PACIFIC ENSO APPLICATIONS CENTER

The Pacific ENSO Applications Center (PEAC) is a pilot-project that was established to conduct climate research, produce forecast information products, and perform outreach and education activities in response to ENSO-related climate variability in the U.S.-affiliated Pacific Islands (USAPI). These include American Flag jurisdictions and Freely Associated States (former U.S. Trust Territory) of the tropical Pacific.[43] Unlike other pilot activities in the South Pacific region, the PEAC is unique in that it was designed to be a centralized source for climate forecast information and regional application activities. The PEAC organizational structure includes institutions with unique functions and capabilities in the USAPI that are capable of providing a regional climate research, prediction, and information system. Such a mix was determined to ideally involve organizations with regional experience in academic research, operational responsibilities and expertise in forecasting activities, and access to local government agencies and industries involved in climate-sensitive sectors. With initial support from NOAA-OGP, other institutions forming the core of the PEAC organization include:

- The NOAA National Weather Service - Pacific Region (NWS-PR);
- The University of Hawaii - Joint Institute for Marine and Atmospheric Research (JIMAR),
- The University of Guam - Water and Energy Research Institute (UOG/WERI); and
- The Pacific Basin Development Council (PBDC), a regional organization directed by the Governors of the American Flag jurisdictions with close cooperative ties to the Freely Associated States.

Key areas of research, information product development, and education/outreach activities were designed to address the needs of climate-sensitive sectors such as water resource and coastal zone management, fisheries, agriculture, civil defense, energy, health, and others of economic and environmental importance to USAPI communities.

Because of its significant organizational linkages, experience, and reputation built in the region over previous years, the PEAC was well positioned to provide policy-makers with useful forecast information in advance of and throughout the 1997-98 El Niño event. This information afforded regional, national and local decision-makers an opportunity to take early steps to reduce the impact of anticipated drought conditions. During 1997-98, for example, the PEAC continued to publish the "Pacific ENSO Update", a quarterly bulletin begun in 1995 to supply climate

[43]Members of the USAPI include Hawaii, the Territory of Guam, the Territory of American Samoa, the Commonwealth of Northern Mariana Islands (CMNI), the Federated States of Micronesia (FSM), the Republic of the Marshall Islands, and the Republic of Palau.

forecast information for the benefit of those involved in climate-sensitive sectors in the various jurisdictions of the USAPI.[44]

To explain the predictive information and to help bolster preparations in the Pacific Islands for the 1997-98 El Niño, the PEAC held a series of multi-sector workshops on ENSO and briefings for government and industry officials involved in site-specific climate-sensitive sectors. These activities were an extremely effective technique for identifying potential users and applications of climate information in the various island communities. Site visits to brief Ministers and Heads of State in Guam, Palau, Micronesia, Marshall Islands, Samoa, and Commonwealth of the Northern Marianas Islands helped establish a capacity for more effective use of information on El Niño and climate predictions relevant to the region. Participation by the PEAC in meetings of regional organizations from the tropical Pacific expanded the community of interest in applications activities while the 1997-98 El Niño event was in progress.

In lieu of formal Climate Outlook Fora, initial distribution of forecast information on climate variability related to El Niño was first made through the Pacific ENSO Update in March 1997 to Hawaii, American Samoa, Guam, CNMI, Micronesia, Palau, and the Marshall Islands, with continued updates in subsequent issues. Project staff in Guam and Hawaii subsequently followed-up with a round of site visits to all the Freely Associated States and the U.S. Territories in the region between September 1997 and January 1998. Nearly every island jurisdiction established local government task forces to cope with serious drought -- the primary consequence anticipated as a result of the event. On a community level, efforts of those groups have made a difference, by communicating that the drought was not a "fluke" that could end at any time, but rather a part of a much wider scale phenomena that is highly predictable in the region.

Task force efforts resulted in mitigation measures that alleviated, within the capacity of local government resources and external assistance, the seriousness of the drought and its impact on the islands. An assortment of information on impacts and local government responses (along with those in neighboring island countries of the Pacific islands region) is available in the local island news section of the PEAC web site or by contacting project personnel directly.

[44] PEAC website and "Pacific ENSO Update": <http://naulu.soest.hawaii.edu/>

PEAC project work remains a highly valued resource within the tropical Pacific islands region and has contributed to anticipation of a more fully developed global network of similar activities. It is anticipated that NOAA's National Weather Service (NWS) will assume full responsibility for financially supporting the PEAC in the near future, transitioning the PEAC from a research-based pilot activity to fully operations-oriented center. In the meantime, the PEAC is actively engaged in further development of operational activities, research, and applications projects.

