Heat Action Plan Recommendations for Informal Settlements in Pimpri-Chinchwad Municipal Corporation

This policy recommendation document shares details of indoor and outdoor cooling strategies for informal settlements with implementation recommendations, followed by short term and long term actions that can be undertaken for strategic implementation and sustenance.

Policy Recommendations:

1. Facilitate the implementation of a diversity of indoor cooling strategies through a contextual approach in marginalised urban settlement structures.

1.1 Indoor Cooling Strategies

Thermal measurements of informal structures in Indian cities have revealed roof temperatures in excess of 50 degree Celsius when air temperatures are 32 degree Celsius. Insides are too hot to inhabit and often do not cool down adequately till about 12 midnight. Initial research has revealed that inhabitants suffer intense thermal stress compounded by lack of adequate rest and sleep, from spending time outdoors while waiting for tolerable internal temperatures. This disproportionately affects women dwellers who must often wake up much earlier than most household members to fetch water from municipal taps and cook food for the household and hence suffer protracted sleep deprivation.

To address this, contextually relevant indoor cooling in informal settlement structures must be facilitated through the availability of a diverse set of material and mechanism options that are deployed ‘in consultation with’ house inhabitants as opposed to a ‘one-size-fits all top-down approach’. A holistic overview of interlinked issues, challenges, etc. need to be considered for context-appropriate implementation e.g. A singular strategy to cool roofs of all homes in a city won’t work given that roofs are used for a plurality of purposes by residents. Additionally, heat stress solutions cannot be implemented in isolation from other structure related issues e.g. Water ingress from the roof during monsoons will need to be factored into the implementation of roof retrofit based thermal comfort solutions to avoid augmenting the vulnerability of low-income households that are already socio-economically and climatically disadvantaged.

The indoor cooling strategies described below encapsulate a diversity of passive cooling mechanisms such as roof insulation, roof shading, roof radiant barriers, night-sky radiation, evaporation and thermal mass (eg. as made possible by Green roofs) in addition to low-cost active cooling appropriate technologies which can be implemented and maintained through support from an informal housing thermal comfort local service ecosystem comprising local material suppliers, fabricators, installation persons, women's cooperatives and financial institutions (as needed) as detailed under the implementation strategy section (ref 1.2).

1.1.1. Thermal Mass

Thermal mass is the ability of a material to absorb and store heat energy. When incorporated on the roof of the house it will absorb heat during the day and release it by night to cooling breezes or clear night skies

Appropriate Technologies

1. **Water Filled PET bottles:** Water has the highest specific heat capacity than any liquid. Specific heat is defined as the amount of heat one gram of a substance must absorb or lose to change its temperature by one degree Celsius. For water, this amount is one calorie, or 4.184 joules. Thus, it can absorb a lot of heat before its temperature rises. This trait helps it to stabilise temperature in its surroundings. To benefit from this heat resisting property of water, locally available discarded PET bottles are filled with water and stuck on the roof. This low cost, zero energy passive thermal comfort solution increases the thermal mass of the roof i.e., its ability to store heat, for a longer duration before letting it seep into the house through the day and reversing the heat transfer process of the water during the night, since the warmed water during the day gets cooled during the night due to the drop in ambient temperature, which in turn keeps the roof cool the next morning even when the sun starts to heat up.

Water-filled PET bottles on a tin-roof

1.1.2. Thermal Mass and Shading

A combination of thermal mass (i.e. the ability of a material to absorb and store heat energy. When incorporated on the roof of the house it will absorb heat during the day and release it by night to cooling breezes or clear night skies) and shading incorporated over the roof can reduce indoor temperatures.

Appropriate technologies

1.Rooftop Gardens: Rooftop Gardens comprise a layer of vegetation cultivated in diverse ways on the roof e.g. in pots, brick beds, wooden crates, grow bags, etc. They facilitate cooling in informal housing structures through shading from the vegetation that facilitates reduction of heat ingress (i.e. passive cooling) through shading provided by the leaf foliage of plants, thermal mass of the soil, and evaporation/evapotranspiration (adiabatic cooling) effect of water evaporation from the soil and leaf surface enabling conductive heat loss from the roof sheet below which in-turn reduces mean radiant temperature of the occupied space below, in addition to serving as a source of food for the household.

Rooftop Garden (on a tin-roofed house)

1.1.3. Radiant Barrier

Radiant barriers consist of a highly reflective material that reflects radiant heat rather than absorbing it thereby reducing indoor temperature when retrofitted to the roof. They can be installed as static barriers (under the roof) and also dynamic over the roof barriers i.e. they can be opened and closed, thereby facilitating cooling through shading the roof from the sun's heat when closed during the day and from night-sky radiation when opened at night.

