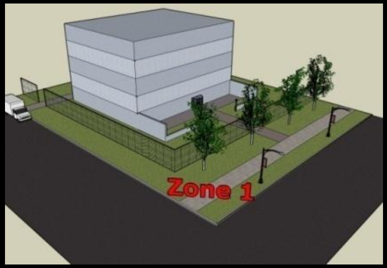
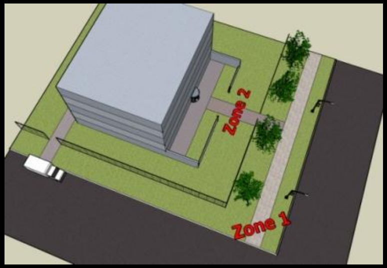
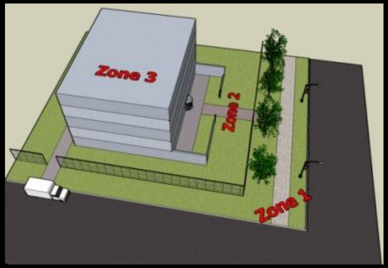
Introducing the concept of Disaster Risk Reduction Through Environmental Design (DRRTED), and proposing a methodology for the creation of safer environments.







Presentation prepared for:

Conference in Disaster Risk Reduction

Disaster Management Training and Education Centre for Africa (DiMTEC)

26 & 27 May 2009

Presented by:

Theuns van der Linde

“As the world continues to industrialize and urbanize, it is continually creating conditions for more and worse disasters in the future.

The industrialization and urbanization processes, however positive in effects along some lines, will both increase the number of potential disaster agents and enlarge the vulnerabilities of communities and populations at risk.”

Quarantelli (1997)

“natural and human-induced disasters are one of the top three threats to the safety and security of urban dwellers in the 21st century.”

The United Nations Global Report on Human Settlements for 2007

“By 2050, the world population is expected to grow by 3 billion people. Most of this growth will take place in developing countries - and within these countries, in cities and towns - more than doubling urban populations.

Large numbers of people will be concentrated in megacities and on fragile lands, making reduction of vulnerability to disasters in metropolitan areas a critical challenge facing development.”

Editors’ Note – Building Safer Cities – The future of Disaster Risk
World Bank, 2003

What is Disaster Risk Reduction through Environmental Design (DRRTED)

DRRTED aims to reduce disaster risk by utilizing the built environment to influence components that contribute to disaster risk, and in doing so, reduces the overall disaster risk in (urban/built) environments.

Federal Emergency Management Agency (FEMA) Building Design for Homeland Security, adapted for Disaster Management.

Overview

- Introduction & Clarification
- Components of the Built Environment
  - Zones of Influence
  - Tools of Influence
- The Theory of Disaster Risk (R = H, V, C)
  - Hazard, Vulnerability & Capacity
- Making the Link – DRRTED
- Examples & Applications
  - Floods
  - Major Events
  - Earthquakes
  - Security / Terrorism
  - Disaster Response
- Shortcomings of DRRTED
- Possible way forward
- Conclusions and Recommendations

Disaster Risk Reduction through Environmental Design (DRRTED)

Environmental Design:

Urban & Built Environment, *not* Natural Environment

Environmental **Design:**

Planning, Creation, Construction

Introduction

Assuming that:

'Uncontrolled' Development / Urbanization can lead to the unsafe urban environments.

Also be assumed that:

'Controlled' Development / Urbanization can lead to safer environments.

This is not a new concept – Architects, Engineers & Urban Planners:

- Building Regulations & Structural Design Guidelines
- Urban Planning Guidelines
- Zoning and Land-use restrictions

However, in order to create disaster 'resistant' urban environments, there is a need for an Integrated approach (including specific guidelines) to incorporate **<u>disaster risk reduction science</u>** into the **urban planning, engineering and architectural fields.**

This is the aim of Disaster Risk Reduction Through Environmental Design

Limitations

• Not provide answers to all the challenges faced in creating 'disaster resistant' urban environments.

• Nor is the aim to replace existing Building Regulations, SABS codes, or any other safety or risk reduction technique

• Aim is to propose a framework/approach to facilitate in the creation of 'disaster resistant urban environments'

• ***Stimulate debate between Academics, Government Officials, Scientists & Professionals***

Forget about Disaster Management – Focus on the Buildings

Components of Built Environment:

Zones & Components

Image: TC van der Linde (2008) ©

Components of the Built Environment

Consider that the Built Environment can be characterised in terms of two aspects:

Functions and Relationship of **Zones** within the Urban Context

(Where?)

Components of the Built Environment

(What, why, how?)

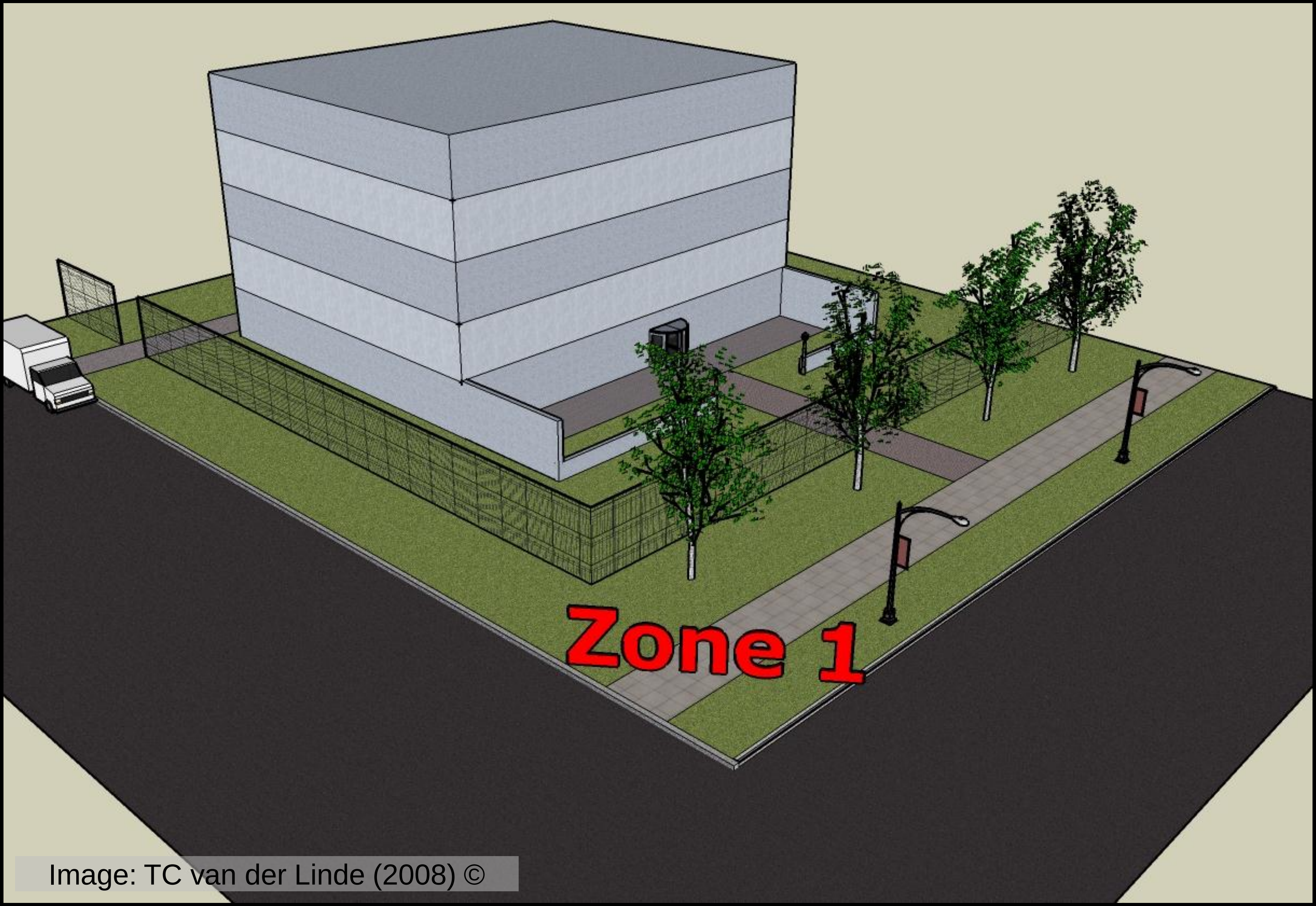
Components of Built Environment:

Zones (Where?) & Components (What, why & how?)

