Installation of Smoke Alarms in an Informal Settlement Community in Cape Town, South Africa

Acknowledgements

We would like to extend our sincere thanks to the community of the Wallacedene Temporary Relocation Area (TRA) for their collaboration in this project. We are especially grateful to members of the Wallacedene TRA Committee for their guidance, co-ordination, oversight and partnership, without which this project would not have been possible.

We are most thankful to Santam, particularly Tersia Mdunge and John Lomberg and his team, for believing in the potential of this project to significantly reduce fire deaths and injuries in informal settlements, and for providing funding that covered all phases of this multi-stage intervention. This intervention is the first of its kind conducted globally.

We also need to acknowledge the work of Ms Patricia Zweig from the Research Alliance for Disasters and Risk Reduction (RADAR) for her engagement with the Wallacedene community and many contributions to both the overall project and to the writing of this report. Robyn Pharoah, also from RADAR, was instrumental in designing the survey questionnaires and administering the entire data collection and analysis process. Rodney Eksteen, from the Western Cape Disaster Management, Fire and Rescue Services, was responsible for the co-ordination of the installation process and use of smoke alarms. Dr Richard Walls, and his team from the Stellenbosch University Structural Engineering Department (Fire.SUN), was responsible for the stringent testing that enabled the selection of the device used in this pilot study.

This project builds on the work and contributions of many people and organisations and is partly derived from initial work conducted by the Breede Valley Fire Department.

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Contents

Table of Figures

1

BACKGROUND AND RATIONALE

In 2002, the World Health Organisation (WHO) calculated that the fire-related mortality rate in Africa was around 6.1 per 100,000 person-years (WHO, 2002), much higher than in other parts of the world. South Africa has a complex burden of injury associated with fires, with a high number of at-risk populations living in informal dwellings. In the Western Cape Province, for example, approximately 300 to 400 fire-related deaths are reported annually, usually occurring within the winter months, and generally in low-income areas, where burn injuries are frequently associated with paraffin burns from cooking stoves.

The Paraffin Safety Association of Southern Africa (PASASA) estimates that more than 200,000 people per year in South Africa are injured or lose their property from paraffin-related fires (Bradnum, 2007:4), with over 40,000 households affected by uncontrolled fires in informal settlements alone (Mrubata & Dhlamini, 2008). In comparison with all causes of unnatural death, fire is one of the leading causes of death in South Africa (Norman et al., 2007) (Figure 1).

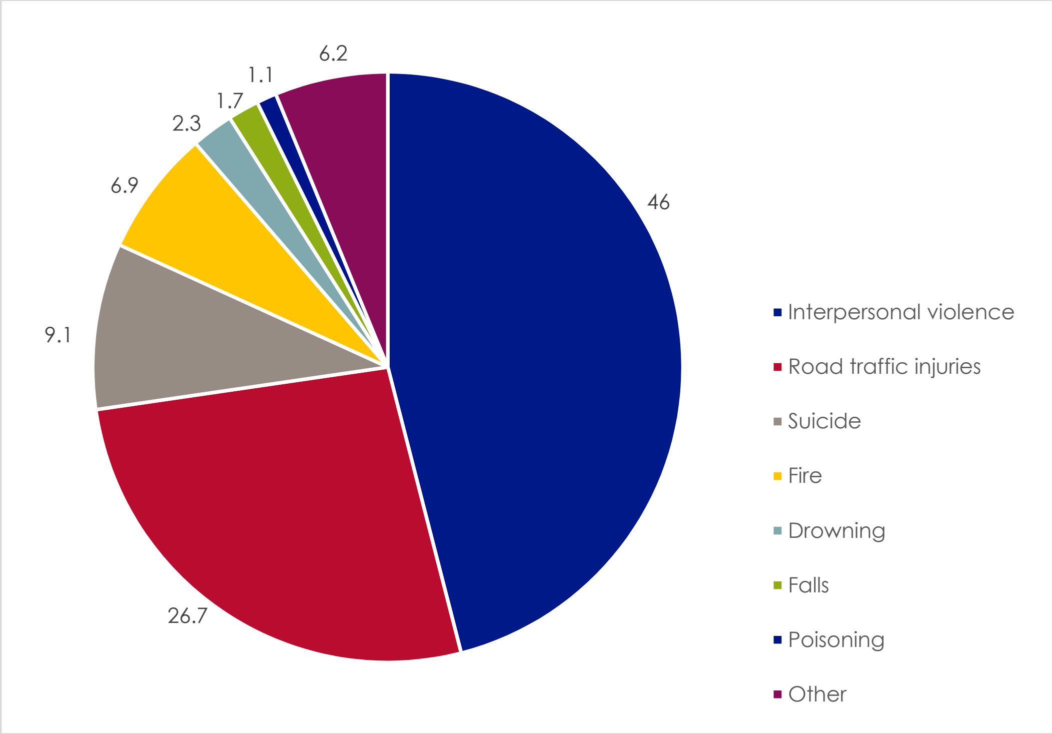

Figure 1. *Leading types of injury mortality in South Africa*
(Source: Norman et al., 2007)

Statistics South Africa (2014) reveal that the most vulnerable victims include young children and the elderly (Figure 2). Many other reports corroborate this finding (Groenewald et al., 2008; Van Niekerk et al., 2009:2; Ahmed, 2004:10) and highlight the high prevalence amongst young children, particularly between the ages of 1 and 4 years.

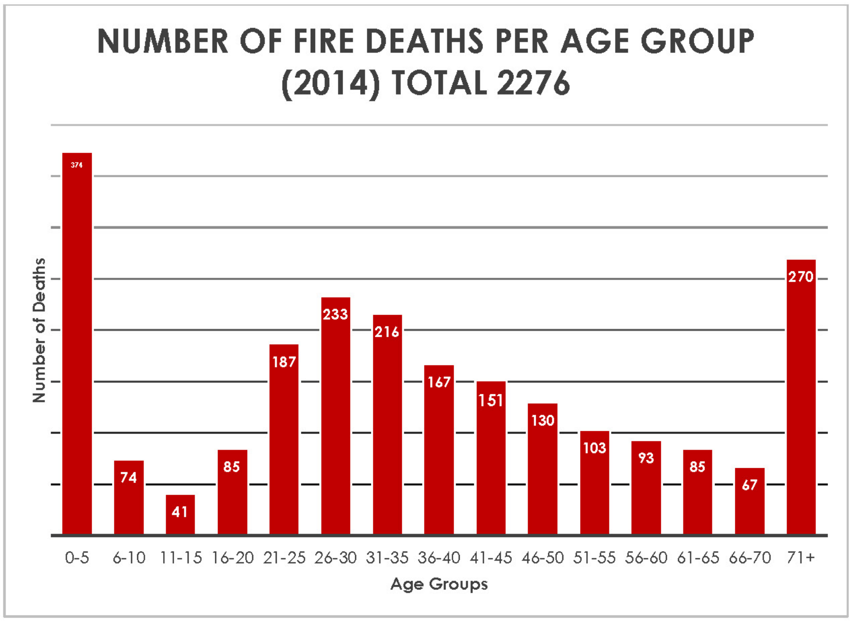

Figure 2: *High-risk victims include young children and the elderly*
(Source: Statistics South Africa, 2014)

According to numerous reports, Cape Town has become South Africa's most fire-prone city (Gqirana, 2015; Donson, 2008:44) and has been quoted as the 'fire capital of South Africa'. Evidence from the report 'A Profile of Fatal Injuries in South Africa' (Donson, 2008:44) indicates that out of the four largest South African metropolitan centres, the City of Cape Town has the highest overall fire-related death rates (Figure 3).

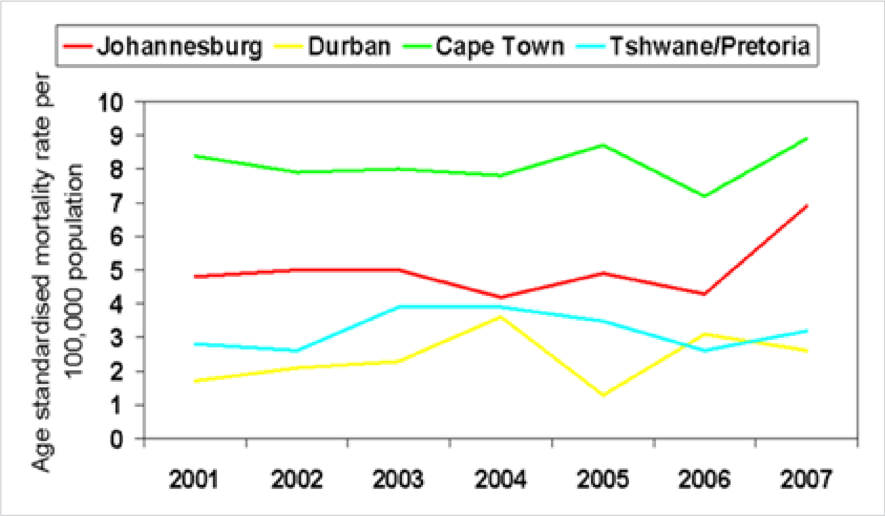

Figure 3: *Fire/burn mortality rates 2001-2007 in four cities in South Africa (Source: Donson, 2008:44)*

A study by the South African Medical Research Council, undertaken between 2001 and 2004 in Cape Town, reported a burn mortality rate much higher than WHO's (2002) African average, at 7.9 per 100,000 person-years (Van Niekerk et al., 2009). A concentration of these incidents occurs during the Cape Town winter in July and August, and then again during the holiday months of November and December.

The Western Cape Government has recognised that a strategic shift is required to manage fire prevention interventions proactively to meet the immediate and longer-term needs of society, preserve a healthy environment and protect lives and property. Research and international experience clearly indicate that the destruction of the environment, homes, property and lives due to fire can be prevented. In terms of frequency and loss of life, the incidence of fire within informal settlements is at an unacceptably high level.

The Western Cape Disaster Management Sub-Directorate: Fire and Rescue Services has been working collaboratively with various partners to develop strategies to prevent fire-related injuries and deaths in the Western Cape. The Western Cape Strategic Framework for Fire and Burn Injury Prevention advocates for projects and programmes to reduce the impact of fires (Western Cape Government, 2015). In this context, and specific to the requirements of household warning systems (objective 5 of the Strategic Framework), the Provincial Disaster Management Fire and Rescue Services initiated an innovative smoke alarm installation programme for High Fire Risk Communities. This was launched by the Minister of Local Government, Environmental Affairs and Development Planning, Mr. Anton Bredell, on 18 October 2016 and aims to combat fires in informal settlements across the Western Cape.