Appropriate Technologies

1. **Alufoil Static Installation:** Alufoil a cross-linked polyethylene foam (also known as XLPE) is a closed-cell foam characterised by a compact feel and resistance to water. It is covered with a low-emissivity and high reflectivity aluminium coating on one side which ensures no heat is emitted to the surrounding surfaces. When stuck under the roof with a strong adhesive with its shiny side facing downwards alufoil supports insulation and ensures that the heat coming through the roof doesn't get transferred to the house as the shiny side facing down doesn't emit the heat absorbed by the foam. In the

context of the material used, explore and substitute currently used industrially produced alufoil with local and reused inorganic waste materials such as reused inner reflective lining of MLP packets.

Alufoil Static (under a tin-roof)

2. **Alufoil Pipe Motor :** Alufoil a cross-linked polyethylene foam (also known as XLPE) is a closed-cell foam characterised by a compact feel and resistance to water. It is covered with a low-emissivity and high reflectivity aluminium coating on one side which ensures no heat is emitted to the surrounding surfaces. The pipe motor installation comprises an alufoil sheet (configured as a folded 'accordion' horizontally deployed 'curtain') that extends over the entire primary roof in its closed position, functioning as a radiant barrier that blocks solar radiation during the day time i.e. the roof is 'shaded' through this mechanism in the day time. After sun-down, to promote radiation of internally accumulated heat embedded in the roofing material and re-radiation of ambient heat absorbed during the day, the Alufoil sheet retracts, eliminating any impediment to heat transfer that is achieved by exposing the primary roofing material to the cool night sky which facilitates the process of natural cooling through night sky radiation. This diurnal cycle of operation restores thermal comfort conditions within the structure below to acceptable conditions that promote human wellbeing. In the context of the fabrication of this installation and the material used, explore alternatives for local fabrication through the deployment of appropriate technology and substitute currently used industrially produced alufoil with reused inorganic waste, biodegradable hand-crafted materials (eg. khadi, sheep wool, rice-husk, areca nut leaf-based panels with reused inner reflective lining of MLP packets).

Alufoil Pipe Motor (on a tin-roofed house)

3. **Alufoil Chain Sprocket:** Alufoil a cross-linked polyethylene foam (also known as XLPE) is a closed-cell foam characterised by a compact feel and resistance to water. It is covered with a low-emissivity and high reflectivity aluminium coating on one side which ensures no heat is emitted to the surrounding surfaces. The chain sprocket installation comprises an exo-skeletal structure (functioning as a operable 'second' roof) that extends over the entire primary roof in its closed position, functioning as a radiant barrier that blocks solar radiation during the day time i.e. the roof is 'shaded' through this mechanism in the day time. After sun-down, to promote radiation of internally accumulated heat embedded in the roofing material and re-radiation of ambient heat absorbed during the day, the panels assume a vertical position, eliminating any impediment to heat transfer that is achieved by exposing the primary roofing material to the cool night sky which facilitates the process of natural cooling through night sky radiation. This diurnal cycle of operation restores thermal comfort conditions within the structure below to acceptable conditions that promote human wellbeing. In the context of the fabrication of this installation and the material used, explore alternatives for local fabrication through the deployment of appropriate technology and substitute currently used industrially produced alufoil with reused inorganic waste, biodegradable hand-crafted materials (eg. khadi, sheep wool, rice-husk, areca nut leaf-based panels with reused inner reflective lining of MLP packets)

Alufoil Chain Sprocket (on a tin-roofed house)

4. **Alufoil Sliding:** Alufoil a cross-linked polyethylene foam (also known as XLPE) is a closed-cell foam characterised by a compact feel and resistance to water. It is covered with a low-emissivity and high reflectivity aluminium coating on one side which ensures no heat is emitted to the surrounding surfaces. The sliding installation comprises an exo-skeletal structure (functioning as a operable 'second' roof) that extends over the entire primary roof in its open position, functioning as a radiant barrier that blocks solar radiation during the day time i.e. the roof if 'shaded' through this mechanism in the day time. After sun-down, to promote radiation of internally accumulated heat embedded in the roofing material and re-radiation of ambient heat absorbed during the day, the installed apparatus folds into a stack of panels in its closed position, thereby exposing a majority of the primary roofing material to the cool night sky which facilitates the process of natural cooling through night sky radiation. This diurnal cycle of operation restores thermal comfort conditions within the structure below to acceptable conditions that promote human wellbeing. In the context of the fabrication of this installation and the material used, explore alternatives for local fabrication through the deployment of appropriate technology and substitute currently used industrially produced alufoil with reused inorganic waste, biodegradable hand-crafted materials (eg. khadi, sheep wool, rice-husk, areca nut leaf-based panels with reused inner reflective lining of MLP packets)

Alufoil Sliding (on a tin-roofed house)

1.1.4. Insulation

Thermal insulation reduces heat transfer and helps minimise indoor temperatures when incorporated in a house structure.

