

## IRIS-Fire

IRIS-fire is an international and interdisciplinary research project aimed at 'Improving the Resilience of Informal Settlements against Fire'. Over one billion people across the globe live in informal shack settlements, and this number is steadily increasing. Many of these informal settlements (i.e. shantytowns, favelas, slums) are at constant risk of lethal, large-scale destructive fires due to flammable construction materials, heating and cooking methods, shack proximity, etc. For occupants of these shacks death and injury from fire constitute 'a serious public health problem'; for example 96% of the world's burn-related deaths ( $\approx 300,000$ /year) occur in lower and middle-income countries (WHO 2016).

Africa is the fastest urbanizing continent on earth, with an average 7% increase in population between 1990-2015, increasing the population in urban clusters by 484 million. The majority of new urban districts are informal settlements constructed ad-hoc using available materials, with no formal space planning, and with few explicit fire safety measures. Statistics vary, but in South Africa it is estimated that up to 33% of the country's population now live in informal settlements. In Cape Town the number of informal dwellings grew from 28,000 in 1993 to 104,000 in 2006 and 220,000 in 2011.

This project initially focuses on informal settlements in and around Cape Town, where the burden of shack fires is particularly high. Across South Africa, there are an estimated ten shack fires a day, often leaving residents dead and in some cases many thousands more homeless. In Cape Town, the 'fire capital of South Africa', the situation is particularly stark. Between 1990 and 2004 the Mandisa GIS database tracked informal settlement fires in Cape Town. Of the 18,504 fire incidents, 47% occurred in informal settlements. Annually there are  $\approx 500$  deaths and 15,000 fire-related hospital admissions due to fire in the city, of which substantial proportions are residents of informal settlements. In recent years there have been numerous large-scale fires in Cape Town, leaving thousands homeless and many dead; Khayelitsha fire, Jan 2013 (4000 homeless, 5 dead); Kayamandi fire, March 2013 (4500 homeless, 2 dead); Masiphumelele fire, Nov 2015 (4000 homeless, 2 dead); the Boxing Day fires, 2015 (8 dead), and the Imizamo Yethu fire, March 2017 (10,000 homeless, 4 dead).

Current discussions on informal settlement policy in South Africa, as in many other jurisdictions internationally, lack the necessary research base to develop creative, interdisciplinary, grounded solutions to fires in informal settlements. Some policies have stigmatized the individuals living within informal settlements, rather than acknowledging the physical challenges and dynamics that create large-scale fires and exploring ways to practically mitigate the risk factors within the local social and physical context. In other cases, policies have simply focused on high-end technical solutions, ignoring the complex political, economic and social dynamics of informal settlements within which interventions must be implemented. The key to reducing damage due to fires is to prevent fire spread from the structure of origin; a key concept in western formal settlement design. Thus the *specific challenge* for this project is to determine *how an interdisciplinary approach to fire science and engineering can improve the resilience of informal settlements against fires.*

## Research hypothesis & objectives

The proposed research aims to *develop new methods and tools required to evaluate and model fire risks within informal settlements of the Western Cape in South Africa, so that appropriate and cost-effective solutions and strategies can be suggested to improve the resilience of South African informal settlement communities against large-scale fires*. The research will examine the hypothesis that fire spread in informal settlements can be technically treated using similar physical models and tools already applied in wildland forest fire analysis, and therefore, that the science and engineering used to manage forest fires could, with due consideration to sociocultural factors, be used at least in part interchangeably. Both types of fires involve non-uniform distributed fire loads over large areas, are difficult to access by fire fighters, and can be assessed in part using satellite imaging pre, during, and post-fire. Some of the key differences between these two fire types are; 1) proximity to, and loss of, human life; 2) characteristics of the fuel load, and thus the combustion physics; and 3) management strategies and resources deployed.

To achieve the research objectives of the project and to assess the hypothesis that informal settlements fires can be treated similarly to wildland fires, several objectives must be achieved:

1. Perform shack surveys in several informal settlements in South Africa (SA) to enhance current stochastic topological data on informal settlement composition (both physical and socio-political).
2. Perform lab and field experiments on real scale dwellings and model settlements to understand and quantify key fire spread parameters required for simulation e.g. fire growth, heat release rate, heat fluxes, wind, fuel type, climate, prevention/mitigation strategies etc.
3. Model the fire experiments to develop a bespoke informal settlement fire model to be used in developing a mapping algorithm to identify critical at risk areas within informal settlements.
4. Produce a generic risk-mapping framework and best practice resilience-based technical guideline for improving for informal settlements, and apply this to the informal settlements of the Western Cape.
5. Deliver capacity building and knowledge transfer workshops and CPD events on relevant aspects of fire safety to fire fighters, students, NGOs, policy makers and residents.

Two advisory boards, one based in the UK and one locally in the Western Cape, are being used to ensure that the project delivers impact and to ensure that those living in the poorest of conditions have a reduced risk of fires affecting them and their homes.

The research team comprises of engineers and fire safety scientists from The University of Edinburgh and Stellenbosch University, and includes expertise in the social sciences, wildfire and fire dynamics, forensic investigations, and structural fire engineering. The Western Cape Disaster Management, Fire and Rescue Service are also key partners in the project providing essential expertise and experience of informal settlement fires, as well as their time and resources for the planned experiments.