Specific PEAC Response Activities during 1997-98:

- Pacific ENSO Update alert of El Niño conditions (March 1997) and continuing publication of the "Pacific ENSO Update"
- Development of quantitative rainfall forecasts beginning in September 1997
- Consultation with the United States Department of Defense regarding potential relief efforts from El Niño related impacts
- Consultation with Federal Emergency Management Agency regarding fast-tracking existing projects to secure and enhance potable water supply for the islands
- On-going support for national task forces coordinating regional activities and adaptation of applications strategies to the community level, including weekly teleconferences
- Participation in the South Pacific Regional Environment Program Conference on Climate Change in the Pacific (August 1997)

CONCLUSION

The effects of climate variability associated with the 1997-98 El Niño were widespread, and in many cases, socially and economically disruptive. Natural disasters attributed to the El Niño event included food shortages, population displacements, disease outbreaks, and large-scale environmental damage caused by floods, droughts, and fires. Unlike the 1982-83 El Niño event, however, knowledge of the El Niño-Southern Oscillation, and predictions of its regional climatic effects were used to anticipate and, in some cases, mitigate negative impacts through prevention and preparedness measures. These successes were made possible through efforts by many international and national organizations, including NOAA-OGP, USAID-OFDA, IRI, NOAA-CPC, WMO, and numerous other international, national, and regional partners.

The NOAA-OGP Research Applications Division's international response to the 1997-98 El Niño was in part made possible through groundwork laid by the Pilot Program for the Applications of Climate Forecasts. On-going activities in Latin America and the Caribbean, Southeast Asia, the South Pacific, and Africa provided the background experience and contacts necessary to coordinate effective means for creating and communicating climate forecast information prior to El Niño-related floods and droughts. At the core of this response were the Climate Outlook Fora, venues at which climatologists and meteorologists created regional consensus precipitation forecasts and representatives from various sectors (e.g., disaster management, energy, water resources) discussed uses of climate information. These meetings were an important first step towards enhancing regional capacity to incorporate newly available climate information into decision-making processes and in shaping the development of forecast science according to user demands. For the first time, regional and international forecasting and applications communities were brought together around the problems of forecasting and planning for a specific El Niño event. In essence, the 1997-98 El Niño and anticipatory activities provided a chance for a "dry run" to learn how to apply this new climate forecasting skill and know-how in real world settings. Because of the scientific groundwork laid from TOGA onward and the continuing efforts of NOAA-OGP and its partners, the Outlook Fora were a significant component of the unprecedented international response to the 1997-98 El Niño event.

The Climate Outlook Fora and associated applications workshops demonstrated the need and potential for a long-term strategy for the generation, communication, and application of forecast information. It is hoped that the seeds of the Outlook Fora and applications activities will grow into regional climate forecasting networks which will provide regular, systematic climate information updates tailored to user needs in various regions around the world. The Pacific ENSO Application Center (PEAC), a pilot-project established to conduct research, produce information products, and perform outreach and education activities in response to ENSO-related climate variability in the U.S.-affiliated Pacific Islands, is one example of a centralized forecast dissemination institute tied into a regional network. NOAA-OGP, in cooperation with the Office of Foreign Disaster Assistance (USAID-OFDA) and international partners in S. America, Central America, and the Caribbean, has also initiated the creation of a Pan-American Climate Information System (PACIS) for the production, distribution, and application of seasonal to interannual forecast information in the Americas. It is envisioned that PACIS will involve development of regional climate forecasting capabilities, transformation of forecasts into usable information for managers and decision-makers, and training of both forecast users and producers on the creation, tailoring, and interpretation of climate projections. Signs of forecast networks are emerging in Southern Africa, as indicated by the continuation of the SARCOF process into 1998-99, and in Latin America, the Caribbean, and Southeast Asia, where many consensus forecasting activities similar to the Outlook Fora continue to occur.