Image: TC van der Linde (2008) ©

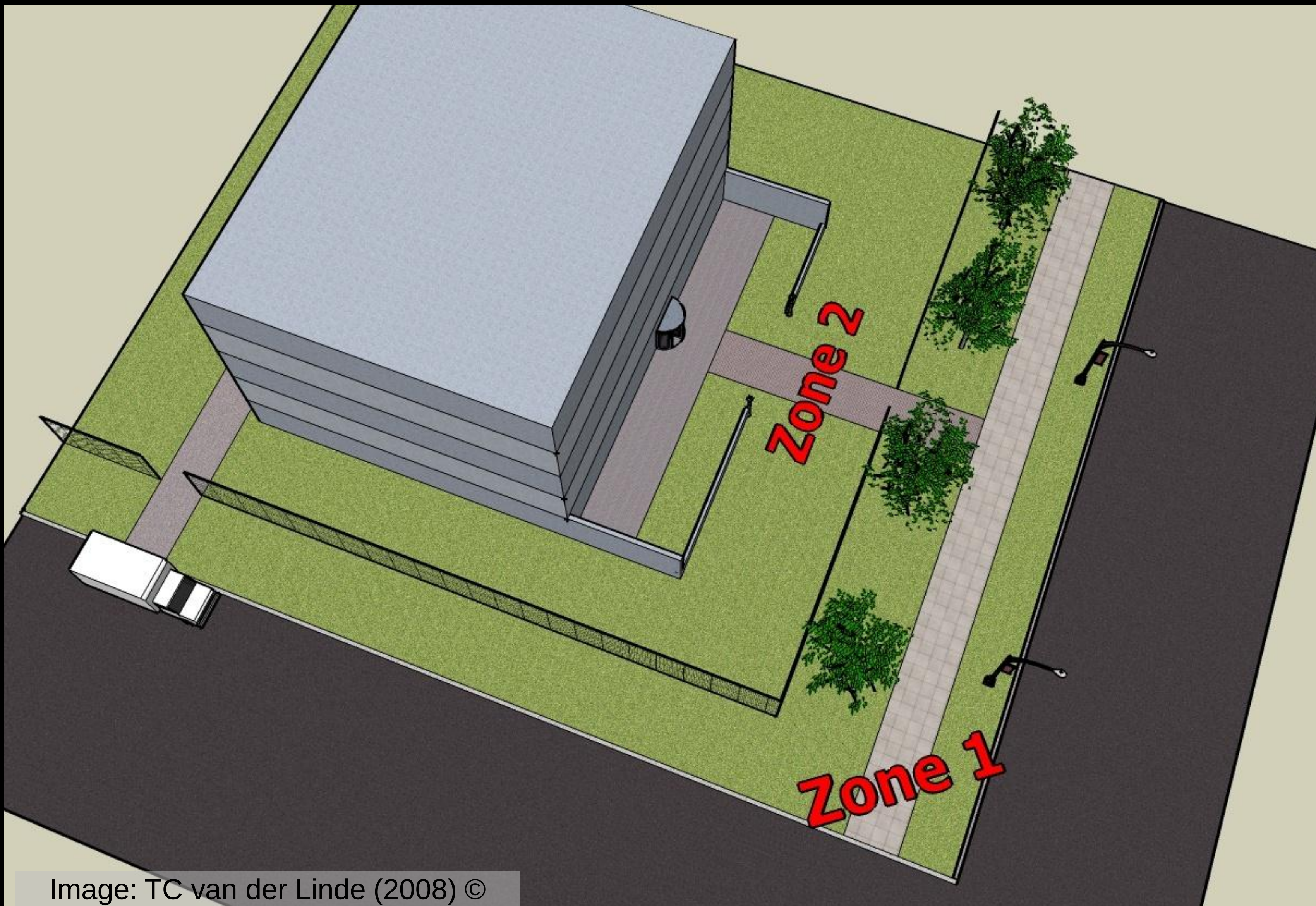
Components of the Built Environment

Functions and Relationship of 'Zones'



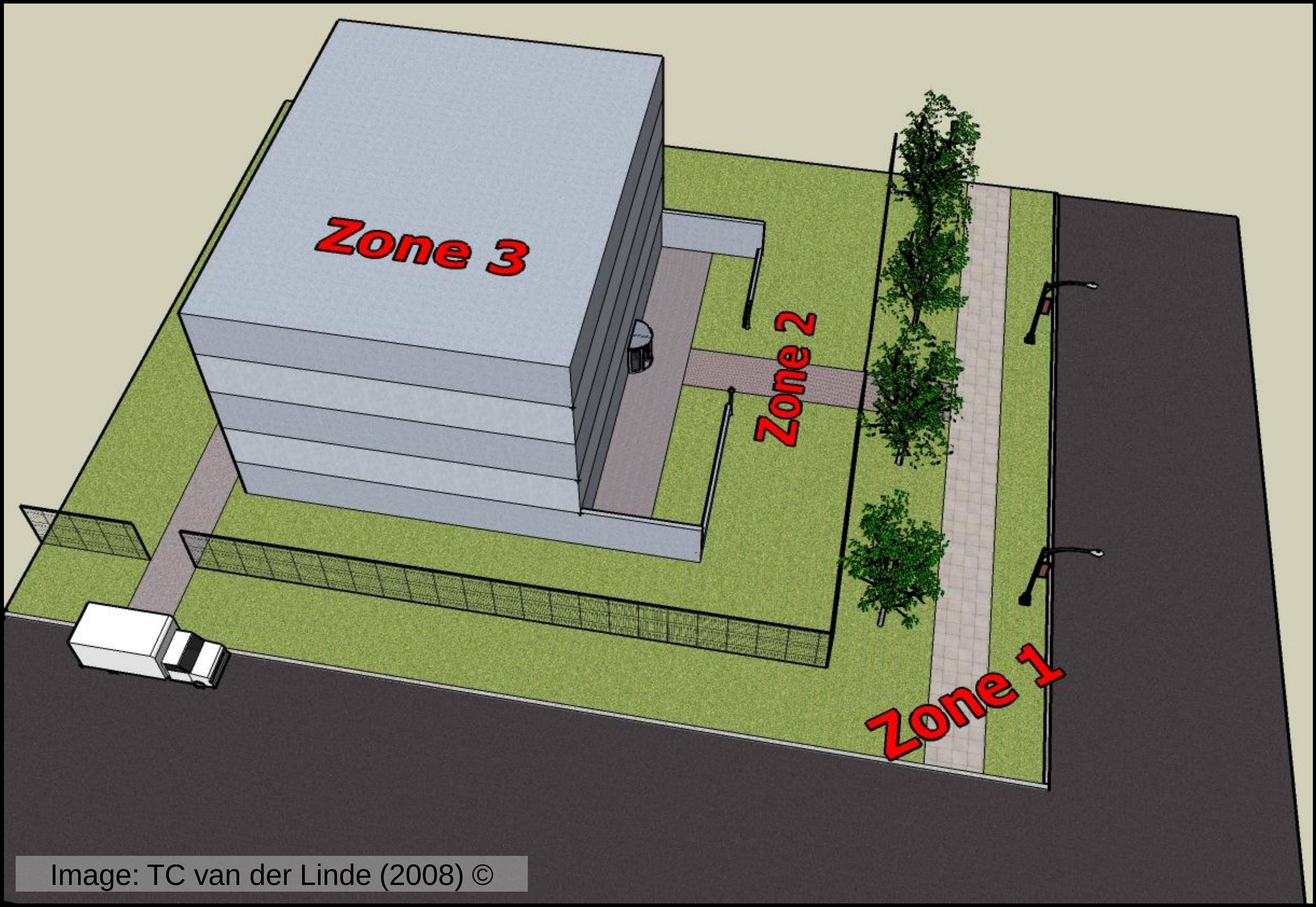
Components of the Built Environment

Functions and Relationship of 'Zones'



Components of the Built Environment

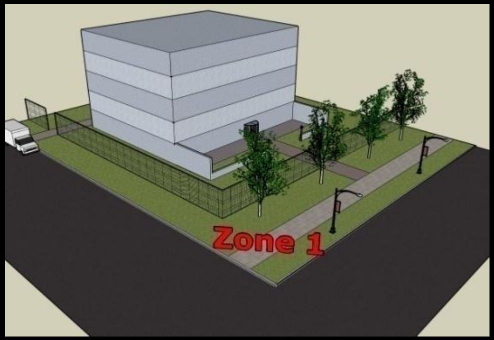
Functions and Relationship of ‘Zones’



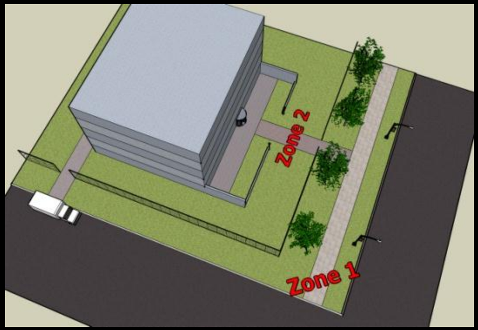
Components of the Built Environment

Functions and Relationship of ‘Zones’

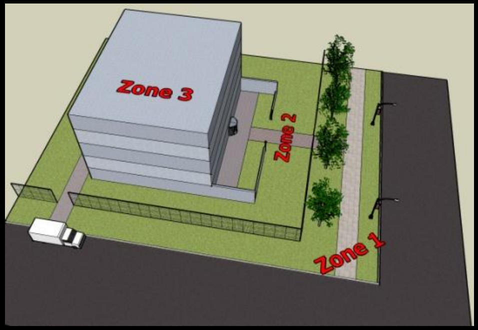
ZONES OF INFLUENCE



Zone 1 – Up to External Boundary



Zone 2 – External Boundary to Building ‘Footprint’



