A Framework for

Fire Safety in Informal Settlements

ARUP

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Foreword

Three years ago, we set out to understand the nature and scale of fires in informal settlements. Our objective was to identify risks and points of intervention to improve fire safety. We quickly realised there is a gap in fire safety knowledge, experience, assessment tools and construction guidance for informal settlements.

We also acknowledged the need for a common language around fire safety in informal settlements. Within the professional fire safety community, attentions are commonly focused on the formal built environment, to the neglect of informal communities. Amongst stakeholders working to support informal settlements, fire is often recognised as a significant risk. However, in the absence of practical tried and trusted solutions, fire risk reduction is seldom given the investment it requires. We, therefore developed this Framework for Fire Safety in Informal Settlements to facilitate collaboration and alignment of global efforts to create safer and more resilient informal settlement communities.

This framework is an initial step. With it, we aim to motivate investments in fire safety by providing a way for stakeholders to engage with the issues. We are also exploring opportunities to develop robust, holistic and accessible tools that empower communities and organisations to assess fire risks and prioritise fire risk reduction efforts and investments. Generally, there is a need to consider fire within holistic strategies for the resilience of communities and cities in the face of multiple hazards. As such, we hope that this framework will also support the incorporation of fire safety within wider disaster planning.

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Fire in Imizamo Yethu informal settlement, 11th March 2017, Cape Town, South Africa
Photo credit: Bruce Sutherland City of Cape Town

Introduction

A fire in an informal settlement can affect thousands of people. Fires take lives, cause serious injuries, destroy property and have long-term impacts on livelihoods. Recovery is a long and difficult process, which can be exacerbated in informal settlements where financial instability, insecure tenure and a lack of insurance are common. But this global fire problem remains largely neglected.

Fire events in informal settlements are rarely reported in international media, even when they amount to major community-wide disasters. Moreover, there are too few investments in fire risk reduction for informal settlements globally.

Limited resources and a myriad of competing needs and risks inhibit communities' ability to improve fire safety. Where resources are devoted to fire safety, investments are seldom informed by a holistic consideration of fire risk and potential risk reduction options. Local fire safety lessons learned and success stories are also rarely shared between settlements, let alone across borders.

It is time to empower communities with fire safety knowledge, resources, and support so that they can become resilient to fire. This framework is an initial step towards facilitating this movement.

Fires cause over **130,000** deaths globally per year. This is **more than double** the annual average deaths due to natural disasters.[1]

In 2016, approximately **one fifth of the world's population live in low/low-middle SDI** countries. However, almost **half of the world's deaths due to fire** occur in these countries.[2]

Informal settlements are unplanned and often densely-populated residential areas where inhabitants may lack security of tenure, have poor-quality housing, limited supporting infrastructure, and services (including health care and emergency services) and high vulnerability to fires and other hazards. Informal settlements include slums, refugee camps and internally displaced persons' camps. One billion people live in informal settlements today.[3]

Socio-demographic index (SDI) is a summary measure that identifies where countries or other geographic areas sit on the spectrum of development. Expressed on a scale of 0 to 1, SDI is a composite average of the rankings of the incomes per capita, average educational attainment, and fertility rates of all areas in the Global Burden of Disease (GBD) study.[4]

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[1] Between 2000 and 2016. Retrieved from Our World in Data (https://ourworldindata.org) on 14th September 2018.

[2] Retrieved from Our World in Data (https://ourworldindata.org) on 14th September 2018.

[3] "Slum Almanac 2015/2016, Tracking Improvement in the Lives of Slum Dwellers," Participatory Slum Upgrading Programme Team Nairobi, Nairobi, 2016.

[4] Retrieved from Institute for Health Metrics and Evaluation (http://www.healthdata.org/taxonomy/glossary/socio-demographic-index-sd) on 19th September 2018.

What is the framework?

Fire risk in informal settlements is a multi-faceted problem. It is framed by a variety of underlying socio-cultural, economic and political factors, and is comprised of many different aspects, at scales ranging from the household to the national government. Improving fire safety in informal settlements is, therefore, a complex challenge.

The framework provides a structured way of approaching the challenge and supports consideration of fire risk reduction. It has been developed to be flexible so that it can be applied to different contexts and settlement typologies. We recommend using the framework in conjunction with analysis of the local context, in order to understand the unique and often complex dynamics of a particular informal settlement. Stakeholder mapping should be undertaken to identify community groups and organisations which may influence, support, or implement actions to improve fire safety.

This framework does not seek to evaluate or quantify fire hazards or safety measures. It is intended as the first step in the development of tools to assess fire risk in informal settlements and target effective and efficient investments in fire risk reduction.

We hope that this framework will be a point of reference for a wide range of stakeholders seeking to better understand fire safety in informal settlements. For a particular informal settlement, the framework could be used to support a holistic consideration of fire risk and potential risk reduction options.

Examples of the anticipated users of this framework include:

- Non-governmental organisations (NGOs)
- Community groups
- Fire and rescue services
- Researchers and practitioners working on the subject
- Public or private sector investors
- Government bodies

Cox's Bazar refugee camp Bangladesh
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Understanding fire safety

What are we trying to achieve?

The performance objectives for fire safety in the built environment focus on protecting life whilst minimising the effects of fire on livelihoods, property and the environment. The fundamental principles consider the following:

- Alerting people to the presence of fire
- Providing suitable routes for evacuation, including for persons who require assistance to escape
- Reducing the potential for rapid fire spread so that escape is not inhibited
- Limiting fire size to enable evacuation, firefighting and rescue operations, and to minimise damage to property
- Protecting structural elements to prevent premature or disproportionate collapse
- Preventing fire spread to other buildings and surrounding urban infrastructure
- Providing access routes and facilities to support firefighting and rescue operations

The evolution of fire safety

Fire safety considerations for the built environment have evolved over time, through lessons learned from major fire events and the development of fire safety science.

For example, following the Great Fire of London in 1666, in which over 13,000 houses were destroyed, a new, more fire-conscious approach to urban development was adopted to prevent such an event from occurring again. The early fire brigade was born, London streets were widened and restrictions on the use of wood and thatch in favour of less combustible materials, such as brick and stone, were established.

In the past century, fire safety science has advanced significantly. Across the world, research has been undertaken on a wide range of topics, including fire development, smoke movement, heat transfer, the response of building materials and structures to fire, and human behaviour in the event of a fire. Codes and standards have been developed to share knowledge and best practices. They continue to evolve as lessons are learned from further fire events, as well as from applied and fundamental research. Combinations of fire safety measures are typically proposed as part of a layered fire safety approach, commensurate with the risks and characteristics associated with a particular component of the built environment.

