Scorching Summers and Schools – The concern and solutions
The earth is warming

- **2023**: Officially Earth’s hottest year ever recorded
- For the **first time** world was close to **1.48°C hotter** than pre-industrial levels

- Predictions: 2024 will be the first year to breach 1.5 °C

- India among countries worst hit in terms of heat
  - April, May, June, 2023: an average of two people lost their lives daily in India due to heat waves
  - June 2023: 252 deaths (~ 8 folds rise in deaths compared to 2022).

*Source: Down to Earth (January 12, 2024); https://www.forbesindia.com/; https://lakesofindia.com/*
Cities becoming heat centres

- CSE conducted a study in nine cities.
  - Five cities have almost **more than 80 per cent** of their area engulfed in extreme heat in the summer months across 10 years (2014-2023).

Source: CSE; https://doi.org/10.1175/2010JAMC2460.1
Peak heat is even higher

- CSE conducted a study in nine cities.
  - Five cities have almost **more than 80 per cent** of their area engulfed in extreme heat in the summer months across 10 years (2014-2023).

- The **peaking** of heat is even higher – nearly **entire cities**.

- Prolonged **exposure** of the population living in the heat centres will have a huge **health** and **economic** impact.

**NOTE:** Maps not to scale

*Source: CSE; https://doi.org/10.1175/2010JAMC2460.1*
Children are more vulnerable

- According to Children’s Environmental Health Collaborative, **559 million** children experience high **heatwave** frequency **globally**.
- By **2050**, virtually every child on earth (~2 billion) is **anticipated** to face more frequent heat (even if the nations are on track to cap temperature rise below 2°C)
- **Children** are **more vulnerable**:
  - Produce more heat per kg of weight
  - Absorb more heat (their body can warm 3-5 times faster)
  - Underdeveloped sweat glands (lower rate of sweating) - less capacity to regulate their temperature
  - Lower adaptation rate to changes in temperature
  - Need reminders to drink water and replenish fluids

Source: https://ceh.unicef.org/spotlight-risk/extreme-heat
Hottest days are not vacations any more

Heat Index - 2023

Heat Index - 2022

Heat Index - 2021

Heat Index - 2020

Caution (26.5 – 32.5°C)
Extreme Caution (32.5 – 40°C)
Danger (40 – 52°C)

Summer vacations
Working months
Flow of analysis – heat discomfort

Discomforts at various stages:
- Commute from home to school
- At school
- In classroom
- Commute from school to home

Interventions to mitigate heat
Selection of schools for analysis

- From among the attendees representing 26 schools from 12 states and union territories (UTs), 7 schools from the Delhi NCR were selected to investigate the issue of heat.
- Schools in Delhi assign points based on the distance from the school, where schools within a 10 km radius are given high points.
- Thus, a 10 km radius was considered around the selected schools.
- Areas within these 10 km were assessed for heat centers.
Discomfort: commute from home to schools

- Average trip length of school bus ~1 hour
- The student getting in the bus from the farthest point, is exposed to heat for the longest duration.
- The commute involves passing these heat centres.

**Heat centres**

10 km

**Area under heat centre**

- JP International School, Greater Noida: 84.01%
- Bal Bharati Public school Noida: 75.68%
- Shiv Nadar School Noida: 42.32%
- Little Flowers Public Senior Secondary...: 37.61%
- The Samarth School, Wazirabad Road: 45.42%
- Birla Vidya Niketan: 32.75%
- Cambridge Primary School: 32.50%
Identifying Urban Heat Centres

1. Estimation of Land Surface Temperatures multiple years
2. Extraction of Built-up from Landuse maps
3. Identification of regions with LST > 45°C for all the years
4. Marking the regions with LST > 45°C for six or more years
Discomfort: at school

• The first thermal shock (sudden change in temperature) experienced by students is during movement from bus to classroom and assembly.

• This shock is even worse in case of air conditioned buses.
  - Moving out of AC could have a temperature difference of 15-20°C in summers. Moreover, staying in AC makes the skin dry and difficult to perspire
  - Body temperature in such cases could rise within 10-15 mins, resulting in heat exhaustion and stress

• This along with the increased heat and loss of body fluids, result in several kids fainting during the assembly sessions.

