graphic representations of a very small number of realistic appearing scenarios and of their most important outcomes. Only when claims to non-trivial results are supported with good argument and imagery will they admit that simulations can yield insights beyond those afforded by sound unaided reasoning.

In the pre-famine period in Wau, three scenarios were discussed locally and shared with the LWF and the SCC. The vehicle for this was a situation report by the UN Advisor, Wau (17 Nov. 1990), which included graphs and analyses of Scenarios 1, 4 and 5. The report strengthened the conviction of the ARRS committee that lumpiness in distribution should be avoided. The report, together with supporting letters from the ARRS, was sent to the SCC and LWF offices in Khartoum and Nairobi. Within a short time, the SCC rescinded its November order, emphasizing that the food should be handled according to the best local judgement.

An unexpected reaction came from the Regional Government. Its Commissioner for Relief and Rehabilitation took exception to the population estimate (56,000) used in the simulations. He later obtained an order from the Governor to register the displaced persons and the residents afresh. This raises a difficult question. In communities which are under stress with the onset of a disaster, do computer simulations tend to stifle rather than liberate thinking? Do computers and computer graphs carry an aura of foreign sophistication that intimidates partners not habituated to formalized reasoning? Are they driven onto the defensive in response to what they see as misrepresentations of their important concerns

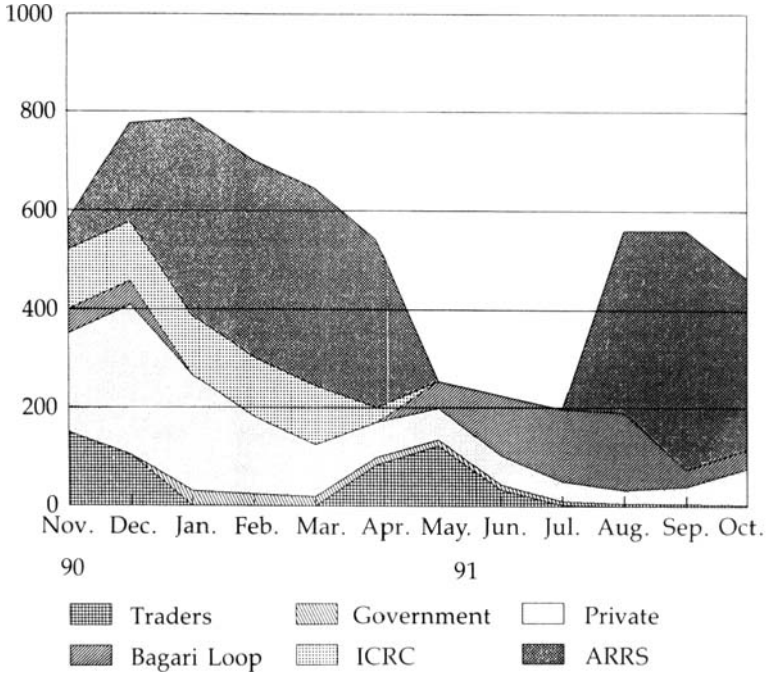
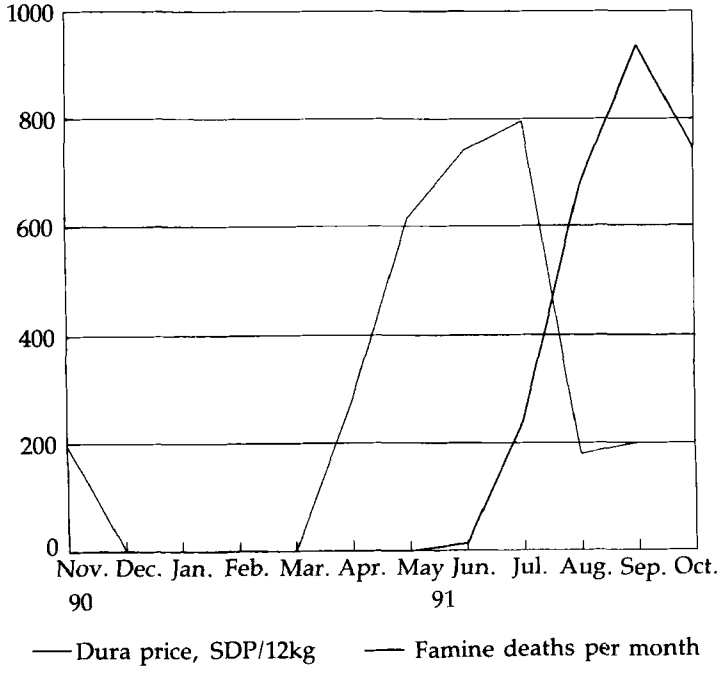


FIGURE 1 *Scenario 5: Monthly disbursements by source in metric tons*



Note: Famine deaths are scaled to 1000 for the worst month (October) of the worst Scenario (4).

FIGURE 2 *Scenario 5: Price of staple food and famine deaths*

— for example, the size of the group they represent? The medium is all too easily invested with an authority that obscures the highly simplified nature of the assumptions upon which the simulations are based and the limited conclusions that may be drawn from them.

The problem can be reduced but not solved. The authors of such simulations have a responsibility to test the robustness of their key findings even when their audience is not equipped to ask all the questions that should be asked (and which the onset of a disaster leaves little time to ask). The point may be illustrated for the two Scenarios which yielded the most surprising results, 3 and 5.

