WHITE PAPER: S. RAGHAVAN

S. Raghavan[1]

1. **What factors account for the dramatically increasing costs of weather-related disasters (specifically, floods and storms) in recent decades?**

While the socio-economic Impact of weather-related hazards has undeniably increased tremendously in the past few decades, the reasons are to be looked for in social, political and economic factors rather than in the meteorological phenomena themselves.

2. **What are the implications of these understandings, for both research and policy?**

The following are needed:

1) Continued research for understanding the meteorological phenomena and the mechanisms of damage including the likely effects of climate change.

2) Pro-active preparedness for disaster mitigation which will include engineering, social and legal measures.

I attach a background paper setting out the basis for these answers.

First question: What factors account for the dramatically increasing costs of weather-related disasters (specifically, floods and storms) in recent decades?

While the socio-economic Impact of weather-related hazards has undeniably increased tremendously in the past few decades, the reasons for the increase are to be looked for in social, political and economic factors rather than in the meteorological phenomena themselves. I shall confine myself to tropical cyclones, which are the most hazardous weather phenomena and floods which are the most disastrous weather-related events. I am illustrating with two recent examples from India.

Tropical Cyclones

Andhra Pradesh (location shown in Fig. 1) is one of the most cyclone-prone states in India with a coastline of about 1030 km. Reliable meteorological as well as economic data are available since about 1970. From a study of the tropical cyclones hitting the state in the period 1971-2000 it was shown by Raghavan and Rajesh (2003) that there was no trend of increase of frequency or intensity of tropical cyclones (actually there was a negative trend within these three decades) but the estimated damage was increasing over the period. Normalisation of the damage for inflation, increase in population and economic activity in the region showed that there was no trend in the normalised damage figures. This agrees with similar studies in the USA (Pielke and Landsea, 1998). The study could not be extended to other coastal states in India because of difficulties in getting reliable damage data although reliable meteorological data are available. There is however no reason to expect a very different result in those states. Actual damage in future cyclones is expected to increase further.

I have also examined the attention given by administrators to *preparedness* for disastrous events and for *post-disaster relief*. The figures for Andhra Pradesh (source: Government of Andhra Pradesh) are as below.

[1] Deputy Director-General of Meteorology, India Meteorological Department (Retired), Mailing address: 11/16, Bayline Apts.,15, 2nd Cross St., Radhakrishnan Nagar, Chennai – 600041, India
Email: manmatha@dataone.in, raglaksh@yahoo.com, raglaksh@gmail.com

EXPENDITURE[2]	Indian Rupees Crore (Crore means 10^7)
Relief expenditure after the event (including cyclones, floods and droughts), from 1979-80 to 1999-2000.	**2781**
Damage estimated to have occurred in one single tropical cyclone in 1996	**6129**
expenditure on preparedness before each event	**Not available**
World Bank-aided Project in the nineties mostly on infrastructure development	**801**

The fact that data on expenditure incurred on preparedness were not even available except for the World Bank project outlay, shows that much more importance is attached to relief after the event rather than proactive preparedness *before* it. This attitude is understandable in the sociopolitical context and is not confined to Andhra Pradesh. One has only to draw a parallel to the state of preparedness in New Orleans, USA, before Hurricane Katrina, despite elaborate plans being available.

Although in recent decades, awareness on cyclone preparedness has improved in this region, there is a "Fading Memory Syndrome", which results in slackness in disaster preparedness if there is no cyclone affecting an area for a few years (Raghavan and Sen Sarma, 2000). The phenomenal damage and deaths in the "super cyclone" (defined as one with maximum sustained surface wind of 62 m s^{-1} or more; in this case 72 m s^{-1}) which struck the Indian State of Orissa in October 1999, may be largely attributed to want of preparedness.

