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**BUILT ENVIRONMENT ISSUES IN
SMALL ISLAND STATES AND TERRITORIES**

Organised by the Faculty of the Built Environment,
University of Technology, Jamaica

**“Observations on Building and Maintaining Resilient Buildings
and Human Settlements to withstand Disaster Impact”**

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ABSTRACT

Many societies have to live with natural and other types of risks and the threat of disasters has always presented a major challenge. Residents of the Caribbean region need no reminder of this reality. The challenge is to devise ways to achieve sustainable development by reducing patterns of vulnerability. The issue of disaster reduction is therefore crucial and must have a significant place in public and political perceptions, in national policies and operational practice. These are all needed to create favourable conditions for effective hazard reduction at various levels. This can help in increasing the resilience of communities at risk to absorb disaster shocks, bounce back following their impact and adapt during disaster recovery. Thus the aim of this paper is to explore the concept of resilience in general and consider what this means before, during and after disaster impact. Two models are described to show how resilience relates to pre and post-disaster contexts and what happens when resilience does not exist. Various case studies will be cited to indicate how resilience operates or fails to occur and why. The concluding section of the paper defines how resilience can be developed to create sustainable societies, economies, systems, structures, buildings and settlements that focus on four key concepts: robustness, redundancy, resourcefulness and rapidity.

KEYWORDS

Resilience, Communities, Settlements, Buildings, Disasters, Vulnerability, Risk, Safety,

“Can we please stop hearing about the resilience of the British people? People everywhere are resilient.

Londoners went back to the tube on Friday because they have to; they have jobs to go to etc. People do not have a choice but to get on with life. At least in London we still have an infrastructure which allows us to do this, unlike survivors of the tsunami, or the residents of Baghdad who have shown tremendous resilience in rebuilding their lives.”

Desna Roberts, letter to the Guardian,
Quoted in ‘This Week’ July 16. 2005 p.29

BACKGROUND

This paper explores resilience, considered in relation to communities, the systems that support society and its varied functions and the physical, economic and natural environment. In recent years there has been a growing acceptance of this concept in the broad field of disaster risk management. Thus the centre where I work carries this title and ‘UK Resilience’ is the title given to the UK Government’s national system of emergency planning. The popularity of the word ‘resilience’ may simply relate to current fashions in terminology, just as the word ‘sustainability’ became ubiquitous throughout the 1980’s. But more positively the word has a useful value to express a concept that can be conveniently used to describe a policy framework, or an approach that can relate to all phases and sectors of disaster and risk management. Resilience is a complex, multi-faceted and widely used word, conveying multiple meanings. Thus, this paper seeks to illuminate and unravel some of the complexities of the subject as well as posing a number of questions addressed to researchers and policy makers concerning ways to build and maintain resilience.

The ideas expressed are rarely original, and I wish to acknowledge my thanks to my colleagues in Cranfield University, especially Yasamin Izadkhah, who have generously assisted me with their support and insights as I have developed a number of papers relating to this topic. (DAVIS, 2003; 2004; 2005).

This paper was being written during the first weeks of July 2005 and during this period on July 7th terrorist bombs exploded in central London with a cost of 53 killed and over 700 wounded (BBC NEWS). Therefore a brief case study has been added to others to consider the level of resilience found in London in the week following this outrage.

Resilience will be considered from a number of standpoints in the following sequence:

Part 1. Observations on the nature and goals of resilience.

Part 2. Characteristics of resilient communities.

Part 3. Characteristics of non-resilient communities.

Part 4. The key dimensions of resilience.

Part 5. Summary: How can resilience be created and maintained?

PART 1. THE NATURE AND GOALS OF RESILIENCE

How has resilience been defined?

- *“The ability that a person or institution has to recover quickly from a setback or misfortune.”*
- *“Something that is resilient is strong and not damaged easily by being hit, stretched or squeezed”*

Collins English Dictionary 1987

- *“The act of rebounding or springing back...”*
- *“Buoyancy, power of recover....”*
- *“The power of resuming the original shape after being bent compressed or stretched...”*
- *“Rising readily again after being depressed: hence cheerful, buoyant, exuberant...”*

The Shorter Oxford English Dictionary 1983

- *“The act of rebounding...”*

Fowler’s Modern English Usage 1968

- *“The ability of a body to recover its original form after deformation”*
- *“An ability to recover quickly from or adjust easily to misfortune, change or disturbance”*
- *“Capable of withstanding shock without permanent deformation or rupture”*
- *“Jump back, recoil...”*

The Penguin English Dictionary 1982

- *“The capacity of a system, community or society to resist or to change in order that it may obtain an acceptable level in functioning and structure”*

UNISDR 2002

From these definitions a broad collection of keywords can be deduced that describe the many functions of resilience:

recover, rebound, recoil, resist, robust, arise, buoyant, adjust, absorb, cope, strong, elasticity, flexible, cheerful, exuberant, active

All these rich ideas are considered in this paper where resilience is defined as:

The ability of communities, their physical, social, political and economic systems and their buildings and settlements to withstand hazard generated forces and demands, to bounce back rapidly and to adapt to cope with future threats.

In disaster situations, the over-arching aim is to create *resilient* systems and to build *resilient* societies who inhabit *resilient* buildings and settlements. Since the main focus of this paper is concerned with the protection of buildings and settlements an important point needs to be stated at the outset of this paper concerning the earthquake hazard. Unlike any other natural hazard, the cause of deaths and injuries in earthquakes comes from the failure of buildings under the extreme forces of seismic impact. 98 percent of all earthquake casualties derive from building failure. Thus it has been often said that “*buildings kill people, not earthquakes...*” Therefore when considering the subject of resilience in relation to buildings it is essential to recognise that the key issue is the need to create and maintain safe buildings set within safe settlements. Community preparedness and public awareness programmes can play a part in this process but they will never be a substitute for safe building and physical planning measures.

Resilience can be secured through four ambitious objectives. In order to build a resilient disaster and risk management it is necessary to consider the:

1. probability of failure (through risk assessment leading to risk reduction measures)
2. consequences of failure, (in terms of fewer injuries, fewer lives lost and reduced direct and indirect damage)
3. time needed for recovery, and
4. patterns of vulnerability during the process of reconstruction.

Summary, Part 1.

In this introductory discussion the concept of resilience has been introduced, a wide range of definitions have been stated, with the selection of a specific definition of resilience for use in this paper. Emphasis is given to the need to focus on buildings in relation to the earthquake hazard. Part 1. concludes with a list of four objectives that need to be secured if resilience is to be achieved

Part 2. CHARACTERISTICS OF RESILIENT COMMUNITIES

A resilient community is one that has:

- *the ability to absorb the shocks of hazard impact, so that they do not become disasters.* (Thus to reduce the probability of failure)
- *the capacity to bounce back during and after disaster.* (Thus to reduce the consequences of failure)
- *the opportunity for change and adaptation following a disaster.* (Thus to reduce the time needed for recovery as well as patterns of vulnerability).

