The Grey Lens

Ageing, Sustainability, and Climate in Our Shared Tomorrow

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TERI Alumni Association

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About the series 'Books for the Concerned Citizen'

Leveraging the diverse expertise of its members in the subject domains and in publishing, the TERI Alumni Association proposes to publish a series of books on topics related to energy, resources, and the environment. The idea is to share information and, even more important, critical insights and understanding, with citizens who are keen to know more about some of the critical issues facing society and the world today but are lost in the deluge of information.

Our target audience is educated adults who are concerned about topical issues but lack the understanding to make sense of what they read or watch in the mass media—the series aims to equip them with conceptual tools and essential information not only to enrich their understanding but also to encourage them to act and thereby, albeit indirectly, further the UN Sustainable Development Goals.

The topics to be covered in this series and their respective subject-matter-specialist authors are listed below.

- *Your City, Your Impact*: Priyanka Kochhar
- *Responding to Climate Change in South Asia: lessons from India*: Divya Sharma, Raina Singh, and Aditya Raghwa
- *Keeping Cities on the Move*: O P Agarwal
- *The Grey Lens: ageing, sustainability, and climate in our shared tomorrow*: Arvindd Narayanan and Ambika Shankar
- *The Untold Story of Waste Treatment Plants*: Hina Zia and Priyanka Kochhar
- *Carbon Markets*: Nitu Goel

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CONTENTS

FOREWORD

India is undergoing two profound transitions that will shape its social and developmental trajectory over the coming decades. The first is demographic. Improvements in healthcare and longevity have resulted in a rapidly growing population of senior citizens, bringing questions of health, care, security, and dignity to the centre of public policy. The second is environmental. Climate change, environmental degradation, and increasing climate variability are altering living conditions across rural and urban India, with direct implications for health, livelihoods, and access to basic services. These transitions are often addressed separately in policy frameworks. In practice, they are deeply interconnected.

Senior citizens experience the effects of environmental change more acutely and more persistently than do most other groups. Rising temperatures, declining air quality, water stress, and extreme weather events place a disproportionate strain on ageing bodies, exacerbate chronic illnesses, and increase the dependence on healthcare and social support systems. These risks are further shaped by housing conditions, mobility constraints, income insecurity, and social isolation. As India's elderly population expands, the intersection of ageing and environmental stress will increasingly influence demands on public institutions and welfare systems.

From the perspective of social justice, this intersection deserves far greater attention than it has received so far. Policies for senior citizens have traditionally focused on income support, healthcare access, and social security. While these remain essential, they are no longer sufficient in a context where environmental conditions directly affect health, functionality, and the quality of life in later years. Ensuring dignity and well-being for senior citizens in the coming decades will require that ageing-related policy engage more explicitly with questions of climate resilience, environmental exposure, and adaptive capacity.

At the same time, it is important to recognize that senior citizens are not only recipients of protection. They carry lived experience of resource conservation, community stewardship, and adaptation to

environmental uncertainties. Practices of restraint, reuse, and collective responsibility, which are now central to sustainability discourse, have long been part of everyday life for many senior citizens. A balanced approach to ageing in a fast-changing climate must therefore recognize both vulnerability and contribution.

This book makes a valuable contribution by examining ageing through what it terms a 'grey lens', bringing together insights from public health, environmental science, social policy, and lived experience. By doing so, the book highlights how climate change influences biological ageing, health outcomes, and institutional readiness while also drawing attention to the role of senior citizens as custodians of knowledge and practice relevant to sustainability.

For institutions engaged in the formulation and implementation of policies for senior citizens, this perspective is particularly relevant. It underscores the need for greater coordination across sectors such as health, housing, urban development, disaster preparedness, and social welfare. It also points to the importance of designing age-friendly climate adaptation strategies that address exposure and risks before they translate into avoidable harm.

I hope this work will draw the attention of policymakers, practitioners, researchers, and civil-society organizations working at the intersection of ageing, environment, and social development. More importantly, I hope it will encourage integrated thinking that places senior citizens firmly within conversations on climate resilience and sustainable development. As India plans for its future, ensuring that senior citizens are able to age with security, dignity, and well-being in a changing environment must remain a shared priority. Additionally, elderly persons shall be motivated to adopt natural approaches for healthy ageing including yoga, naturopathy, and other therapeutic practices.