Global research suggests that the early detection of home fires is critical in preventing deaths and injuries. Stringent tests conducted by Stellenbosch University's Engineering Department show that the chances of surviving a fire may be much greater, and fire deaths and injuries reduced, if dwellings in informal settlements are fitted with a smoke alarm (Walls et al., 2017). This research shows that long-life photoelectric smoke alarms with a silence function are most effective in the informal structures tested (Figure 4).

[1] The term "person-years" is used by epidemiologists to represent a measure of the probability of occurrence of a given condition in a population within a specified period of time.

Figure 4: *Long-life photoelectric smoke alarm with silence function*

These alarms are activated early by smoke, rather than by heat or the presence of flames. They detect potential fires in the 'smouldering stage', which precede 'flaming stage' fires. The rapidly spreading smoke and gas that often occurs while people are sleeping is highly toxic and are a leading cause of fire-related deaths.

Most fire deaths are not caused by burns, but by smoke inhalation. In fact, it is estimated that smoke inhalation injuries, including burns to the respiratory system, cause 50% to 80% of fire deaths (Hall, 2011:1). Smoke also often disorientates people or incapacitates them so quickly that they cannot escape, while sleep studies have shown that smell of smoke does not waken people (Lynch, 1997:137). If a potential fire can be detected during the smouldering stage, this reduces the risk of asphyxiation and provides time for people to evacuate.

Although smoke alarms have been used extensively and successfully in domestic properties and formal residential dwellings all over the world, their efficacy in informal dwellings had never been established. It is, for example, unclear how durable alarms are in informal settings, the potential for nuisance alarms, or how environmental or behavioural conditions may impact their effectiveness. It is critical to understand these issues before rolling out the installation of alarms at scale.

The Wallacedene informal settlement was selected as a case study site for a large-scale test of the smoke alarm technology, following a highly successful community-based risk assessment undertaken there by the Research Alliance for Disaster and Risk Reduction (RADAR) in July 2015 (RADAR, 2015). Located in the Cape Metropolitan area, the settlement is home to between 4 000 and 5 000 people, living in approximately 1 200 or more dwellings. After the risk assessment, during which solutions were discussed in a multi-stakeholder forum, the community, together with local government officials, successfully carried out several risk-reducing interventions. After consulting with community leaders, RADAR suggested that Wallacedene TRA presented a suitable pilot site in which to test the efficacy and acceptability by the community of the smoke alarms.

2

INTRODUCING THE PILOT SITE - WALLACEDENE TRA

Wallacedene TRA is located within the greater Wallacedene area, situated some 40 kilometres from Cape Town in the eastern suburbs near, Kraaifontein. Wallacedene is a sprawling suburban township, covering an area of 54 hectares (Muzondo et al., 2004). It forms part of Sub-council Area 2 of the Cape Town metropole, which includes not only Wallacedene, but also several smaller places, namely, Klein Begin, Kraaifontein East 1 and 2, and Kraaifontein Informal. Today the suburb of Wallacedene has a population of 36,583 people, according to the most recent census data available (Statistics South Africa, 2012).

Figure 5: *Wallacedene aerial view showing relative location of TRA settlement with Table Mountain in the distant background*

During the phased building of houses in Wallacedene, which began in 1991, a Temporary Resettlement Area (TRA) was established, intended for the provisional accommodation of people who had to be moved off the land to make way for infrastructural development. The TRA, although intended as a temporary area, continued to accommodate households that did not receive housing stands, as well as newcomers to the area attracted by the promise of housing opportunities.

Today the Wallacedene TRA spans an area of almost 6.5 hectares (63,566m). It is considered by the Cape Town Disaster Management Centre to be a high-risk settlement, with a history of flooding, poor environmental health and relatively frequent fire outbreaks (RADAR, 2015). Figure 5 illustrates the relative size and location of the TRA settlement within the greater Wallacedene area.

***Figure 6:** A variety of unregulated construction methods and materials are utilised with limited space both in and surrounding the structures*

The installation of the smoke alarms in the TRA coincided with the provision of formal electricity infrastructure in the settlement. This was a critical transitional moment with respect to energy use and changing fire risk in the TRA community. The assumption is often made that electricity is a much safer source of household energy. However, while the South African government works to ensure universal access to formal electricity through their Integrated National Electricity Programme, statistics show that fires caused by faulty electrical wiring in both formal and informal homes are on the rise.

The City of Cape Town's fire incident database reveals that between 2006 and 2016, the number of residential fires caused by faulty electrical wiring and appliances have risen by 132%. In informal homes, the increase in the number of such fires is even more alarming, rising by as much as 335.5% over the same period (City of Cape Town, 2017). Thus, from a research perspective, the case study of Wallacedene TRA also provides an opportunity to investigate the impact of changes in household energy preferences and how they impact on fire risk (Figure 7 illustrates a recent fire in a fully electrified informal settlement).

Figure 7: *Newly electrified settlements like Wallacedene TRA experience frequent fires.*

Figure 8: *Aerial view of Wallacedene TRA in 2017s.*
(Source: Courtesy of Sullivan Photography, 2017)

3

PROJECT PLANNING AND DESIGN

The Wallacedene TRA smoke alarm project was intended as a pilot study to determine whether the roll-out of smoke alarms at scale in informal dwellings was feasible and effective in reducing fire risk. It also aimed to determine technological and other design adaptations required to improve the acceptability and effectiveness of smoke alarms in informal communities.

The project included:

- Baseline research to collect information about household energy choices, perceptions of fire risk, and actions in the event of fires, as well as experience of fires;
- The installation of long-life photoelectric smoke alarms with silence function in every household in Wallacedene TRA (approximately 1 400 devices);
- Monitoring over a six-month period to record the frequency and causes of alarm activations, people's views on the alarms and the alarms' effectiveness in reducing fire-related deaths, injuries and property losses; and
- Details and circumstances regarding fires that occurred during the project period.

A positive spinoff from the project was increased awareness among residents of the community about the causes of fire in their settlement and how they should respond when a life-threatening fire occurs.

The project was developed through a multi-stakeholder consultation process with national and provincial government departments such as the Department of Cooperative Governance (COGTA), South African Local Government Association (SALGA), Forensic Pathology Services (FPS) and Emergency Medical Services (EMS). A Project Advisory Group comprising the Western Cape Government and City of Cape Town, Disaster Management and the Fire and Rescue Services, Human Settlement Planning, Stellenbosch University Fire Engineering Research Unit, RADAR and the community leadership of Wallacedene provided strategic and technical guidance. Santam committed to support the project, covering the costs of the provision and installation of the smoke alarms in all dwellings, and the design and implementation of the baseline research and monitoring programme. Additional material, training, installation tools, with support was provided by the Provincial Disaster Management Centre.

4

FULL-SCALE FIRE TESTING

Before the smoke alarms were rolled out in the Wallacedene area, full-scale fire testing was conducted on the smoke alarms to verify their suitability for use in informal dwellings. The Fire Engineering Research Unit (Fire. SUN) at Stellenbosch University, in conjunction with the BreedeValley Fire Department and the Western Cape Disaster Management and Fire and Rescue Services, carried out a number of full-scale tests at the Breede Valley Fire Training Centre. Three different devices were tested, namely (a) a photoelectric smoke alarm (as rolled out in this project), (b) an ionisation smoke alarm, and (c) a rate-of-rise heat detector. Both smouldering (Figures 9 & 10) and flaming tests (Figure 11) were . conducted.

Figure 9: *Detector board during tests (a) initially, and (b) after smouldering fire test was initiated*

Figure 10: *a) Smoke generator setup for smouldering fire test (a) Initially, and after smouldering test*

Figure 11: *Instrumented shack during the "representative" full scale flaming fire tests*

A smouldering fire has a very low heat release rate, producing primarily smoke from the combustion reaction. This would be typical of when a cigarette falls onto a couch and enough smoke is produced to cause death by asphyxiation, even though no flames are observed. The flaming fire tests included both a timber fuel load test, and a representative fuel load consisting of beds, tables, cardboard and other similar items that would typically be found in an informal dwelling. Additional nuisance alarm tests were conducted to investigate how the alarms would perform when candles were used, people smoked, or other traditional home heating events occurred, to try to ascertain whether the devices would activate and the effectiveness of the silence function if they did.

From the tests, it was identified that the photoelectric smoke alarms performed the most satisfactorily overall, which is consistent with international literature. They activated the fastest in the smouldering fire tests, where the ionisation detectors activated significantly later. The rate-of-rise detectors did not activate at all in the smouldering fire test. In the flaming fire tests, the ionisation alarms activated first, although only a short while before the photoelectric alarms. The rate-of-rise detectors only activated shortly before flashover (i.e., a full room fire) occurred which would not provide sufficient time for occupants to escape unharmed.

Resulting from the full-scale fire testing and identification of the most appropriate detection device, 2 000 photoelectric long-life smoke alarms with silence function were purchased through funding received from Santam.

The preliminary testing discussed above will be followed by an in-depth investigation to develop a smoke alarm specially designed and tested for informal settlement environments. This work will be commencing in the near future.

5

IMPLEMENTATION

Rather than adopting a top-down approach, the underlying objective of the project was to empower members of the target community. Bottom-up approaches have been shown to be more sustainable (Fraser et al, 2006). This is because they generate community buy-in and ownership in all stages of a development intervention, which forms an integral part of the planning, design, implementation and monitoring stages (Mercer et al., 2008; Pelling, 2007).

The project was undertaken in several phases that are described below.

5.1 Phase One: Getting started

The design and development of the project was preceded by several meetings held in the Wallacedene TRA office with the leadership committee to ensure a shared understanding about the aims and intended outcomes of the project. It was critical from the outset to ensure that the community accepted the proposed project and were included in every aspect, with the leadership structure overseeing the coordination and the roll-out of the project activities.

Further meetings were then held with community leaders to plan and design the project, with a deliberate focus on empowering the youth through their involvement in the project. Roles and responsibilities were outlined and agreed upon, and the leaders tasked with feeding information about the project back to the community.

5.2 Phase Two: Community training, household survey and alarm installation

The second phase incorporated the design, planning and implementation of a baseline household survey and the installation programme. It was agreed that a team of young women from the settlement with matric-level education would be trained to undertake the household survey, while another team of young men and women were to be identified to undertake the installation of smoke alarms.

