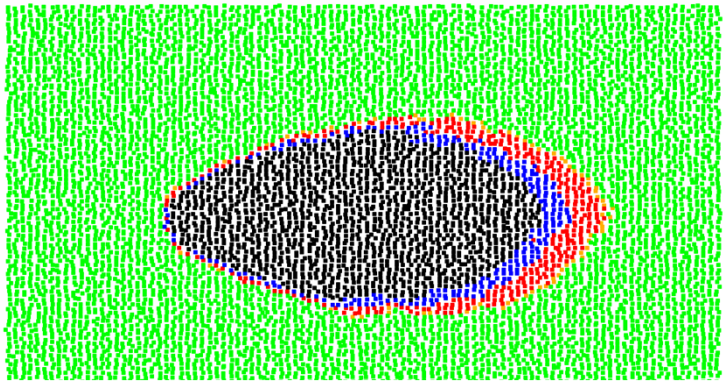

How to (not) burn down a shack – fire safety engineering for the billion

Presented by: Dr Richard Walls – Fire Engineering Research Unit
Department of Civil Engineering, Stellenbosch University, South Africa

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Stellenbosch University– Fire Expertise

Accounting building – February 2015

Admin building – December 2010

Men's residence – August 2007

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SA Students – Fire Expertise

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The FireSUN Team

- First university fire engineering research team in Africa.
- 1 staff, 1 postdoc, 5 PhDs, 7 MEng, 5 BEng students = 19 team members
- Involved with building fire safety, construction products, 3D printed concrete in fire, petrochemical storage, suppression systems, informal settlements, and generally anything that can burn.

- **Postgrad MEng in fire safety engineering being developed.**

How big is the informal settlement and fire problem?

Informal Settlements

- 1 billion people living in informal settlements worldwide.
- There are 300,000 fire-related deaths in low and middle-income countries.
- By 2050 it is estimated that in Africa alone there will be 1.2 billion informal settlement dwellers.
- Informal settlements will double to triple in size in South Africa in the coming decades.

- **If we can't get rid of settlements, how do we improve them through optimal resource usage?**

What happens in a fire…

1. A typical South Africa informal settlement before a fire.

2. The same area after a fire

3. Two days after the fire. Relief construction materials were handed out to people who had lost their homes.

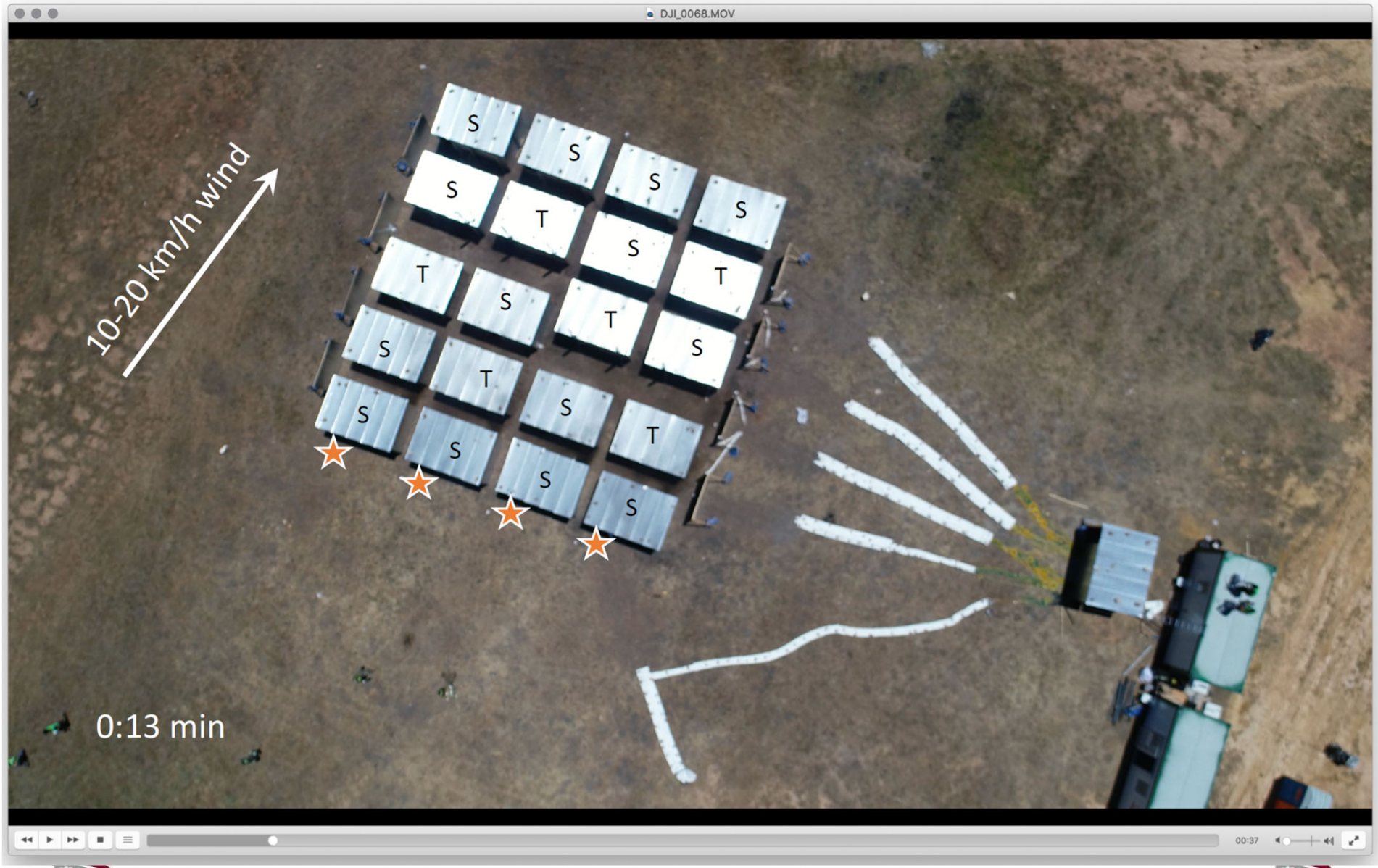
How fast does an informal settlement fire move?

Photos used permission of Ryan Heydenrych (Vulcan Wildfire Services)