Fire safety in informal settlements

In informal settlements, factors such as the high density of buildings and the use of combustible construction materials can cause fire spread to be rapid. Prompt evacuation and firefighting intervention are therefore critical to protect life, minimise property damage and limit the impacts on livelihoods.

Communities that are resilient to fire can withstand, respond to and recover from severe fire incidents, thereby contributing to residents' broader wellbeing and long-term development. This requires action throughout the entirety of the disaster management cycle – mitigation, preparedness, response, and recovery. Improvements in fire safety may be realised through direct investments in fire risk reduction or as co-benefits from investments in informal settlements more broadly. The most effective investments will require a holistic consideration of the physical and social nature of fire risk and fire safety.

Structure of the framework

The framework links the key considerations for fire safety in informal settlements. Underlying contextual factors are placed at its centre, emphasising their universal and constant relevance to all strands of the topic.

The framework is organised around the four stages of the disaster cycle and identifies twelve key aspects of fire safety. The rings represent the different scales at which action to improve fire safety should be considered (household, community, city).

Further discussion on the aspects most relevant to each of the disaster cycle stages is provided in the following pages, highlighting key challenges and providing practical examples of how fire risk can be reduced at different scales.

Context

There are a wide variety of drivers that lead to the development of informal settlements (e.g. economic migration, conflict, disasters), which can be formed as emergency settlements, transitional settlements, or permanent settlements.

Fire risk in informal settlements must be considered alongside other shocks and stresses and in light of competing constraints and objectives.

There are a range of underlying contextual factors, which compound disaster vulnerability within informal settlements. The factors can be broadly categorised as follows:

Socio-cultural – including demographics, cultural beliefs about fire, attitudes towards risk and societal cohesion.

Economic – vulnerabilities brought about or framed by economic limitations and a variety of immediate daily challenges (e.g. access to food, healthcare, education).

Political – relationships between stakeholders and the political will of a local government to support investments in safety and resilience of informal settlements.

The disaster cycle

Commonly used in the context of natural disasters such as flooding, storms, earthquakes, landslides, and wildfires, the disaster cycle may also be applied to fires in informal settlements, which are often community-scale disasters. The disaster cycle has four key stages, any of which may be used as a starting point for considering vulnerability or resilience:

Mitigation – measures to prevent or reduce the likelihood, severity, and consequences of fire.

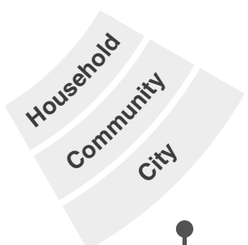
Preparedness – strategies, procedures, resources and training that influence and inform stakeholders' fire response and recovery.

Response – actions taken during a fire incident to save lives, protect property and critical infrastructure.

Recovery – actions taken in the aftermath of a fire incident, both immediately to assist with healthcare and welfare, and longer-term to return communities to normal life and bring about improvements in fire safety.

Aspects

The framework identifies twelve aspects of fire safety – three aspects for each stage of the disaster cycle. Their importance overall, and in relation to each other, will depend on the specific context of each informal settlement. In practice, these aspects may also be relevant for more than one stage.



Scales

The disaster cycle stages and fire safety aspects can be considered at different scales, and by stakeholders at each of these scales. The framework considers three scales:

Household – an individual or a group of people (e.g. a family) living in a single dwelling.

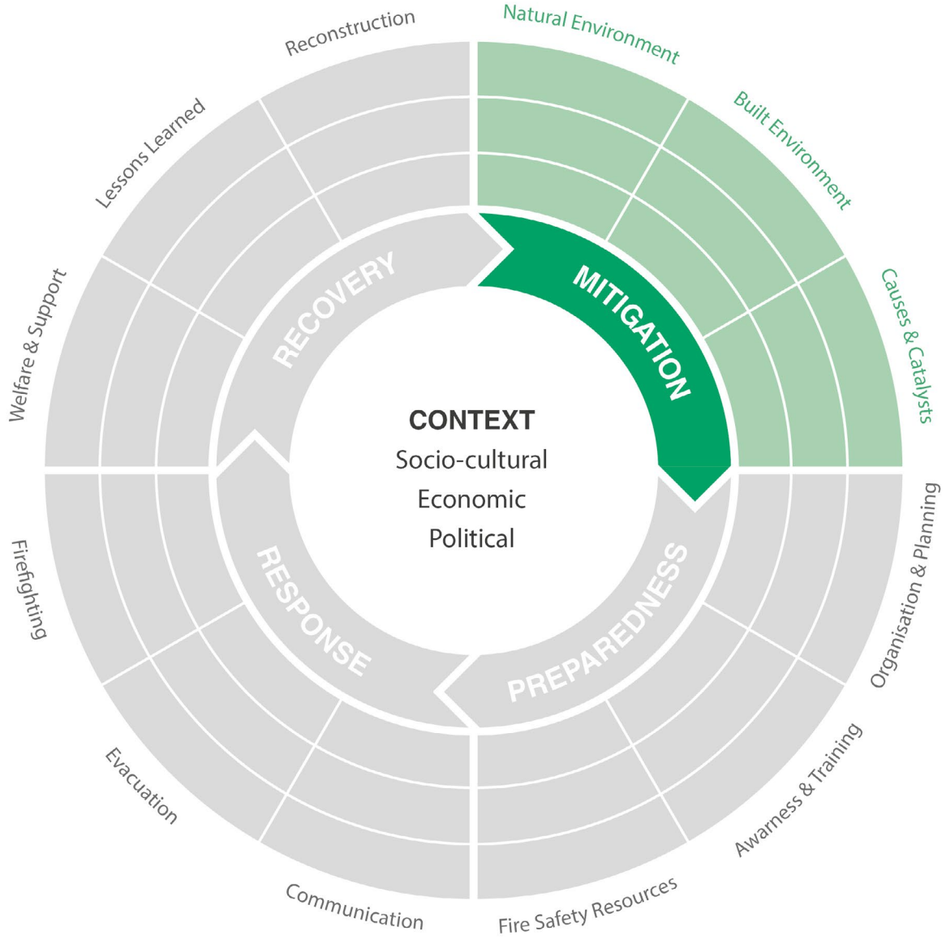
Community – a group of households living in a close geographical area, having a particular characteristic in common.

City – a place where people gather, either by choice or by circumstance.

The interactions and relationships between stakeholders at each scale, and across scales, has a significant bearing on fire safety.

Mitigation

Mitigation measures should be based on the fire risks in each specific informal settlement. Effective mitigation measures can prevent or reduce the likelihood, severity, and consequences of fires. The key aspects to consider when developing fire mitigation measures are the Natural Environment, Built Environment, and Causes & Catalysts. Investments in mitigation are generally a cost-effective use of fire risk reduction resources. Where possible, investments in mitigation should draw on lessons learned from previous fires.