The three contexts can best be described visually on the following matrix, (Figure 1):

1. The diagram or graph describes, in the form of a **Time-Line a Given Situation**, perhaps a country or a large urban centre that seeks to develop over a period of time. It then experiences a major disaster followed by a successful attempt to recover above previous levels of vulnerability.

2. **Quality** is represented on the vertical axis of the matrix, with 100 percent at the top and zero percent at the bottom. The example of a society shown on this matrix is about 50 percent in terms of the quality of say its overall development, or of the quality of its infrastructure, or in relation to the theme of this paper- the level or extent of vulnerability. Thus the example on Fig. 1 represents a typical vulnerable developing country or city.

3. The horizontal axis of the matrix represents **Time**, possible over a time period of say five years over the course of the diagram.

4. There is an angled line that crosses the matrix rising from the left to the right. This starts as a heavy black line but it then becomes dotted. The solid line represents the situation in the society before a major disaster took place, while the dotted line represents a projection of national intentions for the given country, town, or region to improve in quality over time. The line is dotted since this process was interrupted by the disaster impact. The process is normally called '**Development**', and it is often enshrined in Governmental five year plans.

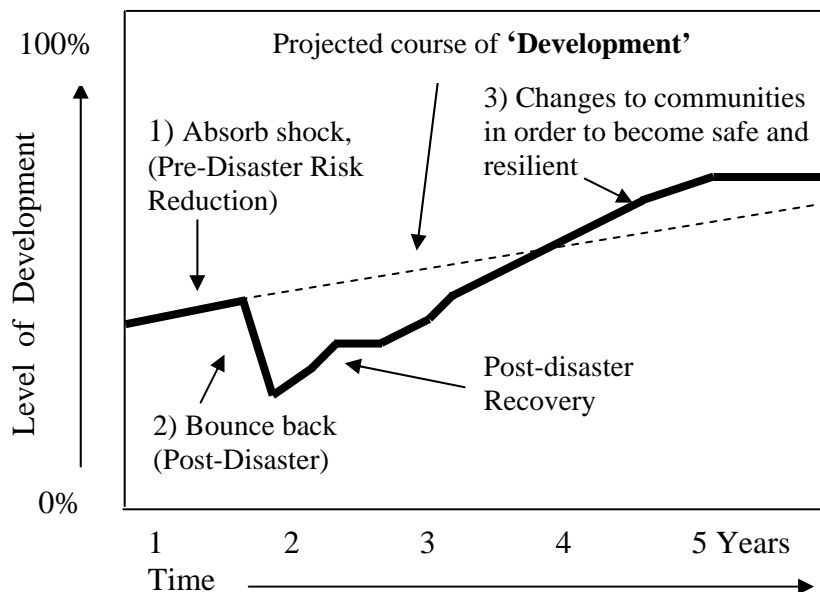


Figure 1. Matrix /Time-Line representing three contexts for the ‘Development of Resilience’. (Described below)

This diagram now becomes the setting for the following text, but some further explanation is needed:

- The first phase noted as ‘*Absorb shock, Pre-Disaster Risk Reduction*’ on the matrix is a pre-disaster phase described within the following text as ‘**The ability to absorb the shocks of hazard impact**’. During this phase there are opportunities to develop structural and non-structural risk reduction measures to absorb the impact of hazards in order to become more resilient.
- The second phase noted on the matrix as ‘*Bounce back (Post-Disaster)*’ is a post-disaster phase called in the text ‘**The capacity to bounce back during and after disaster**’. During this phase the intention is to reduce the extent of the drop in development or quality caused by the disaster, shown on the diagram as a descending black line. The sudden drop indicates the impact of a fast impact disaster such as an earthquake. The drop is not vertical because the full social and economic consequence of major disaster is never immediate, and is offset to some extent by the sudden influx of national and international assistance.
- The third phase noted on the matrix as ‘*Changes to communities in order to become safe and resilient*’ is a post-disaster phase called in the text ‘**The opportunity for change and adaptation following a disaster**’. During this phase the intention is to recover, and in the diagram progress is typically erratic taking a long time to get back to the level of the projected development goals. But since in this case the original starting point was clearly vulnerable, (hence the disaster) the

aim is to rise above this situation, above the dotted line of projected development. So the intention is to rise above the ‘normality’ that may be in the case of place represented on the diagram be identical to ‘vulnerability’.

These three contexts are described as follows:

**Phase 1: The ability to absorb the shocks of hazard impact,
(The Pre-Disaster context)**

There are three linked concerns in absorbing shocks: how to cope, how to gain strength and how to withstand a disaster.

First, find ways to cope with severe pressures:

“The ability of a system to withstand stresses”.

J.F. Horne and J. Orr (HORNE & ORR, 1998)

Second, find ways to ensure that a community is strengthened, becoming less fragile, and less susceptible to disaster impact:

“Vulnerability is intimately related to social processes in disaster prone areas and is usually related to the fragility, susceptibility or lack of resilience of the population when faced with different hazards”.

A. Lavell (LAVELL, 2003)

This emphasis emerged clearly in a memorable dialogue that took place in a Disaster Management Course in 1983

“...the aim of disaster recovery is to restore normality.”

Senior Red Cross Official

“ ..Sorry, but I must protest! In my country, Jamaica, we have lots of people living inside cardboard boxes, so are you telling us that following a disaster the aim is to put them back in those boxes... ?

No, in this case their ‘normality was identical with ‘vulnerability’, so surely the aim of disaster recovery must be to move forwards, above the vulnerable normality?”

W. Patterson, Senior Nutritionist,

Government of Jamaica

Third, find ways to survive despite receiving the impact of severe natural hazards: It is important to note the range of elements of a society needs to withstand, as noted in the following quotation:

“Local resiliency with regard to disasters means that a locale is able to withstand an extreme natural event without suffering devastating losses, damage, diminished productivity, or quality of life without a large amount of assistance from outside the community”.

D. Mileti (MILETI, 1999)

Characteristics of resilience before a disaster

The following themes need to be addressed in this pre-disaster context:

- Promote disaster planning, supported by legislation and regularly update the plans.
- Test the disaster plan regularly.
- Recognise the importance in building a prepared community who know what to do to protect themselves.
- Seek to build a safety culture, where protection of people, property and the natural environment is assumed or ‘normalised’

Societies cope before a disaster by adopting the following approaches:

- By using traditional experience and knowledge
- Preparing for any possible hazard by having emergency kits or supplies, (buffer stocks) ready for the event
- Having family or community disaster plans
- Organising training courses in first aid, etc.
- By moving away from vulnerable areas to safe sites.