RES & RADIATORS


S S S S
S T S S
T S T S
S T S T
S T S T
S S S


A4
A3
A2
A1


DJI_0068.MOV
10-20 km/h wind
S
T
0:13 min
00:37

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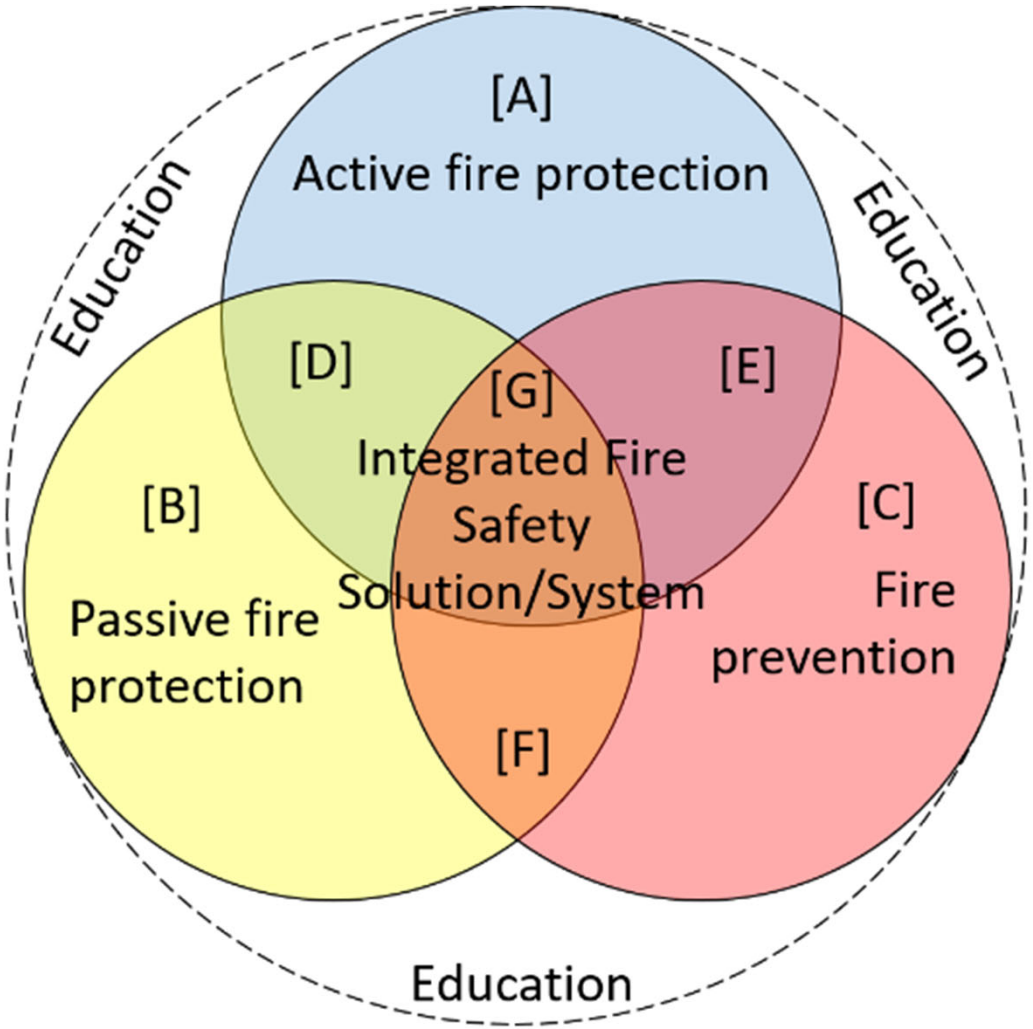
DJI_0069.MOV
5:11 min
00:08


DJI_0071.MOV
16:20 min
00:23

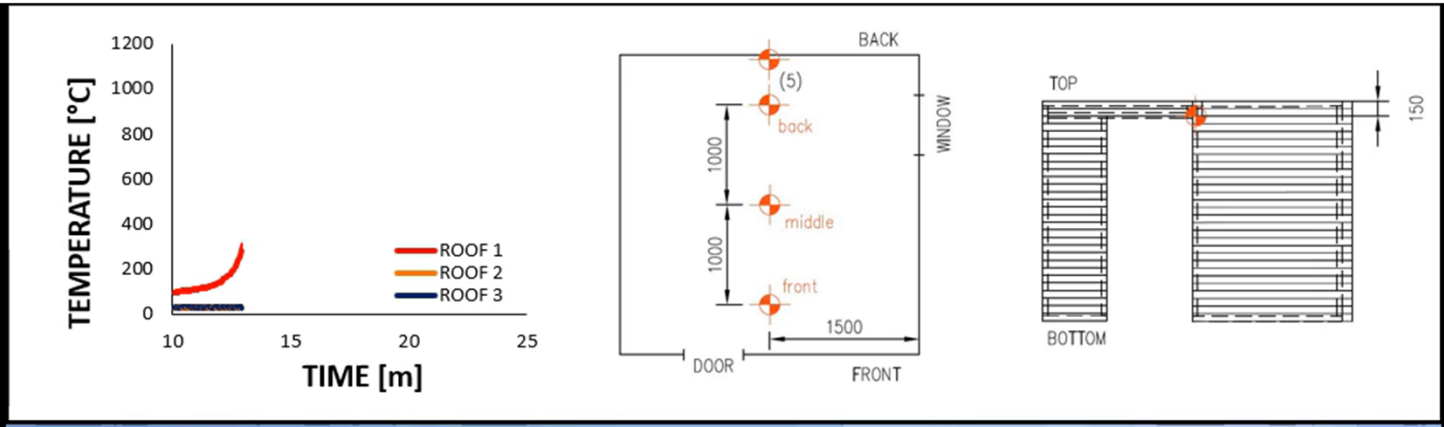

38
The Mythbusters were right. I should not have tried that at home.
ICANHASCHEEZBURGER.COM

So what can we do about it?