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Introduction

Ageing and environmental change are rarely spoken of in the same breath: conventionally, the first belongs to the domains of health, welfare, and social policy whereas the second, to those of climate science, environmental governance, and development. Yet for many people, particularly in later life, these distinctions mean little, because the life of the elderly is shaped increasingly by the environmental conditions under which it unfolds.

Heat that persists through the night, air that sears the already-fragile lungs, water that must be conserved and carried with care, neighbourhoods that are waterlogged following heavy showers—all these form the texture of everyday life for a growing number of the elderly. Age not only changes exposure but also lowers tolerance: the body's capacity to adapt narrows, recovery slows down, and what was once easily manageable becomes a nearly unsurmountable obstacle.

At the same time, societies are ageing within systems that were built on different assumptions. Much of the infrastructure that supports daily life, including housing, healthcare facilities, transport networks, and public spaces, was designed when climatic extremes were less pronounced and the elderly constituted only a small proportion of the population. As environmental stress intensifies, the limits of these systems become more visible, particularly when the elderly rely on them the most. Climate change, in this sense, reveals itself gradually, through pressure points that ageing makes harder to absorb.

This book takes that intersection seriously and approaches ageing not as a marginal concern within the climate discourse, and climate not as a background variable in discussions of life in its later years; instead, the book places the two alongside and asks what becomes apparent when they are viewed together. The grey lens is a way of seeing how environmental conditions, biological ageing, social arrangements, and institutional design interact over time.

Older adults occupy a particular position in this landscape. They face heightened risks from heat, pollution, and environmental instability, yet they also carry forms of knowledge

shaped by long engagement with place, resource use, and community life. Many have lived through periods of scarcity, adaptation, and recovery. Their practices of restraint and repair, often dismissed as habits of an earlier generation, speak directly to contemporary concerns about sustainability. To recognize this is not to romanticize the past but to acknowledge its relevance. The discussion that follows draws on research from public health, climate science, and social policy, alongside examples from India and other countries experiencing similar demographic and environmental shifts. It pays close attention to heat and air pollution, which have emerged as pervasive and unevenly distributed risks, and to the ways in which environmental exposure influences the process of biological ageing itself. The discussion also considers how public systems respond under these conditions, and situations under which the assumptions behind public systems no longer hold.

The sections that follow stay close to this reality. They look at how the elderly experience environmental change in their daily lives, how health and living conditions are shaped by heat and pollution, and how public systems respond under pressure. Together, the book offers a way of thinking about ageing that is grounded in the environment in which it now takes place.

A warming world and ageing citizens

The twenty-first century is witnessing two major shifts that influence how societies function. The first is the steady rise in global temperatures and the growing frequency of climate-related stresses. The second is the rise in the number of older adults in national populations. Each of these shifts is well-documented in scientific and demographic studies; however, they are often discussed separately. Climate change tends to be examined in the context of environment and infrastructure whereas ageing is examined in the context of health systems, economic support, and social structures. When both changes occur at the same time, it becomes important to understand how they influence each other. This section explains that relationship and outlines why planning

for the future must include a greater understanding of ageing populations in a warming world.

Population ageing is a clear trend in India and across the world. *The India Ageing Report 2023* projects that India will have about 346 million people aged 60 years and above by 2050—almost a fifth of the national population. Global projections from the United Nations indicate that one in six people in the world will be over sixty by the same year. These demographic changes will influence the demand for healthcare, participation in the economy, and patterns of social support. At the same time, climate patterns show consistent warming. The past decade has included some of the hottest years in recorded history. The Intergovernmental Panel on Climate Change notes that South Asia is likely to experience more frequent and intense heatwaves, episodes of heavier rainfall, and longer dry spells. These environmental stresses affect health, livelihoods, and infrastructure.

Older adults are influenced by both these transitions. They often have a greater need for stable services and regular medical care. Climate-related disruptions can interfere with these needs. Understanding this connection, or the combined effect of both the transitions, helps in designing policies and systems that remain functional in a changing environment.

Ageing populations and development planning

Ageing influences the structure of households, labour markets, and the distribution of public expenditure. Ageing also influences how individuals interact with the environment. Older adults may have reduced mobility, slower physiological responses, and a higher prevalence of chronic conditions. These factors make the elderly more sensitive to environmental changes such as higher temperatures, air pollution, and water scarcity. Planning for a future shaped by an ageing population therefore requires attention to environmental risks as well.