A team of nine young women, together with two community leaders, were trained to undertake the household survey (Figure 12). A structured questionnaire, available in both English and Xhosa, was administered in each household prior to the installation of the smoke alarms. The baseline survey aimed to establish inter alia, household demographics, fire awareness and strategies for fire avoidance and escape, household energy use, and individual fire histories. It also involved collecting the perceptions of residents as to how and why they thought that fire risk would or had changed with the installation of legal electricity connections.

Figure 12: *Members of the household survey team*

Training was undertaken from 2 to 3 February at the Scottsdene Disaster Management Volunteer Base by two RADAR researchers. Santam and Western Cape Disaster Management provided uniforms clearly distinguishing the team members as survey officers. They also provided field equipment, such as clipboards and stationery.

The Provincial Disaster Management's Fire and Rescue Services trained the installation team in the TRA community leadership committee office. The team initially installed alarms under guidance and supervision, later taking full ownership of the process. The site office was also provided with additional smoke alarms in the event any needed to be replaced post-installation.

Figure 13: *Wallacedene TRA installation team together with community leaders*

Alarms were generally installed in the sleeping area of each dwelling. This was because statistically, most fires occur during the sleeping hours when people are in bed. This location of the alarms also reduced nuisance alarms triggered by cooking and heating. However, the installation team experienced some resistance, with many households insisting that alarms be placed closer to the cooking area, where they believed most fires started. This became a key issue during the monitoring exercise, which checked the extent to which people moved their alarms.

Each household was shown how to use the alarm, test it regularly, and activate the silence feature in the event of nuisance or false alarms. The household also received a sticker and a magnet, providing important numbers to call in the case of an emergency. The installation team visited any households reporting problems with their alarms, replacing them if necessary. Problems included approximately 20 faulty alarms, and several false alarms triggered by insects entering the device.

Figure 14: *Installation of smoke alarms by the installation team*

5.3 Phase Three: Monitoring and evaluation

The planning and design of a monitoring programme followed in April and May 2017. Two RADAR staff members working together with a member of the Western Cape Disaster Management's Fire and Rescue Services developed a short monitoring questionnaire intended for use by a monitoring team. They then trained a team of women from the TRA as monitors. Each monitor was allocated several residential blocks within the settlement (Wallacedene TRA consists of blocks A to R. [Figure 34]) and was tasked to conduct a survey over several days at the end of each month. The aim was to visit households to record the details of both nuisance alarms and real fire threats to establish whether the alarms were working and how members of the community received and responded to the alarms, while also identifying the cause of nuisance or false activations.

Although the monthly surveys were initially scheduled to continue for a six-month period, this process was discontinued after three months because the women became fearful for their personal safety when visiting dwellings on their own, and many community members began to resent being interviewed repeatedly and became unhelpful. A new, less formalised monitoring programme followed. This was undertaken by RADAR project staff and a member of the Western Cape Disaster Management's Fire and Rescue Services. During several monitoring visits undertaken between July and December 2017, and accompanied by community leaders, the project team visited households reporting alarm activations, interviewing household members and their neighbours about the circumstances of these activations. They also took the opportunity to speak randomly to other local residents about their experiences with the alarms, seeking to establish the causes and consequences of both nuisance and real fire threat activations

Follow-up site visits were conducted again in January and February 2018.

6

HOUSEHOLD SURVEY – CRITICAL INSIGHTS INTO SETTLEMENT LIFE

This section of the report details the central findings of the household survey. It also summarises the monitoring data, describing the effectiveness of the smoke alarms and highlighting challenges.

Although the aim of the survey was to interview every household in the Wallacedene TRA, the survey teams struggled to interview all the households. Some residents were not home, even after repeated visits at different times and over weekends. Some households also declined to be interviewed or to receive alarms. A total of 852 households were interviewed – approximately two-thirds of all households in the settlement.

6.1 Household demographics

In more than half (52.6%) of the households that responded to the survey, the heads of households were men. Households were generally small, comprising 2.7 members per household, on average. About a quarter of households (26%) consisted of a single person, while a similar number (25%) consisted of two people. More than one-third of households (36%), however, consisted of three to four household members, while a number of homes (14%) were even larger, with one having as many as ten members (Figure 15).

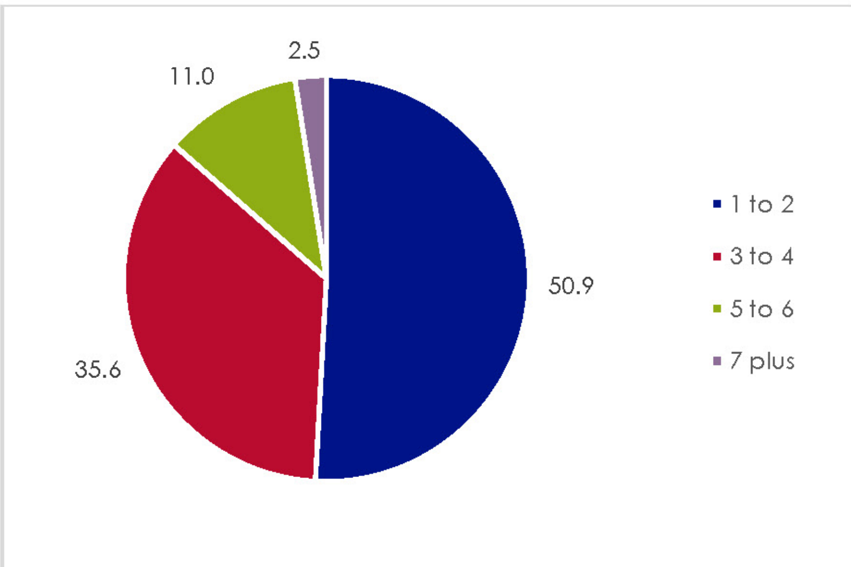

Figure 15: *Household sizes reported in the survey*

Households were also relatively young. As Figure 16 shows, most households were headed by people in their mid- to late-thirties; the average age being 35 years old. A number of households were headed by people over 60, with some even in their seventies.

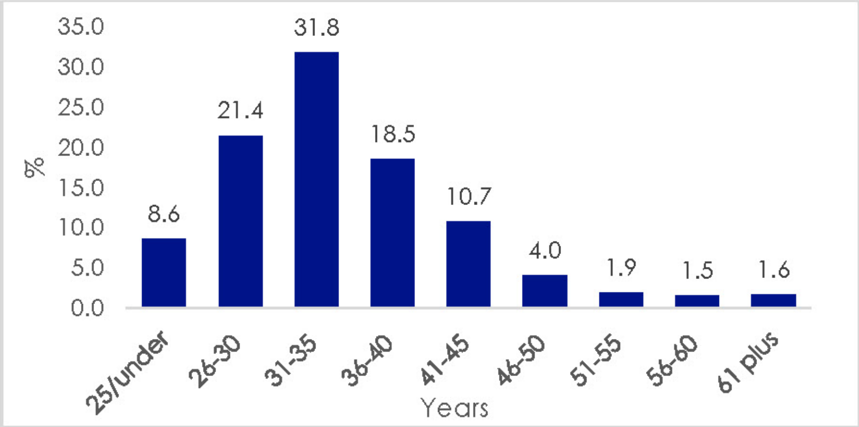

Figure 16: *Age profile of household heads*

The findings show that most households were well established in Wallacedene, but that the settlement was growing. A little over one-third (36%) of households have lived in the settlement between two to five years, and two-fifths (40%) six to 10 years, with 17% claiming residence there for over 10 years (Figure 17).

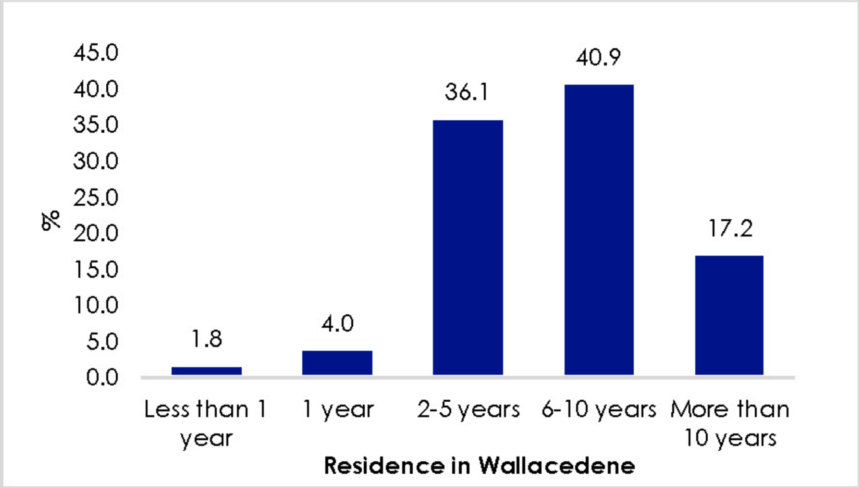

Figure 17: *Duration of residence*

6.2 Electricity and the changing fire-risk landscape in Wallacedene TRA

6.2.1 Fuel use prior to and following electrification

Almost half (47%) of households had used illegal electricity connections prior to the formal electrification programme, while the remainder had relied solely on non-electrical energy sources, primarily fossil fuels for cooking and heating, and candles for light.

With the installation of legal connections, most households now use electricity for cooking (88%) and light (91%), although only 12% reported using electricity to heat their homes. Use of the traditional mbawula (a 25-litre ventilated paint drum filled with live embers that is often carried inside the home [Figure 18]) remained the preferred method of heating (50%), while many households still used paraffin stoves to warm themselves (36%).

Figure 18: *An example of an mbawula which was used in the nuisance testing*

However, it must be mentioned that some homes had not yet been provided with electrical power, as the process of installing electrical distribution boxes was still underway during the survey, while others were newcomers, and were not on the list to receive power. Some others, particularly elderly people reliant on meagre pensions, were too poor to purchase new appliances and were still making use of old paraffin or gas stoves but were grateful to have electric light.

With the advent of electricity in the Wallacedene TRA, the use of electrical appliances had expanded rapidly. The majority of households (67%) reported that they had bought new appliances since the electrification of the TRA settlement (Figure 19).

