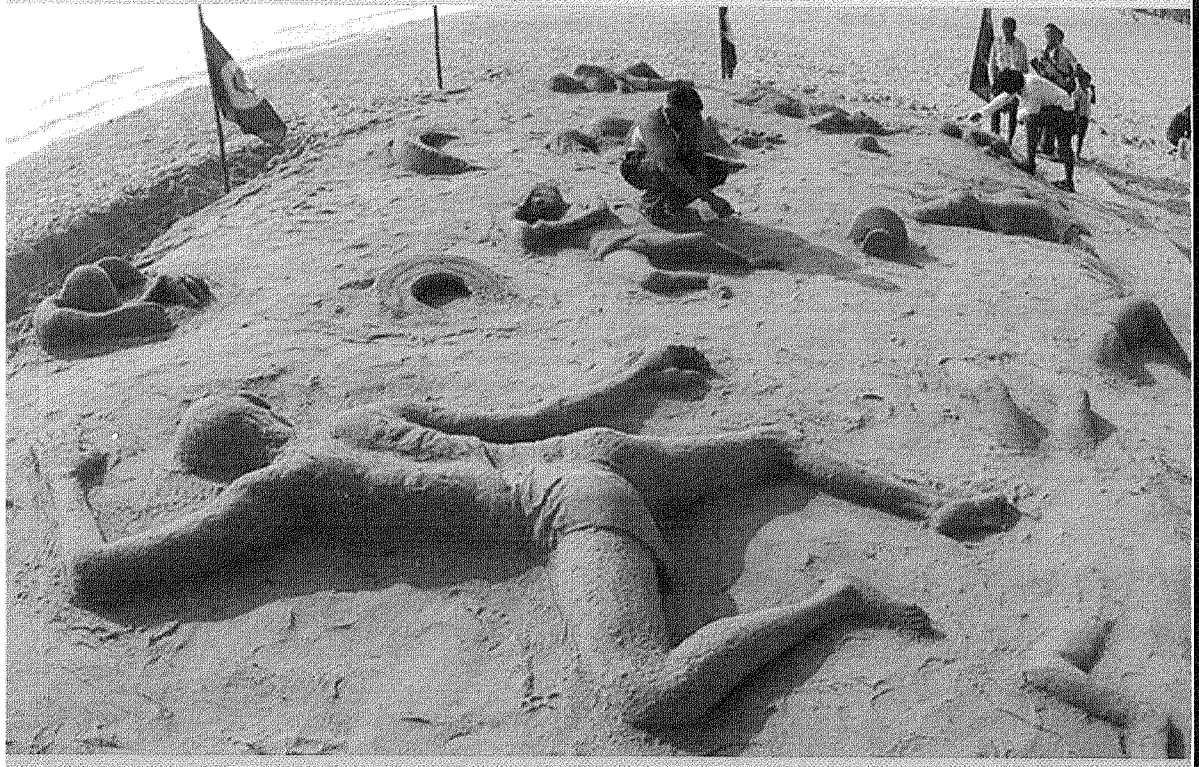
CITTÁ, SALUTE, SICUREZZA

Strumenti di governo e casi studio
La gestione del rischio

Maria Cristina Treu



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E'convinzione diffusa che lo sviluppo economico sia accompagnato da una crescita dei rischi di origine naturale e antropica e che essi assumano forme e pericolosità più differenziate e improvvise che nelle epoche passate. In realtà il rischio è sempre stato presente anche se la sua elaborazione avviene in epoca moderna e, oggi, la salute e la sicurezza delle persone e dei beni patrimoniali sono fattori strettamente intrecciati e accentuati dalla pressione dei processi di inurbamento in alcune regioni metropolitane e dalla marginalizzazione di altre intere regioni.
Nella globalizzazione, gli stili di vita e dei consumi tendono a non riconoscere né limiti né specificità di contesto: prevalgono le evidenze e le convenienze di un presente, si sottovalutano le connessioni con il passato e con un futuro possibile di maggior equilibrio. Le emergenze tendono a rincorrersi e il governo dei rischi perde efficacia.
E'questo il quadro in cui il testo sottolinea la necessità di ampliare interpretazioni e approcci di ricerca e di mettere a sistema più competenze, più linguaggi e più strumenti ribadendo la centralità della pianificazione di area vasta e la partecipazione esperta delle comunità locali. La salute e la sicurezza delle città e dei territori richiedono interventi strutturali e non strutturali su più versanti che non possono essere delegati né a singoli piani di settore né agli interventi di singoli tecnici o di singoli piani comunali.
Il testo riporta i contributi maturati in occasione di più esperienze di ricerca e didattiche: la prima parte del testo contiene interpretazioni e riferimenti a contesti prevalentemente italiani, nella seconda parte prevalgono gli studi su casi di altri paesi.

Maria Cristina Treu, professore ordinario di Urbanistica presso il Politecnico di Milano, ha al suo attivo più esperienze di pianificazione territoriale e ambientale e la responsabilità scientifica di più ricerche sulla valutazione dei rischi e su più temi urbanistici.

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1 month ago: Artists spray water on sand sculptures made to mark the fourth anniversary of the Indian Ocean tsunami, at Marina beach in the southern Indian city of Chennai December 26, 2008. More than 3,500 people were killed on the islands and nearly 9,000 people were killed on the mainland, mostly in the southern state of Tamil Nadu. The picture was taken with 16mm fish-eye lens

Maria Cristina Treu

Città, Salute, Sicurezza

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Maria Cristina Treu

CITTÁ, SALUTE, SICUREZZA
STRUMENTI DI GOVERNO E CASI STUDIO
LA GESTIONE DEL RISCHIO

MAGGIOLI EDITORE

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HURRICANE KATRINA: THE HIGHLY ANTICIPATED SURPRISE

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ABSTRACT - L'URAGANO KATRINA: UNA SORPRESA ESTREMAMENTE ANTICIPATA

In questo articolo raccontiamo la storia dell'uragano Katrina, che coinvolse diversi stati dell'America meridionale alla fine di Agosto 2005, concentrandosi principalmente sulla città di New Orleans. Concluderemo la nostra narrazione con la fase post-disastro traendo delle conclusioni per quanto riguarda le lezioni imparate e non, le apprendibili e non. Prenderemo in considerazione le interazioni tra fattori fisici ed umani, identificandone i punti di forza e debolezza, successi e fallimenti nella preparazione e nella risposta ai danni. Considereremo anche lo stato di conoscenza e lo spirito del tempo in cui vennero prese le principali decisioni, contestualizzandole in termini storici e politici. Iniziando con una cronaca dell'evento, torneremo indietro nel passato per scoprire come vennero accertati i pericoli e i rischi esistenti e come vennero trattati con misure di precauzione per prevenire o limitare possibili danni e distruzioni. Il rischio imminente era da tempo accertato e la vulnerabilità del sistema umano e ambientale era stata identificata, incluse le sue cause principali ed alcune possibili azioni precauzionali e correttive. Mentre l'incertezza è una questione chiave nell'affrontare decisioni che riguardano le misure immediate pre impatto, non ha un ruolo nella pianificazione e nella preparazione, poiché ogni stato ed ogni città o paese in quella zona potrebbe essere colpita dal prossimo uragano. La costruzione di barriere di difesa, un sistema di argini artificiali in continua espansione, era la principale strategia protettiva nei secoli passati, integrata dalle previsioni meteo di tempeste ed evacuazione. Soluzioni tecniche furono privilegiate sulle altre opzioni o combinazioni di esse anche a spese delle difese naturali dell'ecosistema, come le paludi costiere. Queste furono sacrificate per lo sviluppo di aree urbane in zone precedentemente disabitate, incrementando così l'esposizione al rischio non solo di queste aree, ma rendendo più vulnerabile l'intera città. L'origine di tali scelte, qui ed altrove, è radicata nell'idea di progresso e nell'esercizio del potere umano sulla Natura tramite l'applicazione della scienza e della tecnologia. Quando viene intrapresa la strada del controllo della natura, il ritorno al passato è un'illusione e tutte le altre strade possibili sono bloccate. Gli argini artificiali devono diventare sempre più forti, sempre più alti e sempre più costosi. Senza considerare il fatto che diversi tipi di obblighi rendono più difficile proseguire il cammino tracciato in precedenza, ogni nuova decisione è costretta dalle precedenti e a, sua volta, traccia i confini delle opzioni future. Come in un circolo vizioso, più grande è il sistema di difesa, maggiore è l'illusione della non vulnerabilità, e più sottile è l'aumento della vera vulnerabilità. Di certo ci sono stati ripetuti tentativi di trovare alternative innovative per sostituire ciò che si era dimostrato inefficace. Nonostante ciò questi cambiamenti riguardarono scelte amministrative e organizzative, mentre la visione Cartesiana della Natura come materia inerte a disposizione dell'uomo prevalse. E ciò nonostante questa visione fu ripetutamente sfidata da molte voci dissenzienti da diverse fonti che si rifacevano ad argomentazioni di carattere scientifico, economico, ambientale ed etico.