Public discussions about the future often focus on younger populations, emphasizing entrepreneurship, innovation, and

digital transformation. Demographic studies, however, suggest that older adults will play an increasingly central role in shaping community priorities. Many democracies are already observing higher median ages among voters. Their expectations related to healthcare, financial security, public safety, and environmental quality will influence policy decisions.

Cities and settlements need to adjust to this demographic change. Infrastructure systems that were designed around a younger population need to be reassessed. For example, neighbourhoods with high concentrations of older adults require shaded public spaces, accessible footpaths, reliable water supply, and predictable public transport. These needs become more important when temperatures rise or rainfall becomes erratic. Integrating demographic and climate-related considerations in development planning helps ensure that systems remain accessible and resilient to changes.

A useful illustration of this can be seen in Japan, which has one of the world's oldest populations. Rising summer temperatures have led to an increase in heat-related illnesses among older adults. Local governments have responded by establishing community cooling centres and strengthening social support networks that check on older residents during heatwaves. These examples demonstrate how demographic realities shape the measures to adapt to the changing climate.

Climate risks and older adults

Climate change influences health and well-being in several ways. Heatwaves, floods, storms, air pollution episodes, and vector-borne diseases are some of the most visible climate-related risks. Older adults tend to be more vulnerable during such events because ageing affects the body's ability to respond to stress.

The Lancet Countdown 2024 reports a 167% increase in heat-related deaths among adults aged 65 and above since the 1990s. This rise reflects the growing intensity of heat events and the limited capacity of public health systems to protect vulnerable

groups. An example from India illustrates this clearly. The Ahmedabad heatwave of 2010 resulted in a substantial rise in fatalities. Later assessments by the Ahmedabad Municipal Corporation and public health researchers found that older adults were disproportionately affected. This led the city to design one of India's earliest heat action plans, with a focus on early warnings, publicly accessible points that dispense drinking water, and targeted outreach to vulnerable residents. This experience shows how heat affects older populations and how planning can reduce that risk.

Floods and storms also pose challenges. During the Chennai floods of 2015, many older adults living alone found it difficult to evacuate quickly when water levels rose. Disruptions in transport made it hard for families to reach older relatives. Power failures affected refrigeration for essential medicines. Similar patterns were observed during the Kerala floods of 2018, in which many older people required assistance to move to shelters. Relief workers noted that medical needs, limited mobility, and dependence on regular medication made older adults particularly sensitive to prolonged disruptions. These examples highlight that climate events quickly become health events for older populations.

Elsewhere in the world, similar patterns are being repeated. The heatwave in France in 2003 resulted in thousands of deaths, with the majority of deaths being of older adults who lived alone in urban apartments that retained heat. Hurricane Katrina in the United States in 2005 showed that a significant share of those who lost their lives comprised older adults who could not evacuate in time. These events demonstrate that ageing and climate risk are closely linked across different contexts.

Air pollution is another factor that affects older adults more severely. Studies from the World Health Organization show that long-term exposure to particulate matter increases the risk of respiratory and cardiovascular diseases. Older adults who already live with these conditions face greater deterioration in health

during periods of high pollution. This is relevant for many Indian cities in which seasonal spikes in pollution have become common.

Environmental stress and the biology of ageing

Recent scientific studies explore how environmental conditions may influence biological ageing. Research from the University of Southern California in 2025 indicates that adults above 56 who live in regions with prolonged exposure to high temperatures and air pollution may experience accelerated biological ageing. The study estimates that such exposure could increase biological ageing by up to 14 months. Although this field of research is still growing, the findings suggest that the environment interacts with physiological processes in measurable ways.

This understanding has implications for public health planning. Clean air, access to green spaces, effective waste management, and climate-responsive housing designs become essential components of healthy ageing. Urban environments with limited vegetation and large built-up areas tend to trap heat and intensify its effects. This can impose daily stress on older adults. Incorporating tree cover, reflective roofing, and natural ventilation in housing can help reduce indoor temperatures. In rural areas, stable water supply, soil conservation, and sustainable agricultural practices can reduce environmental stressors that indirectly affect older populations.

