Fire and the Environment A Time to Reflect?'

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PREVENTING PROTECTING RESPONDING

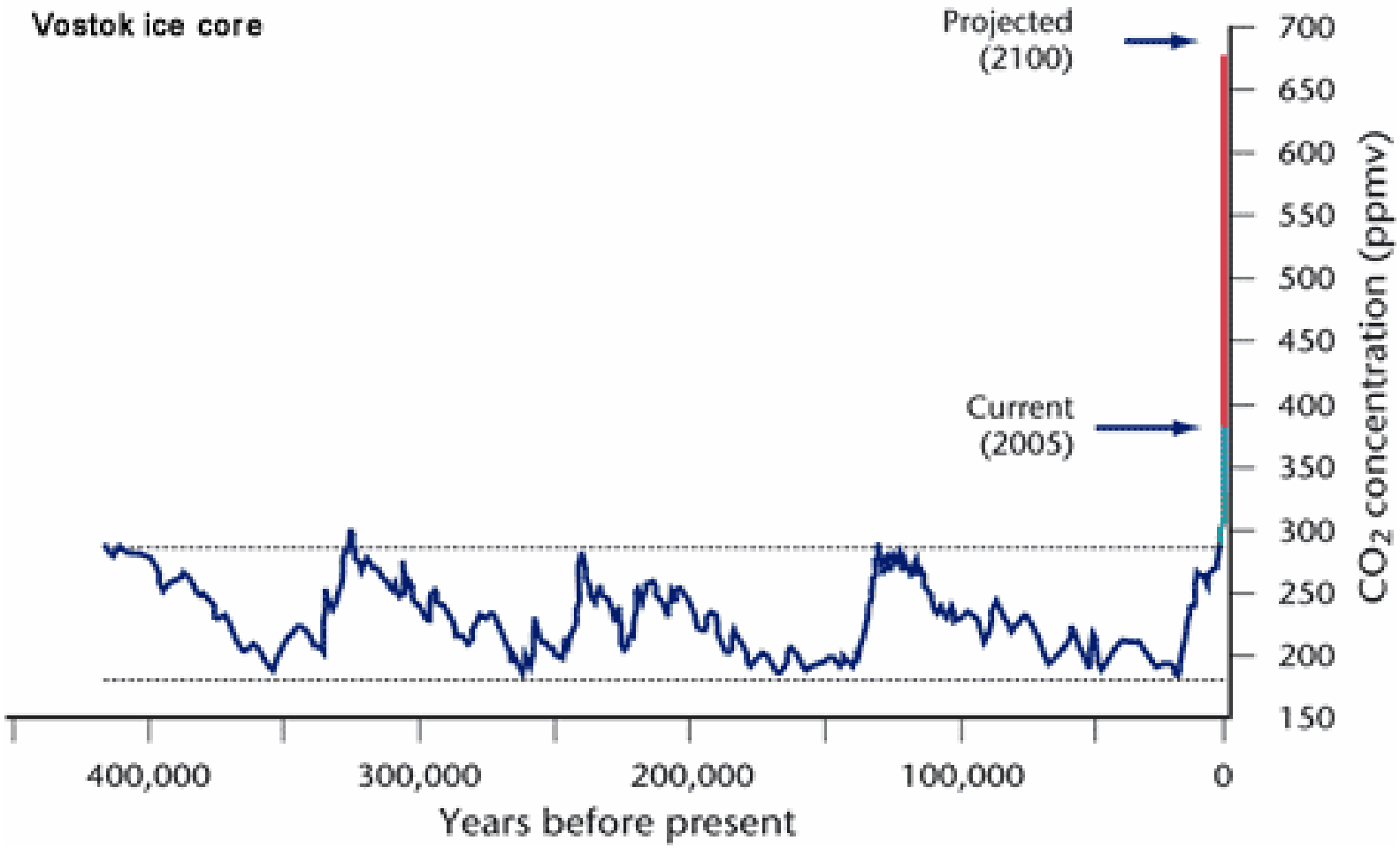
Introduction

- The rise in CO2 a brief overview
- Putting the problem into perspective
    - Estimated outputs from large fires
- National outputs of the FRS
- The real cost of fire
- What are the gaps?
- Where do we go from here?

The Issue of Global Warming

- Since the middle of the Twentieth Century, CO_2 levels of carbon dioxide in the Earth's atmosphere have increased at an average annual rate greater than 1 ppm per year due to a combination of natural processes and increased combustion of fossil fuels. The average CO_2 concentration in the atmosphere is now above 380 ppm; and the rate of increase in carbon dioxide content has increased over the past fifty years, to more than 2 ppmv annually.

The Issue of Global Warming



Are the effects of fire a problem?