Buildings and Settlements can survive disasters, because of pre-disaster actions that include:

- Creating hazard resistant buildings and settlements.
- Ensuring that the physical infrastructure is robust.
- The use of the regulatory environment of enforced building bye-laws and land-use planning controls.
- Progressive insurance companies can use building insurance cover as a ‘carrot’ rather than a ‘stick’ to promote building safety by reducing insurance premia when clients take actions to improve their building safety.
- Making certain that all ‘critical facilities’ are built or retro-fitted to make them safe against hazards (schools, hospitals, cultural assets, places of public assembly, Emergency Management Centres etc.)
- Adaptive behaviour, (strengthening houses, providing emergency protection of doors and windows from high winds, etc.)

CASE STUDY No.1. The Vulnerability of Kingston and Jamaica to Natural Hazards *(The ability to absorb the shocks posed by natural hazard forces)*

Hazards

The city of Kingston “...is vulnerable to a multitude of natural hazards. Located in a tectonically unstable and hurricane –prone part of the world, the region is made up of steep and unstable slopes; naturally frequent floods; unconsolidated, liquefaction-prone sediments composing flatter lands; and low-lying coastal areas susceptible to flooding from storm surges and sea level rise” (McHARDY 2005)

Integrate recovery plans to link social, physical and economic recovery and follow a Recovery Plan

Following the impact of Hurricane Ivan on Jamaica an assessment was made of the lessons from the disaster. The study highlighted the need for:

- “A clear focus by all relevant agencies on potential hazards in Jamaica, causative factors, necessary preventive/ mitigation measures.
- Acceptance and execution of respective roles and responsibilities at the appropriate time and as the need arises
- Strengthening of the parish and community level prevention, response and recovery, restoration capacity.
- Strengthening the Emergency Operations Centre and Function
- Strengthening the capacity and clarifying the jurisdiction of ODPEM
- Building a Disaster Reduction Culture at the policy level of government, private sector, parish and community-based organizations” (JONES, 2005)

Recognise the importance of securing a prepared community who know what to do to recover

The Office of Disaster Preparedness and Emergency Management (ODPEM) of the Government of Jamaica organises an ambitious programme of public awareness activities to prepare the population for possible disasters. These are supported by the media, with particular emphasis on actions that citizens and home owners can effectively take in the event of a disaster.

Take actions to reduce future vulnerability to earthquakes, hurricanes, landslides, and flooding.

“Vulnerability to natural environmental hazards is greatly exacerbated by socio-economic conditions, including deforestation of slopes, vegetation alteration, development along gully banks, diminished health of fringing and protective reefs, sea-grass beds and mangroves due to pollution, and the reduction of sediment transport to reinforce the coast. As a result, roads, bridges, culverts, homes and other infrastructure components are frequently destroyed, while even weak earthquakes can bring heavy damage and destruction.” (McHARDY 2005)

Given to extent of the natural hazards that threaten the Kingston region, that are compounded by the human generated vulnerability graphically noted in the above quote, it follows that an exceedingly ambitious programme of risk reduction is required to secure sustainable development. In her perceptive ‘Sustainable Development Plan’, Pauline McHardy has noted that the lessons following Hurricane Ivan in 2004 indicate the need to tackle corruption; to rectify the lack of manpower and professional training that results in the lack of enforcement of building codes; to develop and enforce land-use planning controls to tackle the threats posed by urbanisation pressures. She also cites the challenge to address poverty that is making the vulnerability of poor communities worse due to their lack of health services and basic food supply as well as inadequate social and physical infrastructure. (McHARDY 2005)

Therefore if the region is to become resilient in absorbing multiple hazard shocks then certain policies and practices to address the hazards and patterns of vulnerability need to be implemented as a matter of urgency. A unique window of opportunity for decisive political action is open following the impact of Hurricanes Ivan, Emily and Dennis in 2004-5.

In the aftermath of Hurricane Ivan (2004) is there evidence of Jamaica having a resilient society and a resilient government?

1. The evaluation of lessons following Hurricane Ivan included this finding on the failures in some areas of effective community resilience:

“Breakdown in communication between the national and parish/community levels was a major shortcoming identified in almost all aspects of response. What appeared to be a general lack of appreciation of risk and vulnerability coupled with some fatalism was evident from reports. The need for individuals and communities to take charge of their vulnerability reduction must be addressed from the national level and therefore community disaster planning must be strengthened throughout all communities of the island and with structured involvement of all stakeholders. This planning must be an on-going exercise and the required resources deployed to enable effectiveness and sustainability”.

(JONES, 2005 p. 27)

These gaps resulted in the following observation that noted that where community disaster response capacity had been built, suffering was minimized as they took responsibility for their recovery. Thus one of the report recommendations proposed the expansion of the:

“.. community disaster planning programme in the context of building community resilience – hazard identification and mapping, vulnerability assessment, risk reduction strategies”

(JONES, 2005 p. 33)

2. Further examples of resilience following Hurricane Ivan include the following:

- The telecommunications performed well partly due to the policy after Hurricane Gilbert (1988) to relocate vulnerable overhead cables into underground conduits. By reducing the weight of heavy telephone cables from utility poles they were better able to withstand the high wind forces and thus maintain the electrical supplies carried on the poles.
- The evacuation of the population in the Portmore, a vulnerable low-lying area of Kingston, was very effective. This was largely due to an evacuation simulation that had taken place prior to the event.
- The media played a key role with their coverage of ‘real-time’ information as the hurricane passed over the country.

(JONES, 2005 p. 32)

Phase 2: The capacity to bounce back during and after disaster, (Post-Disaster, immediate relief phase)

There are two linked concerns in bouncing back: how to deal with the unexpected to recover rapidly and to identify the factors that enable communities to become resilient.

First, find ways to deal with the unexpected and recover rapidly:

*“The capacity to cope with unanticipated dangers after they have become manifest, learning to **bounce back**”.*

A. Wildavsky (WILDAVSKY 1991)

Second, identify the factors that enable societies to become resilient:

“People continually adapt to crisis, coming up with creative solutions. They prioritise livelihoods and household assets rather than the quick fix. Supporting resilience means more than delivering relief or mitigating individual hazards. Local knowledge, skills, determination, livelihoods, cooperation, access to resources and representation are all vital factors enabling people to bounce back from disaster”.

Introduction, World Disasters Report 2004

Characteristics of resilience during and after a disaster

The following themes need to be addressed:

- Integrate recovery plans to link social, physical and economic recovery.
- Follow a disaster recovery plan
- Recognise the importance of securing a prepared community who know what to do to recover
- Take actions to reduce future vulnerability.

Societies cope during and after a disaster by adopting the following approaches:

- Strengthening their houses, providing emergency protection of doors and windows from high winds, as a way to minimise damage.
- Drawing on the support of their community
- Taking stock to determine what they have and what or who is missing
- By restoring communications to facilitate aid distribution
- By mitigating future risks (both psychological as well as material threats)
- Through a recognition that physical recovery work can combine bereavement therapy with a possible income source
- Recognising that the entire experience is a learning process.