In accordo con un tale approccio dominante, ci fu un'interpretazione dei disastri in termini di disfatta dell'uomo contro fenomeni naturali incontrollabili e imprevedibili, mentre la manomissione dell'ambiente è tralasciata dal quadro e scagionata come possibile causa o concausa di eventi non desiderati ed inattesi. Coloro che mettevano in guardia circa un imminente disastro non erano oracoli. Con un po' di intuito e

previsione, raccolsero i dati esistenti e le informazioni sui fenomeni climatici e geologici, la geografia locale, la socio – demografia e le aree urbane, in abbinamento con la conoscenza degli stili di vita locali e dei problemi sociali, incluse povertà e (mal)funzionamento delle organizzazioni burocratiche, in particolare quelle in carica per la gestione dei disastri. Questo tema è altamente controverso, e lungi dall'essere risolto, a causa dell'insufficienza di dati e modelli, ma anche a causa dell'effettiva ignoranza a proposito di tutte le possibili interazioni tra fenomeni climatici e attività umane, che rimangono per larga parte sconosciute. Inoltre, a causa di cambiamenti costanti nella tecnologia e nella società, sono impossibili accurate previsioni sul loro assetto futuro e reciproche interazioni, una situazione molto ben descritta dal termine "indeterminatezza". Per decadi gli scienziati sociali hanno insistito sull'interpretazione dei disastri come risultato dell'unione di fenomeni fisici e vulnerabilità sociale ad essi e la conseguente importanza di evitare pratiche come l'occupazione di aree soggette a rischio. Governare è un processo continuo per la gestione di affari comuni a una società o comunità ed include istituzioni formali e regimi, così come disposizioni informali. Perciò concepire strumenti e strategie per il governo sociale di rischi e danni imminenti richiede il coinvolgimento di tutti gli attori principali, individuali e collettivi, che devono collaborare tra loro. Questo implica che la pianificazione non può essere solo un esercizio da tavolo e che le misure preventive devono essere immaginate in modo realistico, prendendo in considerazione la reale possibilità di implementarle per quelle per cui è previsto farlo. Le lezioni importanti sono state imparate per fare in modo che non accadano più. Dichiarazioni e promesse abbondano e sarà colta l'opportunità di valutarle nella direzione di un futuro sostenibile e ragionevole, lasciando da parte gli errori precedenti, le ingiustizie e le discriminazioni.

I ricercatori del disastro hanno a lungo sostenuto che c'è una considerevole continuità tra le condizioni e gli indirizzi pre disastro e ciò che succede quando un disastro si abbatte. Non c'è dubbio che i disastri come le guerre sono un'opportunità per molti di aumentare il loro benessere, potere ed influenza. E non c'è dubbio che anche la migliore delle intenzioni deve fare i conti con ostacoli reali di tutti i tipi. Visioni conflittuali sono difficili o addirittura impossibili da conciliare, ma in ogni evento un dibattito aperto è preferibile alla mancanza di trasparenza. Un conflitto di questo tipo è quello tra settore governativo e privato, ma anche tra i diversi livelli del primo (locale, statale, federale).

HURRICANE KATRINA: THE HIGHLY ANTICIPATED SURPRISE

In this paper we tell the story of Hurricane Katrina, which impacted several southern states in the US at the end of August 2005, focussing mainly on the city of New Orleans. As many narratives, ours also begins with "once upon a time"; in order to understand what happened, we need to start long ago. We will abandon our narration at the post-disaster phase, drawing some conclusions in terms of lessons learned and unlearned, learnable and non-learnable. Of course, in the real world, the story continues to unfold and updated narratives will account for developments towards more or less "happy endings".

Throughout our paper, we will take into consideration the interactions between physical and human factors in identifying strengths and weaknesses, successes and failures in preparation and response to threats. We will also account for the state of knowledge and the spirit of the time when major decisions were taken, thus contextualizing them in historical and political terms.

Starting with a chronicle of the event we will then go back into the past (sometimes long into the past) to explore whether and how existing hazards, risks, and vulnerabilities were (or could have been) assessed and dealt with by means of precautionary measures for preventing or limiting possible harm and disruption.

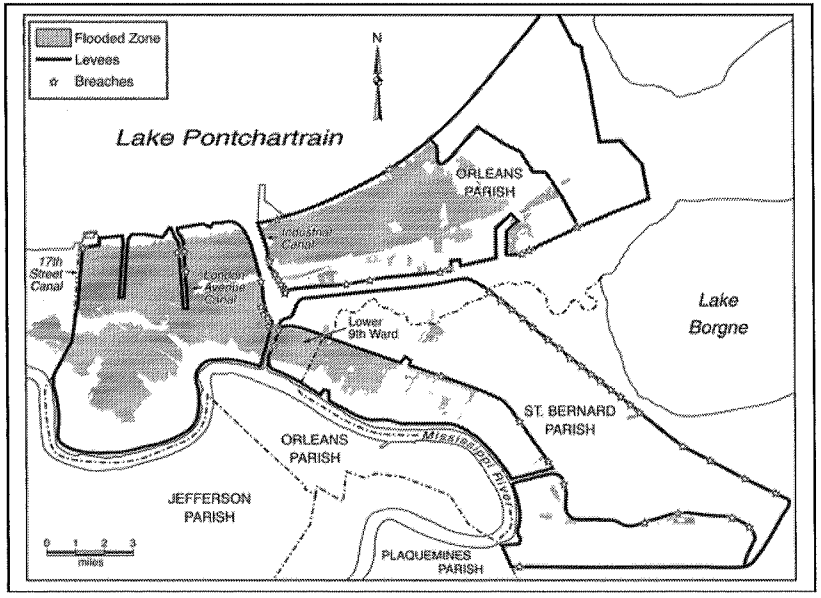

Figure 1 –Katrina hurricane: flooded zone

1 CHRONICLE OF THE EVENT AND ITS IMMEDIATE AFTERMATH

WARNING AND PRE-IMPACT MEASURES

On Thursday 25 August 2005, Katrina then a Category 1 hurricane, made landfall in south Florida, causing a dozen deaths and severe damage. The National Weather Service (NWS) predicted that Katrina would enter the Gulf of Mexico and make landfall on the northern Gulf Coast area, between Alabama and Mississippi. After weakening as it passed over Florida in the early hours of Friday August 26, Katrina moved westward, intensifying over the warm waters of the Gulf of Mexico. In the afternoon, i.e. 56 hours in advance of its Louisiana landfall, the NHC (National Hurricane Center) forecasted that the eye of the Hurricane would pass just east of New Orleans on Monday 29 August as a Category 4 or 5 hurricane.

On Saturday 27, upon request from Louisiana Governor Kathleen Blanco, President Bush declared a state of emergency for Louisiana. In the afternoon, Roy Nagin, mayor of New Orleans, called for a voluntary evacuation. In the evening, the National Hurricane Center Director, Max Mayfield, personally called Blanco, Nagin, and Mississippi Governor, Haley Barbour, to warn them of Katrina's intensity and its potential to cause a large loss of life.

On Sunday 28, the NWS office in Slidell, Louisiana, issued a special advisory, which, despite the acknowledgment of some areas of uncertainty, was unambiguous and, unfortunately, proved very accurate:

"The purpose of this special advisory is to revise the intensity of Katrina to category five. Obviously the big question is how strong Katrina will be at landfall. We have very limited skill in predicting this. Katrina is expected to be a devastating category four or five hurricane at landfall. Most of the area will be uninhabitable for weeks, perhaps longer. At least one-half of well-constructed homes will have roof and wall failure. Water shortages will make human suffering incredible by modern standards. "

On the same day, at 10 a.m. Blanco and Nagin held a joint press conference during which the Mayor ordered the first ever mandatory evacuation of the city. Most of those who had not already left, but had the means to do so, hurried to the airport or the expressways on which contra-flow (all freeway lanes outbound) had been established. Of course the evacuation was by no means easy nor comfortable and many people had to spend long hours trapped in the traffic, driving a long way from the city to find shelter in hotels, at friends' or centres set up by public authorities and non-profit organizations in the area and in neighbouring states.

However, with the contra-flow in operation, the evacuation moved more people, more efficiently than the evacuation for Hurricane Ivan the preceding year. Despite some contradictory information on availability of alternative escape routes and additional capacity that went unused, such as road shoulders (Litman, 2006), an estimated 800,000 were able to flee the danger zone before Katrina struck.

For those unable to evacuate, local officials designated and equipped the Superdome as the "shelter of last resort." The intent was this massive sports arena designed to withstand hurricane force winds would provide the best available survival protection for the duration of the hurricane, i.e. for a few hours. Of course most in need of last resort shelter were poor and predominately African American, and in a society where private transport is largely expected, did not own a personal automobile. The number of people unable to evacuate had been estimated for long (FEMA/USACE 1994), and the New Orleans Comprehensive Emergency Management Plan estimated some 100,000 residents in that condition. Also census data left no possible doubt about the numbers of those in need, revealing the existence of huge inequalities in terms of income, education, morbidity, mortality, life expectancy, type and quality of dwelling in New Orleans. According the census estimates in 2004, 27 percent of New Orleans residents lived below the poverty line (against 10.9 of US residents) (Census data 2004).

