RETHINKING INTERNATIONAL DISASTER AID FINANCE

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Natural disasters pose daunting barriers to development in poor countries. The human and material losses resulting from droughts, floods, storms and earthquakes further impoverish already poor populations. The year 2005 was a case in point. Victims of already longstanding disasters continued to suffer in places like southern Sudan, the Democratic Republic of the Congo and Ethiopia. Recent disasters like the Indian Ocean tsunami, the food crisis in Niger, the earthquake in Pakistan, the hurricanes in Central America and the drought in Malawi struck already vulnerable populations in poor countries.

In order to maximize its value to the world's most vulnerable populations, often the victims of these disasters, the international aid community must endeavor to create an effective and equitable international emergency aid system. To reach this dual goal requires a conceptual shift from a reactive emergency aid business model to a proactive risk-management investment model. Vulnerable populations almost continuously suffer some losses as a result of localized, frequent natural calamities and manmade hazards. To treat these events as emergencies obscures the fact that some populations have become so poor that they can no longer support themselves even in normal natural conditions. From a financial perspective, providing assistance to vulnerable populations to enable them to survive normal one-in-two- or one-in-three-year fluctuations in weather and other expected events is an investment proposition. Aiding populations to cope with extreme events is an insurance proposition. The first needs a predictable, steady flow of investment funds; the second requires contingency funds to cope with probable but uncertain events. The second is the focus of this article.

The dilemma facing any aid agency with contingency funds is how to ensure effective and equitable use of a limited amount of funds within a specific emergency and across all disasters in a specific region during a fiscal year.[1] There are three obvi-

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ous possibilities. First, one could use the contingency funds to create a fund of last resort, in which case one would wait to see how other donors respond to an emergency and fill in the gaps. However, this is hardly a prescription for timely funding. Second, one could fund as much as possible of the response to the first disaster that happens to strike and risk being unable to help victims of disasters which occur later in the fiscal year. Third, one could limit assistance to a dollar amount or a percentage of costs of each disaster, hoping other funds will come in later to fund the full operation. As a provider of last resort the aid agency would forfeit the gains of timely intervention. As a provider of first resort an agency could only provide aid based on a first-come, first-served basis or an arbitrarily limited basis. None of these approaches ensures efficient and equitable use of funds nor do they enable aid agencies to plan and manage effective operations.

Equity, in the sense of fairness, requires forward-looking risk management.

A more equitable and effective system requires managing contingency funding against a portfolio of risks. Risk, in this context, is defined as the potential loss of lives and livelihoods, ultimately requiring a humanitarian aid response, which vulnerable populations face as a result of natural or other disasters in the developing world. Equity, in the sense of fairness, requires forward-looking risk management. Fairness requires anticipation of the magnitude and probabilities of disasters that may occur over the course of a budget period. To be fair, financial allocations over the course of this time must reflect our best understanding of this portfolio of risks—the sum of the spatial and temporal distribution of the risks associated with loss of lives and livelihoods faced by vulnerable populations. Allocating resources, such as a fund or anticipated contributions against this portfolio of risks ensures the equitable distribution of funds across emergencies and over time.

Financial efficiency first requires understanding the correlations between potential disasters. Efficient sizing and allocation of relief funds must take advantage of the portfolio effects of noncorrelated or countercorrelated risks in order to understand how limited capital should be allocated to distinct risks and regions over time. Second, an optimally designed disaster aid finance system must also make use of risk transfer opportunities in order to take advantage of the potential financial efficiencies gained by including vulnerable population risk in commercial risk portfolios held by international reinsurers and hedge funds, as well as to leverage existing capital and risk-taking capacity. This new approach to disaster aid finance promises several advantages. These include more timely and predictable aid in times of crisis, risk price information for sound development portfolio decisions and greater dignity for the beneficiaries. It may also include greater political support for aid by bringing the financial advantages if diversifying developing country natural disaster risk into the international risk markets. This article discusses how one would build such a system.

Managing Disaster Risk Portfolios

Similar to traditional risk-taking entities, actors in the international aid community have important roles as insurers. Indeed, the World Food Programme (WFP) plays a de facto role as insurer of last resort for vulnerable populations facing food shortages in the developing world. But unlike a traditional insurance company, beneficiaries of this protection do not pay a premium. Furthermore, the WFP raises aid funds from donors after the disaster—the loss—has occurred. Despite these differences, there is still an inherent "insurance" obligation in the WFP's work. The WFP honors a promise to provide assistance, mainly in the form of food, in times of loss. But more importantly, the WFP has the extra responsibility of providing life-saving aid. Whereas in the developed world, waiting a few months for a car insurance claim settlement or the payment of a hospital bill is not a matter of mortal peril, the timing of humanitarian assistance in the developing world has critical consequences.

Similar to other (re)insurance companies or financial institutions, the WFP and other actors in the international aid community hold a portfolio of risks. They hold portfolios of contingent liabilities—inherent to their mission of aiding vulnerable populations in times of crisis—that are triggered not by movements in the financial markets, but, like any other agriculture or property/casualty (re)insurer, by drought, earthquakes, floods and conflict. These financial liabilities manifest themselves not in cash claim settlements, but in the mobilization of aid workers, shelter, water, food, clothes, health care and all the other aspects associated with emergency relief.

Thus, acknowledging the insurance nature of humanitarian aid and the critical role of financing requires more than establishing a fund to make cash readily available for emergency relief operations; it requires that the international aid community fully harness the tools and methodologies developed in the financial and risk markets over the past three hundred years to improve their performance.