In addition to the Outlook Fora, NOAA-OGP advanced the support and coordination of research programs related to climate and human health (the ENSO Experiment), social and economic impacts of climate change (the Economics and Human Dimensions Program), and the regional manifestations of global-scale climate variations and their effect on the dynamics of decision-making in climate sensitive sectors in the United States (Regional Assessments Program). The ENSO Signal, a newsletter edited and distributed by NOAA-OGP, continued to highlight advances in forecast applications, new ENSO research techniques and scientific conclusions, and socio-economic issues affected by ENSO. As a specific response to the 1997-98 El Niño, NOAA-OGP activated the ENSO Rapid Response Project, a climate information clearinghouse for monthly and other periodic updates of climate forecast and observation products for officials in the United States and abroad, and the California Pilot Project on the Use of Climate Information, to study if and how climate information affected decision-making in various sectors in California during the 1997-98 El Niño. Both the California Pilot and ENSO Rapid Response projects will run through the La Niña event forecast for late 1998-1999. In summary, NOAA-OGP programs during the 1997-98 El Niño event were multi-sectoral, involved both research support and limited operational activities, and spanned state, regional, national, and international levels.

The full potential of evolving climate forecast capabilities will be realized only when climate forecasts are routinely and systematically applied to practical problems in multiple sectors, both public and private, and at different levels, from local to international. The mere existence of forecasts does not necessarily translate into effective adjustment actions until decision-makers have determined how early-warning information can best be incorporated into the context of their requirements. Equally, developers of forecast systems need to be informed by users of these requirements, including optimal methods from the user perspective for providing and presenting information. Hence, a synergistic approach is required to ensure that forecast systems are created in as efficacious and practical a way as possible. This multidisciplinary dialogue was developed as part of NOAA-OGP's Research Applications Division activities during 1997-98. Given the cyclical nature of the El Niño Southern Oscillation (and forecasts for a La Niña event for 1998-1999), it is clear that the types of severe floods and prolonged droughts associated with the most recent El Niño will occur in the future. The question, then, is not whether climate variability will continue, but whether or not populations around the world will be prepared. A critical component of this preparation will be the practical application of seasonal to interannual climate forecasts.

APPENDIX

ENSO Compendium: An Impacts Survey of Climate Variability and the Human System

ABSTRACT[45]

The NOAA Office of Global Programs began the ENSO Compendium during the 1997-98 warm event as a research project to document the interaction between human systems and the El Niño Southern Oscillation.[46] As a compendium the study provides preliminary impact descriptions that vary in level of detail. It is hoped that the end product -- a compilation of anecdotal information on climate impacts -- contributes insight into human-climate exchange.

The ENSO Compendium began with the belief that processes influencing the development and improvement of forecasts should, at least in part, be guided by the applicability of such information into strategic decisions. Although climate information is rarely the only variable factoring into a particular situation, it is nonetheless valuable to agriculturists, the energy sector, resource managers, aid workers, and a variety of other users. The ENSO Compendium documents the socioeconomic impacts of the 1997-98 El Niño (and eventually the 1998-99 La Niña) in an attempt to contribute to the numerous efforts which make weather/climate information more applications-oriented.

Although the ENSO Compendium relies heavily upon datasets and reports of natural disasters in order to obtain a comparable reference and baseline, it should be noted that the research project is not trying to describe the relationship between human systems and catastrophe, rather the emphasis is on climate variability. Fundamentally these are two very different concepts. Whereas the study of natural disaster covers only the extremes and negative impacts of climate and weather, climate variability attempts to address interaction. Climate variability captures disaster, abundance, and the adaptation of society. Perhaps data that describes the "tolerance" of human systems to climate variability is more valuable than that which documents when thresholds have been exceeded.

Data for the Compendium was compiled from a variety of news and wire services as well as country and international agency reports. A simple criterion was then applied to give rank and precedence to preferred references. In general a priority was given to reports from UN agencies or governments, academic journals, then wire services, then media, and finally NGO or corporate produced figures. Once the data was filtered and assembled, region-specific trends as well as interregional relationships were identified.

For the study of the 1997-1998 period, estimators used to measure negative impacts were: direct dollar loss, mortality, morbidity, persons affected, persons displaced or made homeless, acres affected, households affected, houses lost, villages/towns/cities affected, bridges/culverts destroyed or damaged, km of road damage/destroyed, assistance requested, relief aid given, prevention, and preparedness. Beneficial effects were described through anecdotal information

[45]The final version of the ENSO Compendium is scheduled to be finished in Fall 1999. However, interim drafts containing a full description of methodology and discussion of the limitations on data used in the report are available upon request.