More effective planning might have considerably reduced the number who were unable to flee the city. Although some busses circulated through the city to transport residents to the Superdome, better information about the location of bus stops and the timing of service would have improved the transport of the most needy. Yet, officials did not even press all the existing buses into service and many remained in the depots because drivers were unavailable or for other reasons. Ironically, busses on evacuation missions stalled in the flood waters after the levees failed, further reducing the number for use in the following days. Stories about failure from the part of local officials to accept Amtrak's offer to use one of its train for evacuation purposes remain unconfirmed, but the inability to exploit even existing resources due to poor co-ordination is indisputable and continued in the days after landfall. On September 3rd a fully provisioned train with room for six hundred evacuees left Avondale Station in New Orleans for Lafayette with fewer than one hundred passengers (Office of the President 2006: 40). On top of everything, information was insufficient, confused, often contradictory, and in no way tailored and disseminated as to effectively reach the target audiences.

The Superdome, were the most desperate population sought sanctuary is a large, multi- purpose sport and exhibition facility, with a seating capacity of approximately 70,000, located in New Orleans's central business district. For many residents in low areas of the city, it is difficult to reach under good conditions and a distant walk after public transportation ceased. Once there, getting in was another challenge: many had to stand in long lines and endure searches for weapons and

drugs. Apparently the main concern of the police and the National Guard was "public order", adhering to the mentality of an ordinary crime-filled day in New Orleans. Some late comers arrived just to be told that the building had reached its capacity and, out of desperation and lack of resources, they moved to the Convention Centre, a couple of kilometres away. This facility had been neither designated nor equipped as a shelter of last resort and remained totally unattended by emergency personnel during and after Katrina landfall.

Estimates, likely based on pre-storm projections, indicate some 100,000 people, mostly poor African Americans, remained trapped in New Orleans when Katrina struck. Of that number, approximately 15,000 found shelter in the Superdome and still more in the Convention Centre – which was not declared an official shelter. All these last resort shelter seekers found themselves in conditions that became increasingly unpleasant and difficult as hours turned into days. Reports on exact numbers vary because the Superdome and Convention Centre populations swelled after landfall, as additional evacuees continued to arrive while the evacuation was underway. "The last 300 [people] in the Superdome climbed aboard buses Saturday. Evacuations of the last remaining [people] at the arena were halted before dawn Saturday as authorities diverted buses to help some 25,000 refugees at the New Orleans Convention Centre. The Texas Air National Guard estimated that between 2,000 and 5,000 people remained at the Superdome early on Saturday..." On Saturday, September 3, a representative of the State "Office of Emergency Preparedness put the figure at 2,000, and said [people] had recently begun flocking there not for shelter, but to escape New Orleans after they heard buses were arriving." Except for the ill or injured, no one was evacuated from the overcrowded Convention Centre until Saturday, September 3. By that point, however, over 35,000 people had been evacuated from New Orleans, including all the ill or injured at the Superdome. As the evacuation progressed, the situation at the Convention Centre and the Superdome stabilized, with food, water, and medical supplies available at both locations. (Office of the President 2006: 399).

IMPACT AND IMMEDIATE AFTERMATH

At 7:10 a.m. EDT (Eastern Daylight Time) on August 29, Hurricane Katrina made landfall in southern Plaquemines Parish Louisiana, just south of Buras, as a Category 3 hurricane. Maximum winds were estimated near 200 km/h to the east of the centre.

Katrina generated violent waves and a massive storm surge before colliding with the Gulf Coast. To the east of New Orleans, two hurricane protection levees funnelled the storm surge into a narrowing channel that effectively raised the level of already high water. Overtopping of levees occurred along the eastern portions of St. Bernard Parish and also on the southern section of New Orleans East. This

contributed to flooding within those two sections of the levee system. In addition, as the surge reached the hydrologic dead end at the Industrial Canal, it overtopped the hurricane protection floodwalls there, eroded the base around the floodwall's foundation, and produced a massive levee failure in the lower Ninth Ward. Finally, surge from Lake Pontchartrain, to the north of the city, overwhelmed floodwalls along drainage canals and caused serious failures in three locations that allowed flood waters to pour into the main section of the city's protective enclosure. Combined, the levee failures led to flooding of about 80 percent of the city along with most of adjacent St. Bernard Parish.

The severity of levee failures became known only later, as supervision was not possible during the storm and communication facilities and networks failed during the storm. Several investigations on the causes of levees failures have found evidence of poor design and maintenance (for example Seed et al., 2006; Team Louisiana 2006, and ASCE 2007).

The challenges to emergency responders were huge and, the efforts required overwhelming. Despite the good will and even bravery of many, the chaos within and between the organisations in charge was unprecedented, mostly at top levels (for example see U.S. Congress 2006, Office of the President 2006, van Heerden 2006, Brinkley 2006). With giant gaps in the levees, and water covering much of the urban area, a land response was impossible. State and federal agencies had to dispatch fleets of small boats to navigate through the flooded streets and evacuate stranded residents. The Coast Guard sent in helicopters to pluck those marooned on their roof tops.

As emergency evacuations were underway, reports of violence became the staple of the news coverage. Fearing for the safety of emergency personnel, FEMA and the Red Cross did not enter the city to attend to those in need. Instead, after several days of delays and indecisiveness, National Guard troops arrived en masse. As the Corps of Engineers struggled to close the gaps in the levee system, the military oversaw an evacuation of those who had been stranded at the Superdome and the Convention Centre and initiated patrols to stop looting and violence. By September 5, the city had more troops than residents, although even then the evacuation was far from complete. In a city know for its gaiety, it took on the appearance of an occupied city.

Over the years, New Orleans residents had become accustomed to periodic 2-3 day evacuations, after which they returned to resume their lives. Residents of the lower delta parishes more commonly faced severe flooding and longer displacement, but regional facilities could handle this relatively small population. Katrina produced an unprecedented impact that the emergency response agencies were unprepared to contend with. Emergency supplies were poised to flow into New Orleans, but when the population was not allowed to return, there was no central destination for food, water, ice, and mobile homes. Supplies hovered around the city in staging areas, and

did not reach those in need quickly. Nearly a million displaced people overwhelmed evacuation centres across the region with "guests" who were not able to leave after the normal 2-3 days. Hotels and private homes across the gulf coast states also operated at capacity. All facilities and personnel were strained by the volume of evacuees. The sheer scale of human displacement disrupted all pre-storm planning. Previous experience provided few lessons for the gargantuan mess unleashed by Katrina's encounter with ineffective levees (U.S. Congress 2006).

Twenty-four hour media coverage for several days showed images of devastation, misery and despair, revealing a nightmare scenario and inducing a reflection about the conditions of the poor and the dispossessed all over the country. Many spoke in words of astonishment and grievance and wondered, like Virginia Dominguez how it was possible that, despite plenty of evidence, this "Home-grown Third World" went largely unrecognised. She argued that the rhetoric of the US as a prosperous and powerful country has generated a "habit of thought that ignores, cannot digest or even see all the counter-evidence that exists and surrounds us" (2005).

While keeping the country and the world's attention on the event, the media contributed to confusion reporting news later proved wrong or highly exaggerated of extended murder, rape (particularly in the Superdome premises) and looting. In this way attention and resources were diverted from where they were most needed. Indeed, due to the extended damage to the police department and fire service communication systems, state and federal authorities and agencies started to rely on media as they were not "means" (media in Latin) but indeed sources, and moreover unbiased and unselfish ones (De Marchi 2007). Since the early days of disaster studies, the role of the media has been explored in depth, in particular their contribution to the consolidation of disaster myths (e.g. Goltz 1984, Tierney et al. 2006). It comes to no surprise that in disasters as well as other circumstances, the first objective in the media agenda is to capture audiences, and they pursue it with appropriate strategies, including stirring emotions with stories of sex and violence. The case of Katrina was no different, but unfortunately media reports, in particular TV, were often taken at face value without further checking. As Dynes and Rodríguez (2005) put it: "In social science terms, television constructed the frame of meaning to which audiences and decision-makers came to understand Katrina". In the first days at least, the homo homini lupus idea was reinforced despite empirically based evidence from decades of disaster research that the immaterial aspects of a culture, such as solidarity and civic virtues, are not totally wiped away in a few minutes together with its the material sings (see e.g. Quarantelli 1972).

With "law and order" as one top concern for those in charge, many people remained without any aid, unable to satisfy most basic needs. The Superdome and the Convention Centre became long term traps: the repeatedly announced buses which would take people away materialised only after days and in insufficient

numbers. Those who took them often didn't know were they were heading to and quite a few even got separated from other family members, whom they kept searching for months afterwards.