The Risk Manager's Toolkit

Implementing such a risk management transformation will require the humanitarian aid community to address important questions regarding the risks we hold on behalf of vulnerable populations. Questions include the following:

- How large are the contingent liabilities—the droughts, floods and potential conflicts—in our portfolio, and how do they relate to one another?
- How likely is it that a catastrophic drought will happen in, say, Ethiopia this year, and how much money will we need to adequately assist affected populations if it does?
- How much of the contingency funds available should be set aside for Ethiopia given the other emergencies that are likely to occur?

- How likely is it that we will need more than $x million to cover all the emergency relief operations we will need to run in the next twelve months?

These questions, which would be mandatory in analogous situations in the financial and corporate world, are not generally asked, let alone answered, by those whose responsibility it is to assist vulnerable populations through emergency operations.

Financial institutions monitor and manage risk on a daily basis, calculating measures that describe different aspects of the risk in their financial portfolios every day for every market variable to which they are exposed. These hundreds of calculations are synthesized for senior management each day into a single figure, a portfolio's Value-at-Risk (VaR), an attempt to summarize the total financial risk an institution is bearing.[2] The aim is to make a statement along the following lines: "We are 99 percent confident that we will not lose more than x dollars in the next n days," where x represents the VaR over the given time horizon.[3] VaR has become a risk measure commonly used by financial institutions—bank regulators use it to determine the capital a bank is obligated to keep to reflect the market risk it carries—as well as by chief financial officers and fund managers.[4]

Equally, rating agencies require insurance and reinsurance companies to hold capital, known as a capital charge, against the potential losses they face—measured by VaR or a similar risk metric—in order for a company to maintain its investment grade rating.[5] However, despite the obvious links between risk, its consequences for vulnerable populations and humanitarian aid, the international aid community has been surprisingly slow in converting an uncertain future into an opportunity and capitalizing on the benefits that risk management offers.

Before beginning to manage risk the first step is to understand and quantify it. This mandates recognizing and identifying the frequency and potential magnitude of the risks one faces over a given time horizon in the future. If, for example, one had a $500-million contingency fund for sub-Saharan Africa to be used to financially cover the contingent "claims" of vulnerable populations at risk to natural disasters by providing humanitarian aid, at least two aspects of the portfolio of risks must be quantified.

The first is the expected total cumulative triggered "liabilities" of the portfolio in a given timeframe and the second is the VaR of the portfolio over the same period. The former is important in order to understand the required working capital that such a fund would require and the latter is an estimate to understand the contingent capital that would be required to ensure the fund can function and assist vulnerable populations at all times.

The primary aspect to be quantified is the expected or average total cumulative triggered liabilities that will need to be covered by the fund in a given time frame, for example, a budget year. Ideally there would be enough money in the fund to cover this base-load of expected needs and emergency operations as a result of the various natural disasters and combinations of disasters that vulnerable populations in sub-Saharan Africa suffer on average each year. The secondary aspect is the VaR of the portfolio, that is the possible amount that could be triggered from the fund in the same given time frame, at a given confidence level, as defined above. The insurance "policy" offered to these populations through the promise of aid covers drought, flood, earthquakes, cyclones, tsunamis, volcanic eruptions—against a background of manmade disasters such as conflict and health pandemics—and must be settled in a timely and appropriate manner given the needs victims of such disasters face, irrespective of the absolute levels of global needs at the time. The challenge is how to ensure that $500 million is enough to financially cover all the promises that have been made.