Natural Environment

Fire risk can be greatly influenced by natural conditions. For example, arid and hot climates present additional risks over wetter and cooler environments in terms of ignition and readily burnable fuel sources (e.g. dry vegetation). Informal settlements built at the Wildland-Urban Interface (i.e. where homes are built near or among lands prone to wildland fire) have an increased fire risk. Weather and topography can influence fire behaviour, particularly the direction and rate of fire spread. Fire spread could be exacerbated by strong winds or the position of settlements on hillsides or sloping sites. Other natural disasters, such as flooding, can impact fire escape routes or firefighting access routes, increasing a community's vulnerability to fire.

Built Environment

Construction typologies of informal settlements vary widely depending on the local context and availability of suitable construction materials. Combustible construction materials (e.g. timber) and linings (e.g. plastic sheeting) can increase both the likelihood and severity of fires. Poor building stability can exacerbate fire spread through an informal settlement. Limited space is a common issue in informal settlements, resulting in minimal separation distances between dwellings. Fire spread between dwellings and through entire settlements is therefore common. Limited access through settlements is also common causing significant challenges with evacuation and firefighting.

Causes & Catalysts

The cause of a fire is the way a fire physically starts (e.g. ignition source). Human behaviours that may influence the likelihood or severity of fire are considered catalysts to fire risk. Fires in informal settlements are most commonly caused by open flame sources (for cooking, heating, and lighting) and overloaded or poorly maintained (and often illegal) electrical connections. Fire risk may change with seasons. For example, an increased reliance on heating devices during cold seasons can increase fire risk. Examples of catalysts include children playing with fire, alcohol intoxication and smoking. Fire safety training can help create awareness of the risks associated with these types of behaviours and activities (see Preparedness). The above description of catalysts relates to accidental fires. Arson, the human act of maliciously and deliberately starting a fire is, in fact, a cause of fire.

Household

Natural Environment	Built Environment	Causes & Catalysts
- Remove dry vegetation from around and between dwellings - Avoid building in areas where access for firefighting vehicles may be challenging, such as in areas prone to flooding - Avoid building on steep hillsides, where fire may spread rapidly upwards	- Use construction materials (structure and linings) which do not propagate rapid fire growth (e.g. avoid plastic sheet walls and roof coverings) - Provide multiple escape routes from each dwelling - Maximise separation distance to adjacent dwellings	- Replace open flame cooking, lighting and heating appliances with safer alternatives - Practice safe storage of fuels used for cooking, lighting, and heating - Use surge protectors, circuit breakers, insulated electrical wiring and equipment with fuses - Store waste safely and remove waste regularly

Community

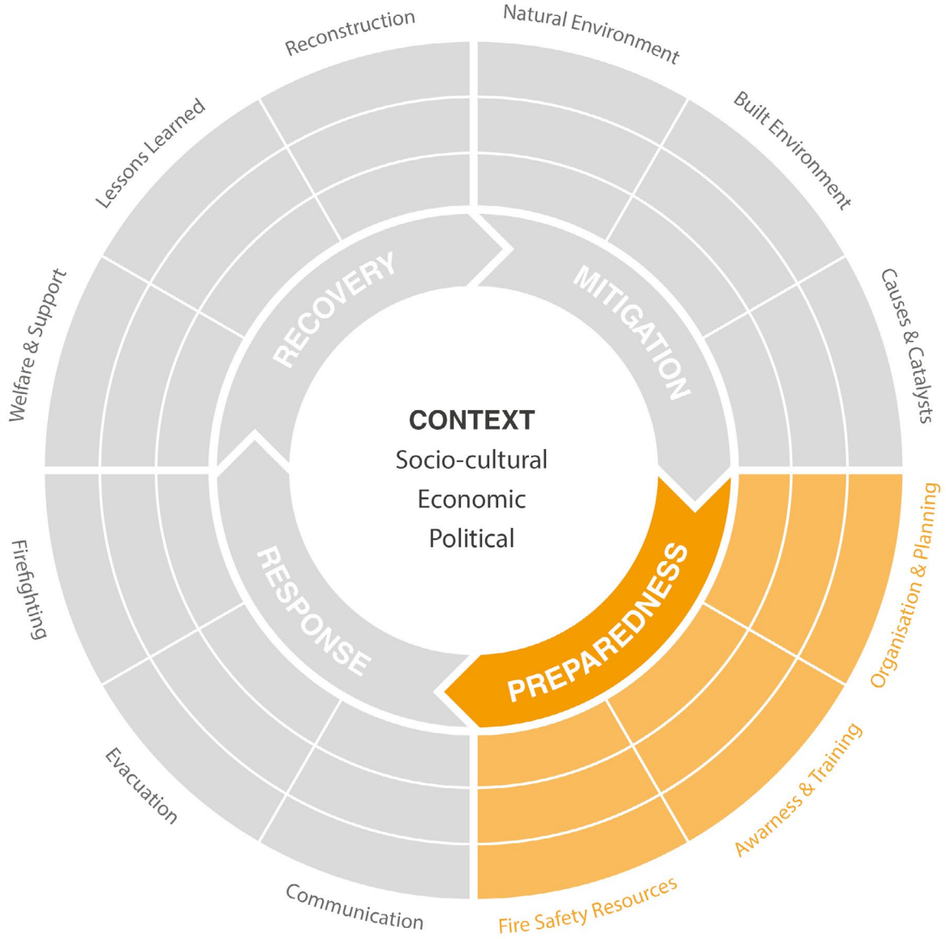
- Manage vegetation at settlement boundary - Avoid settlement development in naturally hazardous areas, such as wetlands and floodplains of rivers - Locate vulnerable or critical buildings (e.g. schools, clinics, community centres) in upwind or less hazardous areas	- Establish and maintain fire breaks, evacuation routes, and vehicle access routes - Maximise separation distance between dwellings and minimise density of dwellings - Avoid settlement development near high hazard areas, such as landfills and industrial premises	- Organise refuse collection services where not officially provided

City

- Implement wildland fire management policies and strategies to help prevent fire spread to informal settlements - Improve wildland firefighting response to help prevent fire spread to informal settlements	- Implement policies relating to land tenure and land use - Implement policies that allow for upgrading of informal settlements and the use of robust building materials - Commit to city planning which promotes and supports the use of appropriate building materials and fire safety principles for dwelling and settlement design	- Provide safe electricity - Provide refuse collection - Subsidize cost of safer cooking, lighting and heating appliances and/or promote market-driven distribution to communities - Implement standards for safer cooking, lighting and heating appliances and enforce regulations to help prevent unsafe appliances entering the marketplace

Preparedness

Preparedness includes the strategies, procedures, resources, and training that influence and inform stakeholders' fire response and recovery. Preparedness strategies should leverage resources, organisational structures, and capacities of communities and relevant stakeholders. The main aspects to consider during preparedness in informal settlements are Organisation & Planning, Awareness & Training, and Fire Safety Resources.