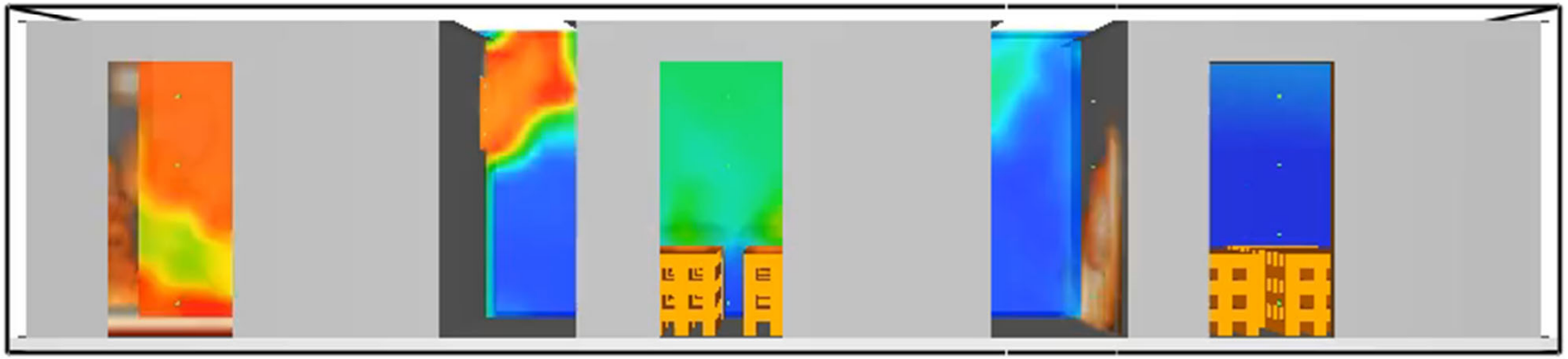
Fire Safety Framework

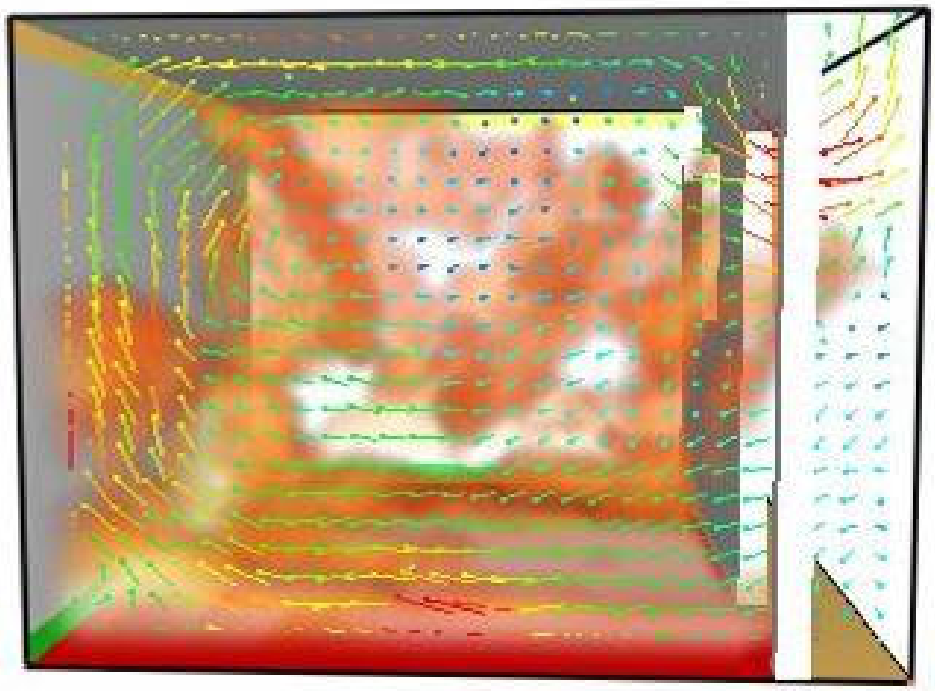


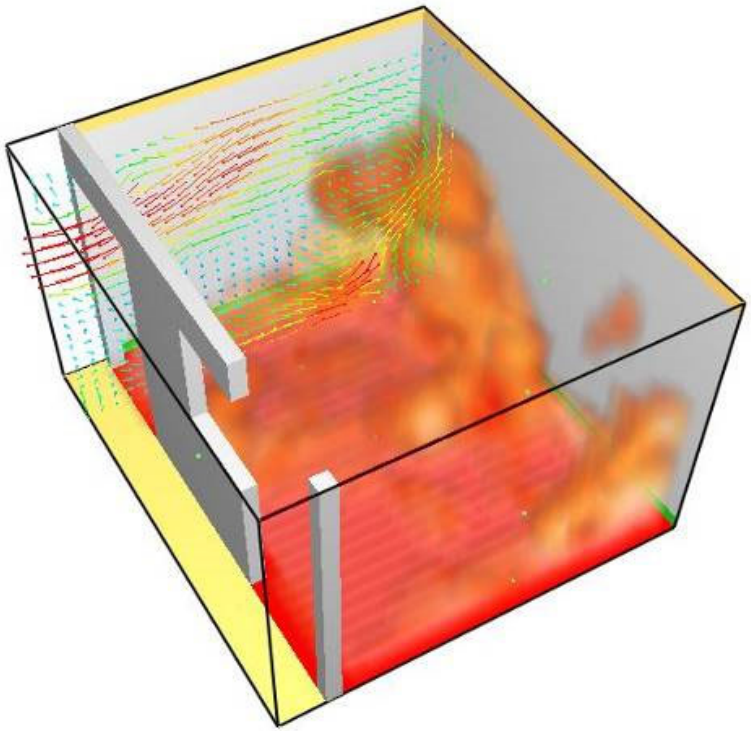
Understand single dwellings


TEMPERATURE [°C]
1200
1000
800
600
400
200
0
10
15
20
25
TIME [m]
ROOF 1
ROOF 2
ROOF 3
BACK
(5)
back
middle
front
1000
1000
1500
WINDOW
DOOR
FRONT
TOP
150
BOTTOM


DALT







Results

- Piloted ignition – i.e. flames finding holes in dwellings – can negate the application of many products.
- A “fire-proofing” paint, or other products, will have little influence if there are gaps between roofs and walls, or if there are windows that are open.
- Fully-developed fires occur so quickly rate-of-rise detectors will in most cases not provide sufficient early warning.