[46] A warm event refers to the EL Niño phase of the El Niño Southern Oscillation, which is characterized by a sustained warming of the eastern equatorial pacific sea surface temperatures among other indicators. During the opposite phase, La Niña, the eastern equatorial Pacific cools.

due to poor reporting. Although the cost of the 1997-98 event was estimated at over $30 billion, the reader should not consider any single total a firm, unquestionable number. However, it is believed that many of the proxies do provide very useful information when used to look for trends in conjunction with other variables or across regions. For instance, a clear inverse relationship between regional mortality and monetary loss suggests that the impact of ENSO-type disasters is largely dependent upon the overall preparedness and development of a region (see Figure A). In combination with anecdotal information the same relationship between deaths and direct dollar loss also highlights possible reporting biases in certain areas.

From specific scenarios the ENSO Compendium is also able to speculate how climate variability might affect humans should current socioeconomic trends persist. As evident from the totals associated with the China floods, population and wealth density are extremely significant factors influencing impacts caused by climate variability. All of the monetary damage totaled by the study from June of 1997 to June 1998 equaled $33.2 billion (see Figure B). Over a forty-day period (from August 1, 1998 to September 11, 1998) a global tally of damage from flooding and drought equaled between $28 and $44 billion USD. Moreover, the number of people affected, injured, displaced, etc. overshadowed the totals produced for 1997-98. Damage from the China floods dominated the total cost of the August-September period. Estimates of direct monetary loss to China ranged from $20 billion to $36 billion

The contrast between the losses of one particular year and a single month illustrates that impacts from climate variability require interaction between the environment and human systems. In this example, the difference between regional population density significantly polarized the magnitude of damage between the two samples. Even though China implemented excellent response strategies, the flooding was wide spread and affected areas of high population density such that the value of property and cost of protecting lives exceeded the global costs incurred during the 1997-98 El Niño.[47] If population size, placement, density, and wealth all significantly determine the degree to which climate variability impacts human society, then as populations grow, become more urbanized, and wealth centers consolidate, climate variability may have an even more pronounced influence on human systems in the future.

Aside from demographic and socioeconomic factors that influence the impact of natural variation, the ENSO Compendium also identifies a series of human activities that cause the local or regional environment to act as an "enhancer" of damage. Enhancers were identified as those preexisting conditions or practices that effectively lowered the disaster threshold. For example, China openly acknowledged that logging practices increased the severity of the floods. Mexico also acknowledged that logging and illegal housing development magnified the amount of damage incurred in Chiapas by flooding. This is not to say the flooding in the two countries would not have occurred if their forests had been left intact, but deforestation and other practices were suspected of increasing the amount of damage.

Much of the analysis performed as part of the ENSO Compendium was limited by a lack of baseline or reference data. In fact, aside from reporting totals and trends, a significant portion of the project is a review and identification of future research needs.

As a general rule the standardization of data collection and reporting of natural disasters is nearly nonexistent, and the few data series that do exist have not been running for much longer than a decade. Even the lengthier data sets are plagued by abrupt changes in the sources used, and

[47] Although 4,000 lives were lost to the floods in China, the number of causalities was exceeding low in comparison to the 223 million people affected or the 15.85 million made homeless.