Organisation & Planning

Roles and responsibilities of communities, local organisations, fire and rescue services, and other stakeholders should be clearly defined to enable an effective fire response and recovery. Coordination minimises duplication of efforts and ensures stakeholders work together to achieve common goals, namely to save lives, protect property and livelihoods, and return communities to normal life as soon as possible. Fire safety management plans that are 'owned' by communities and supported by other stakeholders can be both cost-effective and sustainable. By empowering communities, local knowledge and expertise can be leveraged, responsibilities of community members can be established and technical and organisational capacities can be strengthened.

Awareness & Training

The perception of fire risk influences stakeholders' behaviours with respect to fire safety, including their tendency to invest in fire mitigation and preparedness measures. Fire risk perception is influenced by a multitude of factors, such as past experiences with fire, culture, competing risks, and immediate needs. Fire safety awareness campaigns and training can empower individuals and communities to identify hazards in their own community and take action to improve fire safety. Organisations supporting communities should coordinate their efforts to deliver consistent fire safety messages and standardised training programmes, potentially targeted towards specific groups (e.g. child-friendly, gender specific). Fire response teams (e.g. community firefighting teams, fire and rescue services) should coordinate their training and response structure to the specific challenges of informal settlement fires.

Fire Safety Resources

The ability of stakeholders to respond effectively to a fire is highly dependent on the availability of fire safety resources. Ideally, each household should have a device that warns them of a fire (e.g. smoke alarm) and access to firefighting equipment (e.g. fire blanket or bucket of sand) so they can extinguish the fire early. Fires that spread beyond the dwelling of origin can pose significant challenges, emphasising the importance of personal protective equipment to protect firefighters. Appropriate emergency vehicles, firefighting equipment and tools, and a reliable water supply (e.g. hydrants) can help improve fire response. Alternate extinguishing agents are needed where water is not appropriate (e.g. electrical or oil-based fires). Provisions for persons who require assistance to escape during a fire should be considered (e.g. accessible egress routes).

Household

- Develop an evacuation plan and practice it in advance
- Memorise emergency services phone number(s), save to phone contacts and keep a written record
- Notify neighbours, community firefighting teams and other response organisations (e.g. fire and rescue services) of assistance needed to escape during a fire

- Identify household fire hazards (and develop appropriate risk mitigation measures)
- Use safe cooking, lighting and heating practice (e.g. do not leave appliances unattended, keep clothing/furniture away from appliances, etc.)
- Share knowledge and ideas with neighbours
- Teach children about fire safety and promote safe behaviour

- Device to detect fire and warn residents (e.g. smoke alarm)
- Firefighting equipment, such as buckets of sand or water, pot covers, fire blankets
- Evacuation aids for persons who require assistance to escape

Community

- Make a community fire response plan
- Coordinate fire response plan with other stakeholders
- Support the development of personal emergency evacuation plans for persons requiring assistance to escape
- Establish a community firefighting team and develop community firefighting procedures

- Identify 'community level' fire hazards (e.g. electrical wiring, burning of waste, cooking fuel storage – LPG, wood, kerosene, etc.) and develop appropriate mitigation measures to reduce community fire risk
- Coordinate training and awareness sessions on fire risk and fire safety

- Community warning systems
- Community firefighting equipment including personal protective equipment, fire extinguishers, firefighting tools (e.g. crow bar, beater, hook, axe)
- Community water taps

City

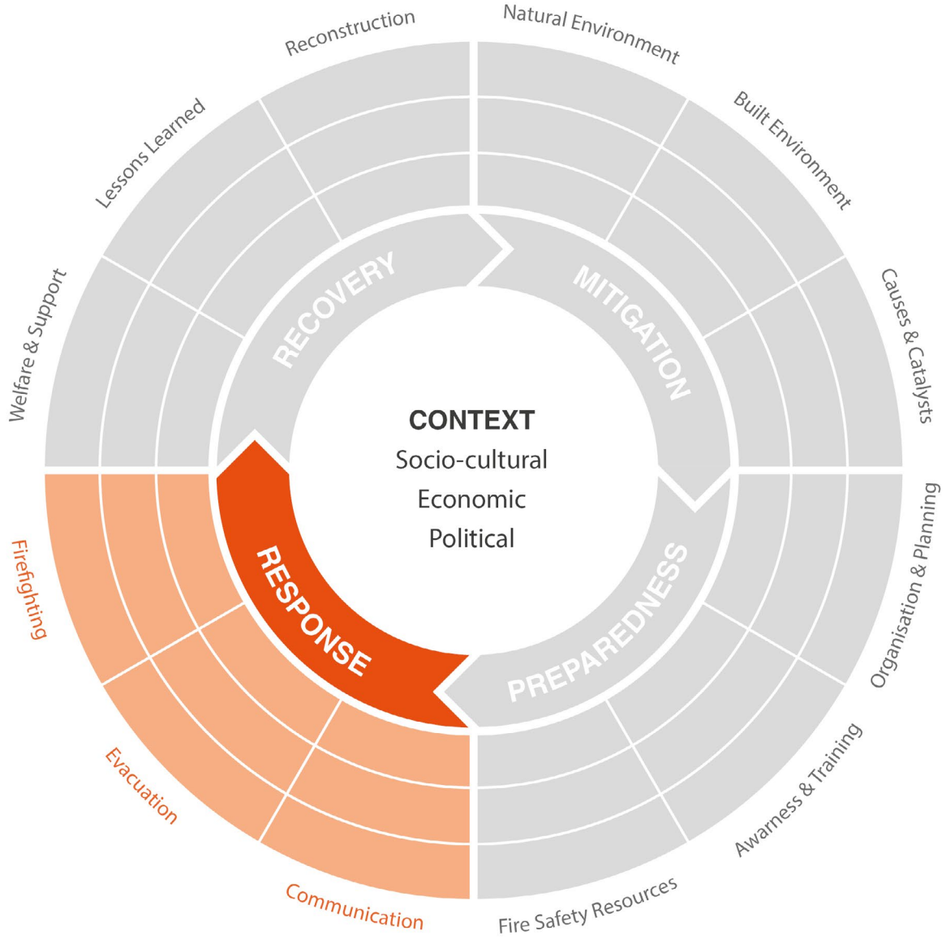
- Support community fire response planning and coordination
- Develop procedures to shut off electricity supply during a fire
- Allocate funding and develop policies and plans to support the community after a fire

- Deliver fire safety awareness campaigns and training for individual households and the wider community
- Provide firefighting training for fire response teams (e.g. community firefighting teams, fire and rescue services) that is specific to informal settlements and consistent with the coordinated fire response plan between stakeholders

- Provide emergency vehicles that can access (and supply/pump water to) informal settlements (e.g. 4x4s, fire motorcycles)
- Provide firefighting equipment for fire and rescue services (e.g. personal protective equipment, hoses, axes)
- Install fire hydrants with suitable hose connections
- Provide local water reservoirs for firefighting

Response

A fire in an informal settlement can spread rapidly and affect thousands of people. Coordination between the community, emergency services and other stakeholders can significantly improve fire response. The key actions during a fire are Communications, Evacuation, and Firefighting. An effective response can reduce the loss of life, property damage, the impact on livelihoods and the effort, time and investment required to return the affected community to normal life.