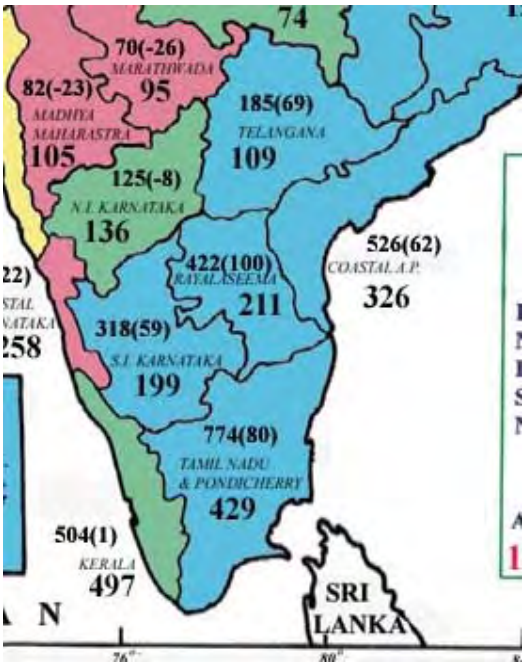

Fig. 1 Map of peninsular India showing location of "coastal Andhra Pradesh" and "Tamil Nadu and Pondicherry" on the east coast. The rainfall figures for the latter are 774 mm from October to December, 2005 which is 80% above the normal figure of 429 mm. – figure courtesy India Meteorological Department.

Floods

Floods occur every year in several parts of India especially during the monsoon months (June to September). In the southernmost state of Tamil Nadu (see Fig. 1) the major part of the rainfall occurs in the October to December season which is locally called the "northeast monsoon" season. In the period October to December 2005 there was a total rainfall of 774 mm which is about two standard deviations above the normal of 429 mm. The rain resulted from several low pressure systems moving in from the Bay of Bengal, some of which attained cyclonic storm intensity (wind speed greater than 17 m s^{-1}) while at sea but weakened before landfall. Hence the damage due to these events was entirely by flooding and not wind or storm surge. According to media and official reports the entire state had unprecedented floods affecting various districts. The rainfall however, was *not* unprecedented. The year 1946 had higher rainfall and five other years in the 20th century had comparable rainfall, but the floods were not serious in those years.

Unlike in the case of tropical cyclones, floods in India have been increasing over the years in severity and area affected, but the causes are not meteorological.

It was found in this case that the floods were largely man-made and attributable to the following causes.

1. Drainages were blocked over the years in the name of development.

[2] At present 45 Indian Rupees are equal to a US Dollar but the exchange rate has varied considerably over the years. Hence conversion of the above figures to US Dollars may be misleading.

2. Large numbers of water storage ponds built in previous centuries for storing rain water for irrigation, were allowed to be silted up or even destroyed by building over them or encroaching on them.
3. Rivers and canals which were navigable even 50 years ago were encroached upon or filled with sewage and garbage. There were even "university" and "government" buildings built over some river beds.
4. Destruction of wetlands e.g. coastal mangrove swamps[3].
5. Encroachments were encouraged or subsidised by governments over the years, to meet real or contrived demands from various sections of society[4].

It is true that for an accurate assessment of floods, complete information on intensity and duration of each spell of rainfall should be examined (e.g. Trenberth et al., 2003), but it is clearly established in this case that the above human-made causes were dominant.

Other Phenomena

There may be other adverse weather phenomena which may themselves be increasing because of "climate change" but even in these cases human activities may often be major contributors. Examples are large-scale deforestation, depletion of ground water, widespread mining and other land use changes.

Causes

Scientific opinion on whether tropical cyclones are increasing in frequency or intensity and whether such increase is due to "global warming" is inconclusive. The work of Emanuel (2005) and Webster et al. (2005) is often cited (in many cases, out of context), in support of the contention that cyclones are increasing due to global warming. According to Emanuel, the "potential destructiveness" of hurricanes increased markedly since the mid-1970s. He concluded that future warming may lead to an upward trend in tropical cyclone *destructive potential*, and—taking into account an increasing coastal population— a substantial increase in hurricane-related losses in the twenty-first century. He did *not* find any increase in number of cyclones. Note that the increase in losses is attributed not just to the intensity of the cyclones but also to societal factors such as increase in coastal population. Also note that most cyclones do not reach the maximum potential intensity given by theory. Emanuel has also said that it is absurd to think that the Katrina disaster is due to global warming. http://wind.mit.edu/~emanuel/anthro2.htm) But this part is conveniently forgotten.

