2.5 NOAA CLIMATE PREDICTION CENTER'S
GLOBAL METEOROLOGICAL DATA DISSEMINATION
IN SUPPORT OF THE US AGENCY FOR INTERNATIONAL DEVELOPMENT

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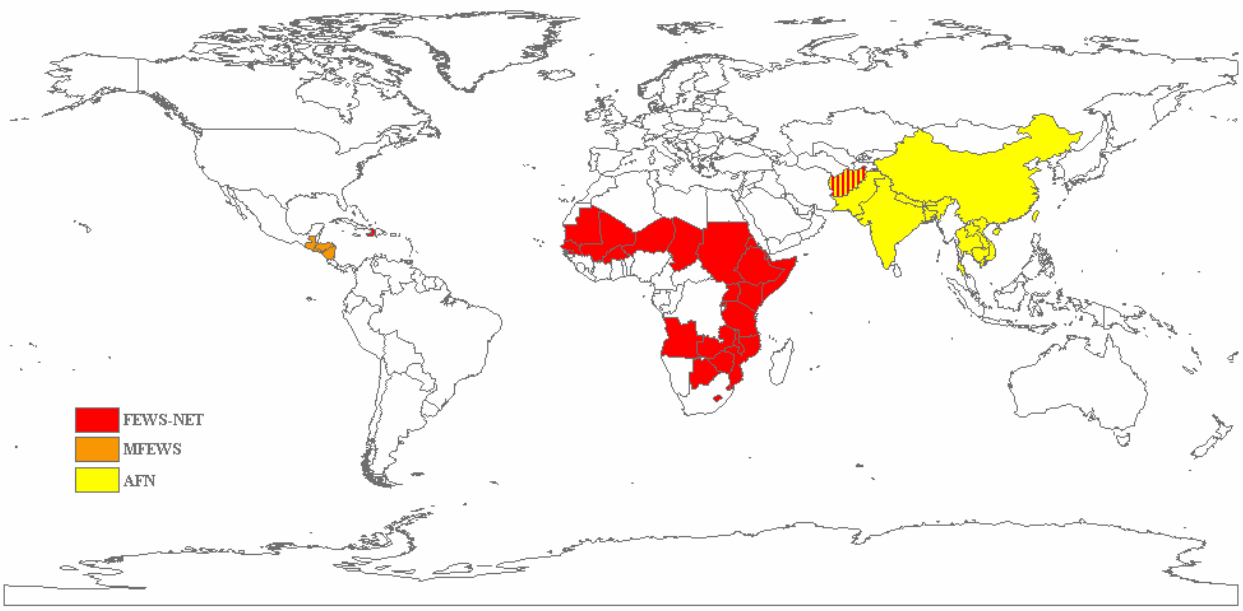
1. INTRODUCTION

The US Agency for International Development's (USAID) project at the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center is dependent on timely, global-reaching information for its daily operations. This sector of the USAID program monitors food security from a meteorological perspective, with its goal to both alert and provide supporting information to decision makers regarding humanitarian emergency situations. This goal becomes problematic to achieve without sufficient accurate data, and is made even more difficult when a humanitarian situation occurs outside of the detailed, discontinuous realm of meteorological data coverage. In response, a global weather monitoring project has been developed in the form of a readily available website to provide both scientists and decision makers with a continuous suite of meteorological products. The Internet address is: http://www.cpc.ncep.noaa.gov/products/fews/global/

There are three programs within USAID that have operations at NOAA's Climate Prediction Center (CPC). (See Figure 1) They are the Famine Early Warning System Network (FEWS-NET), the Mesoamerican Food Security Early Warning System (MFEWS), and the Asian Flood Network (AFN). The FEWS-NET program, which encompasses much of sub-Saharan Africa, formed the beginning of the partnership between the CPC and USAID. The activities that began over the Africa region formed the base for the new international areas of the CPC's coverage that have since been added to the project. Along with the addition of Haiti to the existing FEWS-NET countries, Afghanistan has also been incorporated into the operational monitoring. MFEWS was created with a focus on Central America and the AFN was developed to focus on the Mekong River Area as well as the Himalayan region.

When a humanitarian emergency occurs outside of these existing focus regions, USAID must continue to



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provide relief, and thus the CPC must have the capacity to quickly provide meteorological support. An example of this aspect was the Indian Ocean Tsunami of 2004. Meteorological support was needed for the USAID and other international humanitarian agencies even though many affected countries were not explicitly affiliated with FEWS-NET, MFEWS or AFN.

Along with operations strictly in support of the USAID, the NOAA CPC project provides meteorological and climatic data and forecasts to partners such as the United States Department of Agriculture's (USDA) Joint Agricultural and Weather Facility (JAWF), who monitors agricultural conditions throughout the globe.