Healthcare systems also need to take into account climate-related stress. Older adults often require regular medical monitoring. Extreme weather can interrupt access to clinics or delay the delivery of medicines. Integrating climate preparedness within primary healthcare can reduce such risks. Examples include training health workers to recognize symptoms of heat stress in older adults, maintaining registers of highly vulnerable individuals, and ensuring adequate supplies of essential medicines during peak climate events.

Older adults and contributions to sustainability

Although older adults show specific vulnerabilities, they also contribute to sustainability. Many among the present older

individuals grew up in periods of scarce resources, and their habits of storing, reusing, repairing, and conserving reflect this experience. These behaviours reduce waste and align with current sustainability goals. In rural communities, older farmers possess knowledge about traditional crop varieties, soil management, and water harvesting. This knowledge is valuable for adapting to climate variability.

A study published in 2023 observed that older adults in London participated actively in environmental discussions and adopted low-carbon practices. In India, older community members often play a greater role in managing village ponds, protecting local forests, and guiding community-based organizations. Their presence in local governance adds stability and continuity. Recognizing these contributions helps balance discussions on ageing and shows that older adults may be vulnerable but are also important actors in building resilience.

Moral and policy considerations

The combined effects of ageing and climate change raise ethical and policy questions. Societies rely on older generations for cultural knowledge, caregiving, and economic contributions. Ensuring their well-being during events of climate stress is a measure of social responsibility and reflects institutional strength. Policies that support older adults during extreme weather include those that ensure reliable power supply, accessible shelters, efficient public transport, and strengthened primary healthcare. Programmes that provide financial assistance for home repairs, cooling appliances, or medical needs can help reduce vulnerability.

Countries have begun to respond to these challenges. India's National Disaster Management Authority has developed guidelines for heat action plans, and several cities have adopted the former. Some state governments have included older adults as priority groups in evacuation planning. Internationally, countries such as Japan, France, and South Korea have introduced community support networks, heat health warning systems, and social check-in programmes for older residents during high-risk

periods. These examples show that considerations for the ageing population can be integrated into strategies aimed at adapting to the changing climate.

Towards an integrated approach

Ageing and climate change are interconnected transitions that shape health, livelihoods, and development. Climate stress influences how people age, and an ageing population influences how societies respond to environmental change. Recognizing this connection is essential for designing effective policies. Healthcare, housing, transport, agriculture, and disaster management need to incorporate both demographic and environmental considerations. Doing so can strengthen resilience and improve well-being for all age groups.

The sections that follow examine these links in greater detail, based on global research and Indian experiences to explain how climate affects the biology of ageing, how public systems can adapt to increased demand, and how communities can draw on the strengths and knowledge of older adults. The aim is to build a comprehensive understanding of what it means to age in a warming world and how societies can prepare for the future.

Sustainability through a grey lens: older adults as stewards of a changing planet

In many parts of India, environmental care continues through routine actions embedded in everyday life. In a village in Uttarakhand, a 78-year-old woman, Kamla Devi, begins her morning by inspecting the narrow water channel that runs past her home. She clears leaves and silt that have collected overnight, ensuring that water continues to flow downstream to neighbouring fields. This task, which she has performed for decades, is simply part of her responsibility to the land, shaped by long familiarity with seasonal rhythms and the knowledge that neglect carries consequences for the entire community. Similar acts of quiet stewardship are repeated daily by older adults across rural and urban landscapes, sustaining ecological balance without

formal recognition.

Contemporary sustainability discourse, however, often emphasizes technological innovation, regulatory frameworks, and youth-led mobilization. Although these elements are undeniably important, they do not fully account for the social practices through which sustainability has historically been maintained. Older adults across cultures have lived through periods marked by scarcity, environmental uncertainty, and limited institutional support. These experiences have shaped habits and values that prioritize restraint, care, and continuity. This section examines older adults as central stewards whose lived experience offers insights that remain critical in a period of accelerating environmental change.

Reconsidering what sustainability encompasses

Sustainability is frequently defined through measurable indicators such as emissions of carbon, deployment of renewable energy, circular production systems, and protection of biodiversity. These frameworks provide essential tools for assessment and governance. At the same time, sustainability also depends on less visible social norms that guide everyday behaviour. These norms shape how resources are valued, used, and conserved over long periods.

