Overheating, the magnitude of the problem and challenges for the future: A built asset management perspective

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In this presentation I will

- Examine the impact of climate change on the vulnerability, resilience and adaptive capacity of domestic buildings
- Presents a risk assessment framework model for integrating adaptation to climate change in built asset management plans
  - Consider the implications of adaptation on the building life cycle
- Outline a 10 step decision support tool

This presentation is based on 3 projects

- EPSRC - Community Resilience to Extreme Weather (CREW)
- TSB funded D4FCC project
- TSB funded D4FCC2 project
The average temperature of the earth's surface has risen by 0.6°C since the late 1800s. It is expected to increase by another 1.4 to 5.8°C by the year 2100.

Extreme weather events are likely to become more frequent and intense.

Adaptation
- Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates or exploits beneficial opportunities.

Mitigation
- An anthropogenic intervention to reduce the source or enhance the sinks of greenhouse gases.
What are the implications of climate change on the performance of the built environment?
The CREW Project

Was a multi-disciplinary project involving 14 UK universities.

- The project was broken down into 5 work packages:
  - Coping Measures for EWEs
    - Technical solutions
  - Community Resilience to EWEs
    - Vulnerability, resilience and adaptive capacity
  - EWE Weather Generator
    - Physical modelling of impacts
  - GIS Information Tool
    - Spatial representation of risks
  - Socio-Economic Modelling
    - Deprivation, employment, population movement etc.

- What are the implications of the above to the built environment?
In the UK EWEs are increasing in frequency and severity.

Flooding (UK):
- In 2000 - £500m insurance claims;
- In 2004 – managing flooding cost £2.2bn;
- In 2007 - 165,000 insurance claims resulted in over £3bn.

Storms:
- In 1987 – €5m damage & 34 people killed in the UK & France;
- In 1999 – €13.5m damage & 125 people killed in Europe.

Heat:
- By 2050 – 1.6°C to 5.8°C rise in mean summer temperature.

These events provide a challenge for built environment professionals as they seek to quantify the risks and develop adaptation (and mitigation) plans.
Theory of Community Resilience

SME’s

Policy Makers

Resilience

Households
The risk of a system to perturbations by external forces or hazards that are beyond the normal range of variability under which the system operates.

The ability of a system to cope with such forces or hazards and return to its normal operating status once the perturbations have been removed.

The ability for a system to change to meet the new conditions bought about by perturbations that fundamentally change the system.
• The vulnerability and resilience of RSL’s housing stock was assessed against eleven extreme weather event scenarios.
  ➢ Overheating scenarios
• “As a registered social landlord how can I identify which of my existing housing stock will be most exposed to heat waves as a consequence of climate change in order that I might prioritise which parts of my portfolio to adapt?”
• Modelled the potential heatwave scenarios for London and then evaluated the likely impact of these on the performance of typical housing archetypes.
Projected increase in London average maximum temperature
Heat waves were identified by considering UKCP09 projections with temperatures in excess of 32°C – 18°C -32 °C in line with the NHS for England Heat Plan.

These were then combined with future population projections to identify areas of future risk.
• Two types of property
• Tier 1
  ➢ 1930’s semi
  ➢ 1960’s ground floor flats
  ➢ Victoria Terrace
• Tier 2
  ➢ 1960’ top floor flats
  ➢ Modern detached housing
• Tier 1 typically experience <50% overheating exposure than Tier 2.
Generally Tier 2 buildings will be harder to treat than Tier 1 buildings and will cost considerably more to adapt (£23k for a 2006 Detached house compared to £3k for a 1930’s Semi).
Adapting Dwellings to Climate Change
- Retrofit Advice Tool

Flat Type:
- Ground Floor Flat
- Top Floor Flat
- Combined

Adaptations:
- Front of Block North Daytime Occupied
- Front of Block South Daytime Occupied
- Front of Block East Daytime Occupied
- Front of Block West Daytime Occupied
- Front of Block South Daytime Unoccupied
- Front of Block East Daytime Unoccupied
- Front of Block West Daytime Unoccupied