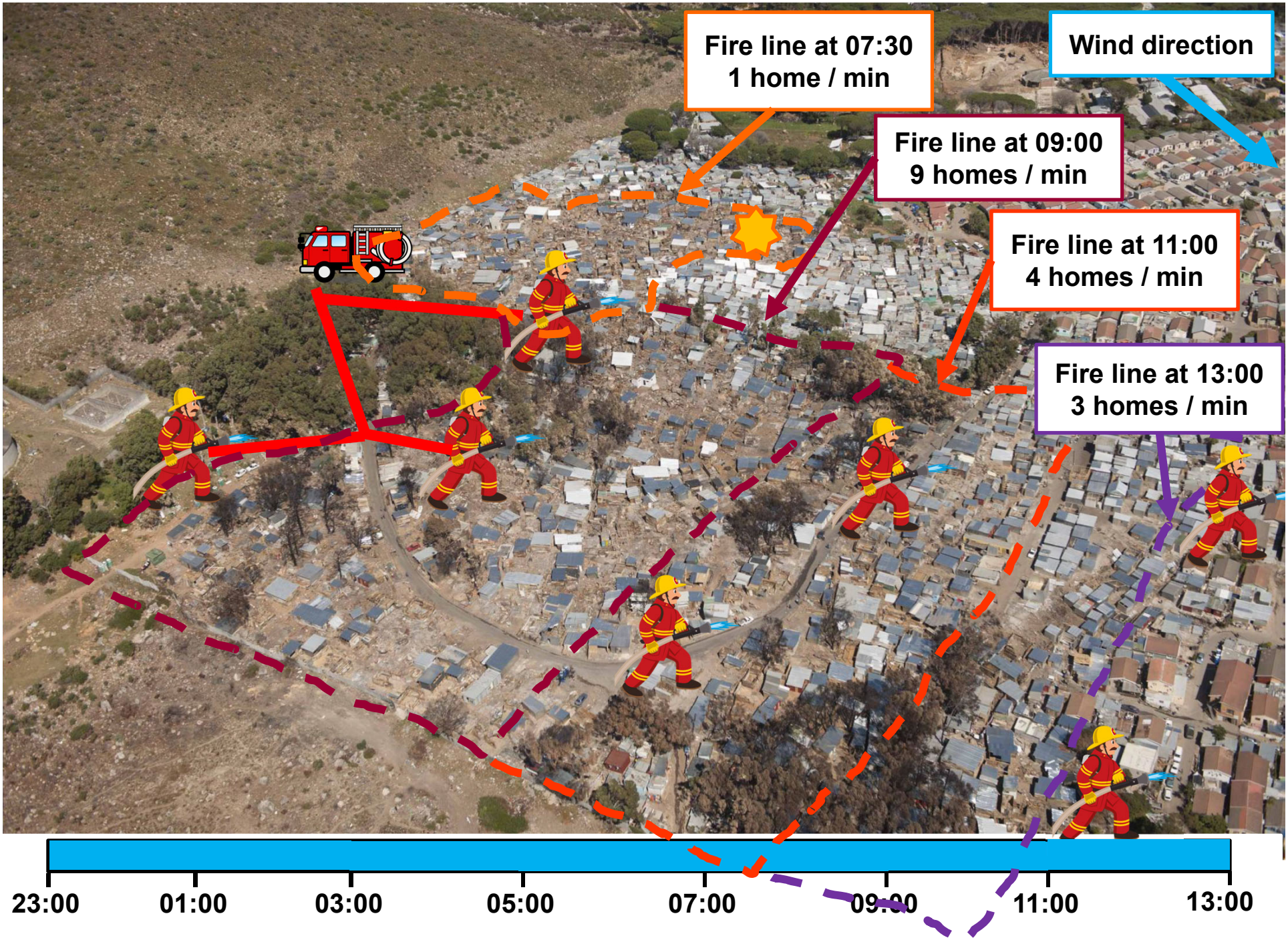
Understand many dwellings

Imizamo Yethu – 11 March 2017 Fire Disaster

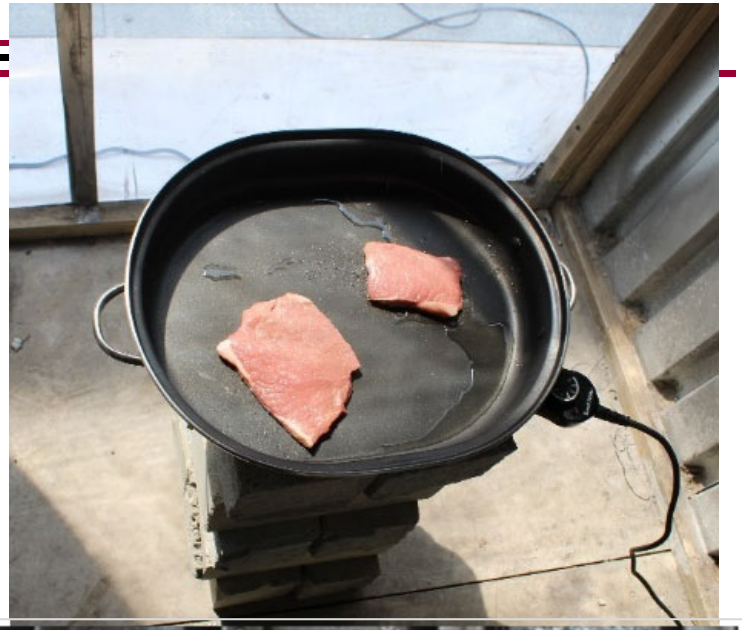
- Summary of the incident:
  - 2197 structures destroyed (incl. 2nd fire)
  - Four fatalities
  - 9700 people left homeless / displaced
  - Extensive damage to the local infrastructure (electrical, water, sanitation and road).
  - Cost of damage to be finalised but expected to be in well in excess of R100 million damage.

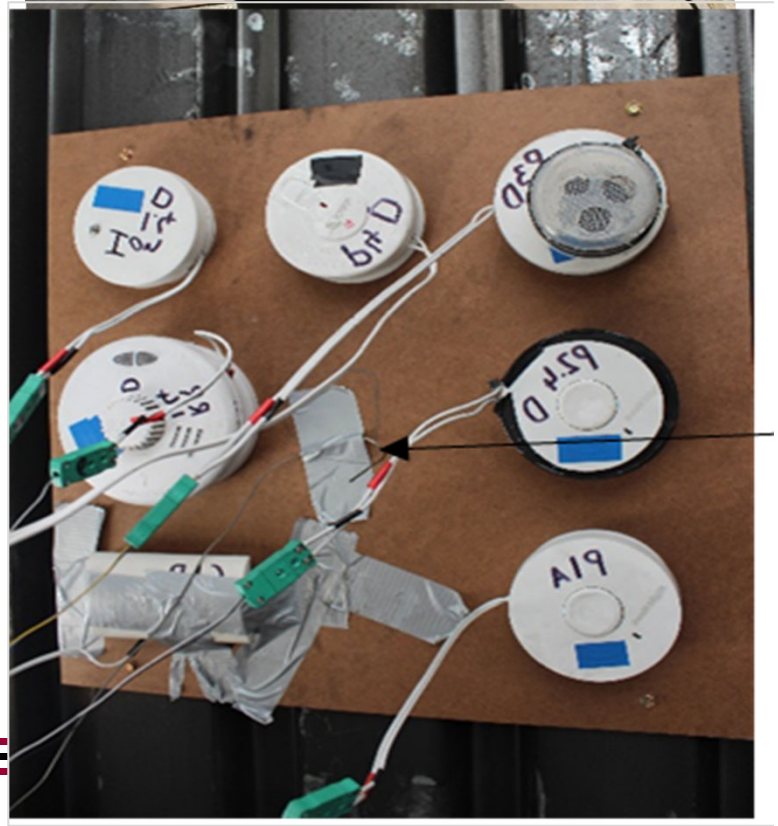

Fire
origin

Photos used permission of Ryan Heydenrych (Vulcan Wildfire Services)


Fire line at 07:30
1 home / min
Wind direction
Fire line at 09:00
9 homes / min
Fire line at 11:00
4 homes / min
Fire line at 13:00
3 homes / min
23:00
01:00
03:00
05:00
07:00
09:00
11:00
13:00

Early warning





Testing of suppression systems

Benchmark Test

- A benchmark test has been developed to evaluate different fire suppression interventions against each other. This being done for FULLY DEVELOPED / POST FLASHOVER fires.
- The idea is NOT to produce a SABS test, but rather a benchmarking process that can be carried out at any fire station in SA.