Zone 3 – Building ‘Footprint’ and Building

Components of the Built Environment

"ZONES OF INFLUENCE"

Components of the Built Environment

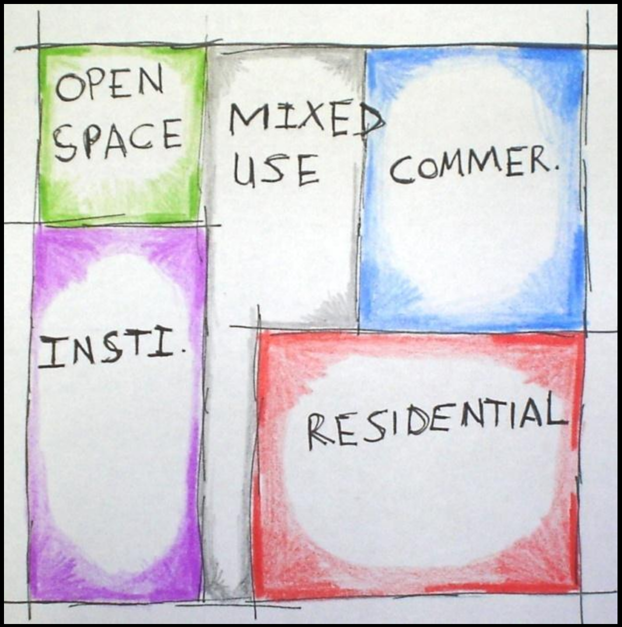
‘Tools of Influence’

(Why tools? – Use to form Environment)

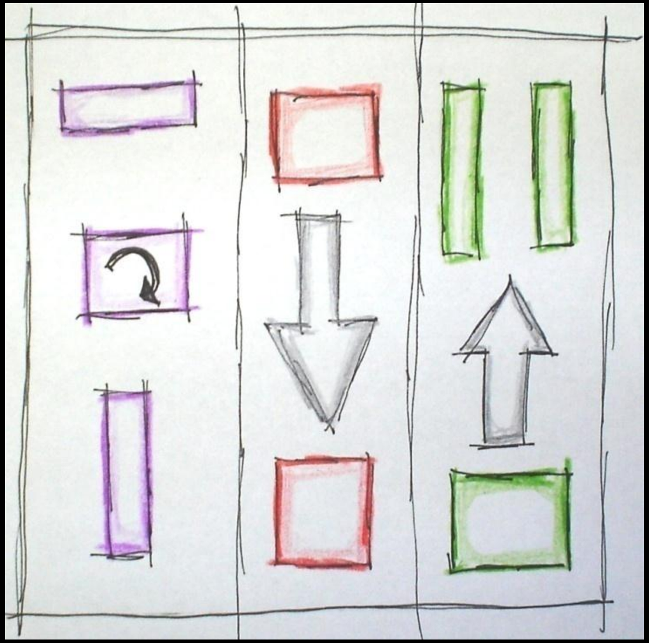
- Tool 1 – Layout, Planning & Design
- Tool 2 – Terrain Components
- Tool 3 – Building Components

Tool 1 – Layout, Planning & Design

• Tool 1.1: Land-, building- or room-use planning (Strategic/Qualitative)

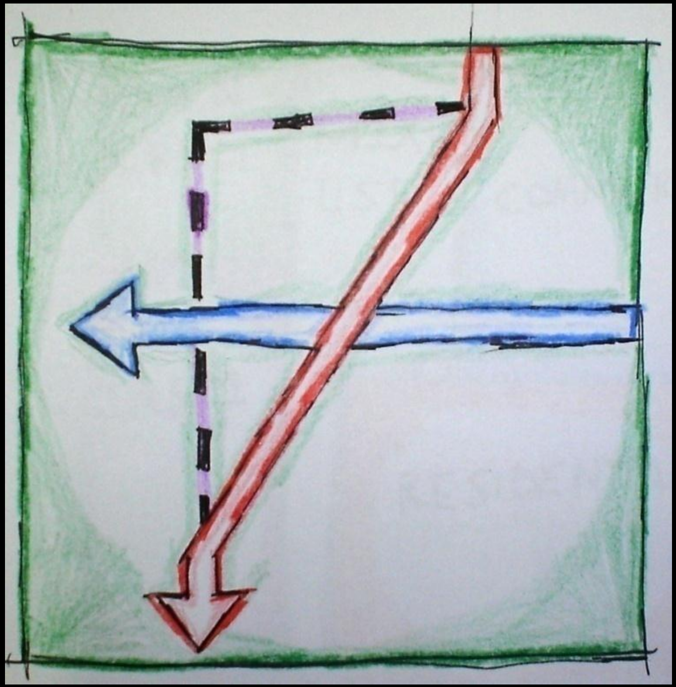


• Tool 1.2: Location, Placement, Orientation and Sizing (Practical/Quantitative).



Tool 1 – Layout, Planning & Design

- Tool 1.3: Access points and transportation/movement routes.



- Tool 1.4: Location, routing and connection points of services.

(Electricity, water, sewerage, communication, etc)

Tool 2 – Terrain Components

Tool 2 – Terrain Components

Tool 2 – Terrain Components

- Tool 2.1: Plants and Vegetation
- Tool 2.2: Landscaping and Artificial topography
- Tool 2.3: Land & Ground cover
- Tool 2.4: Walls, Fencing and Gates
- Tool 2.5: Barriers
- Tool 2.6: Furniture
- Tool 2.7: Signage
- Tool 2.8: Services, including
  - Energy including Electrical Services and Gas;
  - Water Reticulation Systems;
  - Storm Water Services;
  - Sanitation;
  - Transportation;
  - Communication & Information Technology;
  - Mechanical Services (including HVAC, elevators and escalators);
  - Ambiance (including Lighting & Sound); and
  - Fire Safety and Security Systems