Top Floor Flat
- Adaptations - ranked in order of effectiveness. Use the drop down list below to select:
- Room type: living room, main bedroom or living room + main bedroom (for total overheating)
- Direction of the front-facing (Note: living room and main bedroom are both at the rear)
- Occupancy profile (daytime occupied or unoccupied)
- Move your mouse over the adaptation names on the right for a detailed description

Select a value from the drop list to view Adaptation Chart:
- Living Room + Bedroom
- Front east facing
- Daytime Occupied

Living room plus main bedroom west facing
Flat daytime occupied

Solar reflective roof involves coating the roof tiles with a high performance solar reflective paint, costing around £400 per flat, assuming the cost is shared between the 6 flats

Adaptation Description
- Unadapted Flat
- Internal Blinds
- External Shutters
- Curtains
- Low e triple glazing
- External fixed shading
- Night ventilation
- Window rules
- Better insulated roof
- Solar reflective roof
- Solar reflective walls
- External wall insulation
- Internal wall insulation
- Cavity wall insulation

http://www.extreme-weather-impacts.net/twiki/bin/view/Main/PP1CopingTechnologiesSummary
Adaptation Planning - Prof Keith Jones

Current Conditions
- Examine recent history and identify disruption caused by extreme weather events.
- Analyse each event and identify inherent vulnerabilities and resilience of the system (social, physical, economic, legislative).

Future Scenarios
- Develop future scenarios, based on climate change predictions, that cover the range of possible impacts of future events.
- Assess vulnerability and resilience of existing system against each scenario (social, physical, economic, legislative).

Risk Appraisal
- Rate each system component according to impact (matrix of vulnerability against coping capacity).
- For high impact components identify what can be done to prevent disruption or improve the recovery process of the system.
- Cost each measure (e.g., human resources, skills, etc.).

Contingency Planning
- Assess the ability of the system stakeholders to fund/manage the coping measures (quantify the absorptive/adaptive capacity of the system).
- Prioritise coping measures to optimise absorptive capacity.
- Develop adaptation plans.

Monitor performance against target.

Impact/Priority Matrix
- Sum of Coping Capacity
- Flood
- Heat
- Vulnerability
- High Priority

Test plans against scenarios.

Short Term Solutions
- Long Term Solutions
Current Conditions

Examine recent history and identify disruption caused by extreme weather events.

Analyse each event and identify inherent vulnerabilities and resilience of the system (social, physical, economic, legislative).
Develop future scenarios, based on climate change predictions, that cover the range of possible impacts of future events.

Assess vulnerability and resilience of existing systems against each scenario (social, physical, economic and legislative).
Risk Appraisal

Rate each system component according to impact (matrix of vulnerability against coping capacity)

For high impact components identify what can be done to prevent disruption or improve the recovery process of the system

Cost each measure (£, human resources, skills etc)
Contingency Planning

Assess the ability of the system stakeholder to fund/manage the coping measure (quantify the absorptive/adaptive capacity)

Prioritise coping measures to optimise absorptive capacity

Develop adaptation plans
How can we integrate these issues into the building life cycle?
“Your home should be in good working order and fit for purpose - it should meet a certain set of standards, both inside and outside and in shared and private areas to make it a safe and healthy environment to live in.”
<table>
<thead>
<tr>
<th>Potential Vulnerability</th>
<th>Property Archetypes</th>
<th>Coping Capacity</th>
<th>Subjective Judgment Threshold Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Air conditioned homes</td>
<td>Low</td>
<td>No through ventilation; Single south facing aspect; high level of glazing; limited ability for shading; limited ability for overnight purging; low thermal mass; limited ability to cool any room (e.g. bed/sit flat); no access to external shaded space (e.g. garden).</td>
</tr>
<tr>
<td>Medium/Low</td>
<td>19th Century Terraces; Ground Floor Flats</td>
<td>Medium</td>
<td>Some opportunity for cross ventilation; multiple facing aspects; medium level of glazing; some ability for shading some ability for overnight purging; medium thermal mass; some ability to cool at least one room; some access to external shaded space (e.g. garden).</td>
</tr>
<tr>
<td>Medium</td>
<td>1930’s Semi Detached Houses</td>
<td>Medium</td>
<td>Good opportunity for cross ventilation; north facing aspects; medium level of glazing; high ability for overnight purging; high thermal mass; good ability to cool at least one room; good access to external shaded space (e.g. garden).</td>
</tr>
<tr>
<td>Medium/High</td>
<td>Modern Houses</td>
<td>High</td>
<td>Good opportunity for cross ventilation; north facing aspects; medium level of glazing; high ability for overnight purging; high thermal mass; good ability to cool at least one room; good access to external shaded space (e.g. garden).</td>
</tr>
<tr>
<td>High</td>
<td>Top Floor Flats</td>
<td>High</td>
<td>Good opportunity for cross ventilation; north facing aspects; medium level of glazing; high ability for overnight purging; high thermal mass; good ability to cool at least one room; good access to external shaded space (e.g. garden).</td>
</tr>
</tbody>
</table>
A range of technical adaptations to reduce overheating hours in a heat wave scenario (32-18-32°C to 3 consecutive days) were examined and costed.