Appropriate Technologies:

1. **Wood Wool Panel:** Wood Wool Panel is an environment-friendly, recyclable material made from wood wool, cement and water. It is installed under the roof. It supports insulation and ensures that the heat coming through the roof doesn't get transferred to the house. Other insulation materials eg. Reused inorganic waste, hand-crafted materials etc can be explored with alternatives for local fabrication through deployment of appropriate technology.

Wood Wool Panel (under a tin roof)

1.1.5 Ventilation

Ventilation makes use of natural forces such as wind and thermal buoyancy to circulate air to and from an outdoor space, facilitating indoor cooling.

Appropriate Technologies:

1. **Dormer Window:** Dormer window is a hump shaped window that is designed to be retrofitted onto existing corrugated steel/tin/cement roofs. It is made of fibreglass moulded into a hump to be retrofitted. The pane is made of translucent plastic to diffuse light and avoid glare. The mechanism works on the principle of convective ventilation where warm air rises up and vents out of the Dormer window. The window ideally needs to be fit on the highest available height for the principle to function. The fibre reinforced plastic is moulded into a hump with an opening at the bottom towards the interior of the house to allow warm air to circulate and vent. The gap is covered with a metal net to prevent insects and other animals from getting in the house. The translucence of the fibre-glass material used for fabricating the moulded window also enables the ingress of natural light into the interior space. In the context of fabrication, alternatives for local fabrication should be explored through deployment of appropriate technology, and industrial materials should be substituted with reused inorganic waste, biodegradable hand-crafted materials, as appropriate.

Dormer Window

**Note – For more details of appropriate technologies mentioned under point's 1.1.1 to 1.1.5. refer to this link.*

1.1.6 Low-cost modular active cooling

Active cooling mechanisms are dependent on energy sources (i.e. electric, solar, etc) to facilitate cooling. Low-cost modular sustainable active cooling mechanisms are more energy-efficient, affordable and less ecologically

destructive than conventional energy guzzling, climate polluting air-conditioners.

Appropriate Technologies:

1. **DIY (Do-It-Yourself) Structure Cooling 'Kit':** A structure cooling system removes the heat in the structure by way of water flowing through pipes. It impedes solar heat gain from roof and floors by absorbing it before causing thermal discomfort to occupants. The system comprises piping, storage tank, a cooling system and a pump which are locally available. The only active elements are a pump & fan that use negligible energy that a Solar PV Panel can address. For more information refer to the following link.

2. **DIY Evaporative Cooling Kit:** These systems work on the principle that water (like all liquids) extracts heat from the surrounding environment when it undergoes phase-change from a liquid to a vapor. In these systems, a fan draws hot outside air through the water-soaked pads. Adding heat to this water evaporates it. When this evaporated water vapor is combined in the air, the air temperature is reduced. A temperature reduction of as much as 20 degrees can be achieved using this system of cooling. These DIY coolers can be made from readily available local hardware materials and can be assembled by residents of informal settlements if supported through assembly instruction manuals developed through human-centric design processes.

3. **DIY Dessicant Dehumidification Wheel Kit:** Desiccant dehumidifiers contain a desiccant wheel with a silica gel surface, a drive motor and belt, a small heater (which can be solar-thermal powered to reduce dependence of electrical energy), and a blower. Damp outdoor air is drawn into the dehumidifier, passing through the slowly turning desiccant wheel where moisture is adsorbed and collected on the silica gel. Most of the dry air enters the indoor space in informal settlement homes while a small portion of the dry air is reactivated by heating through the solar thermal panel. This warmed, dry air, called regeneration air, is passed through the desiccant wheel to dissipate the moisture collected on its surface, regenerating the silica gel on the wheel. These low-energy dehumidification systems will become imperative to respond to extreme thermal stress (caused by a combination of high air temperatures and high humidity) in informal settlements in Indian cities which might be currently classified as belonging to hot-dry climatic zones (eg. Pune) but are anticipated to experience acute increases in humidity and precipitation as climate change effects intensify in the coming years and decades. The periods when high temperature and humidity intersect are significantly more hazardous to human health than when either one of these effects are dominant. At these times, merely relying on passive cooling solutions will not achieve adequate mitigation of heat stress that protects human health and wellbeing, and these active cooling solutions which can address extreme humidity, will become essential. Most elements of these DIY desiccant dehumidifiers can be made from readily available local hardware materials, regionally produced solar panels, and small amounts of industrial chemicals (silica-gel) and can be assembled by residents of informal settlements if supported through assembly instruction manuals developed through human-centric design processes.