Both have in commn that no food is brought to Wau by road convoy. This was a serious likelihood (as the community fully realised) and a very pessimistic assumption. What if it were relaxed? What if the government succeeded in bringing at least part of its grain from Raja? What if the government achieved the entire haul and, in addition, traders, by their acumen, secured several hundred tonnes of food from central Sudan?

Figure 3 depicts the outcome of increasing quantities of food hauled in by road and of the two different ARRS distribution patterns. The results are consistent with expectations. As long as the local relief committee retains its freedom to align distributions with the behaviour of other food suppliers, the first 400 mt of food that the government succeeds in bringing to Wau saves many more lives than under fixed distribution schedules imposed by the donors. For the next 800 mt of government

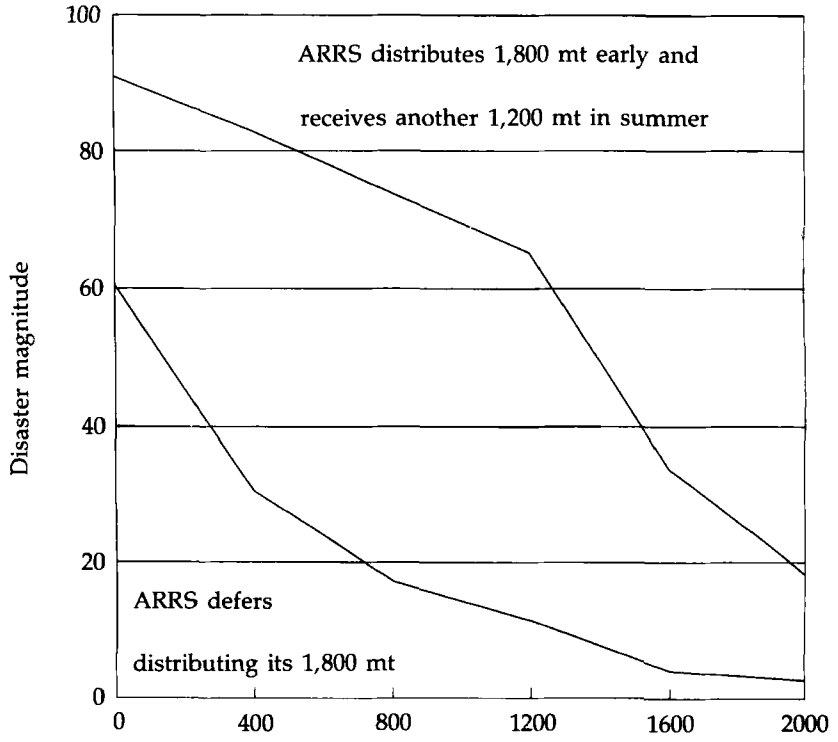


FIGURE 3 *The impact on disaster magnitude of increasing quantities of food brought in by road*

supplies, both ARRS strategies achieve similar reductions in mortality, but it must always be kept in mind that the flexible strategy (depending on 1,800 mt only) is still much more effective than the fixed-time strategy (which claims 3,000 mt over 12 months). Interestingly, the 1991 lean season, after the ARRS had distributed its initial 1,800 mt by April, turns out to be less disastrous only if the private traders receive new supplies beyond the 1,200 mt government shipment. Fresh commercial supplies will mitigate the price effects of hoarding between the two ARRS big distribution periods and thus make it more difficult for malnutrition to build its deadly momentum. In other words, the sensitivity test demonstrates that the outcomes of deferred vs. early distributions are unaffected by variations in other supplies. The two graphs in Figure 3 do not cross: regardless of how much food is brought in by road, the flexible strategy remains more effective throughout.

CONCLUSION

Donors must concede far-reaching autonomy to the local decision makers, who, for their part, should adopt an aggressive style of reporting that goes beyond traditional *ex post* accounting. They should state clearly the objectives of the relief and the difficult choices these make necessary. Donors should then actively support the freedom of the local partners by, for example, sending them fuel and fumigation supplies that permit the relief committee to move to the points of distress and extend the store-life of the grain.

But scenarios cannot foresee which of the potential situations will occur and, therefore, cannot forecast the need for relief. They only make us understand the susceptibility of the food system to certain types of contingencies. By way of example, Scenarios 1 and 3 say that if the government fails to collect its grain from Raja, deaths from malnutrition may shoot up by a factor of almost eight. But this figure cannot be converted to any absolute numbers because the baseline (deaths in Scenario 1) cannot be calculated. Similarly, by comparing Scenarios 4 and 5, we understand that a belated second airlift in the summer 1991 will save relatively few lives. But no amount of number-crunching can say exactly how many.

Computer simulations, therefore, are just another means of making the local community realise that the disaster is basically theirs. Throughout its course, there are important decisions to make, some of which — often very crucial ones — belong essentially to the local community. Simulations are most useful when they strengthen the resolve of the community to make these decisions and persuade donors and relief agencies to respect local autonomy.

Note

I should like to thank Dr Gordon Wagner, United Nations Development Programme, Wau, for his valuable comments. Readers who would like to know more about the technical details of the simulations described here are welcome to write to me at the address below, or to the Editor of *Disasters*.

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