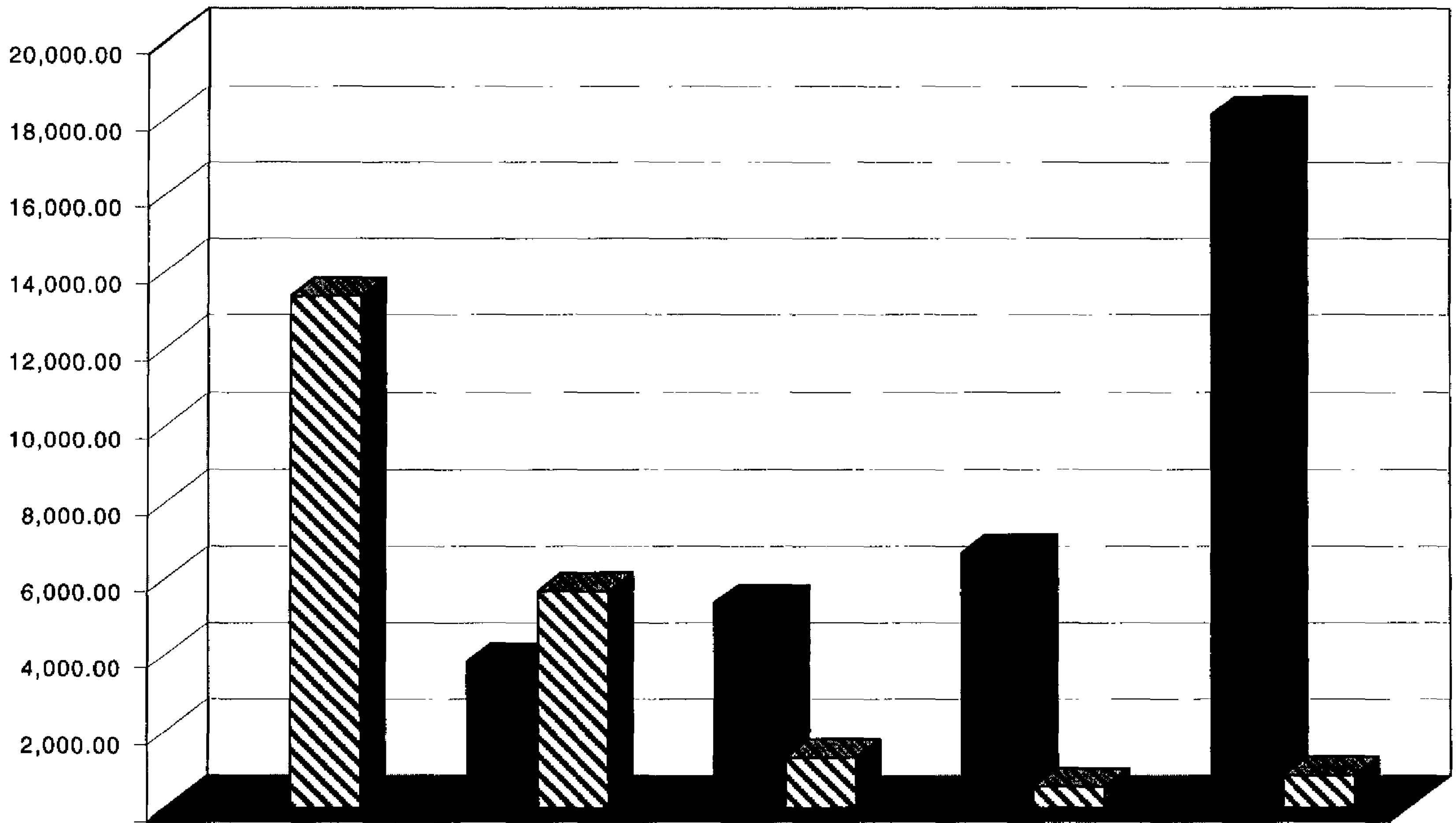
inherently these various references report damages and benefits with differing resolution.

A list of several estimates of damage caused by climate and weather related to natural disasters is given in Figure C. As demonstrated by cost estimates listed by the World Disaster Reports of the International Federation of the Red Cross/Crescent, a ten-year survey of climate/weather related disasters yielded an average of $48 billion per year whereas a five year sample produced a ~$350 billion annual estimate. Such a discrepancy between annual losses illustrates the importance of temporal coverage. The ten-year period captured a more accurate depiction of costs by including years of little loss in addition to extreme years. The disparity also illustrates the extreme variability in the impacts felt from year to year. Another study that addressed the cost of natural disaster to the U.S. (National Science & Technology Council, 1997) provides an annual estimate of $54 billion from a sample of five years. It just so happens these five years cover some of the most costly hurricanes and earthquakes; in turn these few extreme events dominate the cost totals. If the period under examination were lengthened or shifted, it is likely a very different annual estimate of damage would be produced.

Natural disaster datasets are also inherently tainted by a paradigm of how climate variability affects society. Data is almost always reported first in terms of monetary damage then lives lost -- perhaps a tally of persons affected is included. Because these proxies are so few and rarely standardized between datasets, they are not enough to determine how humans interact with climate variations and extreme weather. At best these two or three proxies of global impacts can only identify that we are indeed affected by and exposed to climatic fluctuations. As more resolution is gained, however, by increasing spatial and temporal coverage coupled with a greater host of estimators, more resolution and better comprehension of relationships is gained. Some of the findings reported in the ENSO Compendium suggest that so few categories and ways of describing impacts are the reason data collection lacks standardization. For example "affected" means very different things and captures many extremes (e.g.: starvation vs. persons without power for a day). In addition reported monetary losses or gains will differ depending upon the user or group documenting an event. Damages reported by insurance groups are very different from those of farmers, government aid agencies, NGOs, and also the private sector. Quite often the difficulty of standardizing natural disaster data is filtering out expected or acceptable variation from losses or gains which exceed certain thresholds. When the cane industry reports damages associated with drought, do we report the expected increase in the cost of sugar, losses from individual farmers, or perhaps only increased subsidies?