Beyond the many storms that had hit the region in the past, in May 1990 Bob Sheets, director of the National Hurricane Centre, told a New Orleans audience that "More people would be killed in New Orleans than any other U.S. city in the event of a direct hit by a major hurricane" (Grissett 1990). Neil Frank, his predecessor, had issued similar warnings for years about a category 4 or 5 storm overwhelming the category 3 levee system (Sands 2006 and Grissett 1990). These officials recognized the all-to-obvious gap between the design standards of the levees and the potential impact of a major storm. Although the state had initiated an emergency response planning process in 1985, lack of funding had put that effort on hold by 1987 (Grissett 1990). On the eve of Katrina, a more recent emergency response plan was incomplete in many vital areas (Louisiana 2005 and IEM 2004). The state had been unable to complete a plan in twenty years, although it had not ignored the threat. Yet the scale of past events had not compelled more effective planning and officials relied on levees and evacuation. Perhaps the greatest surprise was that the long-delayed hurricane protection system did not stand up to a storm below its design standards.

One year before Katrina, in July 2004, a desktop exercise had been held in the State Emergency Operations Centre in Baton Rouge over five days. It featured a hypothetical "Hurricane Pam" scenario that was on track to impact thirteen parishes in southeast Louisiana. Using realistic weather and damage information developed by the National Weather Service, the U.S. Army Corps of Engineers, FEMA, the Louisiana Office of Homeland Security and Disaster Preparedness, the LSU Hurricane Centre, and other state and federal agencies performed mock preparations and responses to an unfolding set of circumstances that resembled a real catastrophic hurricane strike. Following the drill, Ron Castleman, FEMA Regional Director stated that, "We made great progress this week in our preparedness efforts. Disaster response teams developed action plans in critical areas such as search and rescue, medical care, sheltering, temporary housing, school restoration and debris management" (FEMA 2004). "Hurricane planning in Louisiana will continue," said Colonel Michael L. Brown, then Deputy Director for Emergency Preparedness, Louisiana Office of Homeland Security and Emergency Preparedness. "Over the next 60 days, we will polish the action plans developed during the Hurricane Pam exercise. We have also determined where to focus our efforts in the future." (FEMA 2004). These and other accounts show that at least some key critical points had been identified, including evacuation and its parallel and opposite problem, the provision of adequate sheltering for those not leaving.

As early as 1994, a joint FEMA – Corps of Engineers report noted the general population in Southeast Louisiana did not have "an accurate perception of their risk

to inundation from storm surge. One possible reason for these inaccurate perceptions might be the false sense of security provided by the extensive levee system" (FEMA-USACE 1994, 4-5). Indeed, assuring the public that the levees being constructed at great expense were intended for their safety during a hurricane fundamentally conflicted with appeals to evacuate. The FEMA-Corps study also revealed variations in how different ethnic groups would respond. In particular, it concluded that the Hispanic population would evacuate at the same rate as the general population. Vietnamese, it observed, might be more difficult to motivate to evacuate. Despite an executive order earlier the same year, the study made no attempt to consider environmental justice in its findings. It pointed out that "the large number of residents reliant on public transportation [15 percent] could create significant problems during an evacuation and should be accounted for in the planning process" (FEMA-USACE 1994, 4-6). This report barely touched on the ability of low-income residents to mobilise, and apparently did not adequately influence subsequent planning. Nonetheless, when an estimated 600,000 evacuated in the face of Hurricane Ivan in 2004, officials witnessed an unprecedented response to evacuation warnings. The horrific traffic jams that resulted prompted many to worry that in advance of the next storm people would stay in the city to avoid exposure to weather conditions on the highway.

A second Hurricane Pam Exercise was planned for the summer of 2005, expanding on aspects of response and recovery that were not explored in the 2004 exercise, but it did not take place, apparently due to a lack of funding.

And the threat was not privileged information, known only to specialists and technocrats. School children participated in hurricane preparation exercises as part of the annual start-of-school activities every August. The Corps of Engineers released a preliminary transportation model in 2001 to be used by local officials throughout the region in preparing evacuation plans. It stated that Southeast Louisiana "is one of the most vulnerable to hurricanes in the entire country" (USACE 2001, 2). In June 23-27, 2002 the New Orleans daily paper Times-Picayune had published a special report, with the unambiguous title "Washing Away", that detailed the possible consequences of a major hurricane hitting coastal Louisiana. The series, by John McQuaid and Mark Schleifstein (McQuaid and Schleifstein 2002a), conveyed the latest scientific thinking about hurricane risks in an accessible way and left no room for optimism or denial.

Both the New York Times and a popular science magazine, Scientific American, carried stories that discussed the hurricane threat to New Orleans early in the new century. The city's precarious situation, which would provide a compelling background, prompted FEMA to hold its national flood conference in New Orleans in May 2002 (Fischetti 2001 and Cohen 2002). At all levels, from the citizen to national officials, the threat had been communicated, if not appreciated.

In an article of November 2004, Shirley Laska, of the University of New Orleans, explored what would have happened, had hurricane Ivan hit the city. She depicted a horror scenario which largely came true after less than one year. If, in Laska's words, "Hurricane Ivan had the potential to make the unthinkable a reality" (Laska: 2004), Katrina did make the unthinkable a reality.

In the epilogue to his book on the "Unnatural Metropolis" published in 2005, one of this paper's authors wrote: "Should a Class 5 hurricane blow water over the lakefront levees, the city could find itself under water for months. Evacuation would face serious bottlenecks due to the limited number of escape routes across the water-logged terrain – and some of those raised highways could be over-topped by storm-driven waves. Recent popular accounts paint a dire picture and suggest that federal authorities might not be willing to make the investments necessary to save a city that cannot afford to protect itself." (Colten, 2005: 191).

Given all such warnings and accounts (and so many others, as we will see in the next section, some from way back in the past), the declaration that President Bush's released on September 1st to ABC 'Good Morning America' appears somewhat ill-informed: "I don't think – he said- anyone anticipated the breach of the levees". While some of the worst-case scenarios reported to the public assumed the levees would hold (Fischetti 2001), such hypothetical depictions anticipated even worse flooding and fatalities. Neither the scale of the disaster, nor the human impact was unanticipated.

The 600-page report by the U.S. Congress Select Bipartisan Committee, established immediately after the storm, described organisational failures as pitiful (U.S. Congress 2006). The report, significantly entitled "A Failure of Initiative" was released in February 2006 and marked "the culmination of 9 public hearings, scores of interviews and briefings, and the review of more than 500,000 pages of documents" (p. x). In its preface, the management of the event is described as "a litany of mistakes, misjudgements, lapses, and absurdities, all cascading together". It blames all levels of government for abdicating "the most solemn obligation to provide for the common welfare (p. x). Documented examples abound about conflicts over competencies and attribution of responsibilities, lack of co-ordination and reciprocal trust within and between organisations with consequent failure to follow correct reporting procedures. Other key malfunctions identified are inadequate foresight capability and insufficient preparation to face an emergency of such proportions.

FEMA in particular became the main target of all critical appraisals and Michael Brown, its director since 2003, was removed from office on 10 September 2005. Several commentators (e.g. Perrow 2005, 2006 and Sylves 2006) have identified the main causes of the agency (new) crisis in the post 9/11 reorganization, which devoted most resources to counter-terrorism and overlooked disaster relief, prevention, and mitigation. FEMA, originally created by President Carter in 1979,

experienced a serious decay in the eighties, until it was revitalised by President Clinton who elevated it to cabinet level. In 2003 however, President G.W. Bush moved the agency into the Department of Homeland Security. Not surprisingly James Lee Witt was one of the most severe critics of such decision. He went before Congress to express his complaint and concern "about the fact that FEMA was losing its people, losing its resources to Homeland Security" and might not be able to respond to a possibly forthcoming catastrophic event (PBS 2006). He is the man that Clinton had appointed as FEMA director in 1993 and is currently (2007) a special adviser to Louisiana governor Katleen Blanco to assist with the post Katrina recovery.

Aside from possible bias in judgement due to personal or political interest, it is indeed the case that organisational changes in the real world do not mirror those on paper. In other words, whereas the mission of a given organisation can be redrawn overnight, with consequent re-allocation of human and economic resources, its culture and habits change but slowly, as they are somewhat rooted and consolidated in long term modes of thinking and operating. Such mis-match makes an organisation crisis-prone (Pauchant and Mitroff 1992), which is most dangerous in an organisation whose task is crisis management.

2 HUMAN SETTLEMENTS IN A HAZARDOUS AREA

PROTECTION FROM RIVER FLOODS

French settlers learned quickly, what Native Americans already knew, that river floods and hurricane surges made the portage site that linked the Mississippi River with Lake Pontchartrain vulnerable to inundation. Strategic value overrode flood risk, and the French opted to establish New Orleans on a low shoulder of land built by the river and separating it from flanking wetlands. The site's founders acknowledged a regular flood risk arising from the river as early as 1720, and hurricanes wiped out the incipient settlement in back to back years – 1722 and 1723 (Colten 2006). Thus, the settlers received ample and frequent early warnings of the flood threat. Indeed, since its founding in 1718, New Orleans has endured at least 27 major damaging flood events. Its defensive levees have fended off many more. Most importantly, despite repeated warnings and actual floods, the city consistently rebuilt and relied on incremental improvements to its flood protection structures (Kates et al. 2006).