With all of these needs compounding their meteorological data requirements: continued expansion of USAID programs, humanitarian disasters occurring globally, and other organizations in need of meteorological products; a forward thinking solution had to be found to meet all users' requirements. This global meteorological monitoring project is a response of these needs. Due to the fact that the project is in the form of a website that is specifically designed to be sensitive to both slower and faster internet bandwidth availabilities, it can be easily accessed from anywhere on the planet that meets the minimal connectivity requirements.

2. GLOBAL MONITORING PRODUCTS

The data disseminated through the CPC global weather monitoring project covers a sufficient temporal distribution to provide a basic insight of the recent climatic conditions, current meteorological analyses, and short to medium term weather forecasts. To address these temporal areas, the core of the project focuses on global atmospheric monthly anomaly information, satellite based rainfall estimate data, infrared satellite imagery, and NOAA modeled weather forecast outputs to two weeks. The website also links to complementary information previously implemented within the NOAA CPC USAID project.

2.1 NCEP/NCAR Reanalysis

To provide an assessment of the current and past conditions of the global atmosphere, a set of products from the NCEP/NCAR Reanalysis project has been added to the CPC global monitoring project (Kalnay 1996) and (Kistler 2001). Based on a 40-year climatology of ground and satellite-based data, the reanalysis provides meteorological variables such as pressure, wind, and temperature at various levels of the atmosphere. This has enabled the creation of global anomalies to complement the raw data available on a monthly basis, and provides the user with a global snapshot of the state of the atmosphere during the past year. Data are provided at a resolution of approximately 250 km.

2.2 Rainfall Estimates

Due to the fact that the availability of ground-based station rain gauge information is poor in many regions of the globe, the project has selected a satellite-based precipitation estimation product to analyze the hydrological conditions of the world. In particular, the NOAA Climate Prediction CMORPH rainfall estimates provide the information that is required (Joyce 2004). The CMORPH, or CPC Morphing method, is a satellite-based rainfall estimation product that uses a combination of polar orbiting microwave rain rate retrievals and geostationary infrared cloud detection fields to model instantaneous and projected global rainfall. This enables the user of the product to determine the absolute rainfall during a selection of previous periods, including total monthly rainfall for the past year, at a horizontal resolution of approximately 8 km.

Using a 40-year precipitation climatology from the Global Precipitation Climatology Project (Huffman 1997) this has enabled the creation of global anomaly and percent of normal maps, from 60 degrees south to 60 degrees north (due to limitations from polar orbiting microwave retrieval methods). Thus, graphics showing areas of excessive and deficient rainfall become evident, and may be used to analyze potential drought or flooding conditions.

2.3 Infrared Satellite Imagery

Geostationary satellite infrared temperature products are available for the global domain to enable real-time monitoring of weather patterns. For each region selected throughout the world, a 24-hour satellite loop is available using information from the CPC global infrared half hourly dataset (Janowiak 2001). The inclusion of this 4 km spatial resolution dataset allows any user to gain a perspective on the current weather activity in the region and therefore is well suited to customers with a wide variety of backgrounds.

2.4 Short to Medium Term Forecasts

To accommodate the varying needs of users of weather data, the CPC global weather monitoring project selected the NCEP Global Forecast System (GFS) meteorological model to display forecast information that is relevant to humanitarian requirements throughout the globe (NMC 1988). The GFS model is the primary physical model used at NOAA for monitoring international land areas, and is accessible to mesh smoothly into the processing techniques necessary for this project. The current spatial resolution of the GFS model is approximately 37.5 km for forecasts in the one to seven day range and 250 km per grid box for forecast outputs in the eight to fourteen day range. Current forecast products displayed at the CPC global monitoring webpage are:

- 24 Hour Precipitation Accumulation
- Minimum Daily Temperature
- Maximum Daily Temperatures

- Surface Pressure, Six Hour Precipitation Totals
- Surface Temperature and Wind Streamlines
- Precipitatable Water and 925 mb Wind Streamlines
- 850 mb Temperature, Pressure, and Wind Streamlines
- 500 mb Pressure, Vorticity, and Wind Streamlines
- 300 mb Pressure, Wind Speed, and Wind Streamlines
- CAPE and Lifted Index
- K Index and Relative Humidity
- Snow Depth
- Change in Snow Depth

2.5 Existing CPC USAID Products

Complementing the global meteorological products described, existing resources are provided from the USAID-funded project at the Climate Prediction Center. The primary tool, forming an important base of the project is the regional rainfall estimate (CPC RFE2) which provides high resolution, accurate rainfall estimates for Africa as well as much of southwestern and southern Asia (Xie 2002). This product integrates satellite rainfall estimates with station-based rain gauge data to create a bias-reduced daily precipitation estimate. Over the Africa region, a high resolution satellite-based rainfall climatology enables the creation of unbiased precipitation anomaly products for the entire continental domain (Love 2004).