Estimated costs for reducing overheating to less than 100 degree hours per year ranged from £2000 (fitting internal blinds and night time ventilation to 1930-1950 houses) to £8000 (for adaptations to upper floor flats).

Prioritised in the adaptation plan.
<table>
<thead>
<tr>
<th>Management</th>
<th>Vulnerability – OVERHEATING</th>
<th>Timescale for Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Floor Flats, Modern Houses and Sheltered Accommodation</td>
<td>Where ever possible prevent vulnerable properties overheating to the point at which it becomes a danger to health of the resident. This would include:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitor properties to establish the extent to which overheating is currently a problem (through tenant satisfaction surveys and physical monitoring where appropriate).</td>
<td>Years 1</td>
</tr>
<tr>
<td></td>
<td>Undertake detailed surveys for the most vulnerable properties to assess the potential of adaptation measures to reduce overheating and/or heat stress (including thermal modelling where appropriate). Undertake detailed surveys of the remaining on properties as part of the next condition survey.</td>
<td>Year 2-30</td>
</tr>
<tr>
<td></td>
<td>Install adaptation measures as appropriate.</td>
<td>Year 2-30</td>
</tr>
<tr>
<td></td>
<td>Develop an approach to assess the vulnerability of individual residents to heat stress.</td>
<td>Year 2-5</td>
</tr>
<tr>
<td></td>
<td>Where residents are particularly vulnerable to heat stress, consider relocating them or providing a ‘cool room’, either in the flat or in the block.</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>In sheltered accommodation provide a cool room for vulnerable residents.</td>
<td>Year 1-5</td>
</tr>
<tr>
<td></td>
<td>Develop guidance for residents on how to use their home during a heat wave. Guidance should include the use of curtains/blinds/Windows during the day to reduce solar gain and ignited to wage night-time purging. Guidance should also include advice on how to stay healthy during heat waves and on the personal equipment that tenants could obtain to assist the cooling/circulation of air within their home. Consult the NHS for England Heat Wave Plan.</td>
<td>Year 1</td>
</tr>
</tbody>
</table>
Policy / Strategy

Identify Need / Establish Cause
- Identify Current Threats
- Develop Future Climate Scenarios
- Map Current and Future Threats
- Identify Coping Capacity

Articulate expected Performance

Develop Solutions
- Develop Adaptation Strategy
- Set Priorities
- Identify Possible Adaptations
- Prepare Adaptation Plans

Implement and Monitor Plans
Underlying theory (CREW) worked well... BUT... the underlying data needed for robust decision was patchy.

- No consistent UK wide data on the potential weather impacts
  - No single organisation could afford to run the weather models
- Existing building performance data is not appropriate for adaptation planning
  - SCSD is simplistic;
  - Asset Management data doesn’t support performance modelling.

Whilst the above didn’t undermine the strategic level investigation of adaptation to climate change it did affect the operationally planning

- Effectively the lack of robust evidence resulted in high levels of uncertainty in the risk models and resulted in a ‘wait and see’ approach to adaptation planning.

This needs to be addressed if the UK is to avoid a housing adaptation back-log.

Questions?