During and after disasters, Buildings and Settlements need to maintain a series of specific functions:

- Hazard resistant buildings and settlements save lives and protect livelihoods.

- Buildings need to protect their occupants from secondary threats (for example, post-earthquake fires and aftershocks)
- Critical facilities such as hospitals have an obvious key post-disaster function and school buildings can provide shelter and serve vital emergency functions.

CASE STUDY No 2. Resilience following terrorist bomb attacks in London, July 7th 2005 (*The ability to 'bounce-back' after disaster impact*)

Hazard. Four high explosive devices exploded, without any warnings being issued, during the morning rush hour in Central London on July 7 2005. Three bombs exploded in London underground trains and one was on the top deck of a double-decker bus. 53 people were killed and 700 were injured in the various blasts. The timing of the attack coincided precisely with the start of the meeting of the G8 Prime Ministers in Gleneagles under the chairmanship of Prime Minister Tony Blair. It was immediately assumed to be a terrorist attack.

Integrate recovery plans to link social, physical and economic recovery.

London has a Strategic Emergency Plan (www.londonprepared.gov.uk) This covers the steps needed to recover and maintain essential services despite the pressures of disaster impact. Given localised damage confined to underground stations there was no need in this crisis to follow a physical or economic recovery plan. However the social needs are extensive requiring long- term psycho-social support to victims and the families of the dead and wounded.

Follow a disaster recovery plan

The Strategic Emergency Plan was created by law following legislation called the 'Civil Contingencies Act' that was prepared after the 9/11 attack. The plan was implemented within 15 minutes of the last of five bomb attacks. Due to sensitivity concerns only certain sections of the plan are available to the general public. This plan has been frequently tested in both table top as well as actual drills, but this was the first time it was activated. The cornerstone of the plan is based on integrated emergency management from the Civil Contingencies Secretariat (CCS) based in the Cabinet office under the chairmanship of the Prime Minister. The strategy is that in the event of a disaster to bring the relevant ministers and senior officials together to the Cabinet Office Briefing Room (COBRA). This centralised command structure was established after inter-ministerial policy conflicts tensions during the Foot and Mouth outbreak in 2000.

Recognise the importance of securing a prepared community who know what to do to recover

It is doubtful if the population of London have any knowledge concerning what they need to do following a terrorist attack. Before the bombing a low-profile had been given to raising awareness among the general public. Perhaps the reasons for the lack of a high profile campaign to inform the public concerning steps to take in the event of a disaster relate to governmental fear of causing public tensions or outright panic. In the two critical hours following the bombing there was a total absence of advice to the public provided by the Metropolitan Police. But within an hour of the bombing the national networks of BBC Radio 4 and 5 conducted an interview with Sally Lievesley, probably the leading expert on terrorist protection in the UK. She filled this gap in official advice for those listening by proposing that the public must remain within their buildings rather than be out of doors since their buildings provided a shield of protection against blast impact.

Take actions to reduce future vulnerability to terrorist attacks

There are probably only three effective ways to prevent terrorist attacks. The first is to address the root causes of the conflict. In this case this may relate to the underlying anger of a disaffected group of Muslim extremists. Their cause could relate to their perception of acute official injustice in relation to Middle Eastern conflicts. There is the repeated failure of the UK and the US to oblige Israel to follow repeated UN requirements and cease to occupy Palestinian territory in the West Bank. A further disaffection could relate to the recent wars in Afghanistan and Iraq in which the UK was the US government's principal ally. (ALI ,2005). As yet there is no evidence to suggest that the UK wishes to acknowledge that the above suggestion is a significant factor in the bombing or that political issues need to be addressed to reduce this terrorist threat.

The second option is to open negotiations with terrorists, who exist in some organised entity, to identify their demands and seek settlements to reduce tensions in order to secure peace. Discussions with security officials now reveal that such communications took place (often through third parties) throughout all the years of the IRA conflict with the UK government although Prime Minister Margaret Thatcher persistently maintained a public posture that "*We do not negotiate with Terrorists*". Recent revelations indicate that the US Government is already holding negotiations with representatives of various international terrorist organisations in relation to reducing hostilities in the Iraq conflict. The third way to reduce terrorist threats is through effective tight security measures. Officials in the UK claim that about ten attempted terrorist attacks on London since the WTC was attacked in 2001 have been averted by the vigilance of security officials. Therefore, this failure of intelligence will result in additional resources being deployed to support the various intelligence gathering authorities. The suggestion of a possible fourth option to develop security checks as people board buses and trains, on the lines of tight airport security has been rejected as being totally impractical given the vast

In the aftermath of the bomb attacks in London is there evidence of resilience?

1. An exceedingly high level of resilience was demonstrated by the emergency services who all worked to a well rehearsed and well understood emergency plan that proved to be very effective.
2. Good business continuity was achieved following a brief interruption in offices due to transport shutdowns following the bombing. This was aided by a stock exchange financial procedure aimed to minimise the risk of rapidly falling share prices.
3. Excellent political leadership from Prime Minister Tony Blair as well as from the G8 leaders who were meeting at the time of the bombing and who decided to continue their meeting irrespective of the crisis in London as a symbolic gesture that the terrorists would not achieve the prize of a discarded international gathering.
4. No panic by the public who remained calm throughout the emergency.
5. Evidence of strong social solidarity and coping strengths and abilities by the public including those wounded and affected by the blast.
6. Resilience was also demonstrated in the police enquiry by successfully identifying the bombers within 5 days of the attack.

CASE STUDY No. 3. Resilience following Bam Earthquake, Iran 26th Dec. 2003

(The ability to 'adapt and change' following disaster impact)

Will the city of Bam rise again more resilient than before the disaster? Bam will probably be rebuilt, as promised by the former president of Iran, Khatami, as "Stronger than before".... "There is need for training in sound buildings practices and promoting public awareness of disasters".

Hazard

Iran is located in Alpine-Himalayan Seismic Belt set within a highly active tectonic zone. The earthquake, measuring 6.5 on the Richter scale struck the city of Bam including the town of Baravat, and their surrounding villages in Kerman province of Iran early in the morning when the residents were asleep. Out of population of 120,000, the earthquake claimed around 26,000 dead and caused injuries to 30,000. The impact made more than 60,000 people homeless and severely damaged or destroyed nearly 85% of the buildings in the area. The economic damage totalled \$1.5 billion Dollars.