Burning Rates and Production of CO_2

- Burning rates can range from 0.035kg m^{-2} s^{-1} to 0.075kg m^{-2} s^{-1} typical
- CO_2 Yields can be as high as 53grams m^{-2} s^{-1}
- In addition to CO_2 other gases such as CO and compounds based on Cl_X can cause damage to the environment

The Effects of Large Fires

Buncefield

An estimation of Buncefield CO2 Rates

- The complexities of burning rates result in different yields
- In commercial combustion systems 1 litre of fuel produces approximately 3 kg of CO2
- Buncefield contained 190,000 tonnes of fuel
- Taking average density of 800kg/m3
- Approx 237 500 000 litres!
- Burned for 5 days
- Required large amounts of foam to extinguish

CO_2 Rates

Quantity Consumed	0.5kg/l	1.0kg/l	1.5kg/l	2.0kg/l	3.0kg/l	Average Tonnes
100%	118 750	237 500	356 250	475 000	712 500	380 000
80%	95 000	190 000	285 000	380 000	570 000	304 000
60%	71 250	142 500	213 750	285 000	427 500	228 000
40%	47 500	95 000	142 500	190 000	285 000	152 000
20%	23 750	47 500	71 250	95 000	142 500	76 000

Large Scale fires

- Buncefield
  - Total 190 000 tonnes of oil products
  - Burnt for 5 days
  - Estimated Carbon Dioxide output

  - 400,000 - 712,000 tonnes of CO2

Large Stacks

- Stacks can be seen as ‘Carbon Banks’
  - Wood $C_6H_{10}O_5$ [Basic Cellulose]
  - Tyres C_5H_8 [natural rubber {Isoprene}]
  - Plastic $(C_2H_3Cl)_X$ [PVC]

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Stack Size m^2	CO_2 per min (tonnes)	CO_2 per Hour (tonnes)
100	0.018	1.08
500	1.59	95.4
1000	3.18	190.8
10000	31.8	1908

Grass and Wildfire

Grass and Wild Fire

Last week's fires in southern California broke out after the paper was written but Wiedinmyer applied the new computer model to analyze their emissions. Her preliminary estimates indicate that the fires emitted 7.9 million metric tons of carbon dioxide in just the one-week period of October 19-26, the equivalent of about 25 percent of the average monthly emissions from all fossil fuel burning throughout California.

California Wild Fire

- 8 million metric tons of climate-warming carbon dioxide.
- In just a week
- One-quarter as much as fossil fuels do in that state in that month

Structure Fires

Environmental impacts

Greater Manchester Fire and Rescue Service 2006-2007

Type of Incident	Number	CO_2 53g/hr	CO_2 15 mins	CO_2 27g/hr	CO_2 27g/15min	Area M^2
FDR1 Vehicles	3500	4000	1000	2000	500	6
FDR1 Dwellings	3830	14615	3653	7307	1826	20
FDR1 Business	730	13928	3482	6964	1741	100
FDR3	16341	13177	3294	6588	1647	4
Total	27501	45720	11429	22859	5741	N/A

The scale of CO_2 emissions within our community [Fire and Rescue services]

- Taking the Metropolitan brigades
  - CO_2 Yield annually is approximated at 300,000 tonnes
- Assuming within the rest of the brigades an annual yield of 20,000 tonnes per brigade
  - CO_2 yield is 1.5MT
- Total Nationally could be in the region of 2MT per year of CO_2

Estimation of CO_2 from stacks

Stack Size m^2	CO_2 per min (tonnes)	CO_2 per Hour (tonnes)
100	0.018	1.08
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Some simple concepts of Combustion

- The combustion of hydrocarbons is fairly fundamental
- Consider a simple combustion process