Communication

Effective communication is critical during an informal settlement fire. There are a wide range of emergency communication systems found in informal settlements, from residents using verbal alarms (shouting “fire”) to hand-cranked alarms and text-message systems that warn the affected community. Communication systems that address the needs of deaf/hard of hearing people are beneficial. Mobile phones are prevalent in many informal settlements around the world and can be used to activate fire response teams (e.g. community firefighting teams, fire and rescue services). However, potential challenges with mobile phone battery charging, phone credit and awareness of emergency phone numbers should be considered. Also the complexity of local or national emergency communication systems varies, which can affect the response time of emergency services.

Evacuation

The potential for rapid fire spread and unstable structures in informal settlements makes prompt evacuation crucial. However, insufficient provisions for evacuation are common in informal settlements. Delays in fire detection and warning can cause a loss of critical time for safe evacuation; this is especially common when residents are sleeping. Dwellings with one narrow escape route leave residents with no alternative way out if the single exit is blocked by fire or smoke. Persons requiring assisted evacuation are particularly vulnerable if others are not aware of their needs. It is not uncommon for residents to return to their homes to save their belongings (e.g. furniture) during a fire. This puts their lives in danger and can interfere with others’ evacuation, firefighting and rescue operations. Residents who evacuate to an assembly point need to maintain awareness of the potential dangers as fires in informal settlements can be extensive and unpredictable due to the scale and nature of the settlement.

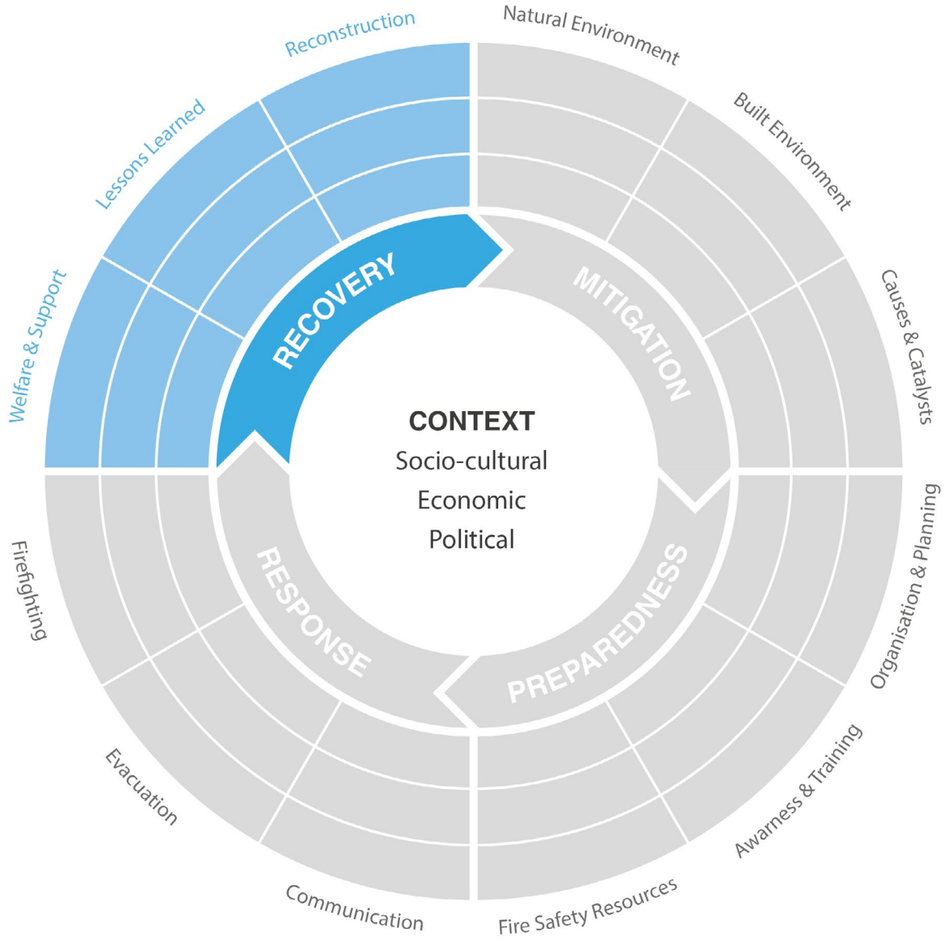
Firefighting

If a fire is detected early, there may be an opportunity to extinguish it using simple equipment such as a bucket of sand or water. However, as a fire grows, so does the risk and complexity of firefighting operations. While a spontaneous firefighting response may be formed by the community (e.g. bucket brigades), organised community firefighting teams can be much more effective (see Preparedness). In some instances, wildfire tactics may prove useful, such as creating fire breaks by deliberately knocking down dwellings to remove fuel and prevent further fire spread across the settlement. Significant challenges with emergency vehicles getting to the fire location are common due in part to inaccurate fire location reporting, traffic congestion and narrow streets. A lack of suitable water supply for firefighting is also common.

	Communication	Evacuation	Firefighting
Household	- Alert children and family members of a fire - Alert neighbours of a fire - Activate community warning system - Alert community fire response teams (e.g. community firefighting teams, fire and rescue services) as per community response plan	- Assist children and family members who need support evacuating and leave dwelling immediately - Walk to assembly point via evacuations routes - Notify fire response teams of persons requiring rescue - Do not return to dwelling until firefighters confirm it is safe to do so	- Try to extinguish small fires if it is safe to do so (e.g. using pot cover, sand, water, fire blanket, fire extinguisher) - Shut off electricity supply to the house if possible
Community	- Communicate accurate location of fire and information relevant to persons who require assistance to escape to community fire response teams - Alert neighbouring communities of fire	- Notify fire response teams of persons requiring rescue - Implement a method of checking in at assembly point to monitor who has/has not escaped - Support persons requiring assistance to escape (if they not able to self-evacuate)	- Community firefighting teams can try to extinguish fires where they have appropriate fire safety resources and training appropriate for the specific fire incident (see Preparedness)
City	- Activate fire and rescue operations upon notification of fire - Coordinate response with other emergency services (e.g. police, ambulance) - Activate welfare support services as necessary	- Fire and rescue services to rescue persons in danger - Fire and rescue services to support persons requiring assistance to escape (if not able to self-evacuate)	- Shut off electricity supply during a fire - Fire and rescue services should carry out firefighting and rescue operations as per their training, policies, and procedures

Recovery

Recovery is a dynamic process during which the immediate needs of survivors need to be balanced with long-term strategic objectives. Recovery includes the actions taken in the aftermath of a fire, both immediately to assist with healthcare and welfare, and longer-term to return communities to normal life and bring about improvements in fire safety. The primary considerations during recovery are Welfare & Support, Reconstruction and Lessons Learned.