There have been four major phases of river oriented flood protection efforts since European settlement began: (1) individualistic levee construction from 1718 to 1846 (2) state oversight of levees from 1846 to 1879, (3) the federal levees only period

from 1879 to 1927, and (4) the federal levees and outlets period from 1927 to the present.

To contend with flooding, the French and later the Spanish and American administrators of the lower Mississippi River delta undertook distinct strategies to contend with the dual threats posed by the river and by tropical storms. Initially, river flooding posed the most crucial and frequent danger, and authorities focused their attention on the more predictable hazard. Company officials responsible for the colonial settlement chose to erect an earthen bulwark along the river side of the city's rectangular grid. By 1730 local workers had heaped up a modest 1.3 meter high levee parallel to the waterway. Given the locality's topography, this barrier could not prevent flood water from rising into the city's rear quarters. Efforts to completely encircle the city with levees ensued, but the great flood of 1735 overwhelmed the hapless barrier.

Even before this dramatic event, the colonial government sought to extend the levee system farther up and down stream and thereby prevent flood waters from flanking the bulwarks. Laws passed in 1728 and again in 1743 demanded that riparian landowners erect levees on their own property. In theory, private citizens occupying a string of contiguous plantations would collaborate to construct a long line of flood protection levees. Private levees proved a flawed approach however. Gaps in the occupation of river front properties left stretches unprotected, and lacking strict engineering standards, landowners built levees according to personal whimsy. These circumstances ensured the river would find a weak link whenever it rose. During the Spanish colonial rule (1763-1803) and the early American period (1803-1848), individual responsibility for the ever-growing levee system produced a barrier that stretched from Baton Rouge to well below New Orleans on the river's east bank. New Orleans depended on this flood protection system and over the years continued to improve the levees along its waterfront. Floods continued to plague the city and the region during the early nineteenth century, offering repeated warnings (Colten 2005, 19-32).

Levees confined the river to a narrower channel and actually raised the flood level. As early as 1817, geographer William Darby observed, "The confined body of water increased in height." (Darby 1817, 56-57). The more effective the levee system, the fewer breaks and the higher the flood stage. Flood protection actually increased risk, and policy acknowledged this dynamic situation. The first territorial law dealing with flood protection called for land owners to raise the level of their levees 0.3 meters above the highest flood and the city of New Orleans had a comparable ordinance (see Colten 2005, 22-23). These legislative actions codified the practice of responding to the last flood and continued the strict reliance on structural defences despite warnings that levees contributed to increased risk.

In the mid-1840s, the state assumed the principal authority for flood protection when it created an office of the state engineer and assigned it the duties of co-

ordinating levee construction. Local levee districts fought for the state engineer's attention and limited funds, and this created a reactionary process of repairing breaks or tending to demands from politically powerful individuals. Even when the U.S. Congress transferred thousands of acres of swamp lands to Louisiana with the intent that sale of the wetlands would fund levee construction, the state and local levee districts were unable to contend with the risk of high water. On the eve of the American Civil War (1861-65), a weak line of levees stretched along both banks of the Mississippi River. They were under the joint responsibility of the ineffective state officials and local levee districts. Only New Orleans had a relatively reliable barrier. Levee neglect during the internal conflict left the levees in an extremely weakened condition. When floods passed down the river valley in 1862, 1865, 1867, 1868, 1871, and 1874, flooding was widespread in many agricultural districts, but high water overtopped the levees at New Orleans only in 1862. Backdoor flooding had not been remedied, but levees effectively closed the front door at New Orleans (Colten 2005, 19-32).

The post-war spate of flooding prompted a federal investigation on the lower Mississippi. In 1879, the Army Engineers suggested that federally maintained levees would enhance navigation on the river by forcing the river to scour a deeper channel. Based on this flawed theory, Congress created the Mississippi River Commission the same year and assigned it the duty of building and maintaining a stronger and more consistent levee system downstream from southern Illinois in the interest of navigation. This effectively transferred the principal authority for levee design, construction, and maintenance to the federal government.

The initial federal policy was a "levees only" approach. That is, to minimise construction costs, federal levees followed the main stem of the Mississippi River and closed several distributary channels. Distributaries previously served as safety valves and carried portions of the excess flow during spring floods. When severed from the river system, the main channel, confined by levees, had to convey the full volume of water – raising the flood stages and forcing the construction of higher levees. The shortcomings of the "levees only" policy became all too apparent with the huge flood of 1927 that breached many levees upstream from New Orleans and prompted the Corps of Engineers to intentionally breach a levee below the city to act as an artificial outlet and reduce the flood stage. Although New Orleans suffered no flooding from the river, federal policy shifted after this episode (Colten 2005, 19-32 and Camillo and Pearcy 2004).

After 1927, the federal government explicitly assumed flood control responsibility – and no longer was levee building presented in terms of navigational improvements. In the lower Mississippi River, there was a fundamental shift in federal flood protection policy. The Corps of Engineers abandoned the "levees only" policy and substituted a "levees and outlets" policy. Levees remained a central component of flood protection, but in addition, the Corps began construction of

massive diversion channels that would mimic the old distributaries long severed from the river by levees. By the early 1950s, the Corps had completed both the Bonnet Carré spillway and a pair of diversions that would feed flood water into the Atachafalaya Floodway. Seldom used, the two spillways have successfully protected the lower river from disastrous floods. As a consequence, massive industrial and urban development now crowds the floodplain behind the levees along the Mississippi River, thus fulfilling Gilbert White's prophecy that structural devices tend to encourage development in flood-prone areas (White et al 1958, Camillo and Pearcy 2004, and Cowdrey 1977).

PROTECTION FROM HURRICANE FLOODS

Tropical cyclones had impacted New Orleans repeatedly before Katrina, but were not part of an annual cycle associated with rising river waters. With a return frequency that was relatively low and highly erratic, investments in hurricane protection lagged well behind river levees. Before 1900, no explicit efforts, local or federal, attempted to create defences against hurricane in the New Orleans area. Property owners who had residences or businesses on the highly vulnerable shore of Lake Pontchartrain typically built structures on stilts to escape flooding caused by high water, whether hurricane induced or otherwise. Other than fishermen and businesses associated with lake shipping and several entertainment destinations, there was little development on the lake side of the Metairie/Gentilly ridges. Thus the wetlands and a natural rise of nearly 2 meters between the city and the lake provided a two-part buffer against direct hurricane impacts from the lake. From the east, more extensive wetlands and barrier island system than remains today provided an impediment to surge.

Before the late nineteenth century hurricanes remained a force of nature that were too extreme and unpredictable to defend against. Beginning in the late nineteenth century, there were four basic stages of hurricane protection: (1) an ad hoc stage from the late nineteenth century until about 1915, (2) a period of local efforts from 1915 until about 1947, (3) limited federal assistance coupled with local efforts from 1947 to 1965, and (4) major federal investment and oversight after 1965.

Beginning in the late nineteenth and accelerating during the early twentieth century, local drainage districts encircled wetland tracts with low levees that fronted the lake and began pumping water from within their perimeter. These levees were designed to enable drainage and not to protect against hurricanes. More than anything these drainage districts began to lure residential development toward the hurricane susceptible lakefront. In 1899, the city received approval to begin a major public works program that would accelerate wetland reclamation on the lake side of the Metairie-Gentilly Ridges. The initial phases of drainage works construction

focused on the existing urban area – on the river side of the ridges. Following a Progressive Era economic rationale, planners explicitly avoided investing in the lakefront fringe during the system's initial years of construction (Colten 2005, 89-91). This proved most fortuitous when a massive hurricane pushed across the lower delta and passed just to the west of New Orleans. Although this track was not the most perilous route for the lakefront areas, it produced serious flooding and damage. A surge of over two meters flooded lakefront entertainment establishments and pushed water back up Bayou St. John a natural gap in the ridges. The combination of water flowing into the city through its drainage canals, excessive rainfall, and the retention effect of the modest levees caused flooding within the city to reach eight foot depths and damages thousands of residences. It took several days for the new drainage system to expel the excess water (USACE 1997, 16). This destructive storm prompted a rethinking of lakefront hurricane protection.

In an effort to offer greater protection and encourage continued lakefront development, local authorities sought to enhance structural defences along the lakefront. In 1922 the Orleans Levee Board began work on sinuous 5.5 mile seawall set some distance out into the lake and that rose 3.2 meters above the water level. Dredges scoured sediments from the lake bed and placed the material behind the seawall creating new residential real estate (Colten 2005, 144). In adjacent Jefferson Parish, local officials teamed with the state to build a two meter high barrier in 1924 that also served primarily as a highway roadbed (U.S. Congress 1946 and 1950). Neither barrier was designed explicitly to defy hurricane surges, but they represented incremental improvements carried out by local authorities. When the next major hurricane struck in 1947, the Jefferson Parish highway/levee had subsided, compromising its effectiveness. The concrete seawall in Orleans Parish proved more reliable when gusts of over 125 miles per hour drove floodwaters inland. Storm surge caused flooding behind the seawall, but produced depths of only 0.3 meters. Waves overtopped the Jefferson Parish roadway. While the barrier did not prevent lake water from entering the new suburban districts, it kept the water from draining back into the lake. And given subsidence of much of the lakefront property, floodwaters rose as high as six feet and required as much as two weeks to pump dry (USACE 1997, 26).