Among the other tools available is a collaborative product, which merges information from various scientific and humanitarian agencies, named the Weather Hazards Assessment. The purpose is to provide decision makers and other interested personnel with an advance warning of any weather or climate related phenomenon with the potential to affect people's livelihoods. Currently, the product is available for Africa, Central America & Hispanola, and the Afghanistan region.

3. CONSIDERATIONS AND WEB PAGE FORMAT

The most crucial aspects of data dissemination are that the information provide increased knowledge and must reach the appropriate end user. In order to determine what information should be disseminated, the target audience needs to be identified. For the USAID-funded project at the Climate Prediction Center, there are three primary customers: 1. USAID and partner organizations, including decision makers and environmental scientists alike; 2. International humanitarian agencies; and 3. Local ground-based field personnel. Owing to this triumvirate of users, a common means of displaying and sharing meteorological data was needed. The Internet stood out as a viable method of dissemination. Due to the fact that many countries with the opportunity to benefit from global humanitarian assistance tend to have somewhat limited Internet access, file size is a critical issue. Thus, the products provided from the CPC global weather monitoring project are in medium-resolution graphical format, and all graphic intensive data are accompanied by smaller files intended for low Internet bandwidth connections. The page menu is set up in such a way to minimize the number of graphics on the screen at any one time while maintaining a straightforward and concise flow throughout. Looking ahead, considerations have been made to enable a straightforward addition of modern, supplementary information to the project Internet site as well as the addition of new graphical product spatial domains.

Since users of these products will range from organizations interested in localized areas to those needing a broad perspective of meteorological conditions, an array of spatial graphical windows has been created

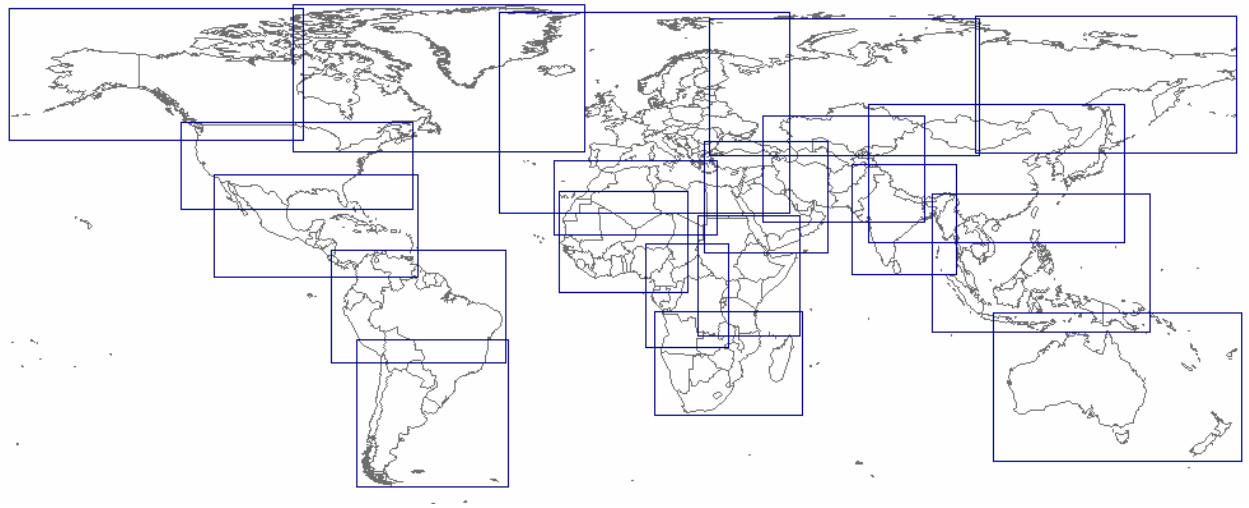

Figure 2. A depiction of product spatial domains. All meteorological products created within the CPC global monitoring project are produced graphically for each of the regions shown. This enables the user to select enhanced, regional imagery for their area of concern.

(see Figure 2). Complementing these regional windows, large-scale continental imagery provides an overview of conditions throughout the area. Between the available geographic scales and given the meteorological and climatic information that is provided, the user is able to determine the overall meteorological situation for any desired region.

4. PRIMARY APPLICATIONS

4.1 Existing USAID-Funded Regional Monitoring

The CPC global weather monitoring project has improved NOAA's ability to support USAID programs. This is the primary function of the USAID-funded work at the Climate Prediction Center, and correspondingly serves as the primary application of the global weather monitoring project. The use of meteorological and climatic imagery created and disseminated via the Internet portal allows the user to gain a perspective of the latest weather conditions for virtually any area throughout the world. Due to the fact that the monitoring of food security conditions is a primary duty of the USAID projects associated with the NOAA Climate Prediction Center, the products contained within the global weather monitoring project allow for a detailed meteorological view of localized regions in question to support agricultural activities. Monitoring of weather related hazards such as flooding and severe weather is also made possible via the combination of available products.