Welfare & Support

A range of welfare and support services may be required during and after an informal settlement fire (albeit they are not always available). There may be an immediate need for treatment of burns, smoke inhalation or other injuries. First-aid assistance may be provided by the community, emergency responders or NGOs, but more serious injuries could require medical attention from a local hospital. In addition, shelter, food, water, sanitary facilities, direct financial support, and psychological support may be required for persons affected by the fire. The process of replacing important documentation (e.g. proof of identification, registration documents) lost during the fire could require substantial support, coordination and time. If the fire caused fatalities, funeral and burial support will be required.

Lessons Learned

A post-fire investigation should be completed, which includes an assessment of fire causation and fire spread, a review of the performance of fire mitigation measures and of the efficacy of fire response (communications, evacuation and, firefighting). Data on the fire causes and consequences (number of injuries/fatalities/displaced, property loss, etc.) should be collected and recorded in a national or international fire statistics database. Specific lessons learned should be shared with the community and other relevant stakeholders (e.g. other communities, NGOs, fire and rescue services, international researchers). These lessons learned can inform evidence-based, practical enhancements to future mitigation, preparedness and response to fire. Furthermore, direct experience of a fire can increase thr perception and awareness of fire risk, which could influence behaviour and motivate further investments in fire safety.

Reconstruction

Reconstruction after fire is not always achieved in informal settlements. This is often a sensitive political topic due to a variety of issues, including land tenure, property rights and immigration status. Where reconstruction is supported and adequate finance is available, there is an opportunity to build back better. Lessons learned from the fire incident and wider fire safety considerations should be implemented in the reconstruction process. There are inherent planning challenges with rehousing the existing population density when trying to achieve reasonable fire safety standards (e.g. emergency vehicle access and fire breaks between dwellings). Design and implementation processes that are driven by the community and coordinated amongst stakeholders can lead to a significant improvement in fire safety.

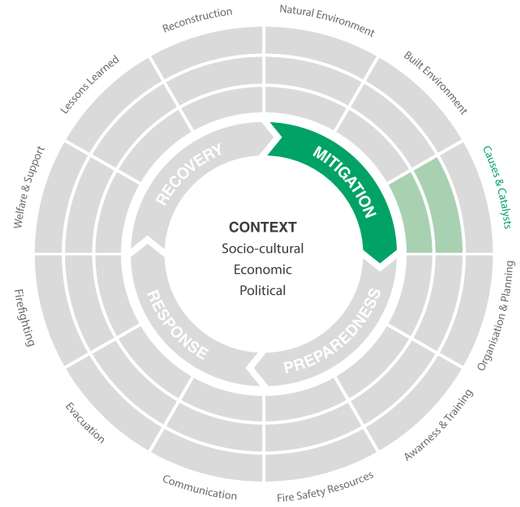
	Welfare & Support	Lessons Learned	Reconstruction
Household	- Seek medical attention, legal assistance, mental health services and other support as needed	- Participate in the post-fire investigation as appropriate to allow accurate data to be developed - Share lessons from direct experience in the fire incident with other stakeholders	- Re-build houses and community buildings - Communicate their needs to community leaders to be incorporated into community reconstruction
Community	- Provide first-aid medical treatment - Identify community members' needs and communicate those needs to stakeholders who are providing welfare and support - Advocate for additional support if needs not met - Develop support groups/ mechanisms which focus on affected residents	- Contribute to the post-fire investigation as appropriate - Review the post-fire investigation and data record for accuracy and to learn lessons for community fire risk reduction	- Re-build houses and community buildings - Leaders to lobby for reconstruction and for the community's needs to be taken into account in reconstruction - Identify and engage with organisations supporting the reconstruction process (e.g. NGOs, local government)
City	- Provide healthcare (including mental healthcare) and medical supplies - Provide legal assistance, welfare services, and facilities to meet the needs of the local community - Coordinate support provided to the community to avoid duplication and assure the actual needs of the community are met.	- Perform a post-fire investigation to reveal lessons from the fire incident - Record data in national or international fire statistics database - Share lessons learned from the incident with relevant stakeholders (e.g. other communities, NGOs, fire and rescue services, international researchers)	- Re-build houses and community buildings - Facilitate engagement with the community and help prioritise their needs - Support communities in reconstruction with financial and material support, as well as technical design support - Coordinate organisations supporting reconstruction (e.g. NGOs, local government)

International Insights

The Framework for Fire Safety in Informal Settlements provides a platform for considering fire safety and fire risk reduction through the four stages of the disaster cycle (mitigation, preparedness, response, recovery), at different scales (household, community, city).

On the following pages, real-world examples are presented to demonstrate how the framework relates to different informal settlements globally, and how local context is integral to fire safety considerations.

Photo credit: Pollinate Energy



Fire risk reduction in India's urban slums by addressing energy poverty

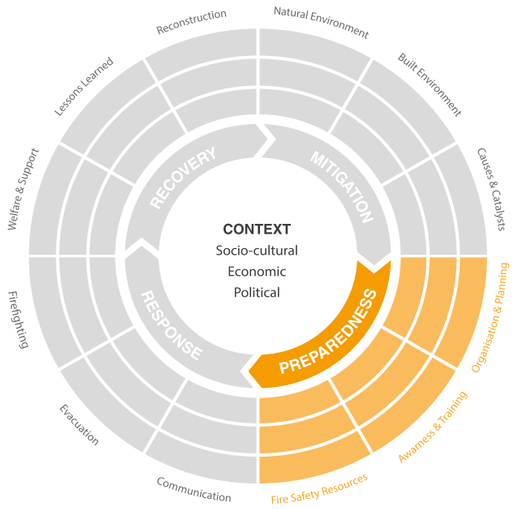
There is a lack of reliable data on the causes of fires in informal settlements. However, unsafe electrical connections and open flame sources used for cooking, heating, and lighting are the primary causes of fires in informal settlements around the world.