Tool 3 – Building Components

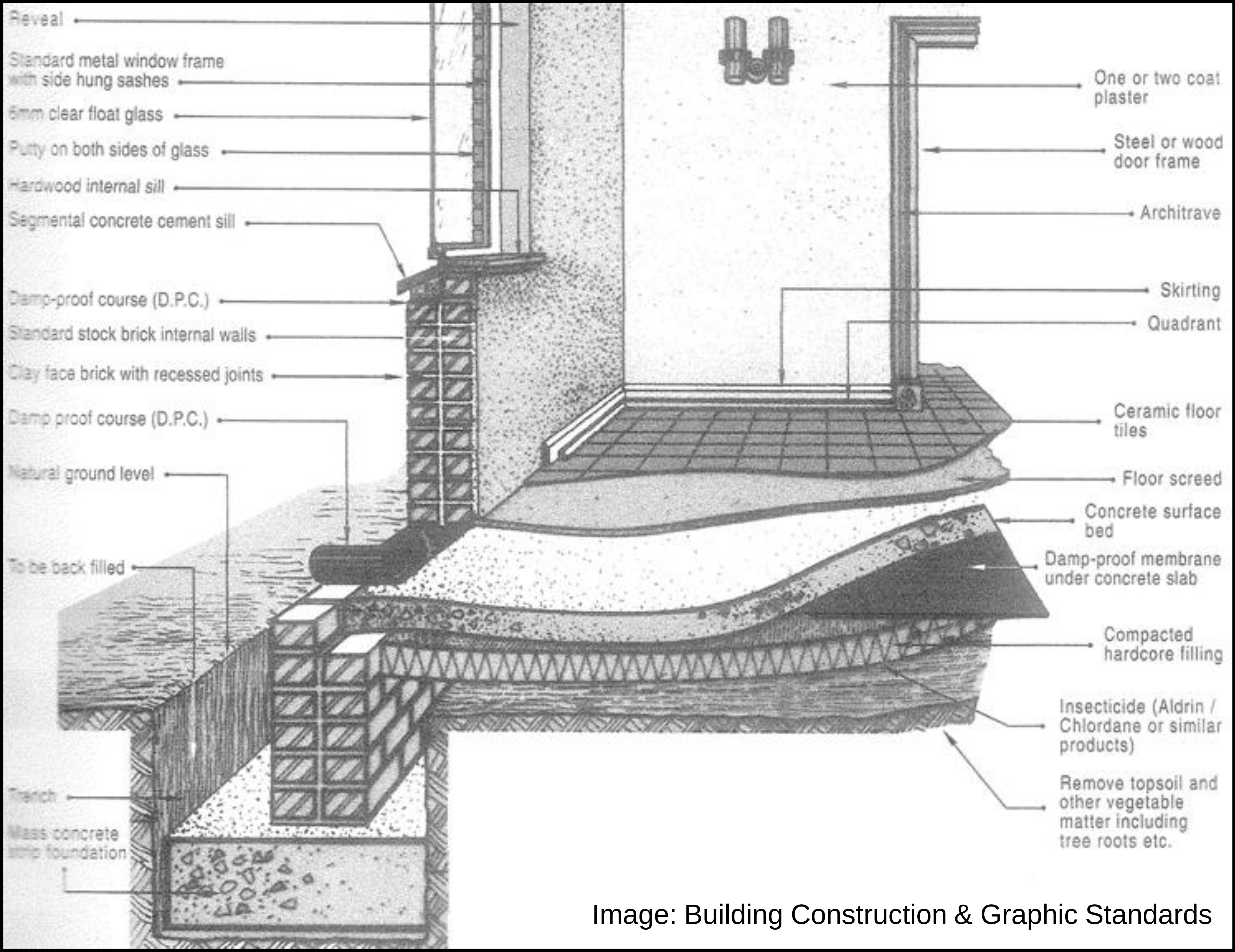


Image: Building Construction & Graphic Standards

Tool 3 – Building Components

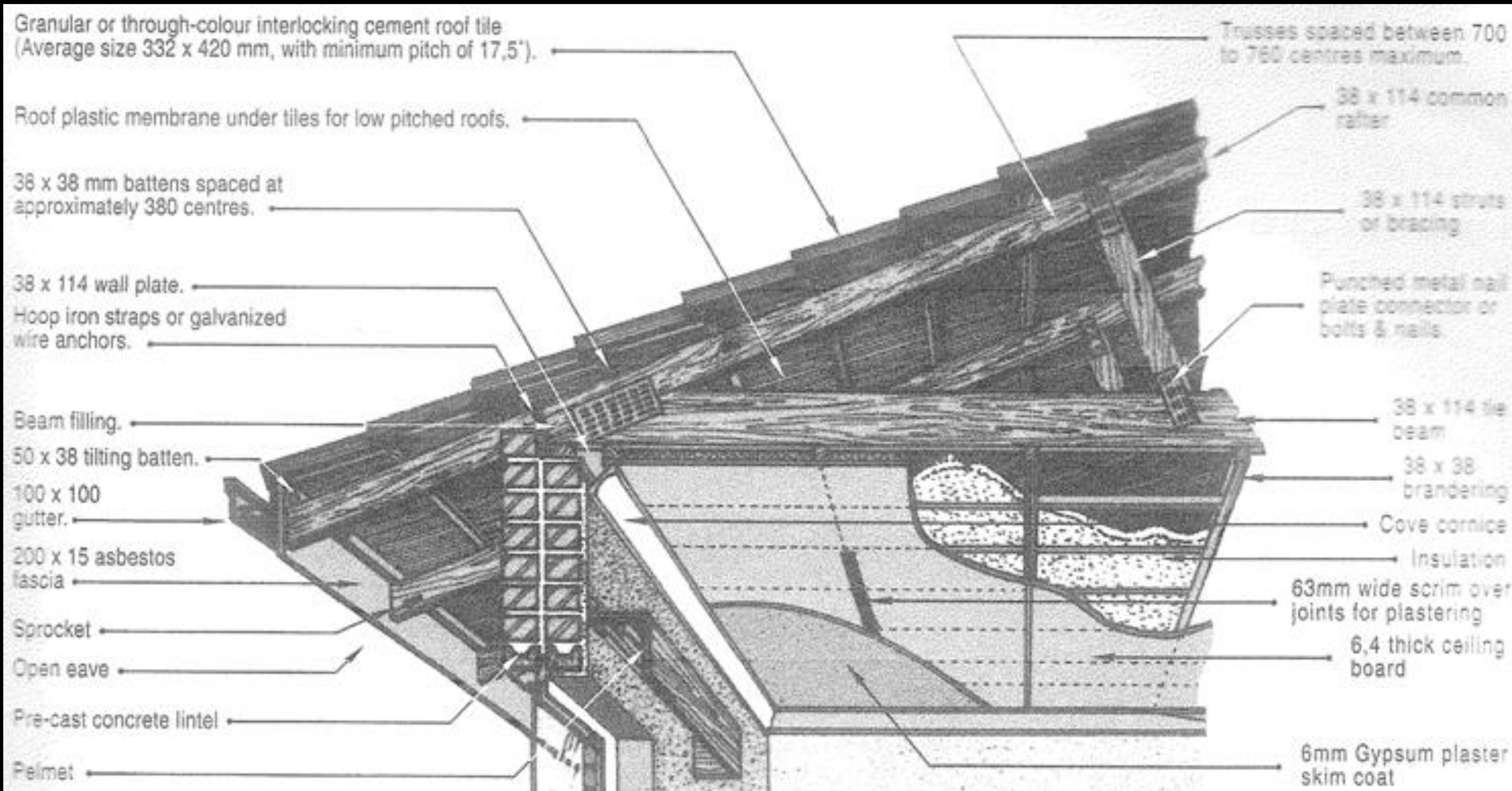


Image: Building Construction & Graphic Standards

Tool 3 – Building Components

- Tool 3.1: Foundations;
- Tool 3.2: Ground floor construction;
- Tool 3.3: Other floors (2nd, 3rd and other storeys);
- Tool 3.4: Structural frame;
- Tool 3.5: External envelope;
- Tool 3.6: External openings (Doors, Windows);
- Tool 3.7: External finishes;
- Tool 3.8: Roof Structure;
- Tool 3.9: Roof Finishes;
- Tool 3.10: Internal Divisions;
- Tool 3.11: Internal openings (Doors, Windows);
- Tool 3.12: Internal finishes (Wall, floor, ceiling);
- Tool 3.13: Internal fittings; and
- Tool 3.14: Services, including:
    - Energy including Electrical Services and Gas;
    - Water Reticulation Systems;
    - Storm Water goods;
    - Sanitation & Plumbing;
    - Transportation;
    - Communication & Information Technology;
    - Mechanical Services (including HVAC, elevators and escalators);
    - Ambiance (including Lighting & Sound); and
    - Fire Safety and Security Systems

Components of the Built Environment

Zones of Influence

- Zone 1 – Up to External Boundary
- Zone 2 – External Boundary to Building ‘Footprint’
- Zone 3 – Building ‘Footprint’ and Building

Tools of Influence

- Tool 1 – Layout, Planning & Design
- Tool 2 – Terrain Components
- Tool 3 – Building Components

Forget about Buildings – Focus on Disaster Management

Theory of Disaster Risk

Risk = Hazard x Vulnerability (PAR Model & NDMF) (1)

Risk = [Hazard x Vulnerability] / Capacity (2)

Risk = [Hazard x Vulnerability] / [Manageability x Capacity] (3)

Risk = [Hazard x Vulnerability] – Capacity (4)

Risk = [Hazard / Capacity_1] x [Vulnerability / Capacity_2] (5)

Hazard, Vulnerability, Capacity

Theory of Disaster Risk - Hazard

*"A potentially damaging physical event, phenomenon and/or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. … **Each hazard is characterised by its location, intensity, frequency and probability."***