4.2 Support for the Joint Agriculture Weather Facility

CPC, in partnership with the United States Department of Agriculture's (USDA) World Agricultural Outlook Board, forms the Joint Agriculture Weather Facility (JAWF). As part of this cooperative effort, CPC employs meteorologists with a primary responsibility of monitoring daily weather events throughout agriculturally significant regions across the globe.

The Internet and file transfer protocols have become powerful tools in providing weather information to JAWF in downtown Washington, DC, given that the facility is not collocated with CPC in Maryland. The global weather monitoring website created by CPC has been instrumental in providing global meteorological and climatic products extending over the agricultural regions of interest to JAWF. The information and products provided to USDA are utilized to monitor agricultural impacts of droughts, heat waves, freezes, and floods.

A recent example was the wet-season drought in the Iberian Peninsula during the winter of 2004-05. CPC meteorologists, together with USDA agrometeorologists monitored the developing drought and were able to quickly confirm ground and media reports. CPC's tools include satellite precipitation estimates and anomalies, along with forecasts that were relayed through briefings to USDA agrometeorologists and economists.

4.3 Prepositioning of Meteorological Data

Coexisting with the pre-placement of supplies in anticipation of a humanitarian emergency, prepositioning of data is an important aspect of a successful disaster assistance related role. By decreasing the time between a disaster event and the availability of data, more focus can be applied toward providing aid to the people who need it. Thus, a primary concern addressed by the global weather monitoring project is for the CPC to be able to provide meteorological support in a rapid and targeted manner for any possible humanitarian situation. Owing to the global nature of the project, any new area of humanitarian concern that arises will have meteorological support already in place. Take, for example, the Indian Ocean Tsunami of December 2004 and the Pakistan Earthquake of October 2005.

On December 26th, 2004, an undersea earthquake off the coast of Sumatra triggered a tsunami in the Indian Ocean. The enormous wave killed a quarter of a million people and left many more homeless. Shortly thereafter, NOAA received multiple requests for meteorological support. Owing to the existing CPC global weather project, in less than 48 hours a fully functional webpage was established to monitor the northeastern Indian Ocean region. The webpage was designed specifically to assist the myriad of organizations involved with the relief effort, as precipitation forecasts and cyclone monitoring information became the most relevant tools used in this situation.

The northern Pakistan Earthquake of October 2005 devastated much of the region, in a time that the winter season was fast approaching. Along with the numerous deaths, hundreds of thousands of people were left homeless, without substantial shelter, food, or water. Due to the existing global weather project information, meteorological support was provided the next day to a realm of humanitarian agencies.

5. LOOKING AHEAD

The CPC global weather monitoring project is a work in progress. As newer technology and additional data becomes available, and as new demands become known, the project will grow to better support the lack of infrastructure across certain parts of our planet. Primary future products that will be implemented are the use of Geographic Information Systems (GIS) data and the inclusion of quality controlled ground-based station data.

It is apparent that humanitarian organizations throughout the world are moving toward the use of GIS within their daily activities. GIS allows the use of geographically referenced data such that multiple information layers may be compiled and compared to produce a value added product. The NOAA CPC program

has been gradually implementing GIS technology into their daily activities during the past few years, and it is a goal of the CPC global weather monitoring project to convert nearly all of their available products into GIS-format in the near future. Complementing the existing graphical files, these new GID grids will allow a more targeted meteorological support.

A lack of high quality, spatially dense global meteorological data was the problem that initiated the CPC global weather monitoring project. Much of the international station-based information that NOAA currently receives can be inaccurate due to poor local reporting techniques. With this in mind, the NOAA Climate Prediction Center has initiated a project to conduct near real time quality control on ground-based station data received via the Global Telecommunications System Network. This global temperature and precipitation station data will be very valuable as a complement to existing products, especially toward the idea of providing a convergence of evidence when producing weather-related analyses. However; current satellite derived products will continue to be needed in areas lacking a sufficient station distribution.

6. SUMMARY

USAID's FEWS-NET, MFEWS and AFN programs require meteorological data to support humanitarian activities over a large and an ever-growing part of the world. This is the basis for the creation of the CPC Global Weather Monitoring Project at NOAA as a supplement to existing activities. The global nature of the monitoring project provides a continuous suite of meteorological and climatic products over the inhabited Earth and has been specifically designed to compensate for existing shortfalls in global weather data availability and dissemination within the international humanitarian community. Data available over the non-resource intensive internet site include climate products, current weather analyses, and meteorological forecasts, with future applications including GIS-formatted data and quality controlled near real-time precipitation fields. The current state of the CPC global weather monitoring project allows for rapid prepositioning of meteorological data to support the next humanitarian emergency.

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