Programmes that address energy poverty by providing safer cooking, lighting and heating appliances/sources can therefore significantly reduce the likelihood of fire. The vast majority of the 400 million people in India that live in energy poverty rely on kerosene for lighting [1]. Open flame cooking appliances using a wide range of fuels, such as firewood, kerosene, and LPG are also common.

Pollinate Energy is a social enterprise that aims to bring clean energy solutions to the millions of people living in economic and energy poverty in India's urban slums. Empowering door-to-door sales agents called 'Pollinators', their long-lasting clean energy solutions improve the health, safety, quality of life and immediate environment of families who need them the most. Their products have reached 130,000 people in over 1,000 communities so far [2]. One of Pollinate Energy's most popular products is the solar light, which replaces the reliance on kerosene in households and effectively eliminates the risk of fires caused by lighting sources. According to Pollinate Energy, their products have prevented the use of over 4 million litres of kerosene [2]. Solar lights also improve lighting levels, which can help people cook more safely, reducing the risk of burns and fires caused by unsafe cooking practices.

"We used to get oil from the market and pour it into the lamp and light it; the house used to get full of soot and dirt. After we got this solar lamp a lot of things improved. Now we don't worry that there will be a fire."

- Abdul, a slum-dweller in Bangalore who lives in a hut made of wooden board and tarpaulin.



Fire prevention and preparedness in Syrian refugee camps in Lebanon

Fire is perceived to be one of the top two 'most concerning hazards' by displaced persons in Lebanon, according to a survey conducted by the Lebanese Red Cross [3]. However, a 2016 fire risk assessment by Operation Florian, a UK registered fire and rescue service humanitarian aid charity, revealed that there is a low level of fire safety knowledge among displaced populations and that local fire services are inadequately funded and equipped [4]. Operation Florian proposed a holistic approach to improve fire safety, which included community prevention and awareness activities.

The Lebanon Shelter Cluster, a group of humanitarian organisations which supports displaced persons with shelter, recognised that fire safety activities require a coordinated, cross-sectoral approach. The cluster formed a technical committee, which developed 'Guidelines for Fire Prevention, Preparedness and Response (FPPR)'. These guidelines include guidance specifically for informal settlements, as well as for residential and non-residential buildings housing Syrian refugees.

The technical committee was led by Save the Children (SCI) Lebanon, an international non-governmental organisation that promotes children's rights, provides relief and helps support vulnerable Lebanese and Syrian refugee children in Lebanon. SCI Lebanon developed fire safety training tools and resources for implementing partners (other humanitarian organisations in the Lebanon Shelter Cluster) with support from UNHCR (United Nations High Commissioner for Refugees). These 'train-the-trainer' courses include guidance on distribution of fire safety resources ('fire safety minimum standards') and training for communities. Coordination of the Lebanon Shelter Cluster enables fire safety programmes to scale and assures that consistent fire safety messages are delivered to communities.

SCI Lebanon also supports communities directly, by training men, women, and children in how to prevent, prepare for and respond to fires in their homes and communities. This fire safety training is audience-specific. For example, the child friendly training uses a 'fire story', consisting of simplified messages with illustrations and a series of interactive activities. Children are taught how to respond to fire by actively acting out 'stop, drop and roll' as a group.

According to the 'Guidelines for Fire Prevention, Preparedness and Response', community firefighting teams should be established. There is a particular emphasis on the creation of spontaneous fire breaks in response to large fires; the technique to create these fire breaks is described as follows:

"To create a spontaneous fire break, community firefighting teams must… dissemble the third tent/ structure to a tent/structure afire, taking into consideration wind direction. The risk of the adjacent tent/structure catching fire in a short period of time (less than 2 minutes) is high" [3].

SCI Lebanon distributes 'Fire Leaflets', which summarise key fire safety messages (with visuals), and information sheets on how to 'use a fire extinguisher, check if fire extinguishers are valid, and call emergency services'. In addition, SCI Lebanon provided fire safety resources, including smoke alarms, fire extinguishers, and firefighting tools (beaters and hooks) to 29,000 children and their families in 2017 [3].

Photo credit: Save the Children Lebanon

Photo credit: Toby Keller, burnblue.com

Impact of cultural beliefs on fire response in Southeast Asia

A series of internal conflicts in Myanmar (formerly Burma) since 1984 has led to thousands of refugees from a variety of ethnicities fleeing into Thailand. Over the years, Thai authorities have established nine refugee camps near the Myanmar border, with refugee numbers peaking at 150,000 in 2005 [5]. Following third-country resettlement programmes, the numbers currently stand at 98,000. Mae La, with a population of 37,000, is by far the largest [6].

The camps are operated by the Committee for Coordination of Services to Displaced Persons in Thailand (CCSDPT).

In 2014, Operation Florian, a UK registered fire and rescue service humanitarian aid charity, carried out a fire needs assessment of four of the camps in partnership with FIRE AID, an umbrella organisation, which brings together its members to deliver humanitarian aid globally. The primary aim was to advise on fire risk reduction across the camps.

As part of a contextual analysis, Operation Florian learned about several cultural beliefs that relate to fire safety. For example, it is believed that if your neighbour's house is on fire and you follow them escaping, this will bring bad spirits to your house. This presents challenges in approaching fire safety, such as evacuation strategies and undertaking fire drills.

Not all cultural beliefs have a rational basis and many may seem counterintuitive to people from a different culture. However cultural beliefs can be deeply rooted in a community's identity and should, therefore, be respected. Organisations supporting communities with fire safety interventions should perform a contextual analysis with an emphasis on identifying relevant cultural beliefs.

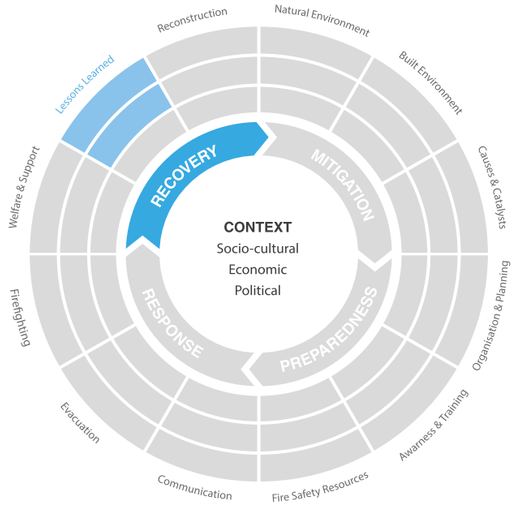
While fire safety training can raise awareness of fire risks and influence behaviours, it is often not appropriate to try to change deeply rooted cultural beliefs. Education in fire safety should be appropriate and sensitive to the context and traditions of each particular community.