The 1947 hurricane prompted a collaborative response that merged local and federal resources to provide hurricane protection. Congress authorised the Corps of Engineers to augment the Jefferson Parish levees and ensure more effective protection in the future. Federal efforts during the 1950s also sought to improve hurricane prediction capabilities. This could greatly improve evacuation efforts that were becoming a key component of hurricane protection. Hurricane Flossy struck coastal Louisiana in 1956 while the Corps was still in the process of making levee improvements. This storm produced extensive flooding in Orleans Parish and

exposed the futility of piecemeal attempts to fend off massive tropical storms in this setting (USACE 1957).

Attempting to address the lingering weaknesses in its hurricane protection system, the Corps of Engineers prepared a substantial report on the means to build a unified and effective hurricane protection system. It submitted this report to Congress in June 1965. In September that same year, Hurricane Betsy delivered devastating winds and flooding to Southeast Louisiana. An effective evacuation effort minimised loss of life. Flooding in the now infamous Ninth Ward forced residents to their roof tops as waters swirled into their homes and produced massive property damages throughout the region. Almost immediately, Congress authorised the Corps to proceed with work on the most recent (and still uncompleted) phase of hurricane protection for New Orleans. (Secretary of the Army 1965 and President Promises 1965).

After further planning and appropriations, the Corps began work on the most extensive and most thoroughly federal effort to minimise the impact of hurricanes in New Orleans in 1967. The plans called for a series of levees, designed explicitly to protect the city and neighbouring areas from the impacts of hurricanes with winds up to 160 kilometres per hour. The original plan also called for a combination of levees and movable barriers to block storm surge from entering Lake Pontchartrain from the Gulf of Mexico. The fundamental strategy was to build a structural system designed and financed largely by the federal government. Local interests had numerous responsibilities in the process as well and ultimately their involvement greatly complicated the completion of this massive system. Delayed by legal wrangling, financial issues, and construction challenges, this system, authorised in 1965, was not complete when Katrina rolled on shore in 2005 (see Secretary of the Army 1965, Comptroller General of the U.S. 1976, and U.S. General Accounting Office 1982).

3 LONG, MEDIUM AND SHORT TERM PREPARATION AND RESPONSE

From a position in the twenty-first century, one can look critically at the heavy reliance placed on levees for flood protection in the lower Mississippi River valley. Yet, this seemingly blind devotion to structural means had its critics even in the nineteenth century and there have been adjustments to, if not abandonment of, the levee option. Sounding amazingly prescient, A. D. Woodridge, the Louisiana State Engineer in 1850 observed, "I find myself forced to the conclusion that entire dependence on the leveeing system is not only unsafe for us, but I think will be destructive to those who come after" (Woodbridge 1850). He focused his critique on the massive initial investment, but also the ongoing enlargement demanded by increasing flood stages. He argued that diverting some of the flow to the sea via outlets would decrease the long-term costs and the future risks. Yet, levees remained

the principal option for defending against floods. And indeed, the barriers along the riverside did as much to enable New Orleans's survival as the South's major city as its strategic location. Although criticized, levees have provided persistent protection for the city.

By selecting the levee option, one generation passed this technological solution on to the next generation, while at the same time imposing a path dependence on subsequent decision makers. With the massive investment in the levees, it is almost inconceivable that later generations would attempt a wholesale alteration. During the nineteenth century, law required repairs following one flood to be built 0.3 meters higher than the previous flood stage – perpetuating the dependence on levees. Raising levees after major hurricanes mirrored the path dependence of river front protection. The Corps of Engineers are merely the latest organisation charged with that responsibility. Their role in levee building in the past century has been dominant. As journalists reported in 2005, "No one has been more responsible for keeping Louisiana habitable over the past 200 years than the Army Corps of Engineers. But the Corps has caused the most problems." (McQuaid and Scheifstein 2002b).

The one major adjustment in the levee path occurred following the 1927 flood. After an experiment with an artificial crevasse at the height of the flood, the Corps of Engineers abandoned the theory that a channel confined by levees would scour a deeper course. Freed of that notion, they returned to the concepts advanced by engineers in the mid-nineteenth century of using outlets to direct excess flow to the Gulf of Mexico. Rather than re-opening bayous that once served as outlets, they created new human-made outlets. This required the construction of massive guide levees along the Bonnet Carré and Atchafalaya spillways. So levees remained a key feature, and the outlets merely provided a safety valve. The outlets did not offer any relief from the delta's need for sediment. Fearing the spillways would fill up with river sediment if used too frequently, the Corps keeps the gates closed except in emergency situations. When opened, the artificial outlets allow sediment to drop out within the broad spillways, far from the coast where it is needed. The volume of sediment in the river has been cut in half since the mid-1950s due to impoundment's and soil conservation practices used in the upper river.

Levees, the Corps have learned, are not a permanent solution. During the major floods of 1973 – the only time when both outlets were opened – there were numerous close calls with levee failures. And the cornerstone of the entire lower Mississippi River system, the Old River Control Structure, nearly failed (McPhee, 1989) Following this flood, the Corps added concrete facing to some levees to minimise the threat of erosion in the future and raised others. Levee improvements never end.

In addition, the levee option has diverted millions of tons of sediment into the Gulf of Mexico rather than across the subsiding delta. This starves the vital wetlands

of rejuvenating sediments and allows subsidence to outpace restoration. As Shirley Laksa reminds us, "Loss of the coastal marshes that dampened earlier storm surges puts the city at increasing risk to hurricanes. Eighty years of substantial river leveeing has prevented spring flood deposition of new layers of sediment into the marshes, and a similarly lengthy period of marsh excavation activities related to oil and gas exploration and transportation canals for the petrochemical industry have threatened marsh integrity." (Laska 2004). Threats to health integrity due to environmental degradation and the presence of petrochemical installations deserves at least a brief mention here, which many authors had documented even prior to the event (e.g. Allen 2003). Investigators began reporting on the coastal land loss issue in the 1970s. Interest and understanding of the process expanded in subsequent years. By 1990, scientists made a sufficiently compelling case that Louisiana officials convinced Congress to pass the Coastal Wetlands, Planning, Protection, and Restoration Act. This act dedicated a combined $65 million annually from the federal and state treasuries to protecting the coastal wetlands. It has produced numerous efforts to construct freshwater diversion projects since restore barrier islands. (Coastal Wetlands Planning, 2006). Despite efforts to offset natural processes that diminish the coastal land areas, sea level rise looms as an additional threat to the low-lying coastal wetlands.

Shifting to hurricane protection, one must realise that the Corps of Engineers employs two entirely different standards. River levees are designed to withstand a flow of over 3 million cubic feet per second at the Old River Control Structure - roughly the flow during the 1927 flood. Using this record setting flood, planners designed for the last flood. By contrast, engineers determined the necessary height for hurricane levees protecting the urbanised area based on a "return frequency" of 200 to 300 years. The main components of the system were designed to repel waves and surge driven by 100 mile per hours winds. The Corps had adopted what they defined as a "standard project hurricane" before Hurricane Betsy in 1965. Ironically the same year that the Corps advanced their preliminary plan to Congress, Betsy, with winds in excess of 100 miles per hour, rushed across the New Orleans region. Four years later, Hurricane Camille, with winds of about 200 miles per hour, roared onto the same stretch of Mississippi shore devastated by Katrina. Despite repeated occurrences of storms that exceed the design criteria within four years of each other, the Corps did not adjust the standard project hurricane until another decade had passed (USACE 2007). While some levee work was completed or in early phases of construction even before Camille struck, delays held up much of the levee work until after 1978. Engineers could have adjusted the standard project hurricane to incorporate these devastating storms much sooner.

One of the lessons learned prior to Hurricane Betsy was the importance of evacuation. In 1957, Hurricane Audrey struck the Southwest corner of Louisiana. The population, most living less than ten feet above sea level, were reluctant to flee

in the face of the storm. Winds in excess of 105 miles per hour drove surge and waves well above the low lying terrain and killed over 550 people. Memories of Audrey prompted the effective evacuation of over 300,000 in advance of Betsy's arrival (USACE 1965). Most evacuation in 1965 was from low ground to slightly higher locations within the urban area, and few made long distance drives. With the construction of interstate highways during the 1960s and 1970s, evacuation out of the region replaced localised movements to slightly safer locales. Despite improved route-ways and regular refinements of the evacuation plans, terrible traffic snarls resulted when the urban population took to the roads in advance of Georges (1998) and Ivan (2004). Planning focused on making the personal automobile oriented evacuation work more efficiently rather than incorporating mass transit options (FEMA-USACE 1994, IEM 2004, Louisiana 2005). When Katrina came calling in 2005, some 800,000 fled New Orleans and vicinity using "contra-flow" for the first time – all lanes of the interstate highway system were used as out-bound lanes. This fine tuning produced far less congestion than the previous year. Planners had succeeded in improving an evacuation process that benefitted those with access to a private automobile.