The historical town of Bam, at an altitude of 1000 m., is now a half dead, half living town 195 km. to the southeast of Kerman. Arge Bam (the historic Bam Citadel), an un-reinforced adobe structure, built on a huge rock mass at the northeast of the living town, was devastated by the earthquake. This famous citadel and strategic stronghold, designated as a UNESCO World Heritage Site was a major international tourist attraction and a vital source of income for people in Bam. This highly vulnerable city mounded from the red clay of the Great Iranian Desert, Dashte Kavir, was a disaster waiting to happen. The government's failure to make adequate preparations, or to introduce structural retrofitting measures to the vital structures against earthquake impact, (a very frequent occurrence in Iran), compounded the tragedy. The devastation experienced in Bam can be compared with the earthquake of a similar force that occurred a few days earlier in southern California that only destroyed a few buildings, killing just two persons. Thus the criticism is entirely justified that Iran's unelected theocracy had played a crucial role in exacerbating the impact of the earthquake by official neglect and by permitting shoddy construction that breached building regulations in one of Iran's key historic sites.

Integrate recovery plans to link social, physical and economic recovery

The overall response to the earthquake was outstanding. The first Iranian Red Crescent (IRCS) teams arrived shortly after the quake. In addition, an international appeal for international aid was launched. Support was received from many countries including US in setting up field hospitals which were useful for political links. There was a disaster plan for the city but no specific recovery plan until after the disaster. The reconstruction process was an ad hoc process.

Follow a disaster recovery plan

The Bam earthquake highlighted the need for a comprehensive structure for disaster management planning, monitoring and implementation to address such emergencies. However, on a more positive note, many promising efforts have been initiated by the government plus local and international NGOs in order to achieve better construction and education.

Recognise the importance of securing a prepared community who know what to do to recover

Despite the earthquake occurring at a time when many people were sleeping and could not therefore have actively responded, the consequence of the Bam earthquake is that earthquake education has received a significantly higher priority. Observation and interviews by the second author have identified many cases of people who survived, especially children, apparently due to their disaster awareness.

Take actions to reduce future vulnerability to earthquake impact

There are many ways in order to reduce the vulnerability of future earthquakes:

- Oral History
- Informal warning and education
- Knowledge and information dissemination
- Building local capacity
- Coordination between government and the internationals
- Physical planning and use of codes

In the aftermath of the Bam Earthquake is there evidence of resilience?

1. Local people had the knowledge and skills to craft their own recovery.
2. There was a high level of response from the national relief workers immediately after the earthquake.
3. People's coping mechanism for their livelihood was outstanding.
4. Evidence reveals that there was a high percentage of cooperation between the national and international community.

<p>Phase 3: Resilience <u>following</u> a disaster, the opportunity for change and adaptation following a disaster <i>(Post-Disaster, reconstruction phase)</i></p>
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There are two linked concerns in grasping ways to change and adapt following disasters:

First, find ways to create new systems, learning the hard lessons gained from failure:

“The capacity to adapt existing resources and skills to new systems and operating conditions”

L. Comfort (COMFORT, 1999)

Second, find ways to adjust or adapt in order to cope better with future disasters:

“The ability of an actor to cope with or adapt to hazard stress. It is a product of the degree of planned preparation undertaken in the light of a potential hazard, and of spontaneous or premeditated adjustments made in response to felt hazard, including relief and rescue. The most important policy options available to enhance resilience are those that shape formal or informal insurance mechanisms. Insurance is a key tool for use in spreading the economic costs of disasters across society and over time.”

M. Pelling (PELLING, 2003)

Characteristics of resilience after a disaster

The following themes need to be addressed:

- Integrate a recovery plan that links social, physical and economic recovery.
- Follow a disaster recovery plan and have a reconstruction strategy as part of this disaster plan.
- Ensure that local purchase or reconstruction goods and services takes place to revitalise the damaged local economy.
- Recognise the value of a prepared community who know what to do to recover.
- Take actions to reduce future vulnerability.
- Be aware that reconstruction is often delayed to await political, administrative and economic reforms and the enactment of new safety laws. These delays can cause a major loss of momentum.
- However, a resilient society will recognise the importance of embarking on physical reconstruction whilst such reforms are in progress.

Societies cope during the reconstruction phase of a disaster by adopting the following approaches:

- Drawing on support from their community
- By being adaptable, flexible and patient
- Mitigating future risks (of both psychological as well as material value)
- Regarding physical recovery work as bereavement therapy and a possible income source
- Seeing the entire reconstruction experience as a learning process.

During the reconstruction phase of a disaster, buildings and settlements need to be repaired or rebuilt in a manner that does not rebuild vulnerability:

- Repair options need emphasis in reconstruction policies since this approach reduces costs over total reconstruction, repairs can stop the waste of valuable building materials, (often destroyed in a demolition frenzy) and repairs can generate valued jobs in the construction industry and for local suppliers of building materials.
- The aim should be to use local labour and local materials in order to revitalise battered local economies.
- Building codes and land-use planning controls will need urgent reconsideration whether they provide adequate protection.
- Throughout the reconstruction phase buildings need to protect their occupants from secondary threats such as seismic aftershocks that can continue for years after a main event.
- Critical facilities such as hospitals and school buildings need to receive priority concern in any reconstruction strategy.
- The desire of the public and political leaders for a fast recovery programme needs to be firmly resisted, since rapid reconstruction is often at the expense of safety considerations and of full public participation.

Summary, Part 2

In this section resilience has been related to the three phases of Disaster Risk Management: resilience is described as absorbing disaster threats before the event, bouncing back during the disaster and adapting in the post-disaster recovery phase. These are all related to a Time/Quality Matrix described in Fig.1. The concepts are described in relation to resilience being demonstrated, or not, in three case studies: hazard threats in Jamaica after Hurricane Ivan in 2004, the bombing incident in London in 2005 and the Bam earthquake in Iran in 2003

PART 3. CHARACTERISTICS OF NON-RESILIENT COMMUNITIES

Many of the words used in the English language to describe a post-disaster situation have a decidedly optimistic ring about them. Thus we had the prefix ‘**Re**’ set before a wide collection of descriptions that always assume or imply a return to normality after the trauma of death and the havoc of destruction. So we have such confident words as: **Recovery**, **Reconstruction**, **Rebuild**, **Reinvigorate**, **Re-establish**, **Rehabilitation**, **Restoration**, **Regeneration**, **Revitalisation** and of course **Resilience**.

However... not all societies of human settlements do manage to recover from disaster, rather they enter into a state of terminal decline. So, in contrast to societies that are generally resilient, as discussed in Parts 1 and 2 of this paper, what is the nature of those communities that can NOT absorb shocks that FAIL to bounce back and are UNABLE to adapt? What are the opposite definitions of non-resilience in contrast to the descriptions of resilience used at the outset of this paper?

The following descriptions may apply:

fragility, susceptibility, inability to change, vulnerable, weak, inflexible, rigid, un-resistant, non-resistant, decline, failure, passive.

Non-resilient societies will be described, first with a description of the condition using the Ratchet Model and secondly some possible reasons for the lack of resilience will be suggested.