For many older adults, sustainability was never articulated as an abstract concept—it was embedded in their daily practices. Food was conserved because waste was unaffordable; household items were repaired repeatedly because replacement was uncertain; and water and fuel were used sparingly because access could not be taken for granted. Over time, these practices formed a mindset oriented toward foresight and moderation. Rather than responding to environmental limits through formal policy, earlier generations internalized those limits through experience.

In the context of climate change, this orientation remains relevant. Technological solutions and regulatory mechanisms depend on social acceptance and behavioural consistency.

Understanding sustainability as a lived practice, rather than solely a technical objective, brings older adults back into the centre of the conversation.

Low consumption practices and environmental impact

Across regions and cultures, older adults tend to follow consumption patterns that place relatively lower demands on natural resources (Table 1). These patterns are driven not by explicit environmental intent but by habits shaped through long experience.

Table 1 Traditional sustainability practices common among older adults

Area of practice	Typical actions	Environmental relevance
Household use	Repairing appliances, reusing containers, conserving fuel	Reduces material consumption and waste
Water management	Reuse of household water, maintenance of local channels	Supports water efficiency and recharge
Food practices	Seasonal diets, minimal waste, local sourcing	Lowers food system emissions
Housing	Natural ventilation, shading, shared spaces	Reduces energy demand
Community systems	Shared resources, collective caregiving	Limits duplication of resource use

A particularly noticeable aspect is the preference for repair and reuse. Many older adults continue to repair clothing, footwear, utensils, and household appliances rather than replacing them. Skills associated with repair were once common and socially valued. What is now described in policy language as a circular economy functioned historically as a practical response to material constraint. These practices reduce waste generation and extend the life cycle of goods.

Restrained consumption is another defining feature. Older adults often purchase fewer discretionary goods, limit electricity use, and manage household resources carefully. The reuse of containers, conservation of water for multiple purposes, and cooking with measured quantities are widespread practices. Although modest in their impact in isolation, these behaviours cumulatively reduce energy demand and material throughput.

Household structures have also influenced environmental impact. Multigenerational living arrangements encouraged shared use of space, appliances, and utilities. Kitchens, cooling devices, and water sources were commonly shared, reducing duplication of resources. While family structures are changing, these patterns illustrate how social organization influences environmental outcomes.

Traditional ecological knowledge and local resilience

Older adults are often custodians of ecological knowledge accumulated through long observation of local environments. In India, such knowledge has historically supported sustainable management of water, soil, forests, and food systems. Stepwells, water tanks, and community ponds were maintained through local stewardship informed by seasonal rainfall patterns and groundwater behaviour. Agricultural practices such as mixed cropping, seed preservation, and organic soil management evolved through repeated adaptation to local conditions.

Forest-related knowledge included regulated collection of firewood, protection of sacred groves, and respect for regeneration cycles. Dietary practices emphasized seasonal availability and local sourcing, reducing pressure on ecosystems. Much of this knowledge is now threatened owing to rapid urbanization, migration, and cultural fragmentation.

Similar patterns can be found globally. Indigenous elders in regions such as Australia, Canada, and the Amazon basin hold knowledge related to fire management, forest health, medicinal plants, and sustainable harvesting. Environmental science increasingly recognizes the value of these systems, particularly in

contexts where climate variability exceeds the predictive capacity of models alone.

Traditional ecological knowledge and climate adaptation
The Intergovernmental Panel on Climate Change recognizes traditional ecological knowledge as a valuable input for climate adaptation. Its *Sixth Assessment Report* notes that indigenous and local knowledge systems offer context-specific insights that complement scientific data, particularly in managing ecosystems under stress. Older adults play a central role in preserving this knowledge through oral histories, customary practices, and community leadership.

Older adults and environmental action

Public imagery around climate action often centres on the young. At the same time, older adults are increasingly engaged in environmental advocacy and community-based action. In several countries, organizations led by older citizens advocate for climate-responsible policies, framing their engagement around responsibility to future generations rather than personal gain. In India, elders are frequently involved in protecting local water bodies, forest corridors, and coastal ecosystems. These efforts tend to be sustained over long periods and are closely tied to place-based knowledge. Such engagement reflects a form of stewardship grounded in continuity rather than urgency.