$$C + O_2 \rightarrow CO_2$$

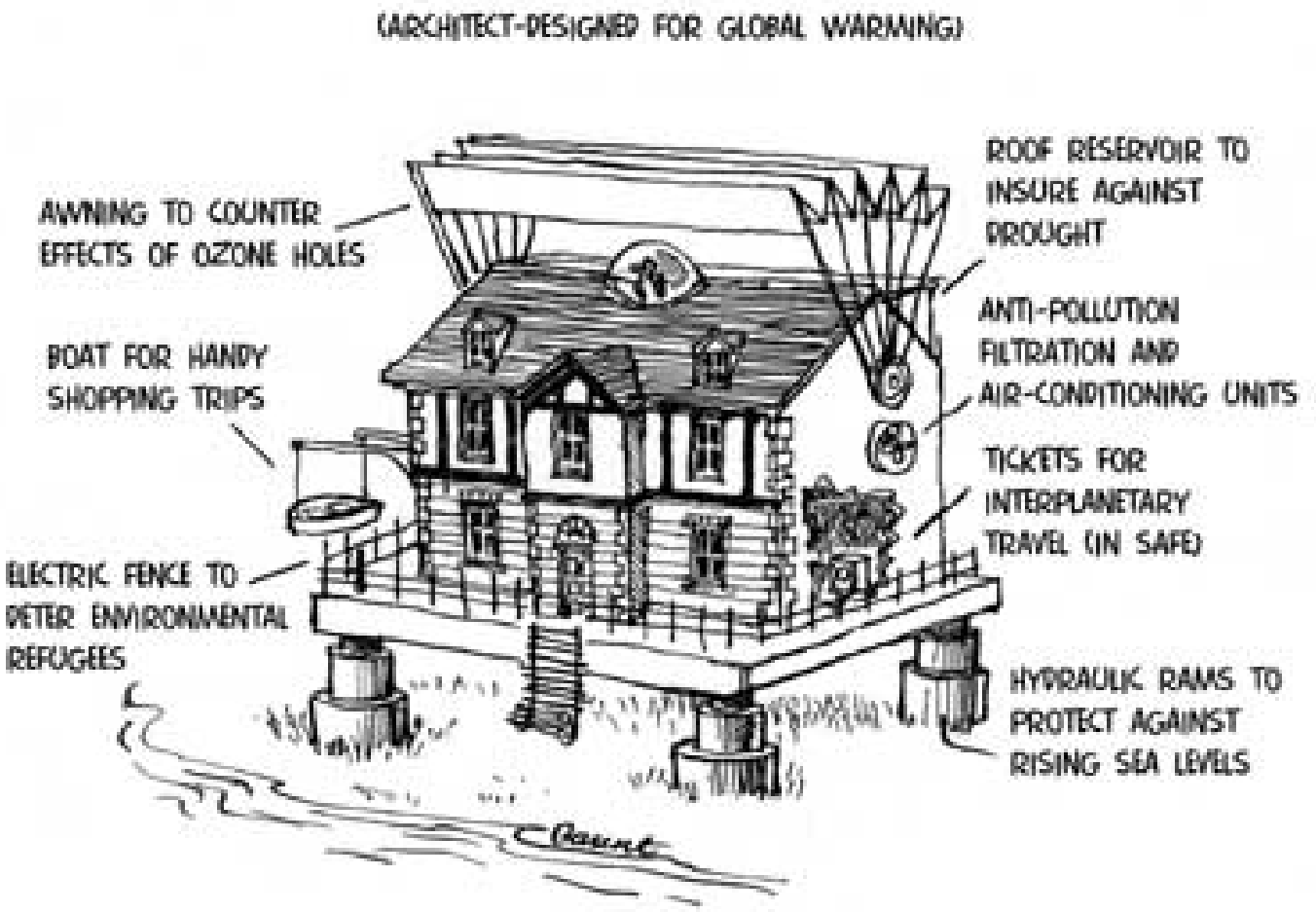
$$CO + \frac{1}{2}O_2 \rightarrow CO_2$$

- But in reality

Environmental impacts of fires

- Usually result in large amounts of water resulting in
  - Water run off
  - Contamination
- Undesirable emissions
  - Carbon Dioxide
  - Carbon Monoxide
  - Chlorine compounds [Plastic]
  - Carbon [smoke]

Building Sustainability



Factors affecting sustainability within the Built environment

- The effects of fire on the environment are currently not taken into account within the building design.
- A sustainable building is only ‘green’ until it has a fire

Embodied energy within Buildings

- The ***embodied*** *energy* of a building is the energy used to acquire raw materials, manufacture, transport and install building products in the initial construction of a building

Typical Embodied energy values

Material	MJ/kg
Recycled Steel	9
Steel	32
Ree Bar	40
Concrete (poured)	1.3
Concrete (pre Cast)	2
Copper Cable	110
Aluminium	227

However

- What about the effect of fire?
- Sustainability?

The Real Carbon Footprint of fire

- Firstly the amount of CO_2 produced from the construction materials used.
- Secondly the embedded Carbon released during a fire

The Real Carbon Footprint of fire

- Thirdly the CO_2 produced for constructing a replacement building
- Fourthly the CO_2 produced in recycling the fire damaged materials (i.e. steel etc)

The Effects of water suppression

- An uncontrolled fire in a building will result in the release of CO_2 and other environment damaging chemicals
- The use of water suppression can reduce emissions to much smaller amounts

Value of Sprinklers

CO_2 Energy Calculator

Building area m^2	Sprinkler Fire Size
1000	10
CO_2 generated Tonnes	CO_2 Generated Tonnes
190.8	1.91
Benefit of sprinkler protection	188.892

What are problems in estimating CO_2 production from fires

- Fire sizes are not well reported and documented
- Gas yields are very difficult to asses at large scales
- Not all fires are the same
- Not all the FRS attendance times are the same

Further Research

- Develop a better understanding of fires within the environment.
- Development of more comprehensive carbon model.
- Greater research in combustion modelling of large scale fires

Thank you