1. Societies that progressively deteriorate into terminal decline

This condition can best be described in relation to a pair of examples represented in a pessimistic model of progressive vulnerability and decline called a “Ratchet Model”. This model is useful since it shows in graphic form how a situation can go into progressive decline, but as with a ‘no-return’ ratchet wheel each stage is irreversible. Once a stage is reached recovery is impossible, and the situation moves relentlessly onwards to the next downward stage, with pressures getting tighter that ultimately lead to death of individuals or of communities and of their settlements ceasing to be viable. The first example, (Figure 2), represents an extreme drought situation leading to famine conditions. The various stages are well-documented stages in progressive decline.

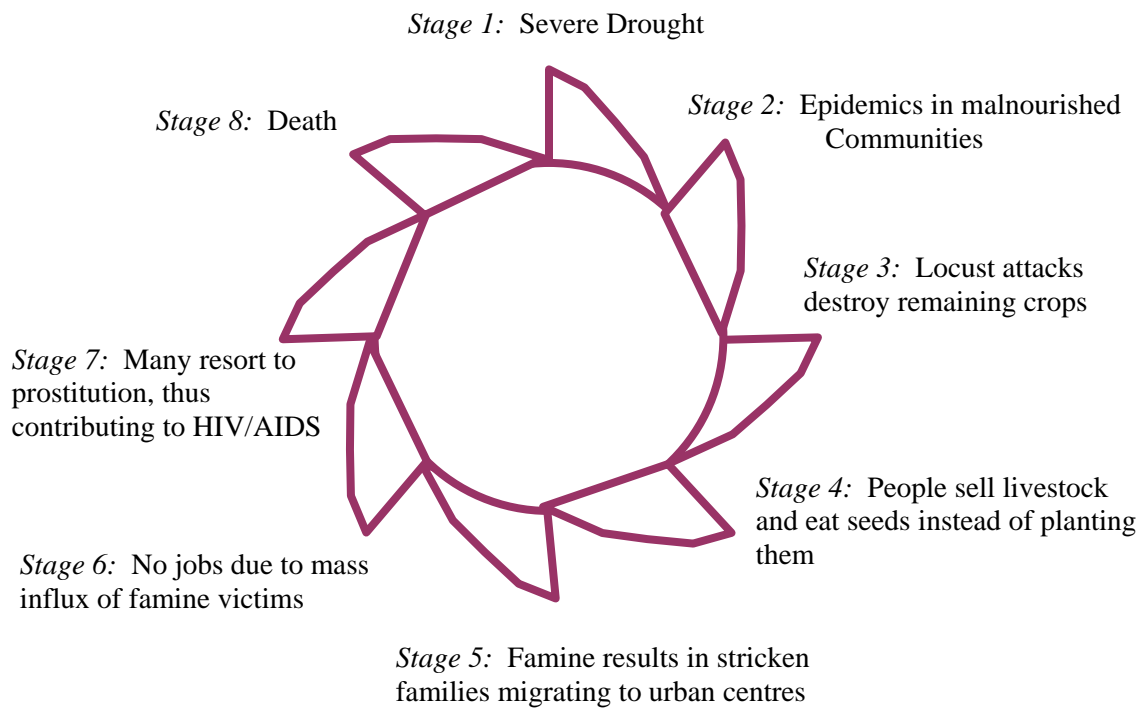


Figure 2. Ratchet Wheel model of Progressive Decline in a Drought/ Famine Situation

The second example, (Figure 3), represents how a potential disaster recovery situation turns into a disaster decline situation leading towards the death of a community. However, the seeds of such decline may have been present prior to the disaster.

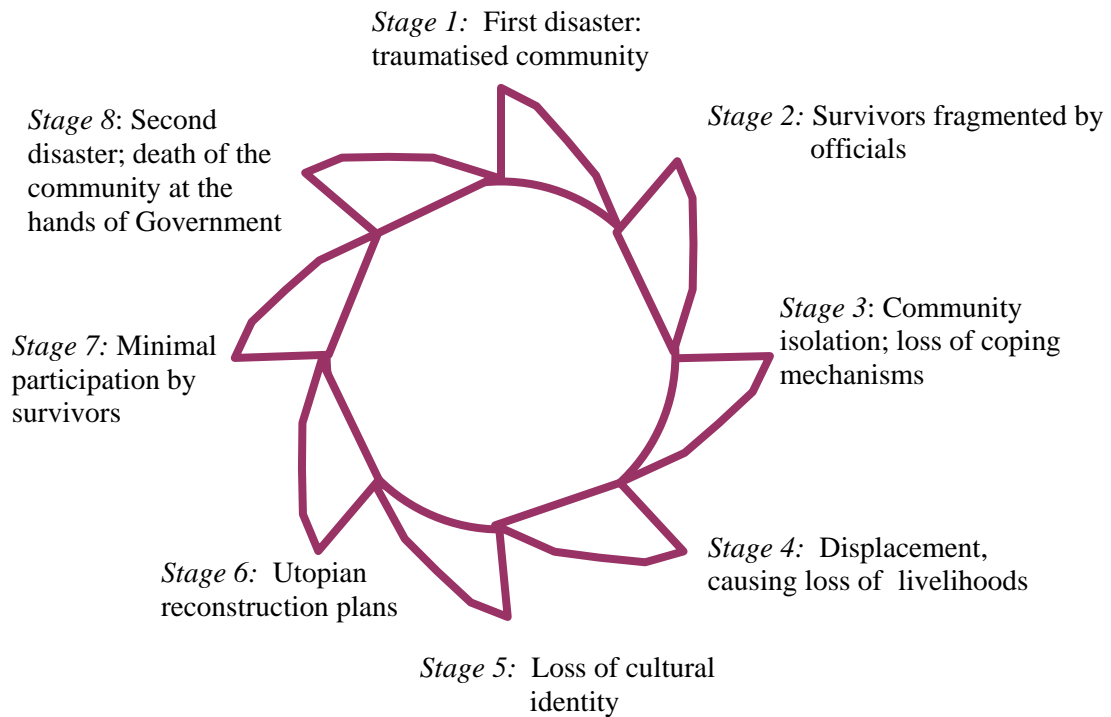


Figure 3. Ratchet Wheel model of Progressive Decline in an Urban Disaster situation.

2. Why are they in this condition?

Reasons can be detected in each phase of disaster planning and management:

They fail to absorb disaster shocks....

They fail to prepare in any way due to a lack of leadership or from ignorance or apathy concerning the risks they face, and they may be unaware of their severe exposure to life threatening hazards. They may have to suffer from a government that fails in its 'duty of care' to protect its citizens

They fail to bounce back during or after a disaster....

They fail to cope after a disaster due to a lack of leadership or knowledge concerning what to do to recover, or of their weakness due to family or material losses as well as personal injuries. They may have a government that has failed to take their responsibility for disaster management seriously.

They fail to adapt following a disaster....

There may be two reasons why communities fail to adapt or initiate the vital changes that are needed following disaster impact. Firstly, a lack of leadership or knowledge concerning what to do to recover, or the government and NGO's runs out of energy resources and political will due to an overspend during the initial relief phase or the demands of a protracted time-scale of extended reconstruction.