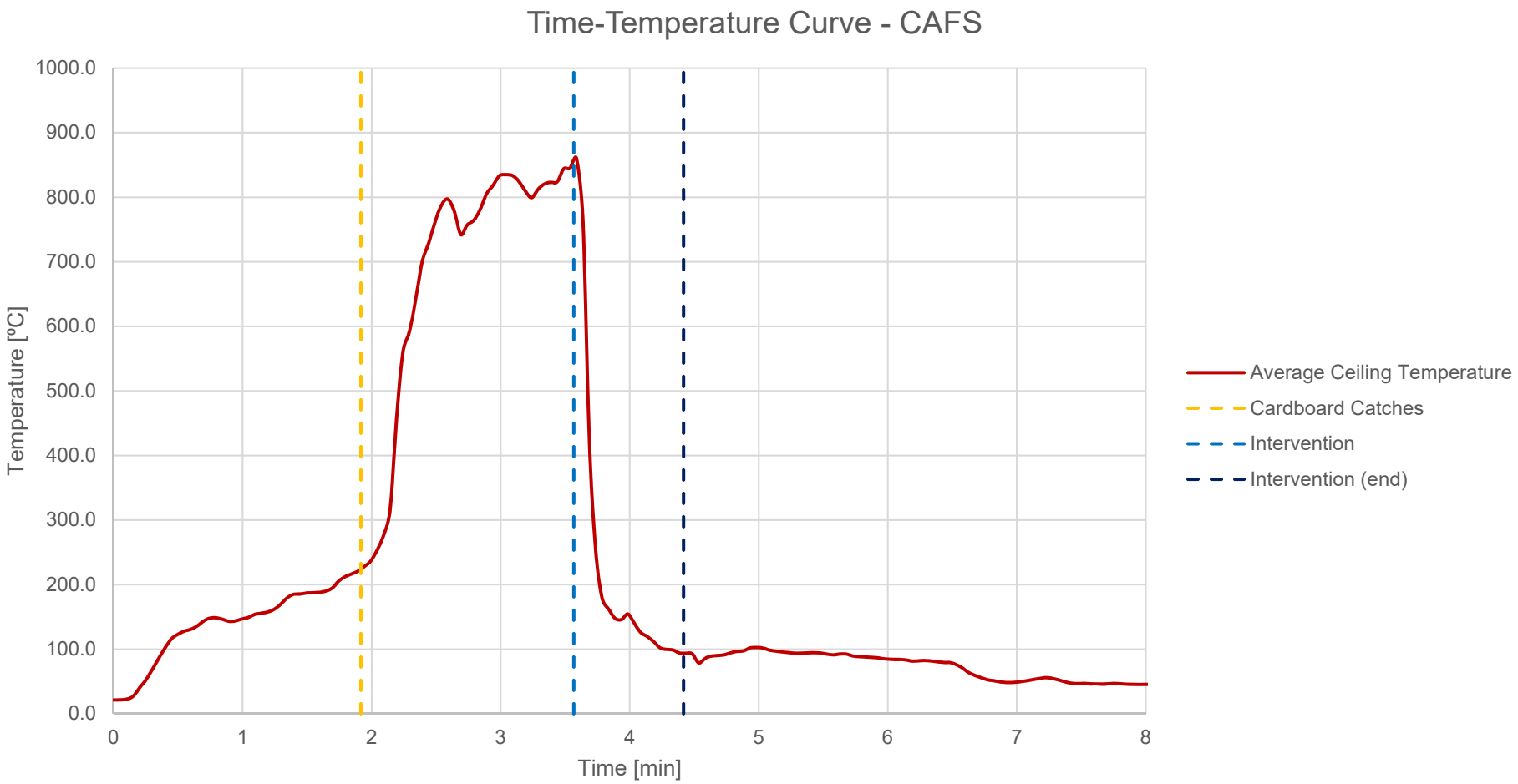
Setup


DALY

Results

- Multiple suppression systems for firefighters and communities tested.
- Many proprietary products did not work for post-flashover fires. Products cost between R300-R600 and as many as 24 units were used in one test.
- Buckets of water are surprisingly effective.

Products tested

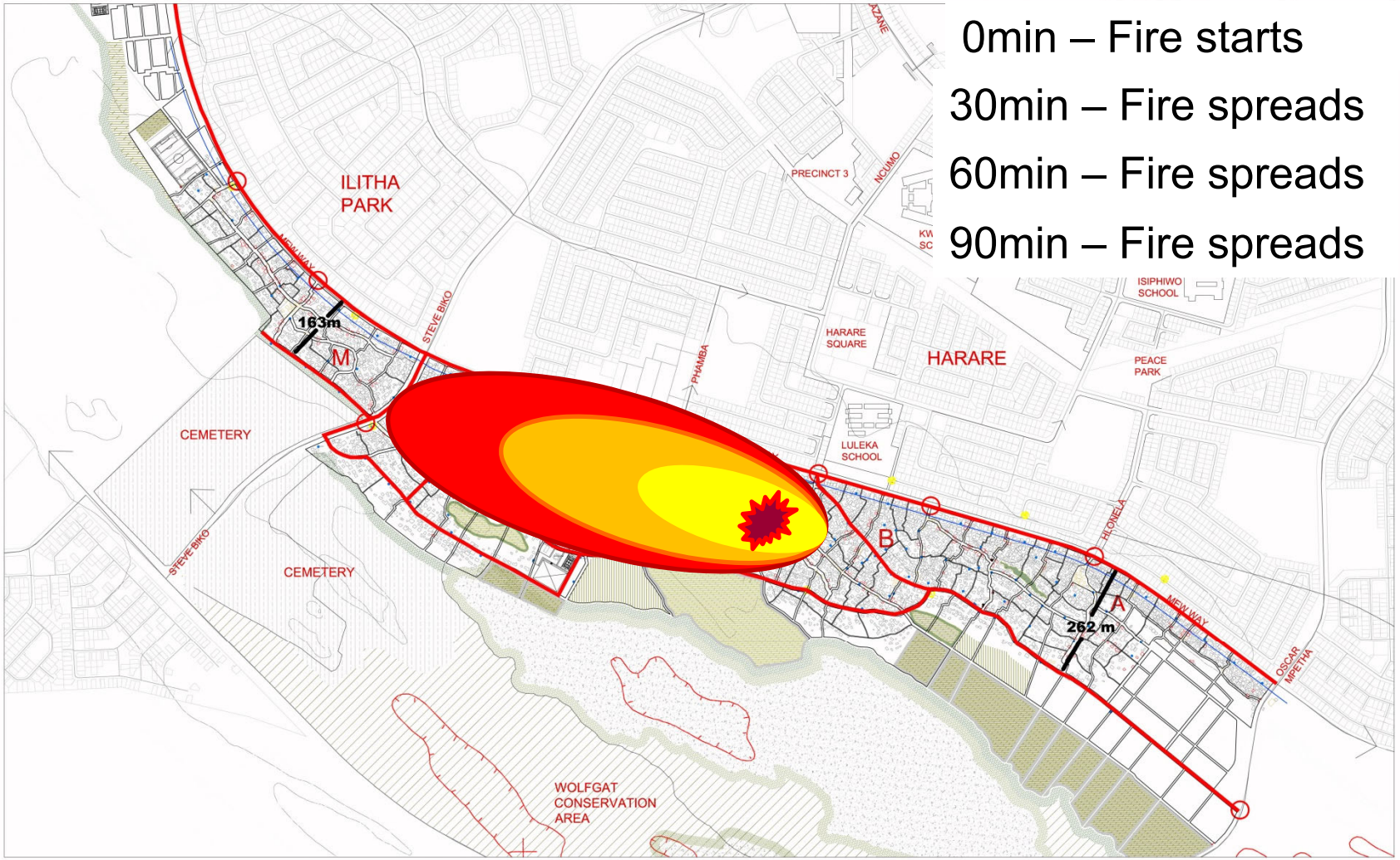


Summary

- **Testing needs to become part of decision making**.
- We propose developing the benchmark test as a publicly available testing system that can be used by municipalities countrywide.