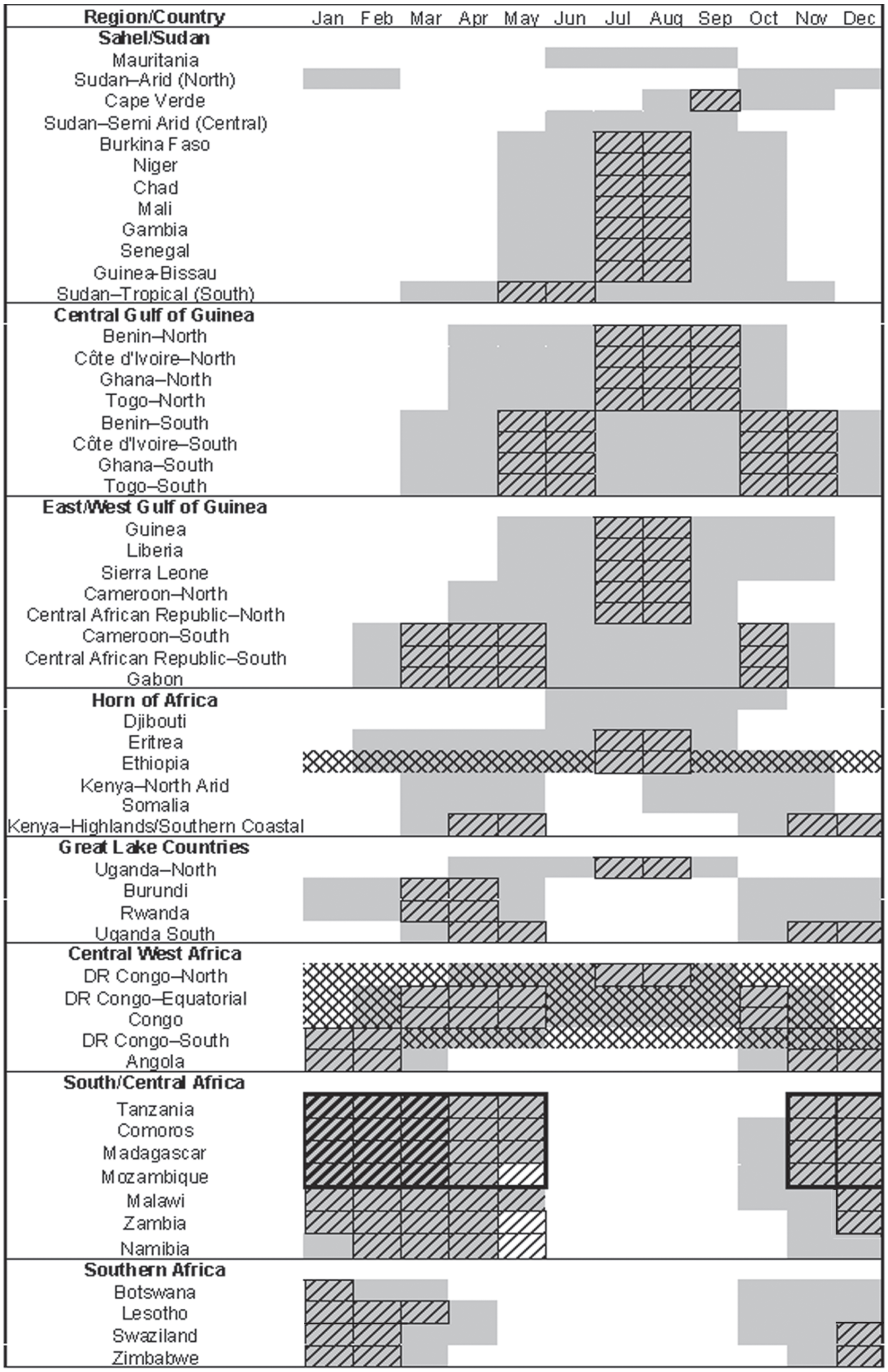
The Humanitarian Enterprise

To give an example of the orders of magnitude involved in relief, the WFP requires approximately $188 million per year for Emergency Operations (EMOPs) and Protracted Relief and Recovery Operations (PRROs) to assist beneficiaries with food aid in sub-Saharan Africa as a result of natural disasters.[6] On average $180 million of this is a result of drought.[7] However, in some years this number of triggered "liabilities" can increase significantly. For example, in 2000, the WFP required $533 million to launch emergency relief operations to assist vulnerable populations affected by weather related crop failure and livestock losses, in addition to $495 million to assist vulnerable populations as a result of conflict.[8] In order to better understand and therefore manage this financial risk, a hypothetical fund of $500 million must proactively monitor and interpret the portfolio of risks it holds on behalf of vulnerable populations every season. By beginning to monitor and anticipate the financial requirements as they evolve during a calendar year, the organization will be in a stronger position to allocate and secure appropriate financial resources ahead of when they will be required, resulting in more timely and predictable aid.

Table 1, on the following page, shows a rough calendar of natural disaster risks in sub-Saharan Africa. Gray entries represent the months of rainfall seasons, which generally coincide with the potential drought risk periods in each country; right-left diagonal shading represents the peak of seasonal rainfall, generally coinciding with the peak excess rainfall and flood risk period in an area. Entries with a thick black border indicate areas at risk from cyclones during the Indian Ocean cyclone season, with bold right-left diagonal shading representing the peak cyclone season. Crosshatched entries are areas at risk to seismic and volcanic activity.

The calendar highlights the significant rainfall months for the regions and countries of the sub-Saharan continent. It essentially tracks the annual progression of the Inter-tropical Convergence Zone (ITCZ)—a semi-permanent band of intense cumu-

Table 1: Calendar of Natural Disaster Risks in sub-Saharan Africa



Source: Authors synthesized from information on http://www.fao.org/giews/workstation and http://www.bbc.co.uk/weather/world/city guides.

lus convection—as it follows the high-sun of the boreal and austral summers, crossing the equator and bringing with it the distinct rainy seasons that mark the beginning and end of agricultural seasons in Africa.[9]

With the notable exception of the equatorial regions in the Horn of Africa, most regions at risk of drought lie further away from the equator at the northern and southernmost, and most unreliable, extents of the ITCZ's progression.[10] These countries rely on the performance of the rainfall season—in terms of the timing of onset and cessation of rains, as well as the quantity and the distribution of rainfall—for their domestic agricultural production. Therefore, these rainfall seasons coincide with the drought risk periods for these regions and determine the food security of vulnerable populations that live there. The arid and semiarid regions, such as northern Mali, southern Ethiopia, Somalia, northern Kenya, Botswana and Namibia are predominantly areas that cannot support agriculture, yet pastoral populations who live in these areas, critically depending on the scarce annual rainfall to ensure sufficient grazing pasture for their livestock, also face significant drought risk.

The predominant risks faced by vulnerable populations in sub-Saharan Africa are meteorological in nature.

Although drought is by far the predominant risk to the lives and livelihoods of a contingency fund's clients in sub-Saharan Africa, the peak rainfall months of the agricultural seasons also coincide with the highest risk period for excess rainfall and flooding. Particularly for those living near major rivers such as the Limpopo and Zambezi this excessive rainfall can damage or wash away crops, livestock and homes. In addition, the coastal regions of Mozambique and southern Tanzania, and particularly Madagascar and the Comoros Islands, are at risk from heavy rainfall and strong winds from tropical cyclones that can form in the southern Indian Ocean from November to April. And although there are no major fault lines in sub-Saharan Africa, populations living in certain areas are also at risk of seismic and volcanic activity. However, the predominant risks faced by vulnerable populations in sub-Saharan Africa are meteorological in nature and hence they, particularly drought, will be the primary focus of the discussion below.

Monitoring Drought and Other Disasters

From a risk management perspective, the critical advantage of these natural disasters outlined in Table 1, over manmade disasters such as conflict, is that they can be objectively observed and monitored in real time. A network of weather stations and satellites continually observe and report data detailing the meteorological and agricultural conditions throughout the sub-Saharan continent.