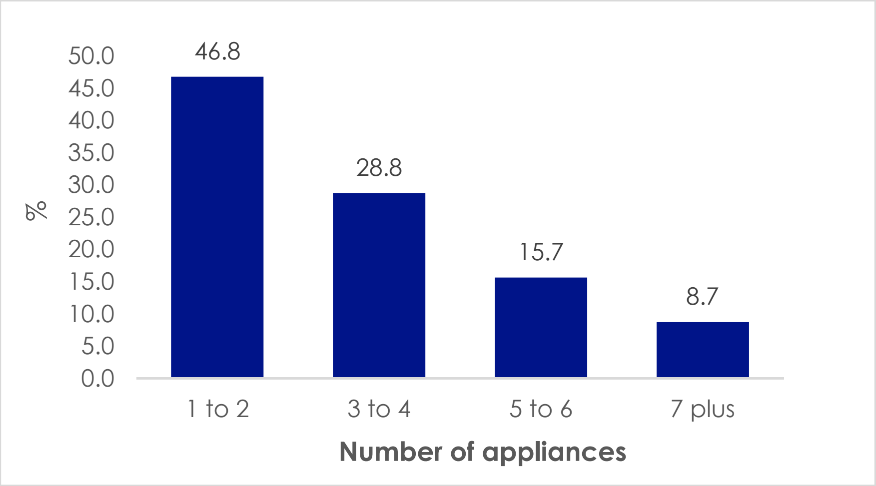

Figure 19: *Number of new appliances purchased since electricity was installed*

Most households had purchased new electrical appliances in the short time since receiving electricity, and one quarter (25%) had purchased four or more items, some as many as nine new items. The most popular items purchased were stoves (20%), kettles (15%), TVs (14%) and fridges (13%). However, less than 1% of households had purchased an electrical heater. Discussions with community members revealed that because heaters consume a lot of electricity, they are not considered cost effective, with households instead opting to conserve their allocation of free electricity units by using mbawulas or other sources of heat. This suggests that fire risk, particularly during the winter months, will remain high.

The abundance of new electrical appliances could conceivably pose a significant fire risk, with many appliances likely to be connected to single plug points simultaneously, which can potentially cause overloading of circuits, a leading cause of fires in informal dwellings as illustrated in Figure 20. This potential hazard is typical of many homes in the Wallacedene TRA today.

Figure 20: *Overloading of electrical circuits in an informal dwelling*

6.2.2 Perceived benefits of electricity provision

The overwhelming majority (88%) of those surveyed agreed that their life had changed for the better since the provision of electricity. Most said that it saved money, as the allocated free units made electricity cheaper than purchasing paraffin and candles (36%), while others reported that it had improved their quality of life (27%). Many also felt safer due to reduced reliance on energy sources like paraffin stoves and candles (12%). Others found that electricity gave them more agency and control over their lives (11%) as they no longer depended on an illegal supply, while some felt it had health benefits (9%), reporting that the fumes from paraffin stoves caused respiratory problems, particularly for their children.

Another of the perceived benefits of formal electricity, according to the survey, is that it allows people to multi-task, doing several chores at once, and leaving more time for leisure.

6.3 Community perceptions regarding fire and fire risk

This section describes the perceptions of households about the changing risk of fire in their homes and in the settlement more generally since the electrification process.

6.3.1 Changing fire risk

The majority of those surveyed (81%) felt safer now that they had electricity. A third of respondents felt that there was a lower risk of fire to their own dwellings and to the settlement more generally, although perceptions were equally spread over medium and high levels of risk. The majority (81%) of people felt safer because most households were using electrical appliances rather than open-flame energy sources, while others felt that the discontinued use of illegal electricity was a contributing factor in reducing levels of fire risk.

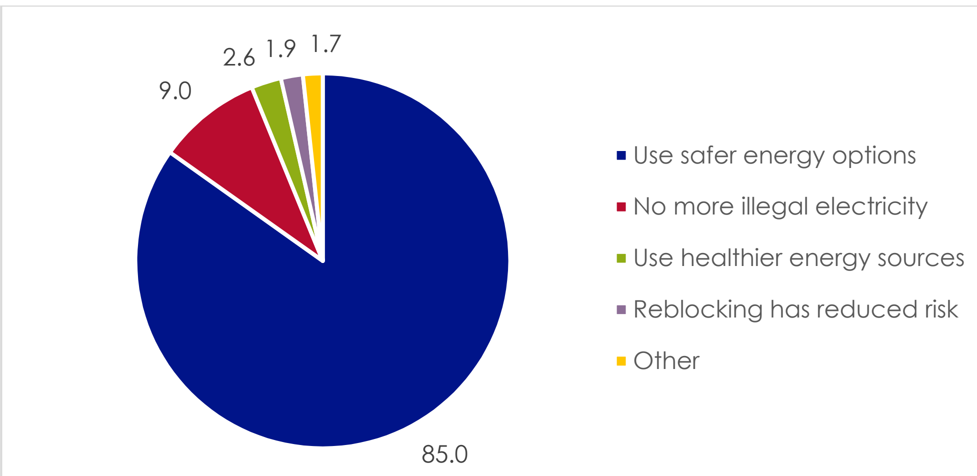

Figure 21: *Reasons for feeling safer in Wallacedene since electricity was installed*

However, among those who did not feel safer, the most frequent reason given was that people reportedly still use paraffin stoves and candles when their free electricity units run out (26%), particularly as the month progresses. Others said that human negligence and irresponsible behaviour would still result in a high fire risk, such as leaving cooking unattended on a stove, or due to substance-abuse related behaviour. The density of the settlement and the inability of residents to fight fire or to escape quickly from dwellings strongly fortified against criminals, were also factors said to be contributing to continued fire danger.

6.3.2 Timing of fires

Fires were perceived to be most frequent over weekends. As Figure 22 shows, 87% reported that fires were most likely to occur on a Friday, Saturday or Sunday, peaking on Saturdays. About one out of every ten (12%) argued that fires are prevalent throughout the week and weekend, while a minority (1%) highlighted weekdays. Although a quarter of respondents felt that fire risk was prevalent every day of the week, the majority believed that weekends presented the highest fire danger, particularly on Saturdays.

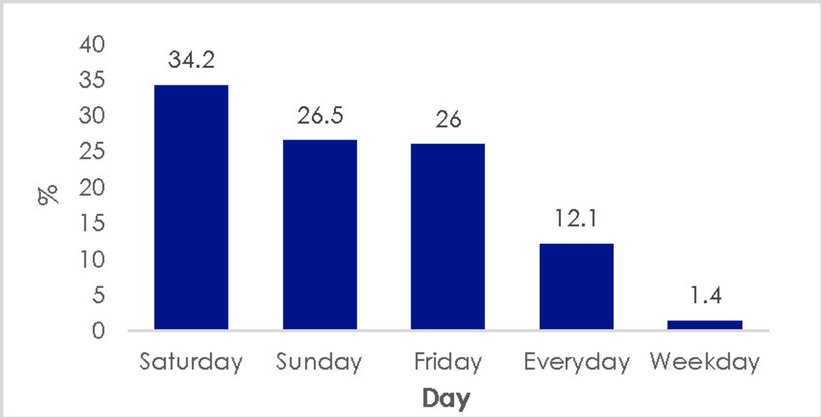

Figure 22: *Days when fires are most likely to occur*

Fires most often started when people were asleep (Figure 23). Three-quarters of respondents (75%) reported that fires occurred most frequently during the sleeping hours. This is in keeping with the fire literature, which shows that most informal settlement fires and fire-related deaths and injuries occur at this time (Van Niekerk et al., 2009). Others felt that early morning was a dangerous period (18%), as people rushed to get to work and to school. (An incident similar to this scenario occurred when neighbours responded after hearing the smoke alarm and finding a pot left on a hot stove). Some also highlighted times when people were using cooking appliances to prepare or heat food. (Several incidents occurred where food was left cooking on the stove whilst occupants were either asleep or away from their dwellings activating the alarms and preventing serious injury).

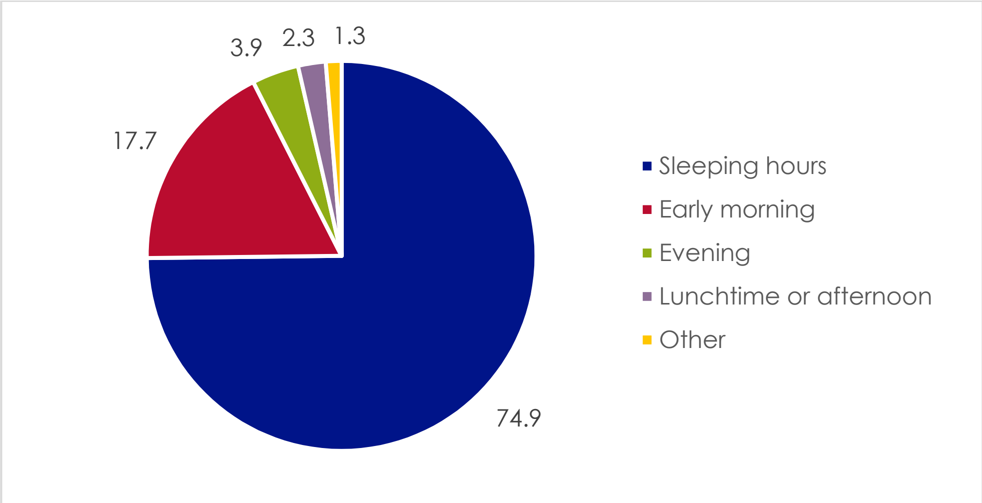

Figure 23: *Time of the day when fires are most likely to start*

The timing of fires was linked primarily to endangering behaviour. As Figure 24 shows, while almost one-tenth (9%) of respondents felt that fires were ubiquitous and could happen at any time, three out of every five (77%) respondents attributed fires to alcohol-related behaviour, especially in the late evening to early morning over weekends. This included people knocking over stoves and candles or falling asleep with a pot on the stove or something burning. Respondents also argued that fires were more common over weekends, and Saturdays in particular, as this was when people did household chores and left stoves unattended while they fetched water or were distracted by chatting to neighbours. Children were sometimes also left alone when their parents went out to socialise, with fires starting when children cooked for themselves or played with matches.