Predict spread

Fire Spread Modelling

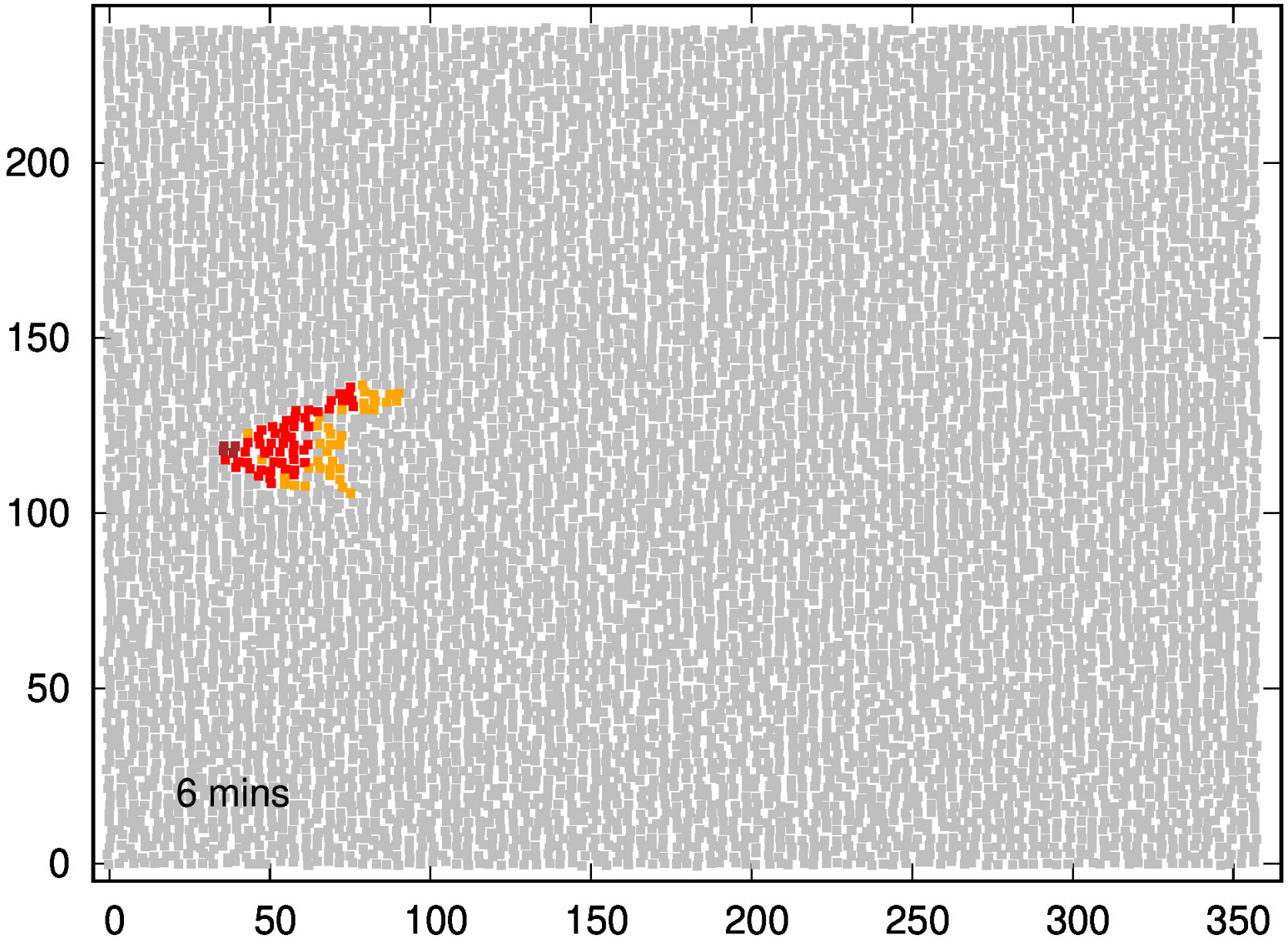


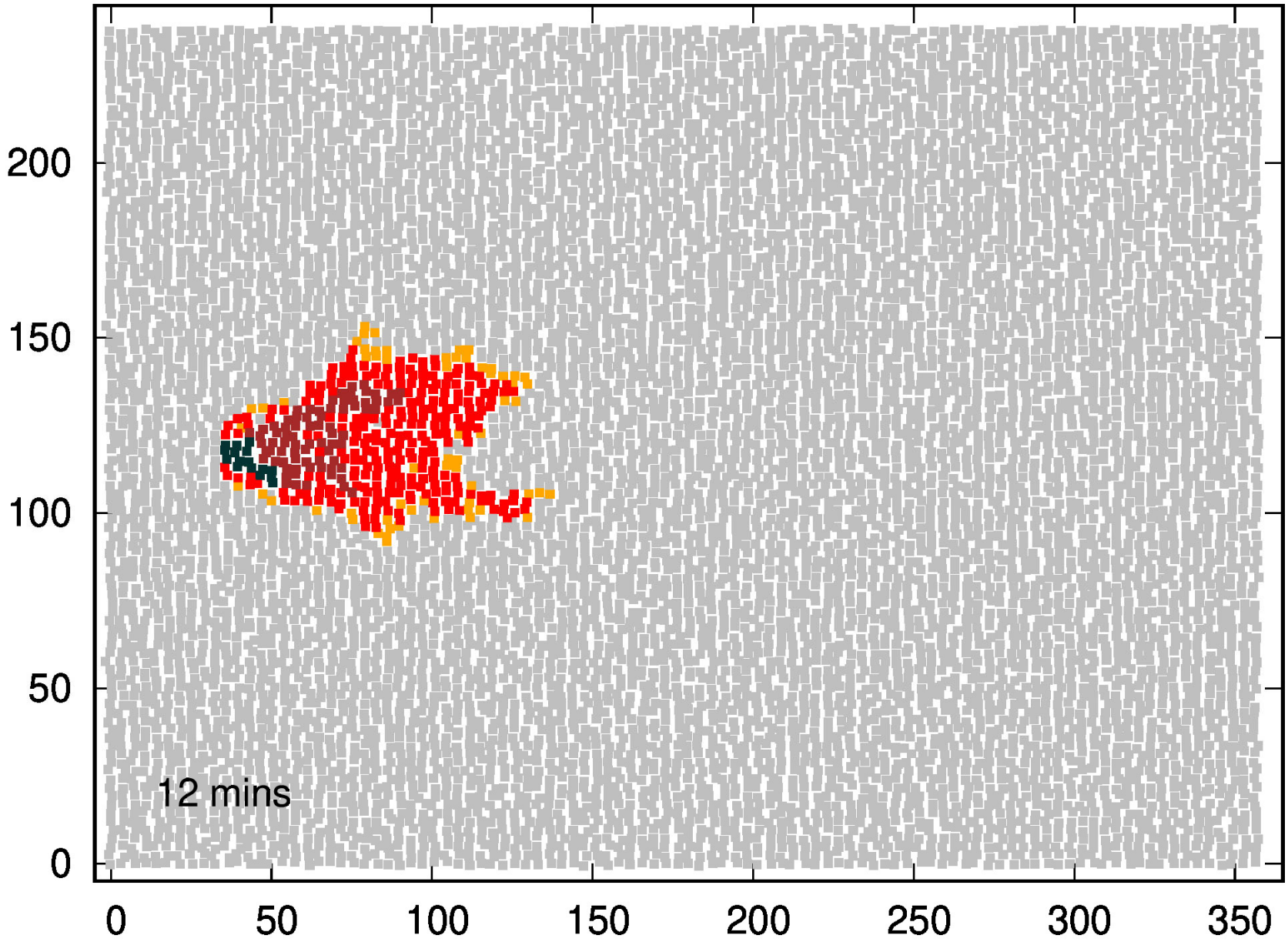
0min – Fire starts

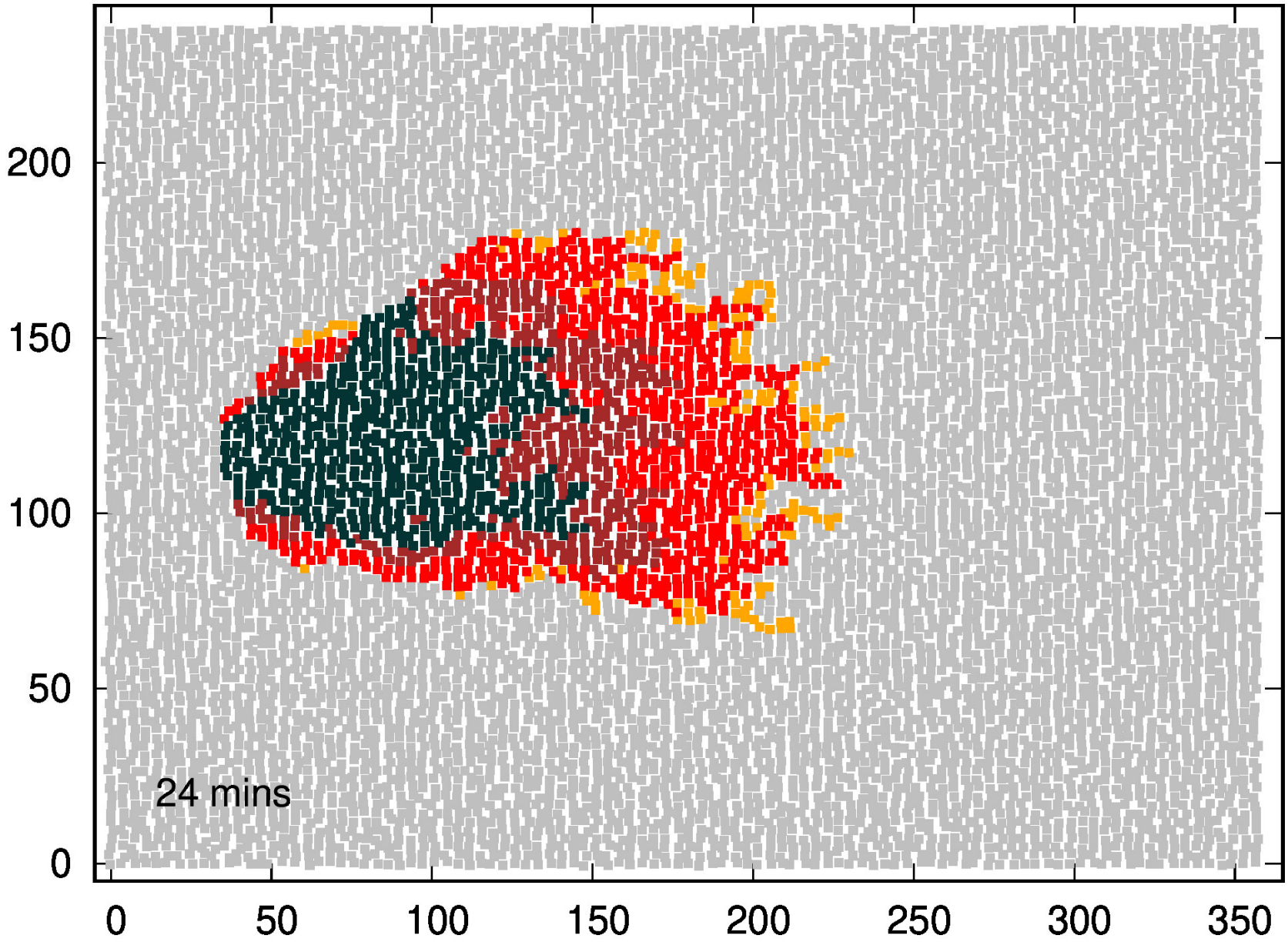
30min – Fire spreads

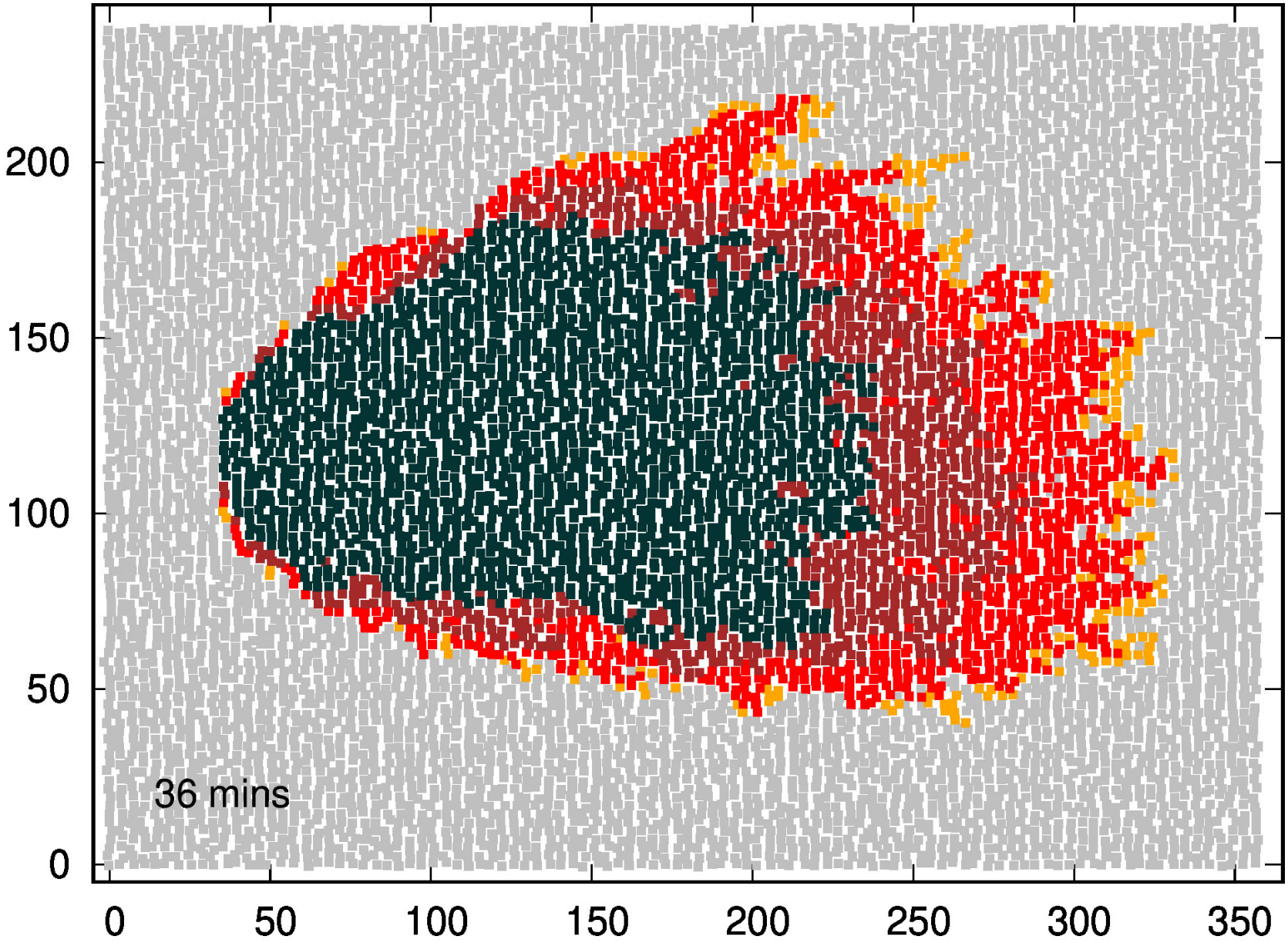
60min – Fire spreads

90min – Fire spreads


200
150
100
50
0
6 mins
0
50
100
150
200
250
300
350


200
150
100
50
0
12 mins
0
50
100
150
200
250
300
350


200
150
100
50
0
24 mins
0
50
100
150
200
250
300
350


200
150
100
50
0
0
50
100
150
200
250
300
350
36 mins

Find fires
(University of Edinburgh)