Webster et al. (2005) examined data of the past 35 years and found that the number of cyclones and cyclone days have increased in the North Atlantic during the past decade but this is not the case in all other ocean basins. A large increase was seen in the number and proportion of intense hurricanes (categories 4 and 5) in all basins but the maximum intensity remained unchanged over 35 years. These increases are attributed by them to increasing sea surface temperature. But (and this part often goes unnoticed) the authors say "*attribution of the 30-year trends to global warming would require a longer global data record and, especially, a deeper understanding of the role of hurricanes in the general circulation of the atmosphere and ocean, even in the present climate state*".

It has been pointed out by Patrick Michaels (of the University of Virginia) http://www.tcsdaily.com/article.aspx?id=091605F that in the Atlantic where good data are available for earlier years also, just the opposite occurred in the period 1945 to 1970 i.e. there was a greater number of intense hurricanes than in the period 1970 to 1994. Gray (2006) is of the view that "the large increase in Atlantic hurricane frequency and strength of intensity since 1995 is natural and is a result of the large increase in the Atlantic thermohaline circulation (THC)". Pielke et al. (2005) also state that the claims of linkage with global warming are premature.

[3] It was found that damage due to the tsunami of 26 December 2004 was minimal in those coastal areas where mangroves were intact compared to severe impact in other areas where they had been destroyed –Swaminathan (2005).

[4] Some of the encroaching structures were demolished after the floods.

The Association of British Insurers (2005) report on "Financial Risks of Climate Change" states "To date, these trends in the number of events and total losses over time have been driven predominantly by socio-economic factors, including population growth, concentration of population in urban areas and rising amounts of increasingly valuable assets in areas prone to storm and flood risk. There have also been improvements in monitoring capabilities, so that more events are now identified and recorded each year".

The projections for the future (based on assumptions of climate change) are sensitive to the model used and vary widely. Therefore, they do not necessarily reflect reality. For example, Knutson and Tuleya (2004) estimate a 6% increase in hurricane wind speeds by 2080. This is disputed by others (e.g. Michaels et al, 2005). According to Pielke et al., (2005), even if this increase is there, the increase by now would have been 0.5 to 1 m s^{-1}, which is smaller than the error in satellite techniques of estimating wind speed and it is also small in comparison with inter-decadal changes.

In the absence of clarity about whether observed increase in incidence of events is due to climate change or periodical oscillations of meteorological and oceanographic parameters the assumptions in the model projections can be counter-productive. An example is the widespread assumption that drought in Asia and Africa would be the consequence of the 1997 El Niño in many regions including India and southern Africa. That did not happen. In southern Africa, people made decisions based on the likelihood of drought, such as not planting, that ultimately hurt them (Dilley 2002).

Answer to the first Question:

Hence it is my submission that the observed increase in ***impact*** *of severe weather events is attributable largely to human-made social, political and economic causes and not due to any increase in the events themselves.*

Second Question: What are the implications of these understandings, for both research and policy?

Are we doing enough to minimize the impact of severe weather phenomena?

Attribution of the increases to global warming or to natural causes is often used as an excuse for inaction by branding the events as "acts of God" (see e.g. Kennedy, 2006). Instead of worrying about whether the events will increase due to climate change the more appropriate and immediate question to ask ourselves is "*Are we doing enough to minimise the* ***impact*** *of severe weather phenomena?*". It is amply evident that we are not.

Relief vs Preparedness:

Palliative "relief" measures after each severe weather event are undertaken at great cost. Pro-active preparedness measures, though less expensive, and more durable, are given less importance and are often totally neglected. Relief measures in the limelight are politically rewarding while preparedness involves hard work behind the scenes. While better preparedness cannot totally avoid damage or relief expenditure, it can mitigate human suffering as well as economic damage. By preparedness we mean the various aspects which may have different relative priorities in different parts of the world.