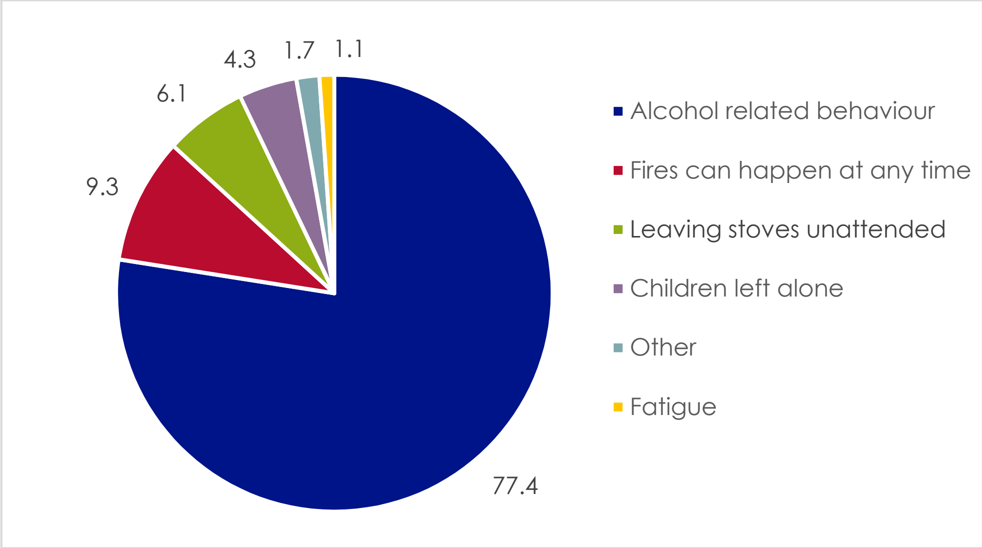

Figure 24: *Perceived reasons for prevalence of fires on weekends*

6.3.3 Perceived causes of fire

In keeping with these findings, people reported that fires were most often started by cooking accidents (29%), followed by children left alone (20%) and candles (20%) (Figure 25). Respondents noted that children left alone by working parents sometimes caused fires when they tried to cook for themselves. A recent fire was started by a young boy using a candle to look for school shoes under a bed. Although the fire was prevented from spreading and no one was physically hurt, the child, aged seven, was left traumatised and frightened, waiting for his parent to return to discover their dwelling completely destroyed.

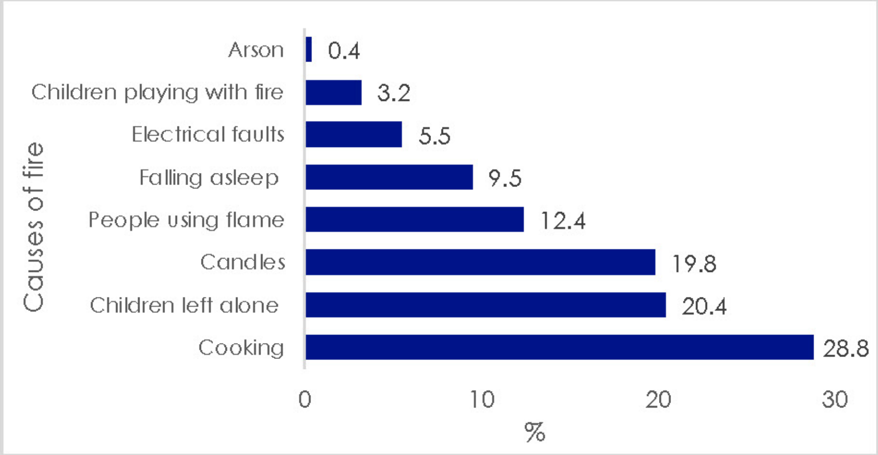

Figure 25: *Most common causes of fire*

Again, discussions with residents suggested that electrification may generate new risks. Prior to electrification, food was generally cooked on paraffin stoves. Now, most settlement residents owned electrical stoves, which were perceived as safer, and therefore might result in people leaving them unattended as they multi-tasked. This may result in fires, with burning food identified as a key source of both fires, and as discussed in the next section, nuisance alarms. Thus, electrification may create a false sense of security that can generate fire risk.

The data suggests that smoking and smoking in bed, in particular, may also ignite fires. Approximately one-third (34%) of households contained a member who smoked. A little under two-thirds (64%) of these reportedly smoked in bed (Figure 26 below). Internationally, research shows that dwelling fires are often started by people smoking in bed, and can be particularly dangerous, as clothing and bedding readily catch fire, trapping and burning occupants (Leistikow et al., 2002). A near fatal incident was averted where neighbours responded to an alarm and saved an elderly man who had fallen asleep whilst smoking.

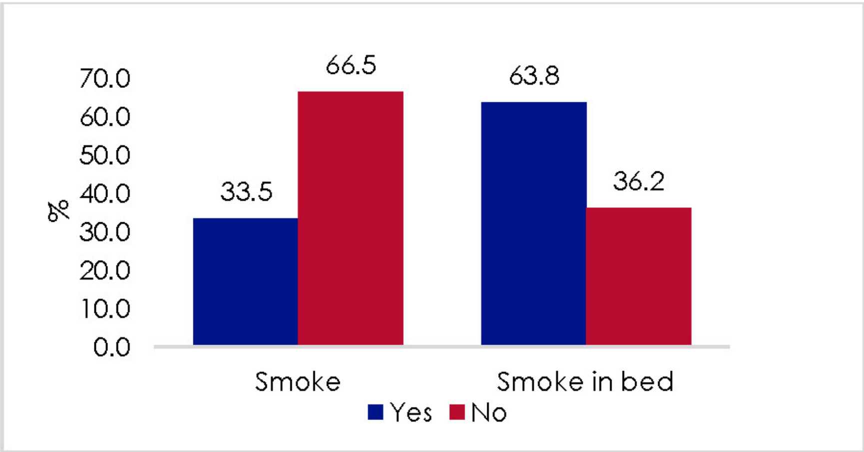

Figure 26: *Perceived reasons for prevalence of fires on weekends*

6.3.4 Perceived area of origin of fires

Virtually all respondents (94%) believed that most fires started in the kitchen or cooking area. This perception proved to be a problem during the installation of the smoke alarms, with many people not wanting the alarms to be placed in the bedroom area. One of the aims of the research was to determine which area in an informal dwelling was the best place to install a smoke alarm. There was a concern that placing alarms in a cooking area may result in nuisance alarms triggered by cooking smoke or steam. The sensitivity of the alarms in such closely confined living spaces is one of the primary focus points of the research and ongoing refinement of the technology for informal living environments.

6.4 Household strategies for fire prevention and evacuation

While most households in the Wallacedene TRA were happy for a smoke alarm to be fitted in their dwelling as an early warning device, most (92%) did not believe that fires could be prevented.

A little over half (55%) of those interviewed believed that it would be difficult or very difficult to escape their dwelling in the event of a fire (Figure 27). The most common reason (47%) was that it is difficult to get out of the door. People reported that it was difficult to quickly find keys to open locks and padlocks, with additional time sometimes required to unlock and open security gates. Fires also often started in the kitchen, which was close to the exit, preventing escape. Some explained that metal security devices (keys, locks, chains and bolts) would become untouchably hot in the event of a fire, preventing householders from opening them. Approximately a quarter (24%) also stated that it would be difficult to reach the exit due to furniture and other obstacles in the way. Almost one quarter (24%) believed that poor visibility, disorientation and dizziness due to smoke also slows escape. Other factors included being too old or intoxicated to respond quickly.

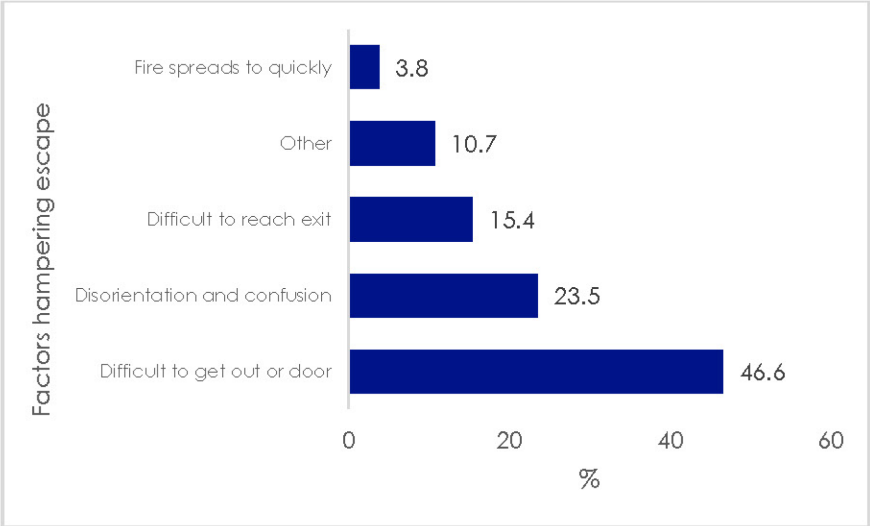

Figure 27: *Factors making escape difficult in the event of a fire*

Less than one out of every ten households (7%) had proactively planned an escape strategy (Figure 28). Amongst those who had, this was generally structural in nature. Almost one-third (30%) had deliberately weakened a corner of their dwelling so that it could be easily forced open in event of a fire. One respondent explained that his plan was to use his bed as a battering ram to break down a wall. A quarter (25%) added a window or additional door to provide an alternative escape route. Many households (14%) had purchased locks that could be opened easily, or they always kept their key in the same place, making it easier to find. A number simply said that they would shout to their neighbours for help in escaping (14%).

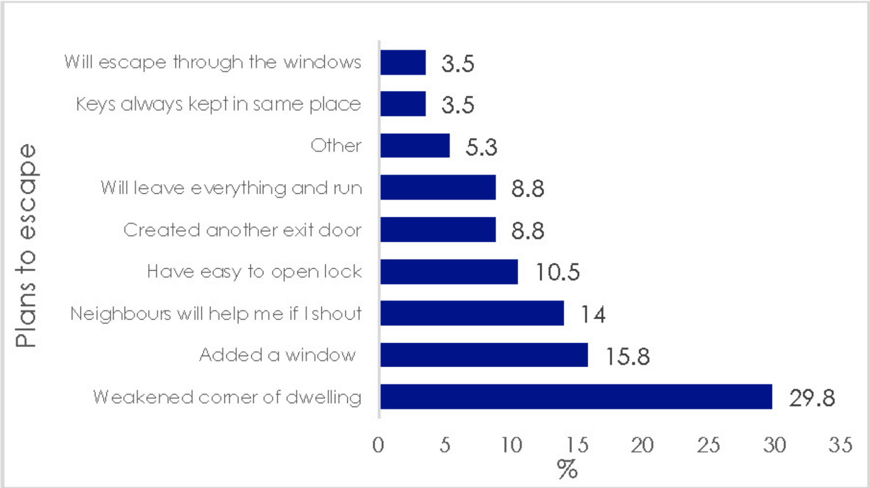

Figure 28: *Household plans of escape*

6.5 Household fire histories

One out of every three households (34%) had experienced a fire during their time in Wallacedene. These households had experienced an average of 2.4 fires. As shown in Figure 29, 30% experienced a single fire, while 34% experienced two. Notably, 8% (21 households) reportedly experienced five or more fires. Of the households experiencing a fire, less than one tenth (13%) reported that it had affected their dwelling. Respondents reported that the majority of fires (67%) started in another dwelling.