Hazard → Location

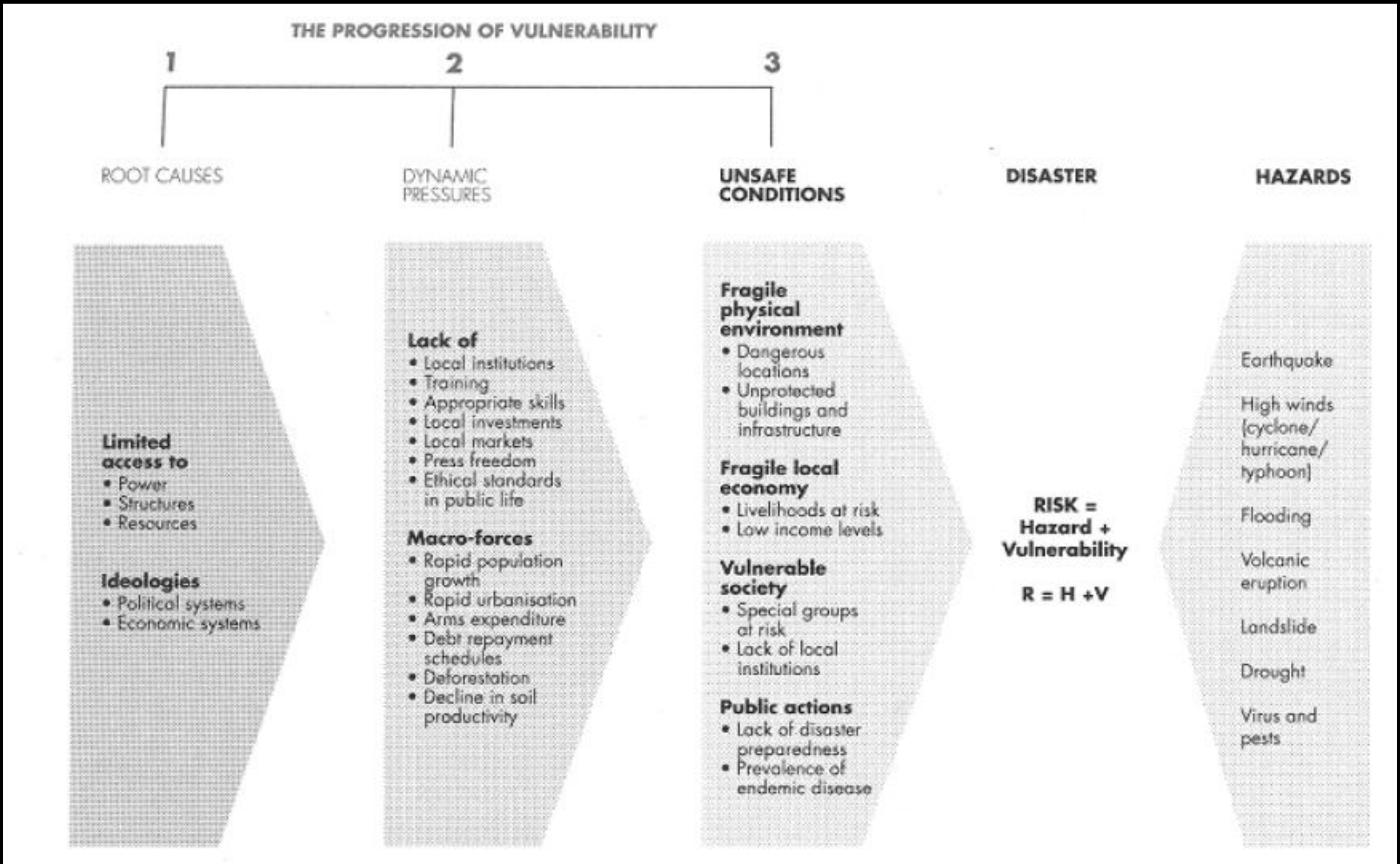
→ Intensity

→ Frequency

Theory of Disaster Risk – Vulnerability

“The degree to which an individual, a household, a community, an area or a development may be adversely affected by the impact of a hazard. Conditions of vulnerability and susceptibility to the impact of hazards are determined by ***physical, social, economic and environmental*** *factors or processes”*

Theory of Disaster Risk – Vulnerability



Pressure and Release Model (Wisner et al. 1994:51)

Theory of Disaster Risk – Vulnerability

Vulnerability → Physical & Structural Characteristics

→ Income opportunities & Local Markets

→ Social Cohesion

Theory of Disaster Risk – Capacity

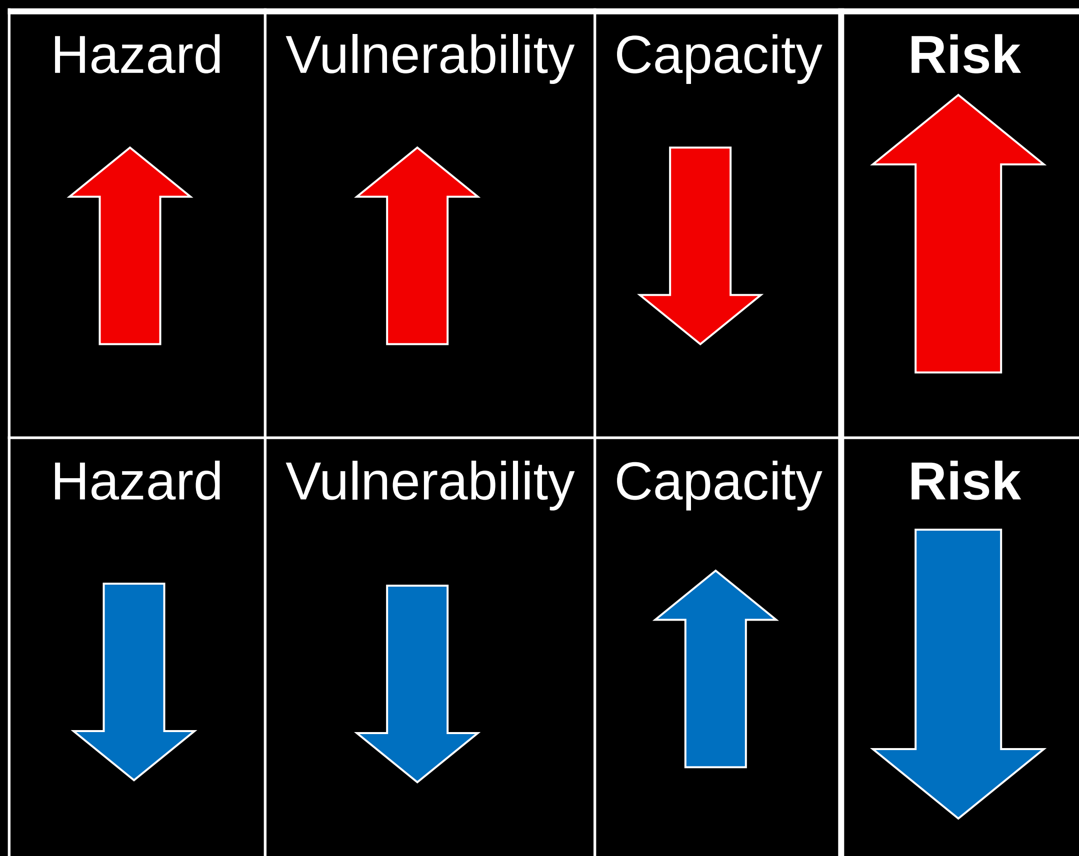
*"A combination of all the **strengths and resources** available within a community, society or organisation that can reduce the level of risk, or the effects of a disaster. Capacity may include **physical, institutional, social or economic** means as well as **skilled personnel** or collective attributes such as **leadership and management**."*

Capacity
- → Access
- → Resources
- → Environmental Factors
- → Communication & Information

Theory of Disaster Risk – Capacity

Risk = [Hazard x Vulnerability] / [Manageability x Capacity]

Risk = [Hazard x Vulnerability] - [Manageability x Capacity]



Making the Link - DRRTED

Disaster Risk

Environmental 'Components'

Hazard

Vulnerability

Capacity

Disaster Risk Reduction through Environmental Design

Tool 1 Layout, Planning &Design

Tool 2 Terrain Components

Tool 3 Building Components

(Within 3 Zones)

DRRTED aims to reduce the risk of disaster (by influencing HVC levels), by using various components of the Built Environment.

Making the Link - DRRTED

HAZARD	Built Environment (Zones 1 – 3)		
	Tool 1 – Layout, Planning & Design	Tool 2 – Terrain Components	Tool 3 – Building Components
Hazard Characteristics			
Location			
Intensity			
Frequency			
Vulnerability Characteristics			
Physical / Structural			
Income Opportunities & Local Markets			
Social Cohesion			
Capacity Characteristics			
Access			
Resources			
Environmental Factors			
Communication & Information			

HAZARD	Built Environment		
	Tool 1 – Layout, Planning & Design	Tool 2 – Terrain Components	Tool 3 – Building Components
Hazard Characteristics			
Location	1		
Intensity			
Frequency			
Vulnerability Characteristics			
Physical / Structural			2
Income Opportunities & Local Markets	4		
Social Cohesion			
Capacity Characteristics			
Access		3	
Resources			
Environmental Factors			
Communication & Information			

1) How can Urban Planners (Zone 1) use land-use planning guidelines (Tool 1.1) to reduce the hazard level caused by fires?

2) How can Engineers (Zone 3) use foundations (Tool 3.1) to reduce the vulnerability of buildings to the effects of earthquakes?

3) How can Architects (Zone 2 & 3) use Landscaping (Tool 2.2 & 2.3) to facilitate the response (capacity) of Fire Services to emergencies?

4) How can Urban Planners (Zone 1) use land-use planning guidelines (Tool 1.1) to increase income opportunities in a specific area, thereby possibly reducing vulnerability?