Even though the ENSO Compendium addresses many of the limitations of data collection and information available, its own estimates are certainly not immune to similar pitfalls. As a study compiling and examining only two years of data, it is recognized that the estimates of direct dollar loss, mortality, etc. are representative of an extraordinary period. In addition, it is understood that the cost estimate of either El Niño or La Niña can be significantly driven up or down by redefining attribution of impacts to ENSO. Nonetheless, careful consideration and inclusion of many caveats does not distract from the results of the ENSO Compendium, rather it is hoped that the study provides a glimpse of the benefits associated with the implementation and application of climate data.

FIGURE A: DIRECT $ LOSS vs. MORTALITY



	AFRICA	ASIA	INDONESIA & AUSTRALIA	NORTH AMERICA	MESO & S. AMERICA
TC	118.30	3,800.00	5,333.00	6,646.80	18,068.00
MT	13,325.00	5,648 00	1,316.00	559.00	858.00

FIGURE B: GLOBAL AND REGIONAL IMPACTS OF THE 1997-98 ENSO WARM EVENT

REGION	DIRECT $ LOSS	MORTALITY	MORBIDITY	AFFECTED	DISPLACED	ACRES AFFECTED
AFRICA	118	13,325	107,301	8,900,000	1,357,500	476,838
ASIA	3,800	5,648	124,647	41,246,053	2,554,900	3,861,753
ASIA PACIFIC	5,333	1,316	52,209	66,810,105	143,984	7,031,199
NORTH AMERICA	6,647	559	INCOMPLETE	41,100	410,000	30,787,900
S. & MESO AMERICA	18,068	858	256,965	864,856	363,500	14,102,690
GLOBAL TOTAL	34,349	24,120	533,237	110,997,518	6,258,000	56,687,632

DIRECT DOLLAR LOSS EXPRESSED IN MILLIONS USD, WHILE ALL OTHER INDICATORS REPORTED IN ACTUAL NUMBERS

FIGURE C

COSTS ASSOCIATED WITH CLIMATE & WEATHER RELATED DISASTERS:

AN ILLUSTRATION OF VARIOUS METHODOLOGIES USED TO PRODUCE IMPACT ESTIMATES

NOAA-OFFICE OF GLOBAL PROGRAMS SURVEY OF THE GLOBAL IMPACTS CAUSED BY THE 1997-98 ENSO WARM EVENT

- **$33.2 billion USD (June to June Criteria)**
- **$~25 billion USD (Federally Recognized Disasters)**

NYT ESTIMATE OF THE GLOBAL MONETARY IMPACT FROM THE 1982-83 ENSO WARM EVENT

- **$21 billion USD (1997 dollars -- $13 billion USD in 1982-83 dollars)**

NOAA-OFFICE OF GLOBAL PROGRAMS TALLY OF CLIMATE/WEATHER RELATED IMPACTS OCCURRING FROM AUGUST 1, 1998 TO SEPTEMBER 11, 1998

- **$28.2 billion USD (using lower-end estimate of China floods)**
- **$44.2 billion USD (using upper-end estimate of China floods)**

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL: MONETARY IMPACT OF ALL NATURAL DISASTERS TO UNITED STATES

- **$54 billion USD (annual average from 5yr survey)(~$1 billion USD per week)**

INTERNATIONAL FEDERATION OF THE RED CROSS/CRESANT REPORTED ESTIMATE OF ANNUAL MONETARY LOSS ACCRUING FROM CLIMATE/WEATHER RELATED DISASTERS (from 1989-1993 sample) (1995 World Disasters Report)

- **~$350 billion USD**

INTERNATIONAL FEDERATION OF THE RED CROSS/CRESANT REPORTED ESTIMATE OF ANNUAL MONETARY LOSS ACCRUING FROM CLIMATE/WEATHER RELATED DISASTERS (from 1987-1996 sample) (1998 World Disasters Report)

- **~$48 billion USD**

MÜNCHENER RÜCK (Munich Reinsurance) 1997 ESTIMATE OF THE COST OF NATURAL CATASTROPHES

- **$30 billion USD ($4.5 billion USD -- 15% -- covered by insurance)(represents all natural disasters)**

MÜNCHENER RÜCK (Munich Reinsurance) 1996 ESTIMATE OF THE COST OF NATURAL CATASTROPHES

- **$60 billion USD (represents all natural disasters)**

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