4. **DIY Thermostorage 'Ice-Box' ACs:** These systems hinge upon the use of either chilled phase-change-materials (eg. silica gel packs used for household remedies for healing inflammations etc.) or ice blocks to achieve cooling and

dehumidification of indoor spaces. The primary mechanism employed in these systems is the blowing of ambient air over these cold surfaces (configured as portable replaceable cartridges that can hold the gel packs or reusable plastic ice cubes) placed in insulated boxes (eg. thermocol boxes) and the re-directing of this cold air through tubes ducts etc. towards occupants of the indoor space (i.e. point of use cooling, similar to systems employed in automobiles and aircrafts which rely upon directly cooling the air volume around the occupant rather than cool the entire volume of air in the space) The regeneration of the functional materials that have exhausted their cooling capacity can be accomplished at local small-scale solar-thermal energy based chilling plants (using Solar VAM Technology) and be operated by women's cooperatives as a micro-scale local business.

1.2. Implementation Strategy

The strategy is rooted in knowledge-sharing, collaboration and network building to facilitate creating space for residents' perspective integration to enable context-appropriate needs-based thermal comfort technology implementation.
It comprises 'annual' awareness drives, capacity building trainings and the development of an online 'PCMC-Informal Housing Thermal Comfort One-Stop-Shop (OSS)' and offline ward-based OSS centres, to:

a. Enable self-implementation of appropriate cooling technologies by residents.
b. Establish an 'Informal Housing Thermal Comfort' service ecosystem comprising women's cooperatives, fabricators, welders, material suppliers, microfinance institutions and other service providers.

1. PCMC- Informal Housing Thermal Comfort Digital One-Stop-Shop (OSS) :

1. Integrate an 'Informal Housing Thermal Comfort OSS' digital portal on the PCMC website (similar to the Citizen Facilitation Centre portal) through the Department of Information and Technology to :
    a. Provide citizens and service providers with technical information on thermal comfort providing appropriate technologies for self-implementation.
    b. Provide citizens with technical service provider contacts (eg. suppliers, fabricators, house auditors, electricians, installation persons, etc)
    c. Provide citizens with financial service provider contacts (eg. microfinance institutions, etc)
    d. Provide citizens with a platform to apply for and track progress of 'thermal comfort retrofit service implementation and maintenance' by women's cooperatives (Responsibilities of women's cooperatives are detailed in Annexure 2)
    e. Provide women's cooperatives, suppliers, fabrication and installation persons, financial institutions and other service providers with a platform to indicate their availability to support citizens with thermal comfort retrofit implementation and maintenance.

f. Create a platform for women's cooperatives to access financial resources from CSRs, city electric utility driven DSM programs[1], microfinance institutions, impact investment platforms, etc.
g. Enable residents (i.e. people inhabiting informal settlements in PCMC) and other non-resident thermal comfort practitioners (eg. researchers, research institutes, etc) to notify the PCMC of new thermal comfort innovations and share details of the same through the OSS platform, which can be reviewed by the PCMC (eg. by the Environmental engineering department) and cleared for updation to the OSS .

A draft suggestive design for the OSS portal is detailed in Annexure 1

2. OSS - Physical centre establishment and operation:

1. Set up ward-level physical OSS centres and operate them year round for people without access to and experience with digital technology (e.g. smartphone, computers, etc.) to:
    a. Share thermal comfort retrofit information through print mediums such as pamphlets, posters, booklets, etc.
    b. Facilitate registration to the OSS portal through a digital system (eg. computer, smart phone), as requested by a resident or service provider.

3. Annual awareness drives to inform citizens about thermal comfort retrofits and the OSS:

1. Train and contract local NGOs to conduct annual physical ward-level awareness drives (preferably during every October heat period i.e. when the thought of summer-heat is alive, to enable proactive implementation and maintenance of thermal comfort solutions before the peak summer period) to inform people about the availability of cooling measures, the OSS digital and physical centres.
2. Conduct digital and print media awareness campaigns through the Department of Information and Public Relations, to inform people about the availability of indoor cooling measures, OSS digital portal and physical centres, annually (preferably during every October heat period i.e. when the thought of summer-heat is alive and to enable proactive installation and maintenance of thermal comfort retrofits before the peak summer period)

4. Annual awareness drives to inform service providers about thermal comfort retrofit based skill building certificate programs:

1. Contract local NGOs to conduct physical awareness drives to inform fabrication, installation persons, house auditors and women's cooperatives of thermal comfort intermediate technology service providing technical and management skills certificate programs, before every annual training program period.
2. Conduct digital and print campaigns through the Department of Information and Public Relations to inform fabrication, installation persons, house auditors and women's cooperatives of thermal comfort intermediate technology service providing technical and management skills certificate programs, before every annual training program period.