Tracking of historical fire disasters

Before | After clearing fire site | Rebuilt settlement

So where to next…

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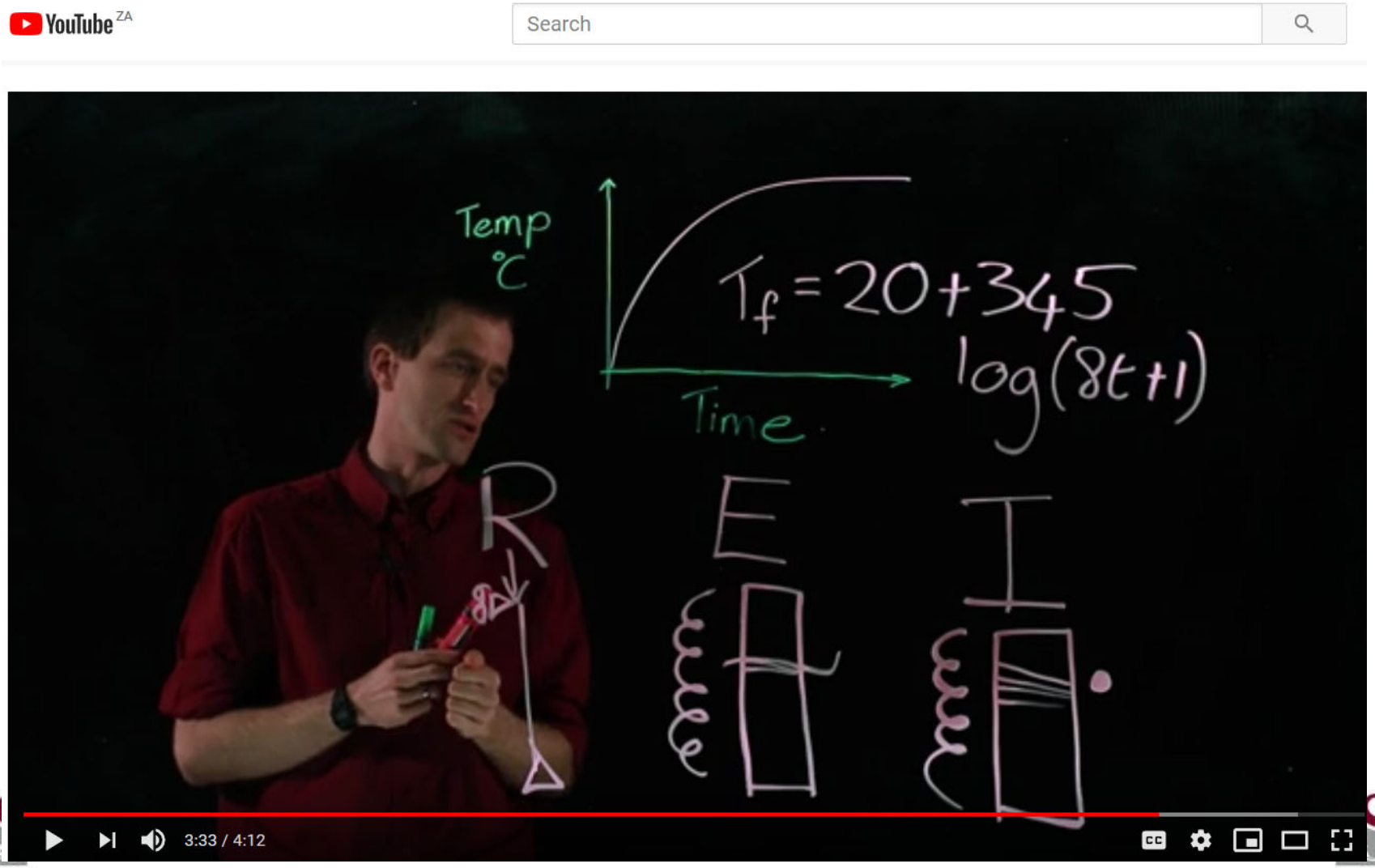
UNIVERSITY

Educate…

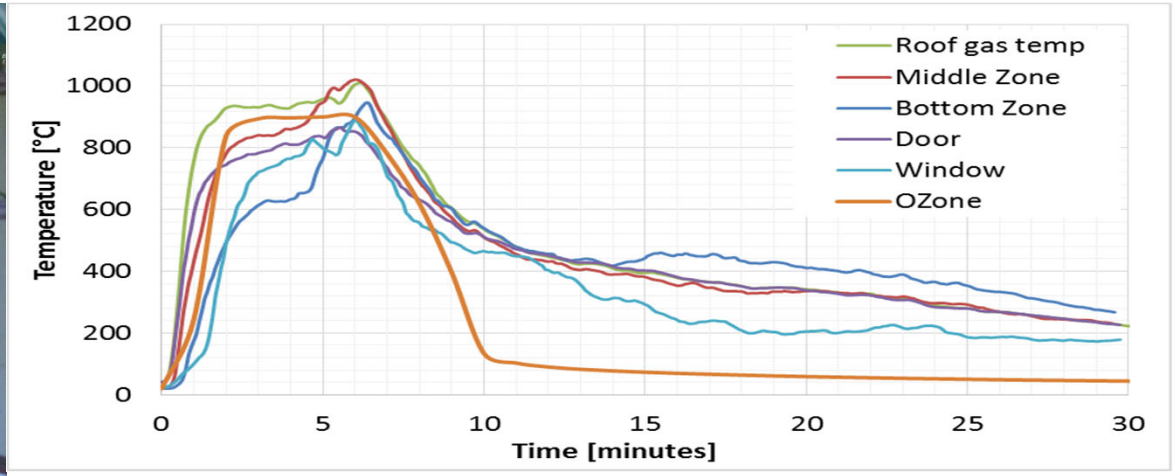


Conclusions

- We cannot stop fires in informal settlements.
- We can try use our resources more effectively and improve the situation.
- Early warning is key.
- A solid scientific understanding of fire engineering can help improve how we address fire safety.
- WE DON'T HAVE AN OPTION. WE TRY… OR WE CONTINUE TO LET HOMES BURN.

Conclusions

- Opportunities:
  - Need fire engineering staff?
  - Corporate Social Investment (CSI)
  - Technology development for smoke alarms
  - Government / municipal engagement


1200
1000
800
600
400
200
0
Temperature [°C]
0
5
10
15
20
25
30
Time [minutes]
Roof gas temp
Middle Zone
Bottom Zone
Door
Window
OZone

Questions?