Preparedness may consist of:

1. Improvement of physical infrastructure e.g. better construction, better roads, drainage, water storage facilities, reliable communication networks[5].
2. Creation of awareness of risks.
3. Discouragement or prevention of unwise land use, preservation of coastal wetlands and shelter belts[6].

[5] A recent development in India is a scheme to disseminate disaster warnings automatically through mobile phone networks which have a large penetration in rural areas.

[6] In India the Government had banned all construction within 500 meters of the shoreline. This ban was violated almost all over the country. Based on the recommendations of a committee which went into this (Swaminathan, 2005), it is now proposed to define areas available for development near the coast on "scientific principles".

These aspects have been studied extensively and there are no technical difficulties in implementing preparedness schemes. The impediments are socio-political e.g. how to overcome conflicting interests, population pressures and so on.

Insurance:

Insurance is one area which needs development in many parts of the world. For example in India, government property is not insured (as a policy) and insurance of private property in rural areas especially agricultural crops is almost non-existent. In the absence of insurance, the Governments step in and provide ad hoc relief after each event. This results in uneven and wasteful deployment of funds and blame games between various agencies and affected people. It also makes the assessment of losses difficult. An insurance policy linked to regulations of land use is desirable.

Answer to the second question:

The following are needed:

(1) *Continued research for understanding the meteorological phenomena and the mechanisms of damage including the likely effects of climate change.*

(2) *Pro-active preparedness for disaster mitigation which will include engineering, social and legal measures.*

References

Association of British Insurers (ABI) , 2005, "Financial risks of climate change", Summary Report, 40 pp., http://www.abi.org.uk

Emanuel K., 2005, "Increasing destructiveness of tropical cyclones over the past 30 years", *Nature*, 436, 686-688.

Gray W.M., 2006, "Global warming and hurricanes", Paper 4C.1, *27th Conference on Hurricanes and Tropical Meteorology*, 23-28 April 2006, Amer. Meteor. Soc.

Dilley M., 2002, "The use of climate information and seasonal prediction to prevent disasters", *WMO Bull.*, **51**, 1, 42-48.

Kennedy D., 2006**, "**Acts of God?"", Editorial, *Science*, Vol. 311. no. 5759, p. 303

Knutson T.R. and R. E. Tuleya, 2004, "Impact of CO2-Induced Warming on Simulated Hurricane Intensity and Precipitation: Sensitivity to the Choice of Climate Model and Convective Parameterization", J. Climate, 17,18, 3477-3495.

Michaels P.J., P.C. Knappenberger and C. Landsea, 2005, , Comments on "Impacts of CO_2- Induced Warming on Simulated Hurricane Intensity and Precipitation: Sensitivity to the Choice of Climate Model and Convective Scheme", ***J. Climate:* 18,. 23, 5179–5182.**

Pielke, R. A. Jr., and C. W. Landsea, 1998, "Normalized hurricane damages in the United States: 1925–95", *Weather Forecasting,* **13**, 621–631.

Pielke, R. A. Jr., C. W. Landsea, M. Mayfield, J. Laver and R. Pasch, 2005, "Hurricanes and global warming", Bull. Amer. Meteor. Soc., 86, 11, 1571-1575.

Raghavan S. and S. Rajesh, 2003, "Trends in tropical cyclone impact:: A study in Andhra Pradesh, India", *Bull. Amer. Meteor. Soc.*, **84**, 635-644.

Raghavan S. and A. K. Sen Sarma, 2000: Tropical cyclone impacts in India and neighbourhood. *Storms,* Vol. 1, R. A. Pielke Sr. and R. A. Pielke Jr., Eds., Routledge , 339–356.

Swaminathan M.S., 2005, Report of the Committee to review the Coastal Regulation Zone Notification, 1991, February 2005, 122 pages pdf file http://mpcb.mah.nic.in/mczma/swaminathan-1.pdf.

Webster P. J., G. J. Holland, J. A. Curry, and H.-R. Chang, 2005, "Changes in Tropical Cyclone, Number, Duration, and Intensity in a Warming Environment", *Science*, **309**, 1844-1846.