This data can be used to track events that impact vulnerable populations: the progression of agricultural seasons; abnormally high rainfall in localized areas or in river catchment areas; the strength and position of cyclones; and meteorological conditions that impact the breeding activity of locusts in certain regions and therefore control the likelihood of pest attacks, which can devastate farmers' crops, or even the outbreak of malaria epidemics.[11]

Moreover, the data that describes the risk faced by vulnerable populations has been collected for several years. High-resolution satellites have been consistently monitoring rainfall and other related indicators in sub-Saharan African since 1995, and lower-resolution satellites have been in use since 1979. Under the guidance and control of the UN World Meteorological Organization, weather data has been collected by National Meteorological Services in a consistent manner for over thirty or fifty years in most African countries.

The availability of real time *and* historical data presents a powerful opportunity for the international aid community. Not only can the real-time data be used to update the early warning systems that already exist for sub-Saharan Africa, but the availability of historical data also gives the community an opportunity to *index* the risks that vulnerable populations face to observable and readily available variables that are reported or monitored on a daily basis. Indexing risk to an observable variable is an attempt to carry out a needs assessment for vulnerable populations beforehand. As soon as a risk event is observed, an estimate of the humanitarian need and their financial implications can be made by using all the information and expert knowledge that is available. This builds upon and improves already existing early-warning systems. Furthermore, as discussed in the following section, the presence of historical data also allows for the quantification and measurement of risk, enabling financial preparation for events that may happen in the future.

Historical data allows the measurement of risk and makes financial preparation for future events possible.

Using the analogy of an insurance company, indexing is essentially setting up the claims adjustment process prior to the "insurance" being offered to vulnerable populations. In other words, it is an apolitical and objective *ex ante* assessment of the risk exposure. Fundamentally, all risks outlined in Table 1 can be indexed, to a greater or lesser extent, to create observable proxies for the exposure that vulnerable populations have—which is passed on financially to the international aid community—to natural disaster risks in sub-Saharan Africa.

Consider a volcanic eruption as a straightforward emergency. As soon as one is detected, information from previous eruptions in the area and past emergency relief responses can be used to estimate the financial implications of a humanitarian response immediately and to make appropriate financial allocations without physically assessing the on-the-ground status of affected populations.

Consider the example of a drought-prone agricultural area. A comparison of previous rainfall seasons measured by weather stations in the area to the corresponding emergency relief operations allows one to establish the relationship between rainfall—its timing, quantity and distribution—and its subsequent impact on vulnerable populations. Creating a drought index means mapping esoteric information, such as millimeters of rainfall, into meaningful indicators for the responding agencies, such as the expected capital required to assist needy populations in the area if a drought of a given magnitude occurs in the future. By monitoring the evolution of such a drought index during an agricultural season and comparing this evolution to historical seasons and interventions, one can make an estimate as to the likelihood and magnitude of a crisis event by the end of the season.

More importantly, the financial requirements of the humanitarian aid response that would result can be estimated *as the season evolves and the rains fail*, without having to wait for time-consuming needs assessments, traditionally carried out by aid agencies in the months following the expected harvest at the end of the rainfall season. Existing early-warning systems are not designed to assess the *financial* implications of events as they evolve or occur. They do not currently capitalize on the expertise and wealth of information that the international aid community has on its own activities and the beneficiaries they serve. But by putting the past at the service of the future, we can turn the currently ineffective system—the response to an observed disaster is only possible if funding is available—into a powerful financial planning and decisionmaking resource.

Quantifying Natural Disaster Risk

Proxy indicators are not perfect predictors of actual events on the ground. However, in the context of humanitarian aid, estimating the cost of an emergency relief operation for the purposes of risk management and *ex ante* capital allocation does not need to be accurate to the nearest dollar. This is a multimillion-dollar enterprise that can and should, given a thorough understanding of the overall nature and timing of risks for which it is responsible, assume a significant amount of "give" and flexibility in how resources are allocated over time. Indexing risk therefore should reflect the best efforts of the international aid community to understand the portfolio of risk they hold, the financial obligations they have made and the flexibility they can assume to optimize the resources at hand. As we will see, indexing risk is a powerful tool for making first-order estimates of the frequency and potential financial magnitude of events over a given time horizon. Moreover, if based on an independent, objective, verifiable and replicable dataset, an index also creates an opportunity to secure contingent capital where potential shortfalls in funding are identified.

By indexing the required aid response to observable risk variables, we can create potentially longer synthetic histories of risk than are nominally available in the databases of humanitarian aid agencies and as a result mine deeper into the information they contain.[12] For example, to continue the drought index example introduced above, if thirty years of historical rainfall data is available for the stations that were used to design the drought index, then thirty index values can be calculated. Each index value represents the aid costs, at current dollars, that would result if today's vulnerable population living in that area were to experience each of the rainfall seasons that have occurred in the past thirty years. After adjusting for any trends in the data, we can take this a step further by calibrating a model and using a Monte Carlo method to simulate thousands of rainfall seasons and therefore index values and generate an entire distribution of potential drought events and the aid requirements that such droughts would entail.

With a distribution, we can therefore estimate powerful statistics *before* an agricultural season begins. We can anticipate the expected aid that this population will need in the forthcoming season, the expected variability in this value, as well as the potential level of aid that could occur at a given confidence level and the financial implications associated with such a scenario. Such an estimate of the VaR is an initial indicator for the capital that should be allocated to this potential risk for this population before the season begins, to be modified as the season progresses. We are now beginning to answer the first set of questions we asked at the beginning of the article.