[1] A Demand Side-Management (DSM) program can be introduced wherein a 'Thermal Comfort Equity Cess' is imposed on high-energy consuming utility users, especially commercial establishments with installed AC capacity above a certain threshold etc. Revenue generated from the 'Cess' could be deployed either directly or indirectly through women's cooperatives, etc.

5. Thermal comfort retrofit service provider skill building through annual certificate training programs:

1. Contract experienced thermal comfort retrofit design and social engagement practitioners to conduct technical, safety supervision and social engagement Training Of Trainer (TOT) workshops of cooling interventions, with relevant vocational training partners (e.g. CSOs, ITI institutes, etc). These trainings can be supported by CSR programs, impact investment platforms etc.
2. Contract experienced vocational training CSOs and government training institutes (eg. ITI institutes) to conduct annual thermal comfort retrofit certification training programs for fabrication and installation persons, house auditors, women's cooperatives etc. These trainings can made accessible to program participants for a minimal refundable fee e.g. INR 2500 (this is to ensure accountability by participants through the training process) or full scholarship (in cases where participants are unable to pay the refundable fee). Training costs can be supported majorly by government schemes, CSR programs, impact investment platforms, city utility DSM programs, etc.
3. Contract vocational training CSOs to conduct Women's Cooperative vocational training management certification programs, annually. These trainings can made accessible to program participants for a minimal refundable fee e.g. INR 2500 (this is to ensure accountability by participants through the training process) or full scholarship (in cases where participants are unable to pay the refundable fee). Training for women's cooperatives can be supported through already existing PCMC schemes eg. PCMCs 'Entrepreneurship development program' (Scheme No.7). CSR programs, impact investment platforms etc. can be other sources of funding to enable management training for women's cooperatives through full scholarships.

2. Facilitate the implementation of outdoor cooling strategies through a contextual approach in marginalised urban settlements.

2.1. Outdoor Cooling Strategies

Informal settlements in urban spaces are most vulnerable to the 'Urban Heat Island effect' resulting from high density of built mass, and hardscaping of pavements, open spaces and roads with concrete blocks that absorb and retain heat contributing to increased outdoor temperatures in a city.

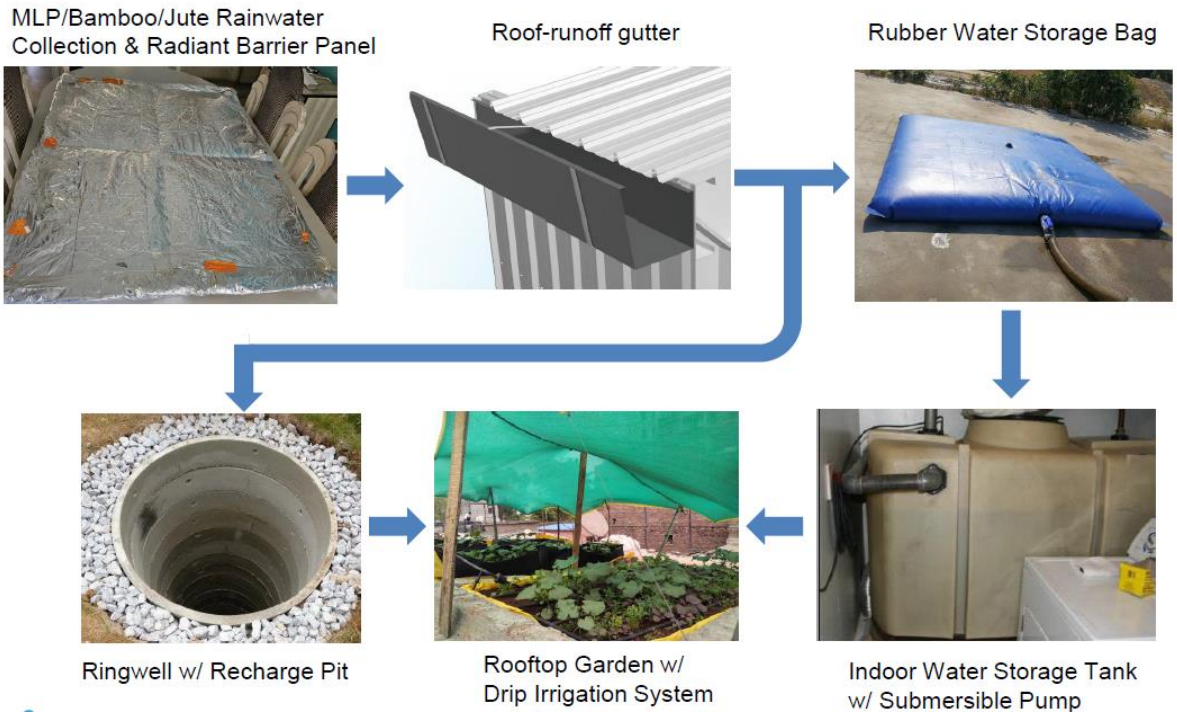
Restoration of degraded water bodies and the integration of rainwater harvesting infrastructure with the use of local materials and intermediate technology to support groundwater recharge are recommended to facilitate thermoregulation of the microclimate in informal settlements and cities as a whole. These are to be implemented in consultation with stakeholders from the community through a participatory approach.