In addition, specific mitigation and preparedness measures could be considered to address the risks introduced or heightened by cultural beliefs. For example, providing alternative exits from all dwellings to help alleviate the aforementioned issue.

Major fire in the Ban Mae Surin refugee camp in Thailand

On 22nd March 2013, a fire broke out in the Ban Mae Surin camp in Thailand. Extensive fire spread has been attributed to dry conditions and firebrands (i.e. burning embers) from grass thatched roofs by eyewitnesses. More than 400 bamboo dwellings and several community buildings were destroyed in the fire.

The fire left 37 people dead, over 100 injured and 2,300 homeless [7].



The difficult road to recovery in South African townships

On 11th March 2017, a fire swept through the Imizamo Yethu township in Cape Town, South Africa. Four lives were lost, 2,194 structures were destroyed and 9,700 people were displaced. It was one of the worst fires in the history of Cape Town [8].

Left with little or no belongings, victims of the fire relied on support from neighbours, NGOs, the City of Cape Town, and various departments from the Western Cape Government in the immediate aftermath of the fire. This included food, supplies and temporary relief accommodation in tents and community halls. Medical treatment and trauma counselling were also provided to residents affected by the fire [9].

On March 12 2017, just one day after the fire, the City of Cape Town announced plans to rebuild Imizamo Yethu [9]. The City normally provides housing kits to residents whose dwellings have been destroyed in a fire [10]. However, in an effort to improve living conditions and prevent such an extreme event from occurring again, the City of Cape Town proposed a new approach to reconstruction termed 're-blocking'. The Executive Mayor described this scheme as follows:

"Super-blocking... provides for blocks separated by roads and pedestrian/service corridors, with electrification and communal taps and toilets provided per block. Road access, electrification, fire-breaks, and fire hydrants are anticipated to significantly reduce fire risk in an area such as Imizamo Yethu" [11].

The 'super-blocking' of Imizamo Yethu was estimated to take three months (estimated completion July 2017) [12] and it was intended to be completed in partnership with the local community. However, several media reports stated that the community was dissatisfied with the public consultation process. Many residents started rebuilding independently of the City's super-blocking process, which inhibited the community-wide reconstruction effort. This prompted the city to obtain a court interdict against anyone who continued to erect structures before super-blocking commenced. Violent protests erupted in response to contested issues such as the City's demolition of structures, inadequate emergency housing, fears of permanent relocation and significant delays in the reconstruction of Imizamo Yethu [13].

Following the protests and subsequent meetings between the Mayor and the community leadership, a joint statement was released to proceed with super-blocking. The project completion date was adjusted to July 2019, two years after the initial estimated completion date [14].

By March 2018 however, one year after the fire, minimal progress on the super-blocking had taken place. As a result, Imizamo Yethu community members held a peaceful demonstration and handed over a memorandum of grievances to City's officials. Residents demanded to be allowed to rebuild their homes without fear of demolition and court interdicts. They also called for the provisions of basic services, a means to engage directly with the City and *"that the upgrade be done in a collaborative manner, with input from residents"* [15]. Following this, the City re-affirmed their commitment to supporting the community through super-blocking.

This example of post-fire reconstruction highlights some of the challenges and complexities associated with the recovery stage of the disaster cycle. Recovery is a dynamic process where the immediate needs of survivors must be balanced and aligned with long-term strategic objectives to build back better.

"Governments attitudes to informal settlements range from opposition and eviction to reluctant tolerance and support for legislation and upgrading."

- William Robert Avis, Urban governance topic guide

Photo credit: Sullivan Photography

Research behind the framework

The framework concept and thoughts outlined in this publication have been informed by numerous avenues of learning, drawing on the research and experiences of Arup and others.

Arup's Fire Safety in Informal Settlement's research programme is led by our international development group and fire safety engineering group. Arup International Development (AID) partners with development and humanitarian organizations to create more sustainable and resilient communities globally. Arup Fire comprises an international team of 200+ fire safety specialists dedicated to protecting people, properties, assets and operations from the various fire hazards and risks that exist in the built environment.

Over the past three years, we have visited numerous informal settlements and conducted interviews with community leaders, fire and rescue services, NGOs, academic institutions and social businesses, primarily in South Africa but also in other locations around the world. Our research has also been informed by several desktop studies and reviews of technical and academic literature.

The key questions that have guided this research so far are as follows:

- How significant is the problem of fire in the hierarchy of risks?
- What are the causes of fire in these contexts and what differentiates the causes and effects in different urban contexts/typologies?
- How effective are the current/proposed fire mitigation and response measures?
- Which stakeholders are most engaged with, or could have the most influence on, fire safety?
- What is the most effective application for fire safety engineering to influence fire safety?

We continue to study fire safety in informal settlements through active engagement with other researchers and practitioners via workshops, conferences, collaborative publications, and projects.

Next steps

This framework was developed to facilitate collaboration and alignment of global efforts to create safer and more resilient informal settlement communities. Further research is needed to learn from previous disasters and to quantify fire incidence, impacts, and causal factors. There is a need for:

- Improved knowledge of the causes, behaviour, and impacts of fires in informal settlements
- Improved understanding of the context and characteristics of different informal settlement typologies globally and how those factors influence fire safety
- Data collection (fire statistics, settlement characteristics, local experience of fires, fire safety success stories, etc.)
- Development of tools to assess fire risk in informal settlements and target effective and efficient investments in fire risk reduction
- Fire safety advice based on practical solutions that take into consideration the vulnerabilities, challenges, capacities, and resources of different informal settlement typologies
- Development of construction materials, fire safety products, equipment and systems which can help improve fire safety in informal settlements

Improved evidence of the likelihood and impact of fires in informal settlements is needed to enable advocacy and continued engagement with those in position to influence policy, governance, legislation, and construction practices.

Ultimately, fire risk reduction needs to be integrated into local, national and global disaster management policy and practices.

The UN Sustainable Development Goal 11, Target 11.5 sets out to *"by 2030, significantly reduce the number of deaths and the number of people affected… by disasters… with a focus on protecting the poor and people in vulnerable situations"*. With this overarching goal in mind, we hope that this framework will support the incorporation of fire safety within wider disaster planning and within holistic strategies for the resilience of communities and cities in the face of multiple hazards.

This framework is intended to support further research, encourage knowledge sharing and promote investments in fire risk reduction in global informal settlements.

An exciting group of interested parties has emerged through FIRE AID / Operation Florian which includes fire fighters, fire safety engineers, international development professionals, researchers and field staff from the public sector, academia, private sector and NGO world. We look forward to working with this group and the many other interested parties, to create and promote solutions for fire safety in informal settlements.

To find out more about the framework or to contribute to further research on fire safety in informal settlements, please get in touch (contact details included at the end of the document).

Photo credit: Sullivan Photography

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