Disasters without Borders

Natural disasters know no national boundaries. Droughts in particular are covariant risks that affect large geographical areas at the same time. There is extensive literature to suggest southern Africa is particularly at risk from large-scale drought during El Niño events, as is the Sahel.[13] Yet El Niño events, modulated by sea surface temperatures in the southern Indian Ocean, have also been associated with heavier rainfall seasons from June to September in the Horn of Africa.[14]

It is well known that during an El Niño, an abnormal warming of the eastern and central tropical Pacific sea surface temperatures—the planetary-scale divergence—the motion of atmospheric flow is substantially altered.[15] Depending on other boundary conditions, this can impact the position and strength of the ITCZ either indirectly through changes in the large-scale atmospheric circulation or directly through interaction with local sea surface temperature anomalies that may or may not be related to the warming in the Pacific.[16]

These large-scale boundary forcings on the ocean-atmosphere system may also introduce correlations or countercorrelations between meteorological events in the tropics and weather conditions in midlatitude regions, such as North America and Europe. Regardless of the physical mechanisms involved, it is clear that the incredibly complex and nonlinear nature of the ocean-atmosphere system implies that the spatial and temporal frequency and magnitude of systematic meteorological risk events affecting distinct geographical regions of the sub-Saharan continent could be potentially magnified or attenuated given the atmospheric and oceanic conditions that prevail.

An equitable and efficient approach to humanitarian aid financing therefore implies that one should not approach the risk analysis problem on a country-by-country basis, what is known as the "silo" approach to risk management, but by considering the overall portfolio of risks together—the interaction between countries, risks and regions. This is not only to understand the overall financial requirements the international aid community must be prepared for in order to assist the vulnerable populations living in Africa, but also to financially capitalize on any natural diversification or even negative correlations that are inherent within the ocean-atmosphere system.

The following example illustrates the financial efficiencies of the portfolio approach over the silo approach in determining the magnitude of the funds that should be set aside for an emergency in one country given that other emergencies are likely to happen in other countries. Assume we find, through a country-specific risk analysis, that the VaR of the humanitarian aid response for the vulnerable populations of Malawi, at the 99 percent confidence level, is $70 million for the forthcoming agricultural season. A similar analysis for Tanzania yields a VaR, at the 99 percent confidence level, of $50 million. Under a silo approach, this would imply that $70 million of capital—hard or contingent "soft" capital—would need to be allocated to Malawi to ensure the financial "worthiness" of the obligations to vulnerable populations inherent in our mandate, and $50 million would have to be allocated to Tanzania, i.e., $120 million of capital in total would have to be deployed into a standby contingency fund prior to the agricultural season.

However, an analysis of the historical data for Malawi and Tanzania shows that both countries have never been affected adversely by weather conditions to such an extent that both have needed an emergency response equivalent to their individually determined VaR levels in the same season. In fact, by running simulations for the risk indices of both counties, capturing the various correlations between the different risks, we find that the VaR of the overall Tanzania-Malawi "portfolio" is only $80 million. That is, given a distribution of possible simulated scenarios, we are 99 percent confident that a humanitarian aid response for both countries together in any given agricultural season will not exceed $80 million. Therefore, when using a portfolio approach, only $80 million of risk capital needs to be allocated to both countries beforehand, freeing $40 million to be allocated elsewhere.

The theory behind the financial advantages of managing diversified risks in a portfolio, rather than on an individual basis, is not a new concept. Yet in the international aid community, where donations are very rarely given on a multilateral basis but on a country-by-country basis, such benefits are not traditionally exploited.[17] Therefore, when considering a portfolio of humanitarian aid risks comprised of many countries, the most efficient use of capital can only be made if the capital allocated to the portfolio is truly fungible.

Allocating Capital

Given a limited financial allocation, a portfolio of risks *can* be retained and managed if the risks are significantly diverse in their characteristics. Understanding the extent of this diversification then becomes critical to being able to assess the overall VaR, and by extension, the amount of capital required to support the portfolio.

With historical data, we can begin to establish the correlations between different risks in different regions and seasons: the correlation between drought indices for different drought-prone countries; the correlation between drought indices and flood indices; the correlation between risks in the southern hemisphere to those in the northern hemisphere; and the correlation between pest attacks in the Sahel and drought events in Malawi. From this data we can simulate thousands of possible combinations of events that can occur over a given time frame, capturing correlations between events through space and time, and generate thousands of potential emergency aid scenarios for sub-Saharan Africa.[18] We can include the possibility of additional risks in the seasons we simulate by including exogenous random shocks, such as earthquakes and volcanic eruptions, and observe how they impact the overall risk profile. Although not indexable to objective variables, even political risks such as the outbreak of new conflicts can be considered to a certain extent in the portfolio of risks as random shocks to the system during any given year.[19] We can estimate the total expected annual aid requirements for vulnerable populations in administrative areas, countries, regions and for sub-Saharan Africa. We can establish the annual VaR estimates by risk, by season, by population, by geographical region and, ultimately, for the overall sub-Saharan portfolio of risk.

Natural disasters know no national boundaries.

So what practical implications do the discussions above have for the management of a hypothetical $500-million fund for natural disaster risk in sub-Saharan Africa? According to observations in Table 1, a natural break in the natural disaster risk year occurs in May, as the ITCZ makes its way north across the equator, signifying the end of the agricultural season in southern Africa and heralding the forthcoming agricultural risk season for the northern countries.[20] June to May, therefore, could be seen as a logical budget year for our fund and the period for which our portfolio risk statistics should be calculated. An initial analysis using the indexing approach outlined above will establish the working, or hard capital required by the fund, that are the expected cumulative triggered "liabilities" that will need to be covered by the fund in a budget year. This analysis must be complemented with country-level working capital estimates to understand which risks contribute most to the working layer of the fund, as well as when and where they occur on average in a budget year. Ideally, the hard capital required to service the entire natural disaster risk portfolio for each budget year will be less than the $500 million available; the working capital analysis will indicate how the overall working capital required should be allocated geographically and over time.