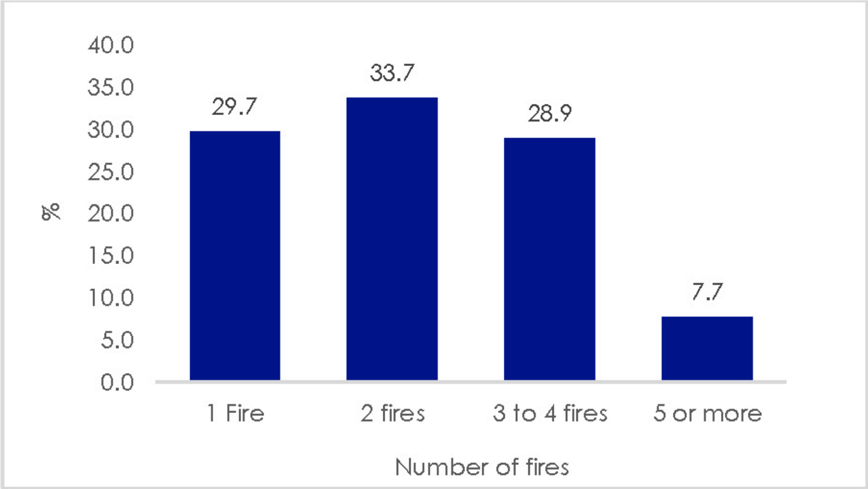

Figure 29: *Number of fires experienced in Wallacedene*

In keeping with prevailing perceptions, most fires occurred during the sleeping hours. As Figure 30 shows, just under half (45%) occurred between 10pm and 5am, with most fires occurring late at night between 10pm and 12pm. An additional one-fifth (19%) occurred between 6pm and 10pm. The remainder occurred during the day, between 6am and 6pm. Slightly more fires occurred in winter (52%) than in summer (48%).

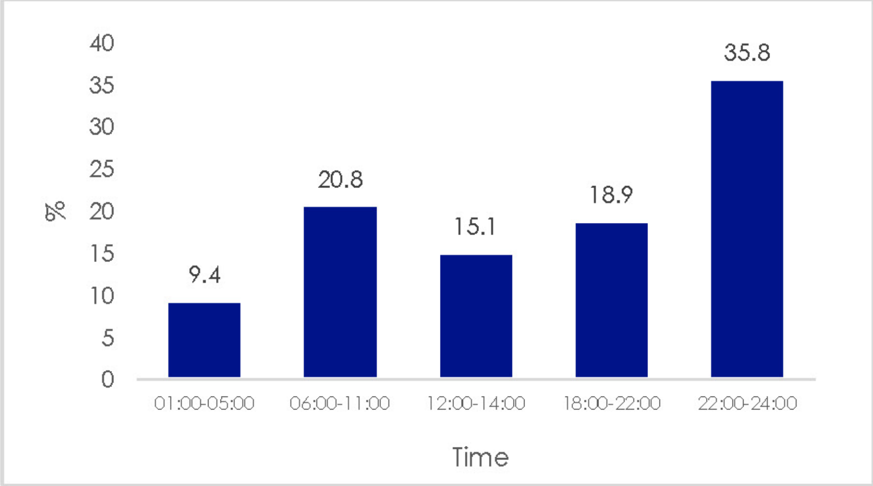

Figure 30: *Time of fire*

The reported sources of ignition were also in line with people's perceptions (Figure 31). Fires were most often started by cooking accidents (39%), followed by people falling asleep with a candle, lamp or stove burning (22%). Approximately 15% were started by children left alone with candles or to cook. In the majority of cases (74%), someone from the respondent's household was at home when the fire occurred. In most cases, the dwelling and contents were damaged (42%) or completely destroyed (42%). For the remainder, the fire was extinguished before it caused any damage to the respondent's home.

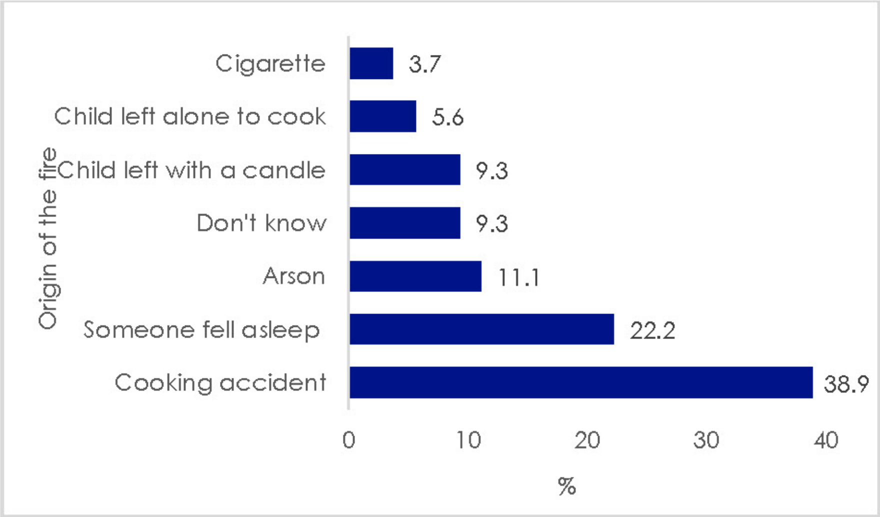

Figure 31: *Ignition source of fires*

In virtually every fire (93%), someone called the fire department. As Figure 32 shows, less than three-quarters (70%) knew a correct number to call in the event of a fire or emergency. One out of four (25%) did not know an emergency number to call. Of those who did, most (37%) would call the police (10111), followed by the universal number used by cell phone companies (112) (17%). One-fifth (22%) would use the emergency number provided by cell phone companies (112). The remainder would call the City of Cape Town's emergency call centre number (107) or the ambulance service (10177). Incorrect numbers (4.1%) generally comprised permutations of the correct numbers.

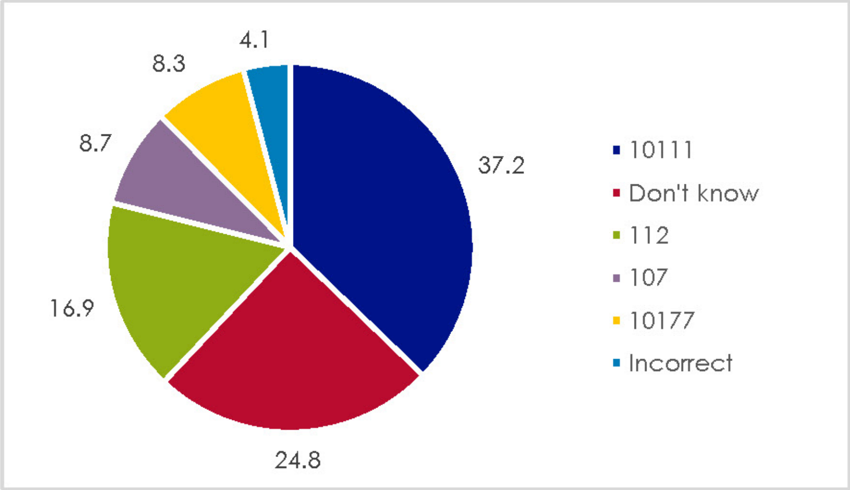

Figure 32: *Numbers to call in the event of an emergency or fire (n=771)*

The findings highlight the trauma associated with fires. As Figure 33 shows, the majority (77%) of respondents reported that the fires had affected them financially.

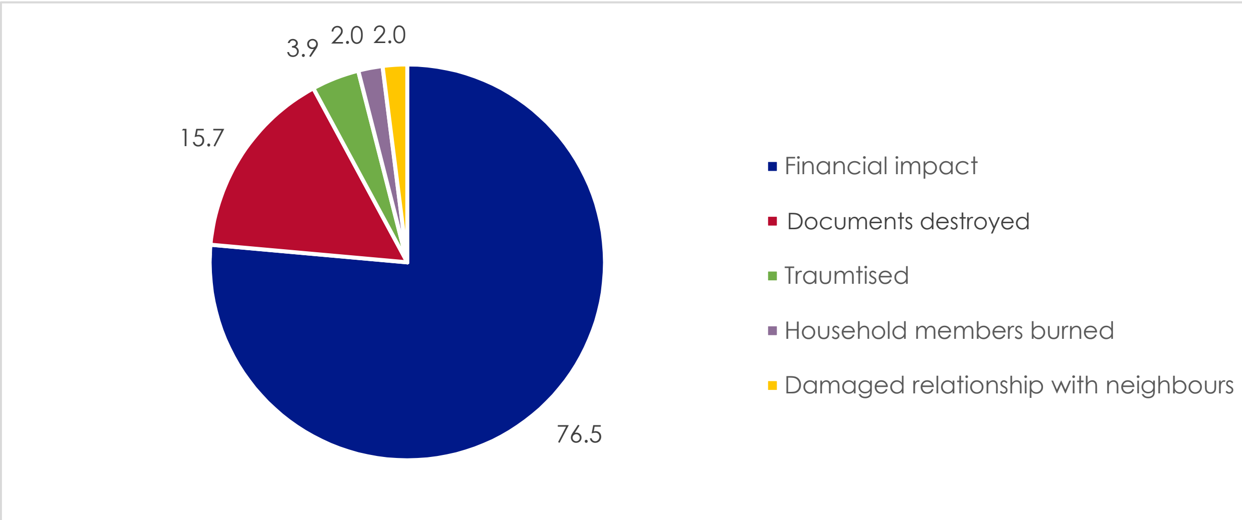

Figure 33: *How fires impacted on affected households*

Many needed to replace damaged belongings and repair and rebuild their dwellings. Fires also damaged and destroyed important documents (16%), such as identity documents, as well as school books and materials. Only a few reported that someone in their household was hurt or felt traumatised by the incident.