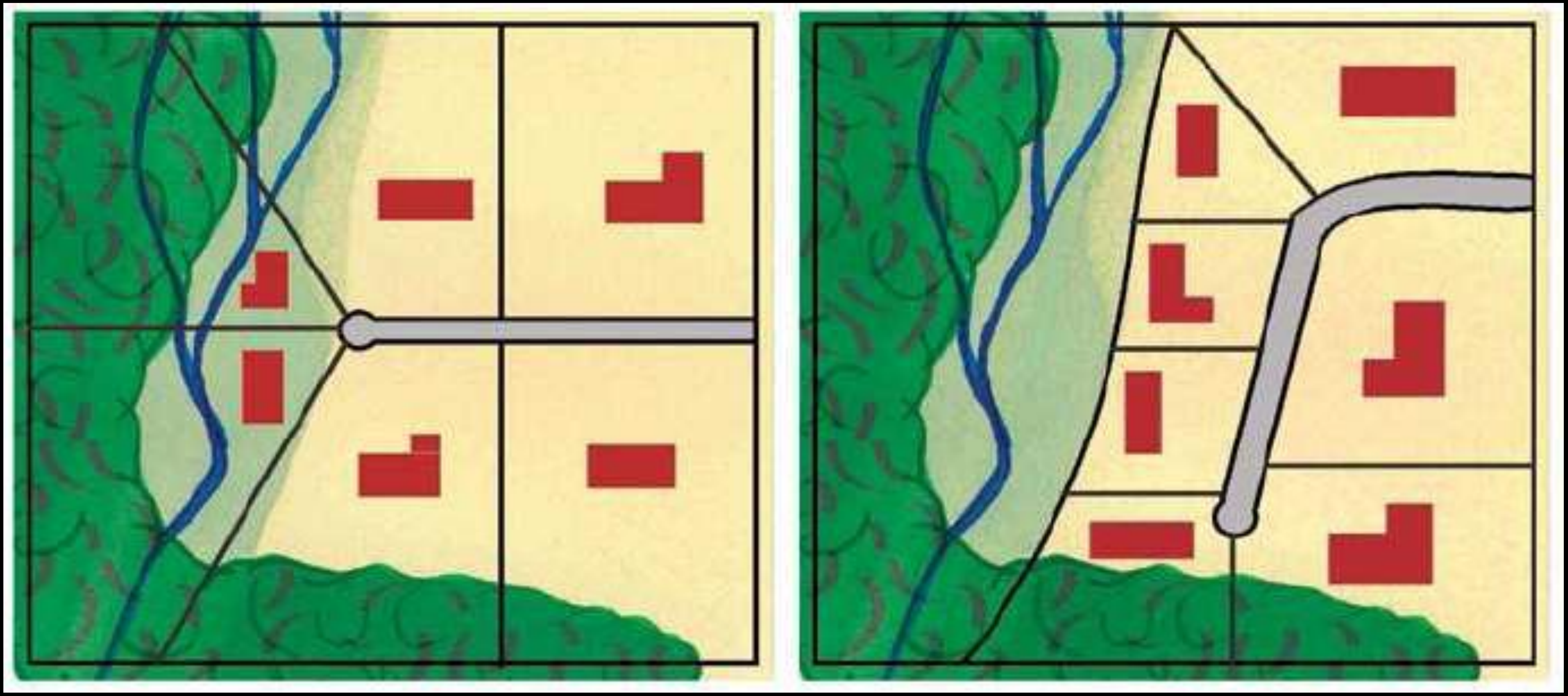
Examples & Applications

- Examples of Existing Measures
- Taken from various sources
- Illustrate inclusion of existing guidelines within DRRTED framework

Examples & Applications (Floods)

	Built Environment																									
	Tool 1 – Layout, Planning and				Tool 2 – Terrain Components								Tool 3 – Building Components													
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	3.11	3.12	3.13	3.14
HAZARD: FLOODS	Land-, building- or room-use planning	Location, Placement, Orientation and Sizing (PracticalQuantitative)	Access points and transportation/movement routes	Location routing and connection points of services	Plants & Vegetation	Landscapng & Artificial Topography	Land & Ground cover	Walls, Fencing & Gates	Barriers	Furniture	Signage	Services	Foundations	Ground floor construction	Other Floors	Structural Frame	External Envelope	External Openings	External Finishes	Roof Structure	Roof Finishes	Internal Divisions	Internal Openings	Internal Finishes	Internal Fittings	Services
Hazard Characteristics																										
Location																										
Intensity																										
Frequency																										
Vulnerability Characteristics																										
Physical / Structural																										
Income Opportunities and Local Markets																										
Social Cohesion																										
Capacity Characteristics																										
Access																										
Resources																										
Environmental Factors																										
Communication & Information																										

Examples & Applications (Floods)



Landuse planning (Tool 1.1) to influence Vulnerability

(Image: FEMA 2005:4-11)

Examples & Applications (Floods)

Landuse planning (Tool 1.1) to influence Vulnerability

(Image: FEMA 2005:9-8)

Examples & Applications (Floods)

Tool 2.2 (Landscaping and Artificial Topography) on a Zone 1 or 2 level to influence Hazard Characteristics

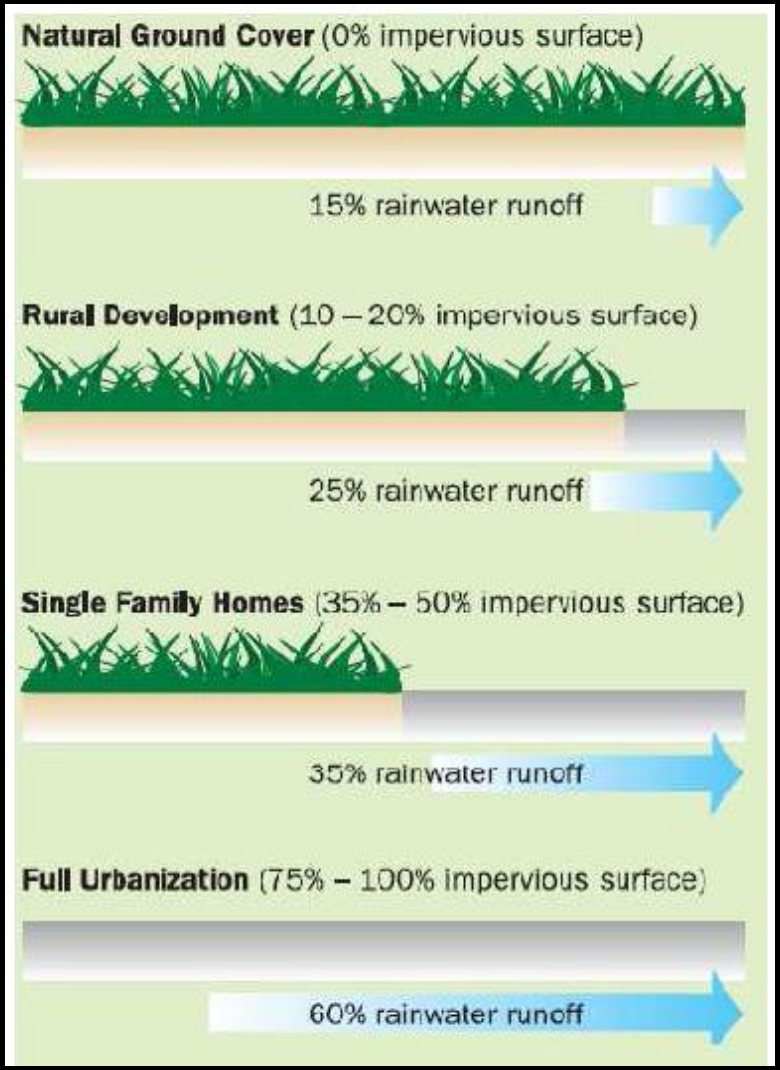
(Image: FEMA 2005:8-11)

Examples & Applications (Floods)

Landscaping (Tool 2.2) and Walls (Tool 2.4) on a Zone 2 and 3 Level.

(Image: FEMA 2005:10-5)

Examples & Applications (Floods)



Land-cover is included in the DRRTED approach as Tool 2.3 (Land- and Ground Cover)

(Image: FEMA 2005:8-2)

Examples & Applications (Floods)

Flood walls, included in the DRRTED approach under Tool 2.4 (Walls, fencing & Gates)

(Image: FEMA 2005:8-10 & FEMA 2005:10-4)

Examples & Applications (Floods)

This specific measure is included under Tool 3.2 (Ground-floor Construction) on a Zone 3 level.

(Image: FEMA 2005:10-2)

Examples & Applications (Floods)

This is an example of using Tool 3.5 (External Envelope) and Tool 3.6 (External Openings) in order to protect a building against flooding.

(Image: FEMA 2005:10-8)

Examples & Applications (Floods)

This is an example of using Tool 3.5 (External Envelope) and Tool 3.14 (Services) in order to protect a building against flooding.

(Image: FEMA 2005:10-8)

Examples & Applications (Floods)

This is an example how services (Tool 3.14) can be used to reduce the vulnerability of buildings against floods.

(Image: FEMA 2005:10-12)

Examples & Applications (Major Events)

Public access and egress

A modern stadium should be surrounded by an outer perimeter fence situated some distance from the stadium. At this outer fence the first security checks and, where necessary, body searches will be made. The second checks will be made at the stadium turnstiles. There should be sufficient space between the outer perimeter fence and the stadium turnstiles to permit the free movement of spectators. The space dimensions are determined by the local authority.

It must be borne in mind that while the entry process may be spread over an hour or more, everyone will want to leave more or less at the same time. The circulation space available immediately outside the exit gates must be sufficient to guarantee that spectators are not at risk of being crushed in the event of a stampede and are able to leave the event in comfort.

At every event, it must be possible to completely evacuate the stadium within a maximum time agreed with the local safety authorities. Preventive measures must be taken to avoid crushing at the public entrances. This may be accomplished by a system of barriers designed to funnel spectators individually toward the entry points.

Public amenities such as toilets and refreshment bars, inside and outside the stadium, should not be situated close to the turnstiles or to the entrance and exit routes. Clear and unmistakable signs must point spectators to their sector, row and seat.

During the entry mode, all major points of access should be used for entry and a couple of small designated points should be clearly marked for exiting. The opposite is required in the exit mode and a combination of the two modes is required during the match itself.