A VaR analysis will estimate the total potential liability this fund could have in any given year, at a given confidence level, and therefore serve as an indication of the likelihood that the $500 million fund could be exhausted or insufficient to cover all contingent "claims" that must be settled within a budget year—thus answering the last question asked at the beginning of the article. Given the potential for systematic risk in the atmospheric system, the probability distribution of the overall risk portfolio during the budget year will no doubt be significantly skewed with a long tail. The 99th percentile of "losses" is almost certain to exceed the available hard capital of $500 million. If, for example, the working capital of the fund is estimated to be $250 million for the forthcoming budget year, how should the remaining $250 million be used to ensure the fund remains solvent and claims can be serviced, if the VaR of the overall portfolio is estimated to be $1 billion? If the fund functioned as an actual commercial insurance company, it would be required by ratings agencies to either hold capital, equivalent to a risk measure such as VaR, against this risk, or alternatively to reduce the VaR the company is running. Insurance companies traditionally do this by seeking reinsurance for their insurance portfolios, that is, leveraging their working capital to enable them to hold more risk.[21] What should a hypothetical humanitarian contingency fund, acting as a de facto insurer, do?

The Pilot Case

To answer this question, consider the four options available at the start of each budget year for our hypothetical fund: (1) do nothing; (2) ask for more money from donors; (3) ask for contingent capital from the donors; or (4) consider contingent capital from the international risk markets.

Option one proposes doing nothing other than allocating the remaining $250 million proportionally among the various regions outlined in Table 1 by the size of each region's VaR. This is obviously an unsatisfactory approach as it is based on the hope that the natural disasters that occur in the coming budget year require a total financial commitment from the fund of less than $500 million.

The second option is to ask donors to contribute a further $500 million to the fund so that it has a capital holding equivalent to the VaR the portfolio contains. From a capital charge perspective, such a strategy is a valid albeit expensive approach, and hardly an efficient use of $500 million, a significant amount of capital that could be put to work elsewhere.

The third option is to establish a contingent capital agreement with a donor or donors. If the $500-million fund is exhausted, the donor community will replenish the fund or provide the excess capital required to address outstanding or potential emergency relief operations for the rest of the budget year. In this case it may be difficult to guarantee timely availability of funds on such short notice. Donors are constrained in their generosity by budget cycles and other financial commitments, yet timely financing is critical in facilitating a prompt response. To be regrettably informed by a donor that due to an unexpected earthquake in Central America they will be unable to honor a contingent capital agreement this year will be of little consolation to vulnerable populations waiting for humanitarian assistance in Africa. Asking donors to set aside funds for contingencies is also an inefficient use of a donor's capital as it could be used for a more effective humanitarian aid purpose elsewhere.

The fourth option is to use some of the capital that is not needed for the working layer of the fund to purchase and secure contingent funding for the additional $500 million from the international risk markets. Although available at a premium, risk-taking entities such as international reinsurers are required to hold capital against the risk they bear and are ultimately the most cost- and time-efficient source of contingent capital. A global reinsurance company's incremental cost of taking on a new risk into its diversified portfolio is significantly less than the cost of that risk to the entity that is seeking to transfer it. The Malawi and Tanzania diversification example illustrates that the entity that bears the risk must hold the entire VaR in capital against it. However, in the reinsurer's portfolio the VaR of the new transaction will only incrementally increase the VaR of their global portfolio, hence the reinsurer has to allocate significantly less capital to the portfolio to accommodate this new risk and can therefore manage it more efficiently.[22] Additionally, this strategy enables donors to free any capital they have been reserving for contingency purposes, for more effective use. Of the four options, this is the least-tested strategy, but given its potential benefits, it warrants further consideration and will be revisited in the following section.

Finally, once the optimal capital charge allocations have been made in advance of the budget year, as the season progresses from June onward the fund must monitor risk indices as they evolve, deploy capital in a timely fashion to vulnerable populations who need assistance and reallocate capital for risks ahead of the calendar, by VaR, as it is freed from allocation to risks that have not materialized.

Some Possible Implications

A prerequisite for being able to manage such risk financially through commercial contingent capital agreements is the definition of an independent, objective, verifiable and replicable index. Such an index, which proxies the financial risk of the underlying portfolio, can be the basis on which a derivative contract, a securitization, a finite financing contract or any other contingent capital agreement can be structured. In order to implement a successful index-based risk management program, the data used to construct the underlying index must adhere to strict quality requirements.[23] These include reliable and trustworthy ongoing daily collection and reporting procedures; daily quality control and cleaning; an independent source of data for verification; and a long, clean and internally consistent historical record to allow for a proper actuarial analysis of the risks involved. In the international weather risk market at least thirty years of daily data are ideally required. The premium associated with index-based risk management strategies is based on a sound actuarial analysis of the underlying risk. Since the appropriate premium charged by the commercial risk-taker will reflect the probability and severity of a specific event the quality of historical and ongoing underlying data is paramount.

The WFP has recently entered into the first-ever humanitarian aid weather derivative contract with a leading European reinsurer to pilot this approach. The contract provides contingency funding in case of an extreme drought during Ethiopia's 2006 agricultural season. From March to October the WFP and government of Ethiopia will be monitoring the twenty-six-station Ethiopia drought index on a daily basis and determining the contract's value by using a "mark-to-model" procedure as the underlying rainfall data is recorded throughout the contract period. Essentially, the contract's value will vary according to the incoming data, and by updating the model—the rainfall pattern expected in Ethiopia during 2006 at the outset of the season, as determined from historical precipitation data—the WFP and the government of Ethiopia can anticipate the likelihood of severe losses over the course of the agricultural season and assess their financial preparedness.[24] Payment will be triggered when data gathered over a period from March to October indicates that rainfall is significantly below historic averages, pointing to the likelihood of widespread crop failure. While the experimental pilot transaction only provides a small amount of contingency funding, the model is calibrated to the potential losses suffered by the seventeen million Ethiopian farmers who risk falling into destitution as a result of extreme drought.