However, responses provided by unaffected households suggest high levels of ambient trauma. Many respondents incorrectly answered this section of the questionnaire, even though no fires had affected their own dwelling. (These cases were removed in the above analysis). These answers describe the emotional impact of witnessing others being injured, experiencing the destruction of their homes and the loss of their assets and belongings. The findings suggest that fire risk looms large even in the minds of those who have not experienced fires in their own dwellings, but through the lived experiences of others around them and the pervasive fear that it may yet happen to them.

7

MONITORING - COMMUNITY RECEPTIVITY TO SMOKE ALARMS

The section below summarises the key themes and issues emerging from the monitoring conducted between May and October 2017, and follow-up site visits conducted in early December 2017 and January 2018. It then reflects on the findings from the monitoring visit undertaken by project staff, which delivered more nuanced information.

7.1 Central findings from the monitoring research

7.1.1. The efficacy of the alarms in reducing fire incidents

Initial indications are that the alarms have reduced the number and lethality of fires in Wallacedene – although the installation of electricity may also be a core factor, as it has reduced reliance on dangerous energy sources such as paraffin stoves and candles.

While several dwelling fires were reported to have occurred just prior to the installation of smoke alarms, only three were reported during field monitoring conducted between May and December 2017. In the first incident, an intoxicated man fell asleep leaving food cooking on the stove. Another occurred after the occupant went to work leaving something cooking on her stove. The alarm alerted neighbours who responded, preventing the smouldering from progressing to a flaming fire. In another incident, the sounding of an alarm drew the attention of neighbours who extinguished the fire and saved a man's life. The inebriated young man had fallen asleep smoking a cigarette, igniting the bedding. He suffered minor burns to his legs. There were also several reports of cooking-related incidents, where the alarms activated timeously, successfully warning people, who quickly responded.

Two fires had been reported subsequently in 2018. A fire broke out in Wallacedene around midnight on 2 January. The dwelling in which the fire started was located in Section K and was unoccupied at the time. A neighbour, who had gone to sleep after the festivities, was woken by the alarm but chose to ignore it possibly due to frequent nuisance alarms in the area. A little while later, however, she sensed intense heat inside her dwelling and went outside to find her neighbour's dwelling alight. An alarm had meanwhile activated in the dwelling of another neighbour, who went outside to investigate and alerted everyone to the fire. Her quick response allowed community members to extinguish the fire using buckets of sand and water. Four dwellings were destroyed in the fire, while another was partially damaged. A community leader described the evening as a very noisy one due to the Tweede Nuwe Jaar (2 January) celebrations. Several people mentioned children playing with fire crackers in the vicinity, which could possibly have caused the fire.

Despite destroying four dwellings, this fire incident illustrated the effectiveness of the alarms as an early warning system, alerting community members to the early onset of a fire. Rapid response from members of the community facilitated the containment of the fire before it spread to other dwellings. However, it has also been noted, and to some extent was anticipated, that households experiencing repeated nuisance alarms due to insect infestation or some other activation, have become somewhat de-sensitised to alarm activations. However, during our visit members of the affected households said they would welcome the installation of smoke alarms in their new dwellings, realising the benefit of early warning to a fire threat, which saved the lives of those in the adjacent dwellings destroyed by the fire.

The location of all these fires, both prior and subsequent to the installation of smoke alarms, are indicated on the map in Figure 34. The installation of the alarms may also have changed behaviour. It was evident that the installation of the alarms, the survey and follow-up monitoring have raised levels of fire risk awareness, both at household and community (settlement) level.

7.1.2. Changes over time

During the initial three-month period immediately following the installation of the alarms, views on the alarms were primarily positive. Many residents reported feeling safer, especially after the alarms successfully averted life and property losses in three real-fire events. In each incident, the alarms alerted neighbours who responded, twice saving the lives of sleeping occupants, and in the other, extinguishing the fire before it could engulf the dwelling. These successes increased trust in the alarms. In one case, women who had taken down their alarms, seeing no value in it, approached the community leader to have them re-installed. At this stage, only a few households reported nuisance or false alarms, and most remained in place.

By the last round of monitoring in December 2017, the results were less positive. Several households had removed their smoke alarm after experiencing frequent nuisance alarms. The number of false alarms appeared to have increased over time, suggesting that they may have become affected due to an accumulation of dirt or that they may have become infested by insects – a problem that was anticipated.

On the evening of Sunday 18 February 2018 at around 11pm, a fire was deliberately started outside a dwelling using a flammable liquid, most likely petrol. The intense fire destroyed 13 dwellings before it could be contained. Unfortunately, due to the suspicious nature of this incident, it was impossible to verify the exact circumstances and whether there was a smoke alarm installed in the dwelling at the time.

In addition, in some cases, smoke alarms were either removed or fell off during renovations or structural changes to dwellings and never re-installed. It would thus be important for the local leadership to be provided with additional devices in order to re-install when required.

7.1.3 Causes of nuisance alarms

Aside from faulty alarms, nuisance activations were commonly triggered by the smoke and steam generated during cooking, particularly oily foods such as meat and when food burned; people smoking, and smoking in bed, especially where the alarm was immediately above the bed; and steam when people bathed. Other causes included:

- Burning of traditional herbs, a common custom performed several times a month in some households for communicating with the ancestors.
- Hair dryers singeing artificial hair when braiding hair or using weaves during styling, causing acrid smoke. (The household survey revealed that many households had purchased hairdryers since the advent of formal electricity installation).
- Smoke from burning wood in an *mbawula* placed inside or near to dwellings' doors.

The survey data suggests that nuisance alarms were most frequent in smaller dwellings, and/or where there was no partition between the cooking area and bedroom, where the alarms were installed. Alarms installed towards the top of sloping roofs may also be more prone to nuisance alarms.

7.1.4 Response to alarm activations

Most respondents to the monitoring surveys reported that they usually investigated when they heard an alarm that was not immediately silenced, sometimes opening neighbours' dwellings to determine what had triggered the alarm. However, it was also found that people had become less responsive because of the increase in false activations, ignoring the alarms when they went off, which would reduce their effectiveness in preventing fires. In some instances, repeated false alarms had soured the relationship with neighbours, particularly where people were away overnight or longer and there was no one available to silence them. Where people were present, most simply pressed the silence button to silence the alarm, with almost all devices silencing properly.

Despite these issues, people continued to see the value of the alarms. In the case of malfunctioning alarms, most supported the installation of a replacement device. In the case of nuisance alarms, respondents supported the idea of better alarms that were more adapted for settlement living conditions, and less prone to activate unnecessarily.

8. Recommended adaptations for informal dwelling contexts

Post-installation monitoring identified the need for modification to smoke alarms and/or installation protocols that are better suited to the environment in informal settlements. Interventions to explore include:

- **Changing the location.** Relocation of the affected alarms to a more suitable location within the dwelling that would create further distance or provide a barrier between the nuisance sources and the alarm.
- **Changing from horizontal to vertical placement.** Smoke and steam naturally accumulate along ceilings; installing the alarms on a wall instead of roof beams may help to reduce nuisance alarms – although most households use cardboard and other cladding to insulate their dwellings, the alarm can be installed along the side wall support beam.
- **Revisiting the silence function.** It may be useful to adjust the timing of the silence feature so that the alarm remains silent for longer periods. This could allow people to silence their alarms proactively, when for example, bathing or smoking.
- **Insect-proofing.** It may also be necessary to modify the alarms or include methods to prevent insect infestation using materials that make it difficult for insects to walk on the device (e.g. anti-adhesive surfaces), creating barriers such as covering openings for smoke entry with a mesh enclosure, or applying pesticides to the device prior to installation, and then periodically thereafter.
- **Discolouration.** Originally designed to be installed on white ceilings, the white plastic cover of the alarm becomes discoloured quickly through insect frass. Although only for aesthetic value, alternative colours or materials can be utilised.
- **Educating household occupants.** Informal settlement dwellers have no previous knowledge of smoke alarm use or maintenance. The provision of educational campaigns and training to keep the device clean could help reduce some of the nuisance alarms. Regular removal from the mounting bracket to clean the device with correct remounting and testing is important, especially with long-life smoke alarms. Education on how to install the devices is also suggested, so that if people extend or renovate their houses they can re-install their devices.

Such adaptations should be piloted in Wallacedene or other settlements to determine their effectiveness, and these refinements should be introduced as the smoke alarm programme is scaled-up and rolled out in the City of Cape Town and the Western Cape. Light-touch monitoring should continue in Wallacedene. Residents should be encouraged to report nuisance alarms to the TRA committee's office, where a record can be kept of the problems encountered and the effectiveness of replacement devices. Residents should be encouraged to clean and maintain the smoke alarms which could reduce activations from insects. Alarms affected by insects should be inspected by an entomologist and / or an engineer to advise on any design modifications that may be necessary.

In continuing to build the resilience of the Wallacedene TRA community to fire risk, it is proposed that young unemployed community members should be trained in basic first aid and fire-fighting. This cadre could undertake fire awareness activities and assist in monitoring alarms and installing replacements. In this regard, the Emergency First Aid Response (EFAR) programme has been developed by the Western Cape Emergency Medical Services of the Department of Health and offers the kind of training envisaged (Sun & Wallis, 2012), which will provide valuable skills to young people and may provide a stepping stone in further empowerment initiatives, while increasing their employment potential. This is consistent with the stated commitment by the Provincial Minister of Local Government, Environmental Affairs and Development Planning to supporting and funding this next stage in the community resilience-building initiative.