2.1.1. Rainwater Harvesting (RWH)

Drastic reduction in underground moisture and groundwater table diminishes thermal mass, and the beneficial dampening effect of a terrain which inflames the urban heat island effect. Water deprivation further severely undermines the possibility of urban agriculture, and rooftop gardening atop homes; both of which are field-verified solutions to address extreme indoor heat stress and contributors to food resilience amongst marginalised communities. Rainwater harvesting for groundwater recharge is an urban heat-island effect minimising strategy in the micro-climate of informal settlements. The implementation strategy for this intervention is mentioned under section 2.2 (A).

Appropriate Technologies:

Rainwater harvesting for groundwater recharge can be facilitated by installing a MLP/Jute/Bamboo-panel based 'pergola' for rainwater capture atop structurally supported metal & cement-asbestos sheet roofs with/without rooftop garden and storing the rainwater using rubber 'bellows' and/or storage bags and a network of recharge pits. In houses with rooftop gardens, the groundwater can be directed upwards through a network of ring wells and submersible pumps.



Rainwater Harvesting System (Preliminary Design)

2.1.2. Waterbody Revival

Presently most water bodies in urban areas manifest deterioration due to pollution and concretization of the water body eg. walls around the edges and, concrete paved banks, etc. which negatively impact temperature regulation among other life-supporting abilities by these ecosystems.

Restoration and conservation of nature based solutions such as water ecosystems located in (e.g. ponds, lakes etc.) and passing through (e.g. rivers, rivulets, streams,) informal settlements, with a socio-ecologically sensitive manner through participatory

engagement processes should be prioritised to facilitate heat island effect mitigation in informal settlements.

Nature Based Solutions:

Naturally occurring water bodies are ecosystems comprising the water itself, the water-bank, the bed of the water body, local flora and fauna. From a thermal comfort perspective water facilitates cooling through evaporation and heat absorption, while the flora supports cooling through evapotranspiration in addition to shading from trees. The water banks additionally facilitate groundwater recharge which supports temperature reduction, as described in section 2.1.1. Water Bodies as a whole therefore contribute to the creation of more comfortable environments by mitigation of the Urban Heat Island effect. They also offer co-benefits such as carbon sequestration and storm water management in addition to other ecosystem services.

Restoring a waterbody should involve simulating its natural form including its vegetation, terrain, etc. for eg. this link shares an example of a water body revival initiative undertaken along a selected portion of a waterbody in Pune. When undertaken in the context of informal settlements, such processes should be facilitated through a participatory approach primarily in consultation with informal housing community members among other stakeholders and conservation should be supported through the incorporation of governance mechanisms. For the implementation strategy refer to 2.2 (B)

2.2. Implementation Strategy

A. Rain Water Harvesting

1. Integrate RWH infrastructure with local materials and intermediate technologies as part of already existing PCMC initiatives :

1. Integrate RWH system deployment through local materials and intermediate technology as part of the PCMCs Sustainability Cells' 'Environment Conservation Initiative' that mandates Rain Water Harvesting in institutional establishments.
2. Integrate incentivization of RWH through local materials and intermediate technologies in informal settlements as part of the 'Sustainable Urban Landscape' initiative of PCMCs Sustainability cell which incentivizes RWH.