Source: https://ceh.unicef.org/spotlight-risk/extreme-heat
Discomfort: in classrooms

• An analysis of questionnaire filled by 335 primary teachers from 35 elementary schools across seven cities (Delhi, Jaipur, Ajmer, Vadodara, Udaipur, Ahmedabad, and Pune) suggests:

![Graph showing most uncomfortable time due to heat]

- **Students Returning Home Early Every Week Due to Heat Related Illness**
  - 67 per cent: > 10 students per week
  - 24 per cent: 5 – 10 students per week
  - 1 per cent – 3-5 students per week

Discomfort in the classrooms

- **Teachers’ observations and the perceived heat-related sickness/symptoms they noticed in their students**

  - Fatigue
  - Restlessness
  - Dehydrated (thirsty)
  - Putting their head down
  - Distracted
  - Slow in work (lazy)
  - Others (sweating, sick)

  `Yes` response percentage

Discomfort in the classrooms

• **Students reported following symptoms during summer season**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>'Yes' response percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy sweating</td>
<td>60</td>
</tr>
<tr>
<td>Tiredness</td>
<td>80</td>
</tr>
<tr>
<td>Fainting</td>
<td>40</td>
</tr>
<tr>
<td>Feeling weak</td>
<td>30</td>
</tr>
<tr>
<td>Feeling dizzy</td>
<td>20</td>
</tr>
<tr>
<td>Headache</td>
<td>25</td>
</tr>
<tr>
<td>Nauseous</td>
<td>15</td>
</tr>
<tr>
<td>Vomiting</td>
<td>10</td>
</tr>
</tbody>
</table>

Discomforts at various stages – while returning home

Classroom

Thermal discomfort

- If non-AC: discomfort due to direct heat
- If AC: change in body temperature suddenly

Corridor

State of thermal shock in case of AC classrooms as it is one of the hottest times of the day (~02:30 pm)

Assembly point

Congestion and rising event of heat causing discomfort and

Bus

Walkway/Waiting area

Continued state of thermal shock and body might start to experience severe discomfort in harsh sun

Primary classes are dismissed earlier, followed by senior classes, resulting in primary students being exposed to heat for a longer duration.
Precautions for beating the heat

- Modification in school timings
- Avoid over-crowding during transportation
- Availability of sufficient water stations
- Relaxing norms regarding uniform during peak summers
- Ensuring comfortable classrooms
- Ensuring availability of ORS

Good Practice: ‘Water bell’ in Kerala, Karnataka, Odisha, and Tamil Nadu, etc.
Design interventions - Shading

Shading by trees
Green and blue elements are heat mitigators: effect on air temperature

Source: Blue Green Systems for urban heat mitigation: mechanisms, effectiveness and research directions, IWA
Solutions exist: green and blue elements affect surface temperature.

Source: Blue Green Systems for urban heat mitigation: mechanisms, effectiveness and research directions, IWA
STEP 1: Locate your campus on Google Earth or a similar software

STEP 2: Mark your campus using the measure tool

STEP 3: Note the Total Site Area
Paved/Road area (non-pervious) + Paved/Road area (non-pervious) + Paved/Road area (non-pervious)

Add all the non pervious areas to arrive at total non pervious area

Pervious and non pervious definition, what constitutes what
Total Site Area - Total Covered area - Total Impervious paved area = Pervious open area

Subtract the Total Covered area and the Total impervious area from site area to arrive at pervious open area
Step 1: Use Google Earth to find your campus on satellite image.

Step 2: Mark 20 metre from the ‘ruler tool’ for your reference.

Step 3: Save your image with the 20m to mark and add a grid to the image.

Step 4: Scale the grid to match the 20m mark, so that 20mx20m boxes cover your image.
Step 5: Mark the areas to under the following categories with a circle over the image to understand the land use pattern.

- Trees
- Open
- Building
- Water
- Kitchen
- Garden

Step 6: Recognize the areas where tree cover can be increased.
Design interventions – Shading
Design interventions – Vertical greens
Design interventions – Double wall with Jaali
Design interventions – Wind barriers
Design interventions – Evaporative cooling
Design interventions – Cool roof
Anil Aggarwal Environment Training Institute
PASSIVE MEASURES

Microclimate Enhancement
- Water bodies
- Plantation
- Shading of open areas
- Vertical plantation
- Permeability of surfaces.
- Etc.

Building Form
- Courtyard planning
- Mutual Shading of building blocks
- Favourable orientation
- Etc.

Envelope/Material
- Window shading
- Building envelope’s heat resistance
- Cool Roofs
- Insulated roofs
- Creation of buffer zones.
- Appropriate building materials.
- Etc.

Ventilation strategy

Daylighting strategy

Incident Solar Radiation for Summer

- Vertical plantation
- Permeability of surfaces.
- Etc.
Plantation for microclimate enhancement

Microclimate Enhancement

- Water bodies
- Plantation
- Shading of open areas
- Vertical plantation
- Permeability of surfaces.
- Etc.
Courtyard typology

Building Form

- Courtyard planning
- Mutual Shading of building blocks
- Favourable orientation
- Etc.
Narrow courtyard

Building Form

- Courtyard planning
- Mutual Shading of building blocks
- Favourable orientation
- Etc.
**Material: Cool roof, insulated walls, double glazed units**

- **Projection factor** reduces direct incidence of solar heat gain
- Effective Solar Heat Gain Co-efficient: 0.25

- **Window to Wall ratio** of 30%
  - Double Glazed Unit
  - U-Value: 2.8 W/ m²K

- Transmits five to six times lesser heat compared to a conventional nine inch (230mm) red brick wall
Thank you