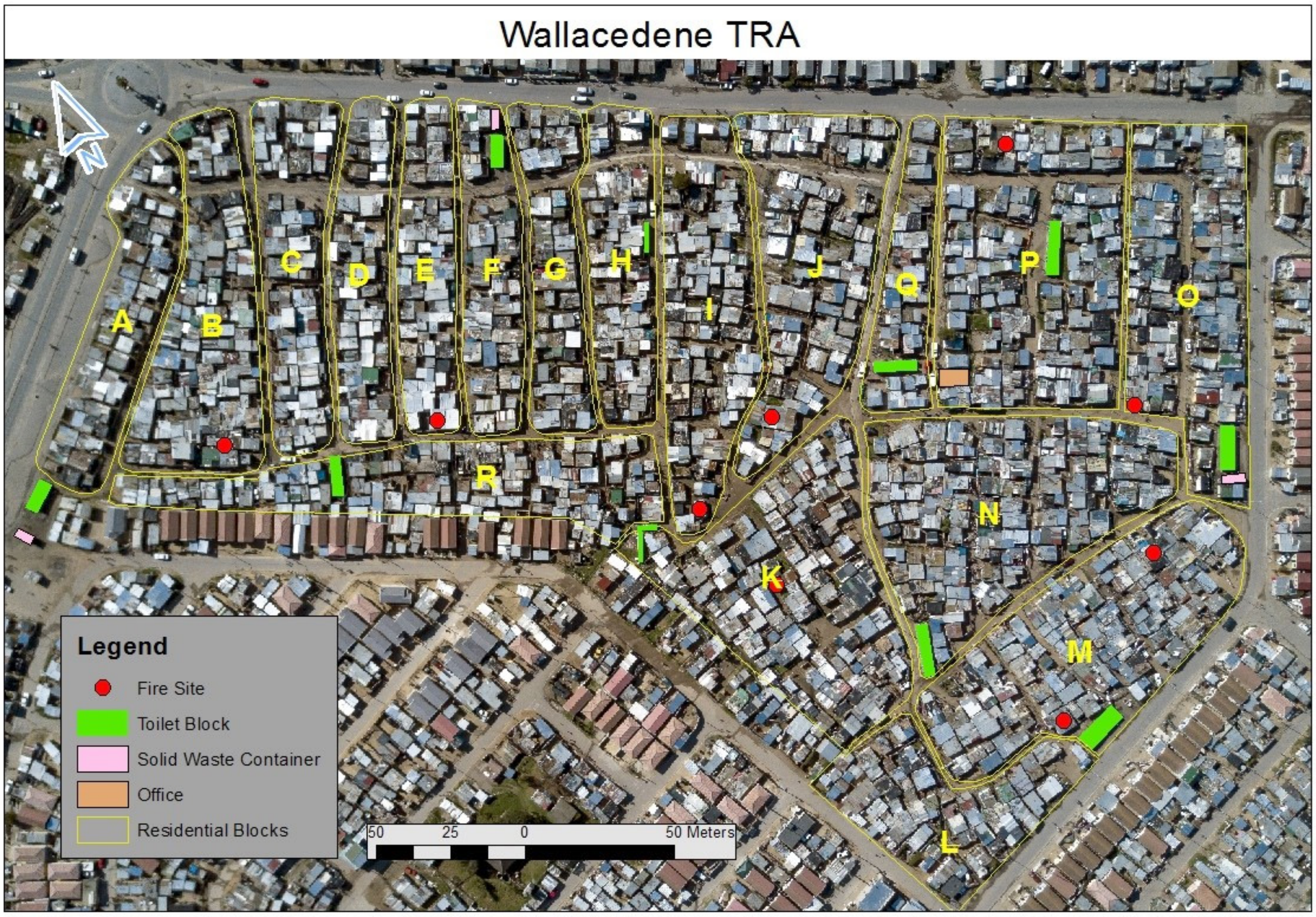

Figure 34: *Aerial perspective showing location of dwellings in which fires have been successfully averted*

9. Concluding remarks and recommendations

This risk reducing intervention was conducted across an informal settlement of over 1 400 households, over a period of one year. It was ambitious in adopting a genuinely participatory approach, run as a collaborative venture with members of the settlement community, with a particular focus on involving unemployed youths. Community members collaborated in every stage of the project, from planning, design, through implementation, and incorporating a follow-up monitoring programme.

While the training of community teams in the installation of smoke alarms and the undertaking of a household survey were relatively easily undertaken, the inclusion of community members in the monitoring programme under the supervision of local leaders was less successful, with members of the monitoring team encountering some resistance from residents to answering monthly monitoring questionnaires. In response to this problem, the project team continued the monitoring themselves, adopting a less structured, informal conversational approach, assisted by community leaders.

Early monitoring clearly indicated that the smoke alarms were successful in reducing fire risk by providing early warnings of potential fire outbreaks. However, several months later, monitoring revealed that nuisance alarms were frequently occurring in certain dwellings, often for no apparent reason. Frequent nuisance alarms began to irritate people living nearby, activating when no-one was at home, often during the night when people were sleeping. This resulted in tense relationships developing between neighbours, and specific households removing their alarms. However, even with frequent nuisance alarms occurring in certain dwellings, most households were satisfied with the fire protection it offered them.

The findings of the monitoring programme suggest that further refinements to the installation process and design of the smoke alarms are required, modified specifically for informal settlement environments. This includes better initial placement of the devices, monitoring for nuisance alarms after installation, and relocating affected devices to more suitable locations. The sensitivity of the devices could possibly be reduced, and the duration of the silence function increased. The issue of insect infestation requires modification to the design of the device, making it impenetrable to insects. Using a pesticide before and after installation might offer another possible solution. Public education campaigns on smoke alarm placement and testing, and particularly the importance of cleaning long-life smoke alarms, is recommended.

The project has demonstrated that the installation of smoke alarms in informal dwellings can and does work to improve protection from fire, and can, with some external support, be managed by settlement residents themselves, by incorporating household-level awareness about the devices. It is also recognised that ideally, such a programme needs to be coordinated by the local leadership structure. Few settlements, however, are fortunate to have a strong leadership structure of the kind that has developed in the TRA, which assisted in the design of the project and took responsibility for the involvement of the community. Their oversight ensured that the community bought into the intervention, strengthening their willingness to cooperate.

6

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Appendices

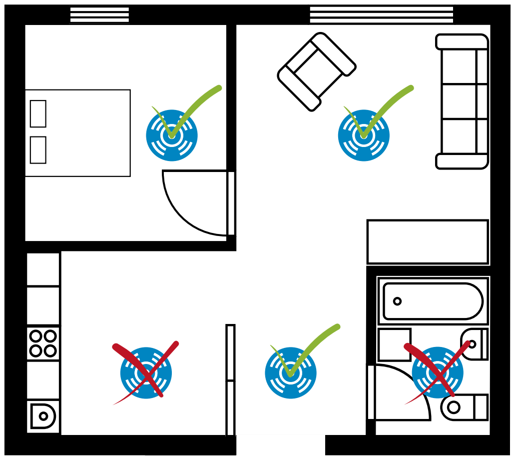
Instructions for installation team

The checklist and illustrations below were provided by the Western Cape Fire and Rescue Services to members of the installation team. They clearly explain and illustrate the process to be followed.

INSTALLATION CHECKLIST

- ☐ Contact the resident and let them know when you will be arriving.
- ☐ Introduce yourself and explain why you are there.
- ☐ Show the smoke alarm to the resident. Let them look at it and hold it.
- ☐ Identify the sleeping area to install smoke alarm (NOT in kitchen).
- ☐ Write the date of the installation on the back of the smoke alarm.
- ☐ Install the base plate using two screws.
- ☐ Connect the smoke alarm and turn until you hear a beep.
- ☐ Test the smoke alarm by pressing on the large button (long press).
- ☐ Tell the resident that this is how they must test it every month.
- ☐ Explain that when the alarm goes - everyone must get out quickly.
- ☐ When they are out, they must call the fire department on 112.
- ☐ Give the resident the fire department information (sticker and magnet).
- ☐ Tell the children that they must tell this to the rest of the family, including the children.
- ☐ Tell the resident that if the alarm makes a noise and they want it to stop - they must push the button once (short press).

Install in bedroom (Not Kitchen)



Screw in base plate

Connect smoke alarm

Push button test

Media report

The success of the smoke alarm intervention in the Wallacedene TRA was reported in the Cape Argus newspaper The report is available online:
https://www.iol.co.za/capeargus/early-warning-systems-save-lives-10474577

Smoke detectors save life

Wallacedene residents give thanks

Cape Argus 26 Jul 2017 +1 more Bronwyn Davids

LIFESAVER: A photoelectric smoke alarm with long-life lithium battery.

THE smoke detectors installed in Wallacedene TRA informal settlement are doing their job and have saved one life already. Community leader Thembelane Mzola, who was trained by Western Cape Government Disaster Risk Management Fire and Rescue and University of Stellenbosch University Engineering Department specialists to install and maintain the photoelectric smoke detectors, said the number of fires had been reduced this winter.

Mzola said there had been 20 fires in the settlement last winter and one young boy was badly burnt when plastic melted on to his skin.

There was only one fire this winter. Neighbours heard the alarm and were able to break down their friend's door and drag him from his burning bed. They were then able to put out the fire.

"Some people complained at first but people don't know until they see what is happening: that the detectors save people's lives and keeps their houses from being burnt," said Mzola.

He said the community members who were trained to install and maintain the detectors and are paid a small stipend by the Western Cape government, inspect the detectors regularly with the university specialists, who are engaged in ongoing research.

Rodney Eksteen, assistant director at the Provincial Disaster Management Centre, said: "We believe that photoelectric smoke detection technology engineered into a self-contained device with a silence feature and long-life battery with a 10-year lifespan will alert occupants of a fire and provide the necessary time to escape, three minutes max.

"About 70% of all fire deaths in the Western Cape occur during sleeping hours."

Eksteen said the devices were installed in bedrooms, away from cooking areas which would activate the alarm.

Already 5 000 smoke detectors had been installed in informal settlements and other vulnerable facilities in the Western Cape, he said.

Over 1 200 devices had been installed at Wallacedene and with the assistance of the private sector and the university, they would be rolled out to other vulnerable communities, in spite of budgetary constraints.

Local Government, Environmental Affairs and Development Planning MEC Anton Bredell said: "For too long too little has been done to proactively tackle the scourge of fires in our informal com munities and many lives and lots o property has been destroyed. The goal o this project is to install smoke alarms i our vulnerable communities that wil wake people up before it's too late."

To comment on this story email arglet@inl.co.za or send a SMS to 32 027 (SMS costs R1) Provide your physical address and phone number (not for publication).

Cape Argus
26 Jul 2017 (3)

Official recognition

Acknowledging the collaboration of the Wallacedene community, a site visit was conducted to the Wallacedene TRA community office by local government dignitaries and sponsors in May 2017. During the visit certificates of appreciation were handed over to team members by Minister Anton Bredell and John Lomberg, head of Santam stakeholder relations and Corporate Social Investment, pictured here with Thembelani Mzola the TRA community leader.

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Western Cape Government

DISASTER MANAGEMENT

FIRE RESCUE