2. Integrate RWH as part of OSS services:

1. Incorporate RWH technical trainings as detailed under the indoor cooling strategy implementation plan (ref 1.2) to contract trained personnel e.g. Engineers, plumbers, women's cooperatives etc. for RWH system implementation and maintenance. The details of the plan are as follows :
    a. Contract experienced thermal comfort retrofit design and social engagement practitioners to conduct technical, site safety supervision and social engagement Training Of Trainer (TOT) workshops of cooling interventions, with relevant vocational training institutions and organisations. These trainings can be supported by CSR programs, impact investment platforms etc.
    b. Contract experienced vocational training CSOs and government training institutes (eg. ITI institutes) to conduct annual thermal comfort retrofit certification training programs for fabrication and installation persons, house auditors, women's cooperatives etc.. These trainings can be

accessed for a minimal refundable fee eg. INR 2500 (this is to ensure accountability by participants through the training process) or full scholarship (in cases where participants are unable to pay the refundable fee) by program participants. Training costs can be supported majorly by government schemes, CSR programs, impact investment platforms, city utility DSM programs, etc.

c. Contract vocational training CSOs to conduct Women's Cooperative vocational training management certification programs, annually. Training for women's cooperatives can be supported through already existing PCMC schemes e.g. PCMCs 'Entrepreneurship development program' (Scheme No.7). CSR programs, impact investment platforms etc. can be other sources of funding to enable management training for women through full scholarships.

3. Integrate RWH as part of annual awareness drives to inform service providers about thermal comfort service based skill building certificate programs (ref 1.2.)**:**

1. Contract local NGOs to conduct physical awareness drives to inform fabrication, installation persons, house auditors and women's cooperatives of thermal comfort intermediate technology service providing technical and management skill certificate programs, before every annual training program period.
2. Conduct digital and print campaigns through the Department of Information and Public Relations to inform fabrication, installation persons, house auditors and women's cooperatives of thermal comfort intermediate technology service providing technical and management skills certificate programs, before every annual training program period.

4. Integrate RWH as part of annual awareness drives to inform citizens about thermal comfort intervention options and OSS portal (ref 1.2)**:**

1. Train and contract local NGOs to conduct annual physical ward-level awareness drives to inform people about the availability of indoor cooling and outdoor cooling measures (including RWH), the OSS digital and physical centres (preferably during every October heat period i.e. when the thought of summer-heat is alive, to enable proactive implementation of thermal comfort solutions before the peak summer period).
2. Conduct digital and print media awareness campaigns through the Department of Information and Public Relations, to inform people about the availability of indoor cooling measures and outdoor cooling measures (including RWH), OSS digital portal and physical centres, annually (preferably during every October heat period i.e. when the thought of summer-heat is alive and to enable proactive installation of thermal comfort retrofits before the peak summer period)

B. Waterbody Revival

1. Incorporate 'Waterbody Revival and Conservation' in informal settlements as part of already existing conservation initiatives by PCMC :

Eg. Incorporate revival of waterbodies located in and passing through informal settlements as part of the PCMC Sustainability Cells 'Environment Conservation Initiatives'.

2. **Integrate water body revival in the narrative of annual cooling awareness drives** (ref 1.2) **:**
    1. Train and contract local NGOs to conduct annual physical ward-level awareness drives to inform people about the availability of indoor cooling and outdoor cooling measures including RWH (ref 2.1.1) and the need for water body revival, as applicable to their contexts.
    2. Conduct digital and print media awareness campaigns through the Department of Information and Public Relations, to inform people about the availability of indoor cooling and outdoor cooling measures including RWH (ref 2.1.1) and the need for water body revival, as applicable to their contexts.

3. **Co-create waterbody revival plans and undertake implementation 'with' the community to avoid exacerbating problems faced by already vulnerable inhabitants of informal settlements**:

    Co-create a plan and undertake a contextually relevant implementation process (i.e. a process that is sensitive to the socio-economic, ecological and climatic context) developed through a participatory approach i.e. 'in consultation and with support from residents' who are knowledgeable about their context, in collaboration with practitioners who have experience with water body revival through nature-based solutions, intermediate technologies and other related restoration and conservation activities (eg. social scientists, ecologists, health department, environmental engineering department, garden department etc)

4. **Facilitate the development of water body governance systems as part of conservation efforts:**

    Contract social science practitioners to facilitate the establishment of local water body governance institutions (eg. water cooperatives, federations etc) with representation from stakeholders located along the water body including informal housing residents, ward representatives and other entities etc. for grassroots ownership to cultivate sustained reciprocity towards the water body for its life-supporting services(flood control, cooling, mental and physical health revival, etc)

Short Term and Long Term Actions for Indoor and Outdoor Cooling in Informal Settlements based on Policy Recommendations