Land-use approaches have seldom been used in preparing for hurricanes in Louisiana. A particularly devastating storm completely obliterated the Chenier Caminada resort off the Louisiana coast in 1893 and killed an estimated 2,000 people. The resort never reopened; its abandonment was one of the rare land-use adjustments. Neighbouring Grand Isle, which also had a resort destroyed in 1893 and battered again frequently since then, continues to serve as a recreational beach area (USACE 1997). The Grand Isle response is more typical, and is writ large in the state's largest city.

The New Orleans area has typically rebuilt and added modest structural protection, even when that protection raises the value of property that will be impacted by future storm. After the 1915 hurricane damaged over 25,000 residences, the local units of government improved the lakefront levees. Again, when the 1947 hurricane left standing water in suburban neighbourhoods of Jefferson Parish for up to two weeks, no one gave up any ground, and levee improvements ensued. Indeed, suburban sprawl quickly filled in the Jefferson Parish during the post-World War II period. After Betsy washed over much of the Ninth Ward in 1965, federal assistance enabled reoccupation of the flooded neighbourhoods. Massive suburban expansion also took place in eastern New Orleans behind new storm barriers. Development pushed into the very areas that had experienced flooding during the last major storm once new levees were in place (Burby 2006).

Despite good intentions, the Corps' work on hurricane protection improvements that began in earnest after Hurricane Betsy in 1965 was incomplete in August 2005. During that forty years numerous influences stymied construction progress. Local business and environmental groups challenged the desired plan that called for the

erection of movable gates across the two openings that linked Lake Pontchartrain with the Gulf of Mexico. Ultimately a federal court ruled the Corps could not build the barrier option. Following court's ruling, engineers literally had to go back to the drawing board and revamp the levees to conform to the alternate "high level" plan. Delays produced cost increases and local governments had trouble raising their obligated shares. This produced further delays (Comptroller General of the U.S. 1976, and U.S. General Accounting Office 1982).

Jefferson Parish authorities, seeking to encourage development and expand their tax base by encircling a larger area than the Corps' plan, took on the task themselves. This ambitious local undertaking collapsed when the Corps rejected the parish's environmental impact statement and the local government then turned the job back over to the Corps. This postponed starting work on the West Bank by several years. Other delays resulted from innovation and engineering prudence. When the Corps sought to use a geotextile mesh to increase the strength and reduce the weight of levees in the lower delta, they had to conduct a multi-year trial to prove the material's effectiveness. Funding disruptions frequently put a wrinkle in the project's timetable. On several occasions, budget-conscious administrations tightened up the federal purse strings and inhibited the flow of funds. This was particularly an issue during the last three years leading up to Katrina (Colten 2006). Congress took note of the delays and ordered investigations in 1976 and 1982 to determine why the task was taking so long. (Comptroller General of the U.S. 1976, U.S. General Accounting Office 1982). Their concern with accelerating progress has not been as evident in recent years.

By the start of the hurricane season in 2005 there had been many disruptions, but no serious threats since Hurricane Juan in 1985. It had caused some flooding on the West Bank where the local-federal power struggle had delayed the project. Urgency had evaporated, and homeland security trumped hazardous weather events. Construction crews continued to make incremental progress; annual reports showed the percentage of work completed inching upward. Despite numerous warnings that New Orleans was a highly vulnerable city, there was no panic. Indeed tropical storms seemed to thwart urgency. Hurricane Andrew in 1992, while brutal to south Florida and portions of coastal Louisiana, did not present a serious threat to New Orleans. Georges in 1998 and Ivan in 2004 veered eastward and spared the Crescent City. Later that same year, Hurricanes Bonnie, Charley, and Frances all battered Florida. The unfinished defences had successfully kept out high water, and evacuations, even when partial, offered a means to remain safe for those with means to drive to high ground.

Despite numerous early warnings, one can point to a series of failures: (1) failure to finish a system originally scheduled for completion in 1978 (Comptroller General of the U.S. 1976, and U.S. General Accounting Office 1982); (2) failure to adequately maintain levees that subsided below their design height (USACE 2007, Seed, et al. 2006, Team Louisiana 2007); (3) failure of adequate emergency planning and management (FEMA-USACE 1994, IEM 2004, Louisiana 2005) and perhaps most importantly (4) failure to control development in highly vulnerable locations (Burby 2006 and Houck 2006).

Ironically, the Corps of Engineers limited development in Jefferson Parish, to the displeasure of local boosters, but urban growth falls under local jurisdictions. Even after the passage of the National Flood Insurance Act in 1968 – a program that sought to deter inappropriate land uses in floodplains – local governments did almost nothing to limit development in flood prone areas. Consequently, FEMA watched as the New Orleans area became a national leader in flood insurance claims. Residents thought they had a double layer of protection – the levees and flood insurance. And some areas that flooded received direct federal assistance – such as Agriculture Street Landfill neighbourhood. When Katrina blew the lake and the gulf into the city on August 29, 2005, the damage costs were considerably higher than they would have been had land-use controls been employed (Burby 2006).

4 LEARNING AND IMPLEMENTING LESSONS: IS IT POSSIBLE?

Few would deny that "a disaster waiting to happen" is an appropriate description for the events depicted in this paper. The impending hazard had been long ascertained and the vulnerability of the environmental and human systems exposed had been identified, including its main causes and some possible precautionary and remedial courses of action. Yet, when Katrina struck, most were appalled by both the amount of destruction and what appeared as inadequacy of long-term planning, pre-impact preparation, and post-impact response.

By no means can one find the key to explain such failures in a lack of scientific knowledge. To the contrary, progress in knowledge and monitoring of climate phenomena, including hurricanes, had increased exponentially in the previous decades, paralleled by a refined capacity of predicting the latter's path and strength. Although many uncertainties remain, available sophisticated technologies permit precise tracking of tropical depressions, tropical storms, and hurricanes. Moreover, powerful computer models provide fairly accurate forecasts of the evolution of the phenomena under observation in the hours and days ahead.

When such technologies are not just theoretically available but actually in place, as in the US case, forecasts can be constantly updated and communicated to the competent authorities and the residents, in order to implement emergency plans and to adopt appropriate actions. It is true however that those in charge must always act in the absence of full scientific certainty, an impossible ideal when we are dealing with complex phenomena such as the climate, and take responsibility for actions (such as, for instance, ordering an evacuation) which can prove unnecessary afterward and potentially harmful.

As we have seen, in the case of Katrina the predictions by the NWS and the NHC were extremely accurate regarding to its path and impact area, as well as its destructive power; this despite that it made landfall in Plaquemines Parish on 29 August 2005 as a category 3 hurricane, rather than the announced category 5. In any event, the special advisory issued by the NWS office in Slidell, Louisiana, just a few hours prior to landfall, contained an acknowledgment of uncertainty: "... the big question is how strong Katrina will be at landfall. We have very limited skill in predicting this".

Whereas uncertainty is a key issue regarding decisions about immediate pre-impact measures, it has virtually no role in planning and preparation, as indeed any state, city or county in the area may be hit by the next hurricane. The impending hazard from hurricanes has long been known, as well as that of flooding from the Mississippi River. The dangerous location of New Orleans had been recognised since the times of its foundation by the French, and the whole history of the city has been one of a constant fight against the waters. Its strategic value, military and political first and subsequently linked to the gas and oil industry and to tourist and gambling activities, was of primary importance for a number of both corporate and public actors at the local, state and federal levels. The construction of defence barriers, an ever expanding levee system, was the main protective strategy over the past centuries, supplemented by storm forecasting and evacuation. Engineering solutions were privileged over all other options (or combinations of options) also at the expense of the natural defences of the ecosystem, such as coastal marshes. These were sacrificed to the development of urban settlements in previously uninhabited areas, thus increasing the hazard exposure not only of such areas but making the whole city more vulnerable.

The origins of such choices, here and elsewhere, are rooted in the idea of progress as the exercise of human power over Nature through the application of science and technology. Successes and failures in the struggle of New Orleans against its environment are to be analysed in that framing, otherwise they are almost impossible to understand. Once the path of control (over nature) is taken, reversibility is an illusion and all other possible pathways blocked. Levees must become stronger and stronger, higher and higher and, more and more expensive. Regardless to the fact that various types of constraints make it more and more difficult to pursue the pre-traced path, any new decision is constrained by the previous ones and, in its own turn traces the boundaries of future options. As in an endless loop, bigger is the defence system, greater the illusion of invulnerability, more subtle is the increase of actual vulnerability. In the case of New Orleans, the technological resources, skills and operations necessary to maintain and update the levee system are so complex and costly to be virtually impossible to pursue, despite repeated promises at any new disaster, that "it won't happen again" and endless reassurance that lessons have been learned.

Certainly, there have been repeated attempts to find innovative alternatives to substitute the ones which had proved ineffective, as it was the case with the shifting of flood control responsibility back and forth from private citizens to state and federal governments. However, these changes involved administrative and organisational choices, whereas the Cartesian vision of Nature as inert matter at man's disposal remained prevalent. This despite that this view has been repeatedly challenged by many dissenting voices from different quarters and appealing to scientific, economic, environmental, and ethical arguments.