Entry Points at Stadium

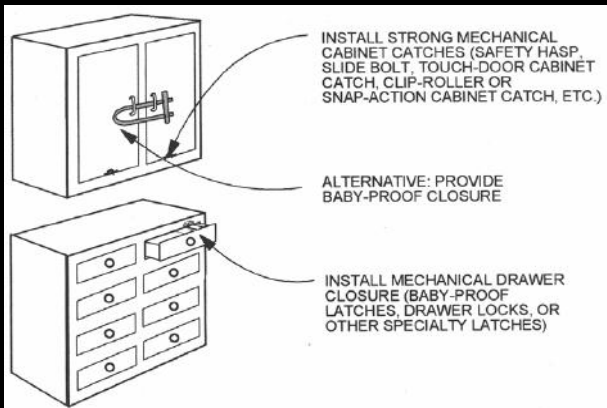
- Tool 1.2 – Location, Placement & Sizing
- Tool 1.3 – Access Points
- Tool 2.4 – Fencing & Gates

Signs

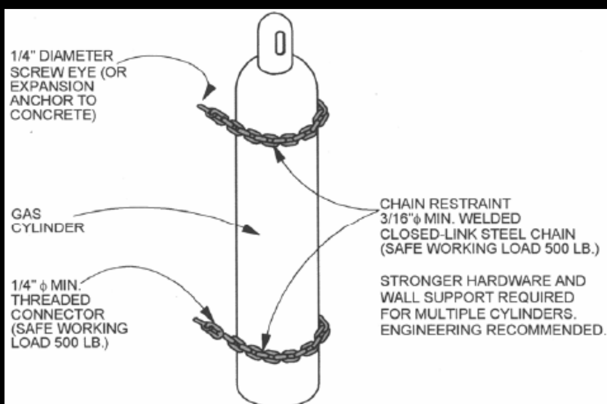
Tool 2.7 – Signage

FIFA Technical Recommendation & Requirements (2007)

Examples & Applications (Earthquakes)



Zone 3
Tool 3.13: Internal Fittings



Zone 2 & 3
Tool 3.14: Services (Gas)

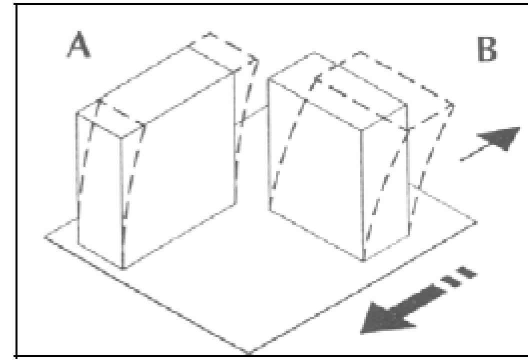


Figure 4-11 *Source: Naeim. The Seismic Design Handbook, 1989.*

Tool 1.2: Location, Placement, Orientation and Sizing

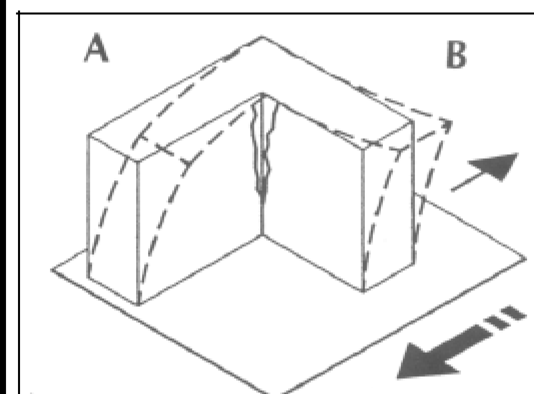
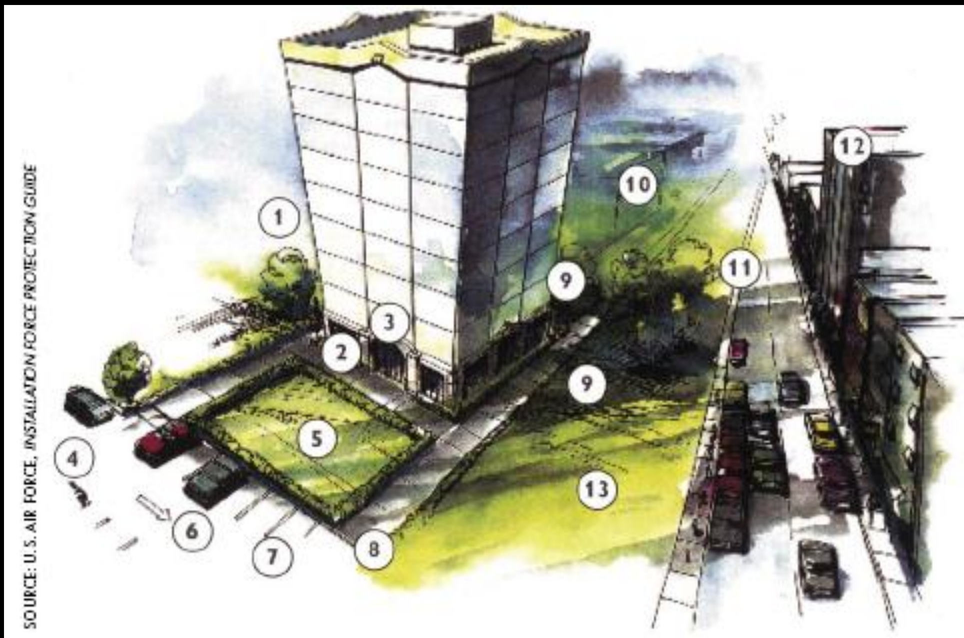


Figure 4-12 *Source: Naeim. The Seismic Design Handbook, 1989.*

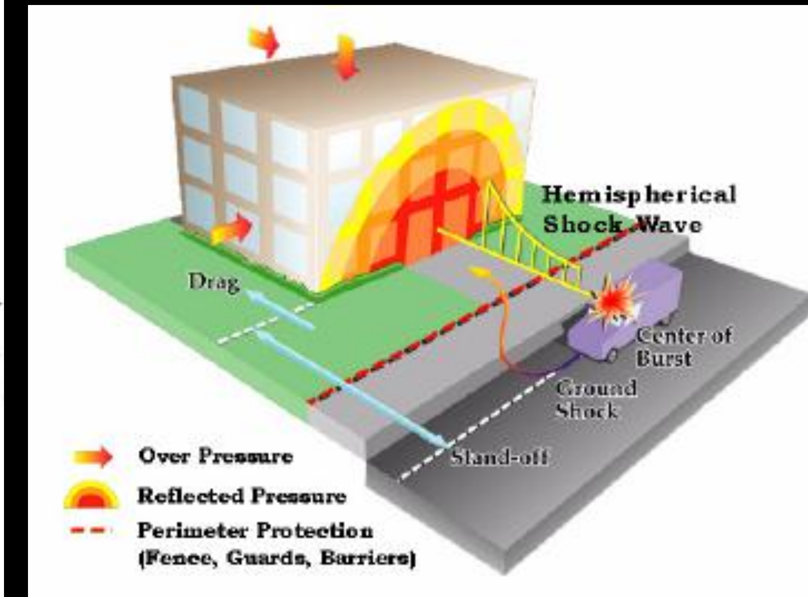
IS-8 (March 1995) Risk Management Series
Building for the Earthquakes of Tomorrow

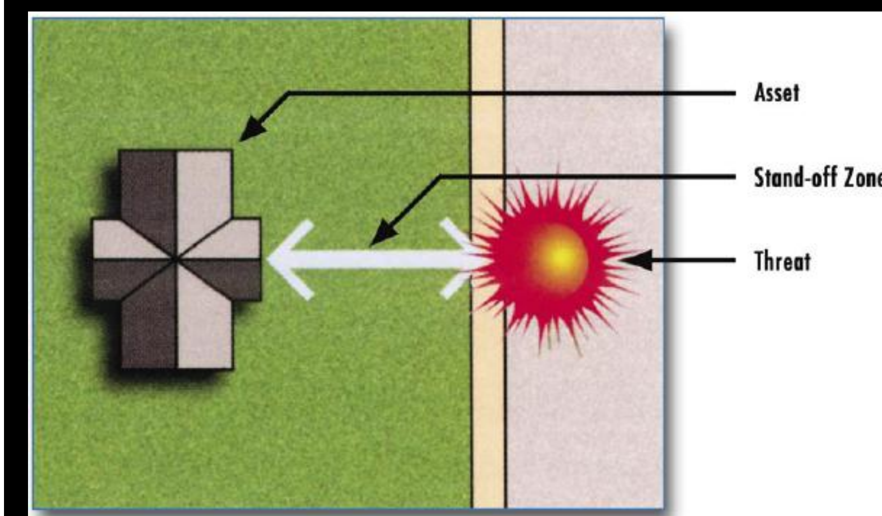
FEMA 577 (June 2007) Risk Management Series
Design Guide for Improving Hospital Safety in Earthquakes, Foods, and High Winds

Examples & Applications (Security / Terrorism)



1. Locate assets stored on site, but outside the building within view of occupied rooms in the facility.	8. Minimize vehicle access points.
2. Eliminate parking beneath buildings.	9. Eliminate potential hiding places near the building; provide an unobstructed view around building.
3. Minimize exterior signage or other indications of asset locations.	10. Site building within view of other occupied buildings on the site.
4. Locate trash receptacles as far from the building as possible.	11. Maximize distance from the building to the site boundary.
5. Eliminate lines of approach perpendicular to the building.	12. Locate building away from natural or manmade vantage points.
6. Locate parking to obtain stand-off distance from the building.	13. Secure access to power/heat plants, gas mains, water supplies, and electrical service.
7. Illuminate building exteriors or sites where exposed assets are located.	