Timely financing is critical in facilitating a prompt response.

Weather market players from both the reinsurance and financial communities—a growing market, valued at $8.6 billion of outstanding risk in the most recent industry survey—are interested in new developing country transactions, such as the WFP's Ethiopia drought risk management pilot.[25] In addition to core weather market participants who offer risk management products to customers, professional investors—such as alternative risk hedge funds—are also becoming interested in weather risk and are beginning to source excess risk from the primary weather market.[26] Weather is an uncorrelated risk that can enhance their portfolio positions and differentiate them from other funds that deal in traditional financial markets. The new risks, introduced by the new developing country locations, allow for more diversification and hence enhance the risk/return characteristics of commercial risk portfolios. Ultimately, this should lead to more aggressive pricing of weather insurance products in the global market, which in turn should lead to more firms entering the sector attracted by greater market liquidity. In due course this should result in greater business growth and expansion through broadening product offerings and increasing global networks that will benefit the end-user customers seeking risk management products.

A valuable new tool for humanitarian aid

Of course not all risks outlined in Table 1 can be indexed to variables with historical data that satisfy all of the risk-transfer requirements outlined above. Nor can all risks be indexed with the necessary accuracy for risk monitoring, quantification and risk transfer. In addition, despite our best efforts, the limits of our understanding and the models used to quantify and index risk of such complexity must always be seriously considered in any risk management decisions that are made. However, in line with the theme of diversification this article has been expounding, the most cost-efficient way to transfer risk is on a portfolio rather than a "silo" basis, as long as capital made available for humanitarian aid is fungible. Therefore, for our hypothetical fund, the best hedge must be found by using a combination of indices that satisfy the criteria and that best capture the overall risk of the portfolio. The potential risk transfer strategies and products available are many and beyond the scope of this brief overview. Applying the principles of risk management to humanitarian aid introduces to the international aid community a whole realm of risk management tools, strategies and risk metrics that the financial and risk markets have been developing for centuries. All possible tools and approaches should be considered to find the optimal contingent capital strategy in terms of cost and efficacy.

This new approach to disaster aid finance—creating contingency funding against a portfolio of risks—promises several advantages. These include more timely and predictable aid in times of crisis and risk price information for sound development investment decisions. The advantages also include greater dignity for the beneficiaries as we shift away from a business model that has to rely on advertising their misery. An additional advantage may derive from the greater political support for aid that might result from the financial advantages that accrue from the portfolio effect of bringing developing country natural disaster risk into the international risk markets.

This is only a first sketch of what will be a long and arduous journey. Many obstacles will have to be overcome before we can hope to reach a point at which the international aid funds are truly maximized to the benefit of vulnerable populations. The concept of emergency aid not as post-disaster charity but as insurance may be difficult for many participants in the international aid community to accept. The sophisticated financial and technical expertise is limited to a few organizations and then only in the most rudimentary forms. Nonetheless, if we are to create an international emergency aid scheme designed to maximize the position of the leastadvantaged, using a more secure financial basis for the enterprise based on calibrated contingency funding against a portfolio of risks seems a critical step.

NOTES

[1] One can create timely funding by treating possible future contributions as contingency funding through effective income forecasting and borrowing. Borrowing against future contributions does not require 1:1 equity; leveraging equity such as in the World Food Programme's (WFP) working capital financing (1:3 and in the future possibly 1:7) is a much more effective use of capital than 1:1 equity to loan revolving funds such as the Consolidated Emergency Revolving Fund and its expanded version recently created by General Assembly. Leveraging capital, however, requires more advanced financial management.

[2] Value-at-Risk (VaR) belongs to a category of prospective risk metrics that describe the risk of a portfolio over a given time horizon probabilistically. Essentially VaR can be measured by any parameter that describes the distribution of a portfolio's future value and as many VaR metrics are possible.

[3] Definition from John C. Hull, *Options, Futures & Other Derivatives,* 4th Edition (Prentice Hall, 2000), 342.

[4] Central bank regulations require that VaR be calculated as the 99th-percentile of a portfolio's loss distribution over a ten-day horizon, the capital holding required is equal to three times this number. From Hull.

[5] For a recent example of such considerations see Standard & Poor's Credit Ratings, "Insurance Criteria: Catastrophe-Specific Capital Charges To Be Extended To Primary Insurers, But Reinsurance Criteria Unchanged," (information release, Standard & Poor's, 7 November 2005), http://www2.standardandpoors.com/servlet/Satellite?pagename=sp/sp_article/ArticleTemplate&c=sp_article&cid=1130746318135&s=&ig=&b=2&dct=24.

[6] United Nations World Food Programme, internal Emergency Relief Operation (EMOP) and Protracted Relief and Recovery Operation (PRRO) data for 1991-2003. Internal WFP database: "Humanitarian Trends Database," http://epweb.wfp.org//htdb/index.shtml.

[7] Ibid.

[8] Ibid.

[9] With the expception of the arid and semi-arid regions where agriculture is not sustainable and the tropical wet regions of the central and western equator, such as southern Sudan and Democratic Republic of Congo, where rainfall generally falls throughout most of the year.

[10] Most notably the countries of Mali, Niger, Cape Verde, Chad, Burkina Faso and central Sudan in the Sahel/Sudan region; Eritrea, Ethiopia and the Kenyan Highlands in the Horn of Africa; northern Uganda in the Great Lakes region; Tanzania, Madagascar, Mozambique, Malawi and Zambia in the South/Central Africa region; and Lesotho, Swaziland and Zimbabwe in Southern Africa.