Congruent with such a domination approach is the interpretation of any disaster in terms of man's defeat against uncontrollable or unforeseeable natural phenomena, whereas his tampering with the environment is left out of the picture and discounted as a possible cause (or con-cause) of undesired or unexpected events. A passage from President Bush's speech delivered about a week after impact well represents this view: "Hurricane Katrina was one of the worst natural disasters in our Nation's history and has caused unimaginable devastation and heartbreak throughout the Gulf Coast Region" (The White House 2005).

From a different perspective, taking into account the multiple and complex interactions between humans and their environments, his statement might be re-written as follows: "Hurricane Katrina was a natural phenomena whose impact on an un-prepared human system resulted in one of the worst disasters in our Nation's history." Such alternative perspective had been put forward well before Katrina stroke, and reverberated in the many "doomsday predictions" (just a few of which are recalled in this paper) derived from scientific as well as local knowledge and widely reported, including by the media.

The many who warned about an impending disaster were not oracles. With some insight and foresight, they put together existing data and information on climate and geological phenomena, local geography, socio-demography and urban settlements, complemented with knowledge of local lifestyles and social problems, including poverty and (mis-)functioning of bureaucratic organisations, in particular those in charge of disaster management.

After Katrina, the debate has been revitalised, to some extent instrumentally, on whether human emissions of greenhouse gases may have already caused and will further induce changes in climatic conditions, including increase in the number and destructive power of tropical cyclones.

The issue is highly controversial and, in our view, is unlikely to be resolved, due not only to insufficiency of data and models, but also to actual ignorance about all the possible interactions between climate phenomena and human activities, which remain to a large extent unknown. Moreover, due to constant changes in both technology and society, accurate forecasts on their future arrangements and reciprocal interactions are impossible, a situation best described by the term "indeterminacy".

Whilst there is no consensus in the scientific community on factual issues, some proponents of opposed views decided to come together with a common statement, where they seek to shift the focus of the debate from the (uncertain) influence of climate change on hurricane activity to the (actual) problem of increased societal vulnerability: "As the Atlantic hurricane season gets underway, the possible influence of climate change on hurricane activity is receiving renewed attention. While the debate on this issue is of considerable scientific and societal interest and concern, it should in no event detract from the main hurricane problem facing the United States: the ever-growing concentration of population and wealth in vulnerable coastal regions" (Emanuel et al. 2006).

For decades social scientists have insisted on the interpretation of disasters as the joint result of physical phenomena and societal vulnerability to them and the consequent importance of avoiding practices such as the occupation of hazard prone areas (e.g. Burton et al. 1978/1993, Mileti 1999). In a time of demographic growth and virtually unconstrained expansion of human settlements impacting all types of environments, viable strategies for responding to climate and other changes need to be sought predominantly in the area of societal governance (Pielke and Sarewitz 2006).

Governance is a continuing process for the management of a society's or community's common affairs and includes formal institutions and regimes as well as informal arrangements (Commission on Global Governance 1995, p. 2). Therefore conceiving instruments and strategies for societal governance in the face of impending risks and dangers requires the involvement of all the many actors, individual and collective, that will have to cope with them. This implies that planning cannot be just a desk top exercise, and that preventive measures must be imagined in a realistic way, taking into consideration the actual possibility of implementing them for those who are supposed to do so. In this respect at least, some lessons seem to have been learnt, and the 2006 New Orleans Emergency Preparedness Plan contains measures for the evacuation of those without private transport means.

This is certainly an improvement for effective emergency management, but the key issue to be faced is the poverty and marginality of so many residents, of which lack of private transportation means is just one aspect and indicator. Even if better plans are in place for evacuation of those most in need, the problem remains of their return. Is there anything left for them in New Orleans? And most than anything, are they wanted back? Or will the disaster become an opportunity to gentrify the districts in which they lived?

There are many reasons why people do not want to leave their homes and communities besides unawareness of danger or lack of means. "Attachment to one's place" expresses aspects as different as concern for being separated from one's dear ones, pets or property, a strong feeling of local identity, urge to share one's

community "destiny", fear of facing an unknown situation in going away and, perhaps mostly, in coming back (De Marchi 2007). Such concerns and fears are amplified when the threat is not only to one's personal safety, but to one's whole "landscape"; when in peril are the material signs and the immaterial symbols which ones is used to recognise as the landmarks of a familiar culture. Also they tend to be stronger for poor people who encounter enormous difficulties in making their voices heard in the public arena and in organising initiatives and pressure groups to counter-balance powerful lobbies (Allen 2003) for example developers in the re-construction business. Support and empathy, comfort and reassurance are necessary to convince people to leave, not just precise information about the impending threat and the accessible escape routes.

At the time of writing (August 2007), the number of households receiving mail in New Orleans, two year after Katrina, was 137,082 or 69 percent of the pre-storm total. Suburban Jefferson Parish has rebounded much more completely with over 98 percent of its pre-Katrina households. A portion of this number is former Orleans Parish residents who opted to relocate from flood ravaged neighbourhoods(Greater New Orleans Community Data Centre, 2007a) The most recent population estimates (from July 2006) report Orleans Parish had 223,000 residents compared to a July 2005 population of 452,000 (Greater New Orleans Community Data Centre, 2007b)

The prevailing (official but not only) discourse after any catastrophe, whatever its origin and wherever its scene, insists that important lessons have been learnt to prevent it from happening again. Declarations and promises abound that the opportunity will be seized to head in the direction of a sustainable and equitable future, doing away with all previous errors, injustice and discrimination. Disaster researchers however have long argued that there is a considerable continuity between pre-disaster conditions and trends and what occurs when a disaster strikes. "One clear implication of this continuity principle is that everyday patterns of social inequality - such as unequal access to housing, information and political power - carry over into post disaster settings and are reflected in victims' experiences." (Tierney et al. 2001, 197). There is no doubt that disasters (as well as wars) are an opportunity for many to increase their wealth, power and influence. And there is no doubt either that even the best of intentions must come to grips with actual constraints of all sorts.

Perhaps a "sustainable New Orleans" is an oxymoron and throughout this paper we have insisted in the limited possibility of choice due to previous decisions and practices, whilst a plan of total dismantling is simply inconceivable. Denial of present constraints (including technological, economic, and cultural ones) would inevitably lead to inappropriate policies, but equally negative would be to stick rigidly to pre-defined options, failing to address the systemic nature of the problems at hand and the complexity of their management. Narrow framing, technological fantasies and lack of foresight would all conjure towards new disasters, independent

of new hurricanes. In the absence of means to control climate phenomena, resources have to be spent in diminishing the vulnerability of the human systems exposed, through a set of integrated measures which range form land use to building practices, insurance schemes, education, training and communication, warnings and so on.

The specification "integrated" points to the necessity of considering the mutual interactions between different components of complex systems whose behaviour remains largely unknown and unpredictable. Moreover, the systems we are referring to are not just "ordinarily complex", i.e. systems whose behaviour (or much of it) can be explained in terms of diverse elements coexisting, in competition and/or co-operation, to reach simple goals (Funtowicz and Ravetz 1994). As they involve humans they are best characterised as "emergent complex systems, [which] by contrast, cannot be fully explained mechanistically and functionally; in them, some at least of the elements of the system possess individuality, along some degree of intentionality, consciousness, foresight, purpose, symbolic representations and morality" (Funtowicz and Ravetz 1994: 570). In such context, it is appropriate to look for the contributions of all types of available knowledge, be it based in disciplinary expertise, technical know-how and daily-life experience.

As to the last point, it needs to be recalled that most valuable local knowledge, e.g. for understanding present risks in the light of environmental and societal change, is lost when its bearers are dispersed, through expulsion, relocation or other means. Similarly, assumptions from officials and authorities about people's behaviours, expectations and attitudes have often been proved wrong and should rather be checked with citizens in flesh and bones. Different types of knowledge bring in different perspectives, different criteria of assessment and, inevitably, conflicting views over the issues at stake, their possible solutions or management options. Some, for example, will privilege an evaluation in terms of costs and benefits, others will claim that money cannot be the standard for everything and will resist quantification of life, health and environment in those terms. Moreover, in both camps dissenting views will emerge. In the former for example, some will adopt a short term perspective comparing only the present costs of initiatives such as rebuilding vs. land reclamation, others will look further taking into account both present and future costs of different options, including inaction. Among the latter some will oppose any monetary evaluation, others will accept it sub condition (e.g. for compensation but not for planning) or as one in a mix of criteria.

Conflicting views are difficult or even impossible to reconcile, but in any event an open debate is preferable to lack of transparency. One such conflict is between government and the private sector, but also between different levels of the former (local, state, federal) which, according to historical accounts is endemic (U.S. Congress 2006).

As stated in the introduction, we will not pursue our narrative beyond the post-disaster phase and will not follow (at least in this paper) the story of recovery and reconstruction, which continues to unfold. Some signs are there that, again, post-disaster trends will largely be modelled on pre-disaster ones, but, after Katrina, the system is no longer the same and surprise might not be far in the horizon.

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