FEMA 426 – Mitigate Potential Terrorist Attacks Against Buildings – Dec 2003

Examples & Applications (Disaster Response)

Shelter and settlement standard 2: physical planning

- Temporary planned or self-settled camps are based on a minimum surface area of $45m^2$ for each person (see guidance note 5).
- The surface topography is used or augmented to facilitate water drainage, and the ground conditions are suitable for excavating toilet pits where this is the primary sanitation system (see guidance note 6).
- There are roads and pathways to provide safe, secure and all-weather access to the individual dwellings and facilities (see guidance note 7).
- Mass shelters have openings to enable required access and emergency evacuation, and these openings are positioned so that access is well supervised and does not pose a security threat to occupants (see guidance note 8).

Shelter and settlement standard 4: design

- The type of construction, materials used and the sizing and positioning of openings provides optimal thermal comfort and ventilation (see guidance notes 4-7).

Sphere Project: Humanitarian Charter and Minimum Standards in Disaster Response

Existing Initiatives

UNEP

After the Tsunami

Sustainable building guidelines for South-East Asia

Technical:
Practical, robust and technically feasible solutions.

Economic:
Cost-effective solutions.

Environmental:
Environmental impacts (positive as well as negative), disaster risks and vulnerability, etc.

Institutional:
Laws and regulations and their enforcement, relevant institutions.

Social:
Health and safety issues, user-friendliness, adaptability to the users' needs and living conditions, acceptance by users, etc.

Placement of houses on sloped sites

In earthquake-affected regions, the following guidelines should be taken into account:

- The house should not be cut into the slope, as the flanking wall might collapse due to horizontal forces.

- The house should not be placed onto the slope or it might slip down.

- The house should not be located close to steep slopes or cliffs or it might collapse due to falling rocks or landslides.

- If a sloped area cannot be avoided, platform should be built first and the house should be placed at a secure distance from the adjacent slopes.

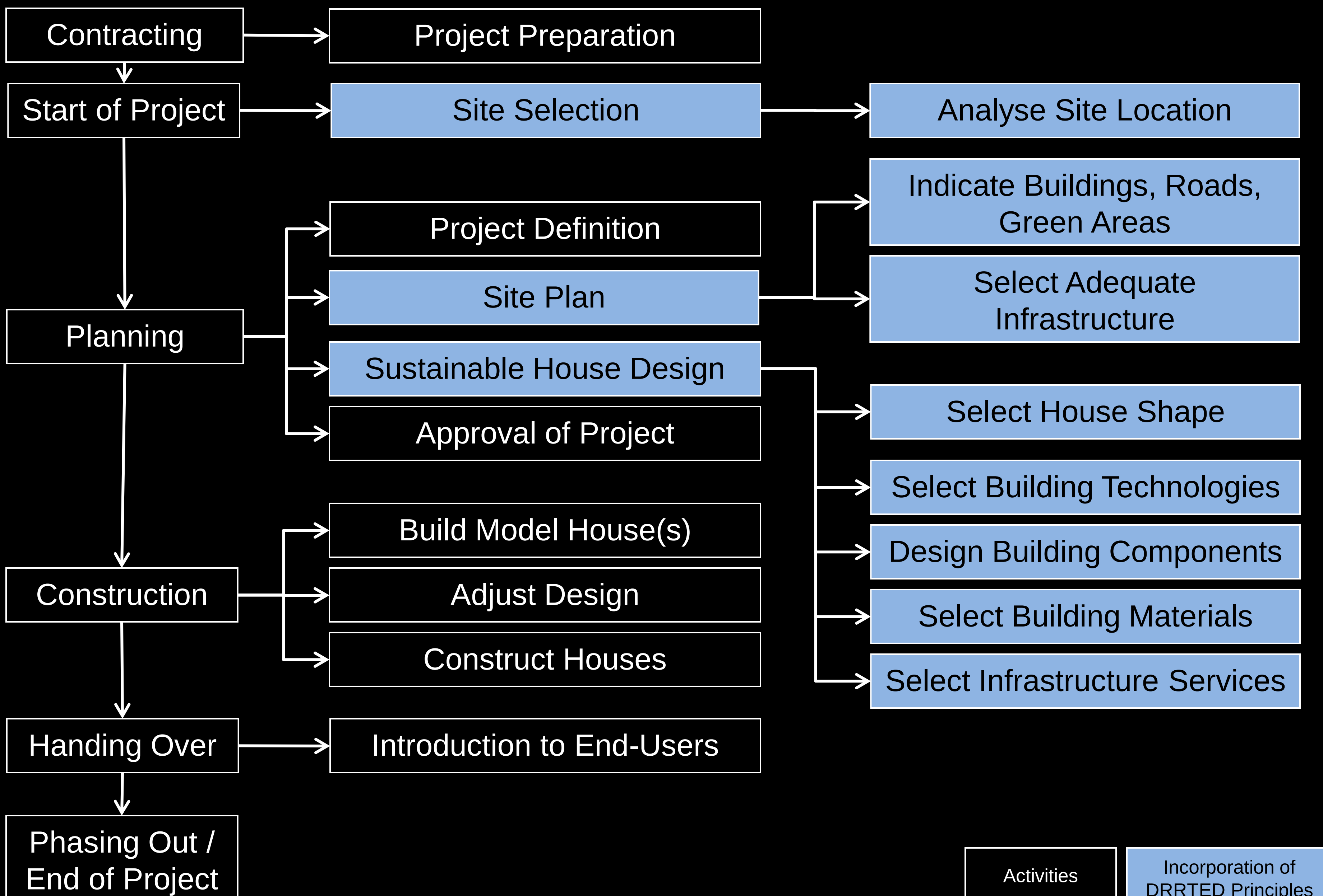
- When siting houses on soft sandy undergrounds select massive and heavy house styles. For rocky soils, choose light and flexible structures.
- Avoid multiple floor levels.

(Source: Minke, G., 2001)

Existing Initiatives

- Building Regulations, SABS Codes, etc.
- CSIR Guidelines for Human Settlement Planning & Design
- Crime Prevention through Environmental Design (CPTED)
- Safer City Initiatives

Sustainable Reconstruction



Shortcomings & Challenges of DRRTED

Examples:

- Mostly focused on Physical / Structural Changes
- Need to Influence Socio-economic (& non-tangible aspects) to influence vulnerability & community resilience

DRRTED in Practice:

- Limited to New buildings or Upgrading of Existing Buildings
- Require effective maintenance
- Will require additional plans/policies/monitoring for effective DRR

Challenges:

- Challenge to get ‘buy-in’ from Developers/Professionals
- Capacity on Local-level

Possible Way Forward

- **Get input from Professionals, DM Officials, Academics, etc.**

- **Invest in Research to further investigate & develop the DRRTED Concept**
    - Refinement of the conceptual framework
    - Process to collect information on existing DRR design guidelines
    - Development of new guidelines

- **Eventual Research outputs can include guidelines / best practises for creating safer environments (similar to FEMA & CSIR Guidelines for Settlement Planning)**

- **Document to provide authorities, government officials, developers and professionals with qualitative and quantitative guidelines on how to created low disaster risk urban environments and buildings.**

Conclusions & Recommendations (1 of 2)

• Aimed to introduce the concept of Disaster Risk Reduction Though Environmental Design (DRRTED)

• The DRRTED approach, aims to reduce disaster risk in the urban or built environment by making use of the suggested *‘tools of influence’* and *‘zones of influence’*

• Tools & Zones can be used to influence the hazard, vulnerability and capacity components that contribute to disaster risk levels.

• DRRTED approach proposes to use a comprehensive approach, and to consider all the factors that might lead to a high disaster risk level in a community, by focusing on hazards, but also vulnerability and capacity.

<u>Conclusions & Recommendations (2 of 2)</u>

• The DRRTED approach also aims to collect different existing guidelines into a single framework / comprehensive planning approach.

• It is therefore recommended that additional research into DRRTED is funded by a suitable organization (such as the UN, NDMC?) to enable researchers to further investigate and refine the DRRTED concept.

• Results of this research might establishment set of guidelines for design professionals to reduce disaster risk in South Africa.

• Additional research into DRRTED will require inputs from various experts including, amongst others, engineers, architects, urban planners, and <u>social scientists</u>.

• The DRRTED should, also, <u>not just remain theory</u>, but must lead to <u>practical solutions</u> that can be implemented, while taking into account the various challenges, in the South African and Southern African context.

Remarks, Questions & Comments

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The fear of the LORD is the beginning of wisdom,
and the knowledge of the Holy One is understanding.
Proverbs 9:10