[11] The U.S. Geological Survey continually monitors seismic activity globally and together with the Smithsonian National Museum of Natural History monitors global volcanic activity. Agencies such as the United Nations Food and Agricultural Organization (FAO) or the United States Agency for International Development's (USAID) Famine Early Warning Systems Network (FEWSNET) convert meteorological information into meaningful indicators for agriculture, such as the expected status of the dominant crops grown by populations in the various agricultural areas given the quantity and distribution of rainfall that has been received so far in an agricultural season, using satellite data covering the entire globe at approximately 10km horizontal resolution. Other satellite products, such the Normalized Difference Vegetation Index (NDVI), that directly monitors crop production by observing biomass, are also available. J. Roffey and J. I. Magor, "Desert Locust Technical Series: Desert Locust Population Dynamics Parameters," (report, United Nations Food and Agricultural Organization, Rome: 2003), http://www.fao.org/ag/locusts/common/ecg/330_en_TS30.pdf; M. C. Thomson et al., "Malaria early warnings based on seasonal climate forecasts from multi-model ensembles," *Nature* 439, no. 7076 (2 February 2006): 576.

[12] WFP, for example, has historical data on emergency relief operations going back to 1991.

[13] C. F. Ropelewski and M. S. Halpert, "Global and regional scale precipitation patterns associated with the El Niño/Southern Oscillation," *Monthly Weather Review* 115, no. 8 (August 1987): 1606-1626; U. C. Hess and J. Syroka, "Weather-Based Insurance in Southern Africa: The Case of Malawi," (discussion

paper 13, Agriculture and Rural Development Department, World Bank, Washington, DC: 2005); A. Giannini, R. Saravanan, P. Chang, "Oceanic Forcing of Sahel Rainfall on Interannual to Interdecadal Time Scales," *Science* 302, no. 5647 (7 November 2003): 1027-1030.

14 For example, FEWSNET, "Greater Horn of Africa Food Security Update," (report, 22 April 2002), http://www.fews.net/centers/files/East_200203en.pdf.

15 M. H. Glantz, R. W. Katz and N. Nicholls eds., *Teleconnections linking worldwide climate anomalies: Scientific basis and social impacts,* (Cambridge: Cambridge University Press, 1991).

16 Sea surface temperature anomalies in the Indian Ocean and Atlantic have been found to be important for understanding the variations in rainfall in the African continent (Giannini et al, 2003). The former, together with conditions in the tropical central and eastern Pacific, are also important for the probability of occurrence of cyclones in the Indian Ocean. S. P. Xie, H. Annamalai, F. A. Schott, J. P. McCreary, "Structure and Mechanisms of South Indian Ocean Climate Variability," *Journal of Climate* 15, no. 8 (April 2002): 864-878.

17 Harry M. Markowitz, "Portfolio Selection," *Journal of Finance* 7, no. 1 (March 1952): 77-91.

18 It should be noted that results from simulations used to determine the underlying distribution of risk, from which risk metrics such as VaR can be measured, should always be interpreted with caution. Monte Carlo simulations and the models used to perform them are not perfect. For example, building simulation models that correctly capture the physical relationships between many meteorological variables at many sites poses significant scientific, mathematical and programming challenges and may not adequately reflect the risks being modelled. Furthermore, as models are often calibrated by events that have happened in the past they may not accurately capture events that may happen in the future. New risks or conditions that have not been considered, such as the impact of climate change, or non-weather related unifying risks that impact an entire portfolio at once, such as an avian flu pandemic, may render such simulations insufficient. However, attempting to quantify these risks, particularly statistics such as VaR, through Monte Carlo simulation is superior to simply using historical emergency relief data. The hope is that as our understanding evolves such work can be improved and refined.

19 While conflict (one would hope) is an unknown element, the risk of new conflict outbreaks in the short-term (six to twelve months out) can be isolated to certain periods of the calendar year for budgeting purposes. Note that humanitarian aid as a result of conflict and war situations is one of the biggest financial responsibilities that the international community has for sub-Saharan Africa. The WFP for example, spends $454 million on EMOP and PRRO efforts a year on average as a result of conflict and war in sub-Saharan Africa (Source: WFP internal EMOP and PRRO data, 1991-2003).

20 With the exception of some regions in the Horn of Africa, such as Ethiopia, where farmers plant long-cycle crops such as maize in the short "Belg" rains in March-April, in anticipation of the main ITCZ-related rainfall season in June.

21 Ratings agencies actually use Probable Maximum Loss (PML) as the underlying risk measure for capital charge purposes for the (re)insurance industry. For a portfolio of insurance risks this is defined as the modelled maximum loss that expected to occur at a given return period, such as once in every one hundred years or once in every two hundred and fifty years.

22 Robert J. Shiller, *The New Financial Order: Risk in the 21st Century* (Princeton: Princeton University Press, 2003).

23 "Managing Agricultural Production Risk: Innovations in Developing Countries," (report no. 32727-GLB, Agriculture and Rural Development Department, World Bank Report, Washington, DC: 2006).

24 Such as the thirty-year rainfall climatology for the country or some other average baseline.

25 PricewaterhouseCoopers (PWC), "Annual Weather Risk Management Association (WRMA) Membership Survey on Weather Data," (report, National Economic Consulting Group, PricewaterhouseCoopers, Washington, DC: 2005), http://www.wrma.org/wrma/index.php?option=com_content&task=view&id=36&Itemid=34).

26 Professional investors are also participating in the secondary trade market through exchange-based weather futures trading. In 1999, the Chicago Mercantile Exchange began listing and trading standard weather futures and options contracts on temperature indexes. They now list twenty-two locations in the United States, Europe and Japan with an estimated notional value of contracts traded of approximately $4.4 billion in 2004/2005. PWC.