1. Short-term Actions:

Timeframe- 1.5 years (max)

Action Steps:

1. Undertake implementation of rooftop gardens in public schools in PCMC similar to the School Kitchen Gardening Initiative by the BMC[2] through a context-based implementation approach i.e. in consultation with users of the space. (Details of a context-based implementation approach can be referred to in this document.)
2. Undertake pilot demonstrations of indoor cooling thermal comfort retrofit solutions in each PCMC ward (e.g. installations in a minimum of 15 houses per ward of which a minimum of 3 houses are retrofitted with the same or similar intermediate technologies). Details of a community engagement approach for pilot demonstrations can be referred to in this document.
3. Undertake foundation building for long term actions (e.g. networking, collaborations, OSS digital portal creation, etc)

2. Long-term Actions:

Timeframe - Annual

Action steps:

1. Operate the online and offline Informal Housing Thermal Comfort One-Stop-Shop portals.
2. Conduct annual awareness drives to inform citizens about thermal comfort intervention options and OSS portal.
3. Conduct annual awareness drives on thermal comfort training certificate programs.
4. Conduct annual capacity building certificate programs for informal housing thermal comfort service providers.
5. Facilitate conservation activities for degraded water bodies 'with' residents from informal housing communities.

For detailed descriptions of the above mentioned points refer to sections 1.2 and 2.2.

[2] Bose,Nayonika. *BMC goes green: Kitchen gardens to be installed at 25 civic schools*. The Indian Express. Retrieved August 2, 2023, from https://indianexpress.com/article/cities/mumbai/bmc-goes-green-kitchen-gardens-to-be-installed-at-25-civic-schools-8867160/

ANNEXURES:

Annexure 1:

OSS digital portal draft suggestive design:

<table>
<tr><th colspan="4">User Registration/Login Page</th></tr>
<tr><td colspan="4">Choose type of service :
● Self-Implementation
● Implementation through Women's Cooperative
● Service Provider Registration
● Thermal Comfort Innovation Proposal Upload</td></tr>
<tr><th>Self-implementation page</th><th>Implementation through women's cooperative page</th><th>Service provider registration page</th><th>Thermal Comfort Proposal Upload Page</th></tr>
<tr>
<td>Links to

1. Installation planning material and contacts :
a. Cooling Solution Details
b. Structure Audit Template
c. Cost estimate template
d. Directory of Microfinance Institutions
e. Directory of structural auditors
f. Directory of solution-specific fabricators
g. Directory of solution-specific installation persons
h. Directory of electricians
i. Directory of suppliers

2. Safety checklist and related contacts :
a. Installation Safety-Checklist
b. Directory of fire stations</td>
<td>1. Select Time slot for household and structure audit

2. Status of Application page indicating :
a. Notification of house audit request to Ward Level Women's Cooperative
b. Completion of household and structure audit visit

3. Payment page for audit services.

4. Installation recommendation download page

5. Indicate willingness to proceed with installation

6. MFI contact details for loan approval (as needed)</td>
<td>1. Select type of service
2. Upload 'Training Certificate' (not applicable for material suppliers)
3. Add contact details
4. Information Review
5. Upload details</td>
<td>1. Page to enter thermal comfort innovation details :
a. Name of Innovation
b. Brief description of innovation
c. Benefits of innovation
d. Downsides of innovation (if any)
e. List of materials
f. Guidelines on how to fabricate/install/implement innovation
g. Guidelines on how to operate the innovation (as applicable)
h. Maintenance guidelines
2. Page to upload images of thermal comfort innovation
3. Reference links (if applicable)</td>
</tr>
</table>

c. Directory of hospitals. d. Child Rights NGOs e. Womens Rights NGOs 3. For grievance registration : a. Ward-level Grievance redressal officer contact b. Grievance submission page	7. MFI loan approval status indication page 8. Pre-installation payment page 9. Status of Application page indicating : a. Initiation of fabrication and installation b. Completion of fabrication and installation 10. Post-installation payment page 11.Installation maintenance support request page 12.Grievance submission page		4. Click Submit to notify the PCMC of your innovation idea

Annexure 2:

Women's Cooperative responsibilities:

1. To document context-specific information of individuals/families interested in retrofitting their house with a thermal comfort solution through :
    a. A human-centric survey aimed at understanding the individual/families hopes, concerns and suggestions for the thermal comfort intervention.
    b. Physical structure audit
2. To draft audit report
3. To coordinate safety-supervision of retrofit fabrication and installation
4. To address implementation based grievances by households.
5. To undertake retrofit maintenance.