Secondly, the seeds of their failure to recover may stem from unaddressed pre-disaster weaknesses. George Nez was a senior Physical Planner who played an active leadership role in the reconstruction of two major cities, Skopje, Yugoslavia (1963) and Managua, Nicaragua (1972) that were both devastated through major earthquakes. He expressed the dilemmas he experienced:

“When you direct a reconstruction programme everyone tends to blame the disaster for this or that problem. However gradually you come to realise that ninety percent of the problems you encounter were present before the disaster event, waiting to be tackled. All that has happened is that the disaster has acted like a sharp surgeon's scalpel that has been used to expose all manner of weakness and failure, such as poor government, un-enforced building codes, lack of planning, corruption in all directions etc. The issue poses a dilemma concerning how far it is possible to go, with the limited resources at your disposal, in rebuilding the society as well as its towns and cities”

G. Nez (NEZ, 1974)

Summary, Part 3

In this section there has been a consideration of societies that are not resilient. Two examples are cited in Figs 2 and 3 using a Ratchet Model that indicates the stages of irreversible decline in a drought/famine situation and in an urban disaster context. Some reasons are suggested for the lack of resilience.

PART 4. THE KEY DIMENSIONS OF RESILIENCE

Bruneau and his colleagues in the Multidisciplinary Centre for Earthquake Engineering Research in Buffalo, have made a significant contribution to this subject by perceptively identifying four requirements for the creation of resilience, (BRUNEAU, M. et al, 2003). These elements are needed in all sectors: Physical/Technical, Social and Economic and a resilient system will not be possible if any of these elements is missing from an overall strategy:

1. Robustness:

(ensuring the strength of elements to withstand stress without losing their function;

the ability to absorb hazard shocks)

2. Redundancy:

(the extent to which elements continue to function in the event of disruption by establishing a wide range of fail-safe, back-up systems that provide the ability to bounce back rapidly after disaster)

3. Resourcefulness:

(the capacity for a creative approach by identifying problems and mobilising resources; the ability to adapt following disaster)

4. Rapidity:

(the capacity to meet priorities and achieve goals in order to contain losses and avoid future disruption; the ability to adapt following disaster).

It may also be useful to see how these requirements apply in technical, social and economic contexts:

PHYSICAL/ TECHNICAL PERFORMANCE MEASURES:

This example relates to the protection from hazard impact of a major urban hospital, a critical facility in any society.

- | | |
|------------------------|---|
| Robustness | Damage avoidance through architectural and engineering design or retrofitting to ensure continued service following a disaster. |
| Redundancy | Backup systems in place, (such as emergency power, duplicate communications systems, rapid data retrieval, etc.) |
| Resourcefulness | Plans and resources available to cope with damage and disruption, well rehearsed hospital emergency plans in place. |
| Rapidity | Buildings and equipment fully functional after disaster shock. |

Case Study: Damage to General Hospital Kobe earthquake of January 1995

An example of the failure of a vulnerable critical facility is the Kobe General Hospital situated on Port Island Kobe, Japan. This hospital suffered some damage during the earthquake of January 1995 when the air conditioning plant on the roof was displaced. This caused some interruption in services, however the overall functioning of the hospital was jeopardised due to the failure of another critical facility on which the hospital depended, the collapse of the bridge that crossed from the mainland to Port Island. This case indicates that the safety of critical facilities needs to extend to the surrounding infrastructure on which they depend.

SOCIAL PERFORMANCE MEASURES, COMMUNITY RESILIENCE:

Robustness	The avoidance of casualties and disruption to the community
Redundancy	Locate alternative means of providing for community needs, such as the identification of evacuation centres for temporary occupation
Resourcefulness	Develop plans and resources to meet anticipated community needs following disaster impact
Rapidity	Optimise the time needed to return to pre-disaster community functions.

Case Study: Social Resilience following the Kobe earthquake of January 1995

- Out of 342,000 displaced persons, over 180,000 were absorbed in school shelters run by voluntary helpers
- 630,000 volunteers arrived in Kobe from throughout the world to provide support
- Schools throughout Japan each sent a one of their teachers to act as a volunteer managing the school temporary shelters.
- About 40,000 went to live temporarily with friends or relatives throughout Japan.

ECONOMIC PERFORMANCE MEASURES, ECONOMIC RESILIENCE:

Robustness	The avoidance of direct and indirect economic losses by risk reduction measures
Redundancy	The identification, before a disaster of alternative suppliers and relocated options to maintain work operations through business continuity plans
Resourcefulness	Through plans and economic stabilising measures
Rapidity	Optimising the time needed to return to pre-disaster functional Levels.

Finally, it may be useful to examine how the concepts of Robustness, Redundancy, Resourcefulness and Rapidity relate to resilient Buildings and Settlements.

PHYSICAL/ TECHNICAL PERFORMANCE MEASURES IN RELATION TO THE DESIGN AND MAINTENANCE OF BUILDINGS:

Robustness The avoidance of direct and indirect economic losses by risk reduction measures in the design of a new building or in retrofitting (strengthening) an existing building. The design of a safe building will relate to its siting, its setting in relation to neighbouring buildings, its overall shape, the selection of building materials, individual building details, means of escape and its structural design. Thus, planners, architects and engineers are all involved in the production of safe building.

One of the key structural approaches to hazard resistant buildings is to create resilient, (or ductile) structures that are strong but also flexible in absorbing extreme forces without failing.

As noted above special concerns need to be given to the design of safe critical facilities so that they are built to robust standards, above normal building code standards. so that authorities can be confident that they will continue to function following disaster impact.

Redundancy This concept can relate to standard architectural practice where alternative means of escape are always provided in public buildings. Redundancy is also built into structural design with design loads being calculated to cope with extreme forces. Redundancy is also a key aspect of social and business continuity through careful pre-planning of relocation options for displaced building occupants or of work operations.

Resourcefulness The design of the range of structural measures needed to create and maintain safe buildings requires creativity and high levels of resourcefulness by all stakeholders. The designers, building contractors, byelaw enforcement officers, managers of buildings and the users or occupants of the building.

Rapidity Planners, architects and engineers involved in disaster reconstruction will all be involved in the challenge to rebuild rapidly but without compromising safety considerations or of the crucial need for full participation in decision making of the users of the rebuilt structures.

PHYSICAL/ TECHNICAL PERFORMANCE MEASURES IN RELATION TO THE DESIGN AND MAINTENANCE OF HUMAN SETTLEMENTS:

- Robustness** The avoidance of direct and indirect economic losses by risk reduction measures in the design of a new safe settlement. The design of a safe settlement is inevitably the art of compromise since it is rare, and probably not desirable to have a clean slate with a totally new settlement being created on a relocated site.
- Redundancy** This is a key aspect of social and business continuity, through careful pre-planning of relocated options for displaced building occupants or of work operations. Business continuity planning is a key mechanism to reduce the direct and indirect impact on livelihoods from a disaster event
- In addition redundancy is a key design philosophy in the design of critical infrastructure so that all essential services such as water, sewage, telephone, electricity, radio/ TV, gas, transportation links are all designed so that there are back up systems that can be utilised in the event of one system failing.
- Resourcefulness** The design of the range of structural and non-structural measures needed to create and maintain safe human settlements requires creativity and high levels of resourcefulness by all stakeholders. These include all the planning, building and infrastructure professionals, government officials, building contractors, byelaw and land-use planning enforcement officers, managers of buildings private sector managers and the users or occupants of the settlement.
- Rapidity** Planners, architects and engineers involved in disaster reconstruction will all be involved in the challenge to rebuild rapidly but without compromising safety considerations or of the crucial need for full participation in decision making of the users of the rebuilt structures.
- One of the dilemmas facing planners involved in reconstruction is to balance the call for rapid recovery by political leaders with the need to revise and upgrade building and infrastructure standards above normal levels. (See Fig 1. and the linked discussion in Part 2 of this paper on the need to adapt and reform at all levels and sectors following the evidence of failure caused by the disaster.) .

Summary, Part 4

In this part of the paper there has been an examination of four features of resilience: *robustness, redundancy, resourcefulness and rapidity*. These have been considered in relation to the key technical/physical, social and economic contexts. Case studies drawn from the Kobe earthquake of 1995 are used to illustrate how these features operated successfully, or failed to function as a clear failure of resilience. The discussion on these four features concludes by exploring their relevance to building and settlement design.

5. SUMMARY: HOW CAN RESILIENCE BE CREATED AND MAINTAINED?

There are many steps that can be taken, however six stand out as being particularly significant:

Public Awareness and Preparedness

There is a need for the public to understand the risks to which they are exposed as well as what steps they can take to protect themselves and their immediate families and work colleagues.

*This step will enable **people and their communities** to absorb shocks, bounce back and adapt as necessary following disasters.*

Disaster Plans

Realistic, well prepared, well rehearsed and regularly updated disaster plans are essential to anticipate problems well in advance and plan accordingly. They need to be fully supported by legislation. Integrated plans are needed at all levels: ‘top-down’ as well as ‘bottom-up’. Specialised plans are needed to maintain business continuity following disaster impact.

*This step will enable **societies and their organisations** to absorb shocks, bounce back and adapt as necessary following disasters.*

Governance

Good governance with responsible and accountable officials is a prerequisite to effective civil protection. Governance will need to embrace the actions of many stakeholders: Government, NGO’s, academia, professions, private sector, religious organisations, media, etc.

*This step will enable **decision makers and bodies that influence society within the public and private sectors** to absorb shocks, bounce back and adapt as necessary following disasters.*

Social, Economic and Environmental Safety Measures

Agriculture needs to adapt to drought and flood hazards. Early Warning Systems (EWS) for floods, tropical storms, volcanic eruptions and tsunamis need to be fully operational. Additional non-structural measures, such as insurance, training, education need to be in place and well integrated into disaster and recovery plans

*This step will enable the social economic and the **natural environment** to absorb shocks, bounce back and adapt as necessary following disasters.*

Safe Buildings and Settlements

Buildings, infrastructure and overall settlements need to be made safe to resist hazards. This requires attention and increased funds to be made available for new building, and for retrofit operations to be conducted to make existing buildings and infrastructure safe. It is vital that critical facilities secure enhanced protection.

This step will enable the built environment to absorb shocks, bounce back and adapt as necessary following disasters.

Lesson Learning

There is a need to avoid continually reinventing wheels. Lessons from the past need to be reviewed, documented, disseminated and applied with changes being made in the light of lessons from both failure as well as success. In any society, but especially in those subject to severe hazard impact, a learning culture needs to be nurtured.

*This step will enable **all sectors and levels in a given society** to absorb shocks, bounce back and adapt as necessary following disasters.*

REFERENCES

ALI, T. 2005, *The Price of Occupation*, The Guardian, July 8, p. 24. BBC News, *More London bombing victims named*, July 13, 2005.

BRUNEAU, M. et al. 2003, *A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities*, Earthquake Spectra, 19(4) 733-752.

COMFORT, L. 1999, *Shared Risk: Complex Systems in Seismic Response*, Pergamon: New York.

DAVIS, I. 2003, *The Effectiveness of Current Tools for the Identification and Synthesis of Vulnerability and Disaster Risk*, Inter-American Development Bank and Universidad Nacional de Colombia- Sede Manizales Instituto de Estudios Ambientales (IDEA): Manizales (available from: <http://idea.unalmzl.edu.co>).

DAVIS, I. 2004, *The Application of Performance Targets to Promote Effective Earthquake Risk Reduction Strategies*, 13th World Conference on Earthquake Engineering, Vancouver, B.C. Canada, Paper No. 2726.

DAVIS, I. 2005, *Resilient Communities*, ppt. presented at Post-war Reconstruction and Development Unit, (PRDU) of York University.

HORNE, J. and ORR J. 1998, *Assessing Behaviors that Create Resilient Organizations*, Employment Relations Today 24 (4), 29-39.

ISDR, 2005, *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*.

JONES, E. 2005 ***Hurricane Ivan – Jamaica. An Assessment of the National Response*** September 3-10, 2004 Final Report Office of Disaster Preparedness and Emergency Management (ODPEM): Kingston

LAVELL, A., 2003, *Indicators for Disaster Risk Management*, Inter-American Development Bank and Universidad Nacional de Colombia- Sede Manizales Instituto de Estudios Ambientales (IDEA): Manizales, (available from <http://idea.unalmzl.edu.co>).

McHARDY, P 2005, *Kingston and St Andrew Sustainable Development Plan*, Kingston and St. Andrew Corporation and Kingston and St. Andrew Parish Development Committee: Kingston, *Unpublished Draft*, 82-87

MILETI, D. 1999, *Disasters by Design, A Reassessment of Natural Hazards in the United States*, Joseph Henry Press: Washington DC., 30-35.

NEZ, G., 1974, Private Communication with Ian Davis following a Meeting to Discuss Reconstruction Policies in Denver, Colorado in May 2004.

PELLING M. 2003, *The Vulnerability of Cities, Natural Disasters and Social Resilience*, Earthscan: London, p. 48.

UNITED NATIONS International Strategy for Disaster Reduction (ISDR), 2002. *Living With Risk: A Global Review of Disaster Reduction Initiatives* (preliminary version). Geneva: UN ISDR, July.

WILDAVSKY, A. 1991, *Searching for Safety*, Transaction Publishers, New Brunswick NJ.

WORLD DISASTERS REPORT, 2004, *Introduction, Building the Capacity to Bounce Back*, International Federation of Red Cross and Red Crescent Societies.