The heatwave in France in 2003 and policy response
The heatwave in France in 2003 resulted in about 15,000 excess deaths, the majority being of adults over 75. Post-event analysis highlighted the role of social isolation and inadequate housing. In response, France introduced a national heat health plan that includes registries of vulnerable older adults and coordinated local responses during extreme heat. The case illustrates how recognition of age-specific vulnerability can reshape climate and health policy.

Intergenerational transmission of environmental values

Older adults play an important role in shaping how younger generations understand and relate to the environment. Values associated with restraint, durability, and care are often transmitted through daily behaviour rather than formal instruction. Younger family members observe how resources are managed and internalize these practices over time.

Many older adults have lived through droughts, floods, and other environmental disruptions. Their memories include not only the events themselves, but the ways communities responded, shared resources, and rebuilt. This experiential knowledge contributes to local preparedness and resilience. Stories of rivers, forests, and seasons as they once were also create environmental memory, grounding sustainability in lived history rather than in abstract targets.

Sustainability and healthy ageing

The relationship between sustainability and ageing is reciprocal (Table 2). Environments designed for ecological balance also support healthy ageing. Access to green spaces reduces stress, improves mobility, and supports cognitive health. Walkable neighbourhoods with shade and low pollution enable older adults to remain physically active and socially connected.

Community gardens and urban farming initiatives illustrate this intersection. Participation in such activities provides physical exercise, social interaction, and access to fresh produce, while also contributing to local food systems.

Community gardening and older adults in Japan

Longitudinal studies in Japan indicate that older adults engaged in community gardening experience lower levels of depression, improved mobility, and stronger social ties. These spaces also function as informal social hubs, reducing loneliness while supporting environmentally sustainable food practices.

Table 2 How sustainable environments support healthy ageing

Environmental feature	Impact on older adults
Tree cover and parks	Reduced heat stress, improved mental well-being
Walkable streets	Better mobility and cardiovascular health
Low pollution levels	Reduced respiratory and cardiac risk
Community gardens	Physical activity and social connection
Mixed-use neighbourhoods	Easier access to services

Barriers to inclusion in sustainability planning

Despite their contributions, older adults are often marginalized in planning for sustainability. Stereotypes frame them as passive recipients of care rather than active contributors. Climate policies frequently overlook ageing, while policies related to ageing rarely address environmental risk. Digital exclusion further limits participation, as climate information and public consultations increasingly rely on online platforms. Physical accessibility of public spaces also shapes who can participate meaningfully.

Repositioning older adults in sustainability discourse

Integrating older adults into sustainability requires intentional inclusion. Community planning processes must engage elders as stakeholders. Traditional ecological knowledge should be documented and preserved. Intergenerational programmes can facilitate knowledge exchange. Digital literacy initiatives can expand participation. Recognition of elder-led environmental efforts reinforces their legitimacy.

Sustainability is often described as protecting the future for children. It is equally about honouring past practices inherited from earlier generations. Older adults have lived sustainability as a way of life shaped by restraint and responsibility. In a warming world, their experience provides guidance that remains indispensable.

Heat, health, and human limits: ageing in an era of climate extremes

In late May 2024, as large parts of northern India experienced prolonged and unusually intense heat, temperatures in Delhi crossed 48 degrees Celsius for several consecutive days. During this period, outpatient departments and emergency wards in several government hospitals began to see a steady increase in patients presenting with symptoms that were not immediately visible as injuries, but which reflected serious physiological distress. Doctors observed elevated heart rates, shallow and laboured breathing, confusion, dehydration, and sudden episodes of collapse. A significant proportion of those affected were older adults. For clinicians, these cases were no longer exceptional. They reflected a pattern that has become increasingly familiar as extreme heat shifts from being a seasonal inconvenience to a persistent public health stressor.

What these episodes reveal is not only the severity of rising temperatures but the manner in which heat is now expressed through the ageing body. Heat exposure is increasingly translating into cardiovascular strain, respiratory compromise, renal stress, and cognitive impairment, often occurring simultaneously. For older adults, whose physiological reserves are already reduced, sustained exposure to extreme heat pushes the body closer to its adaptive limits. This section examines how rising temperatures interact with ageing physiology, how social and infrastructural conditions intensify vulnerability, and why heat now represents one of the most consequential health challenges facing ageing societies.

Ageing physiology in a warming climate

Ageing is associated with gradual changes in multiple systems that together regulate body temperature. The efficiency of sweat glands declines over time, reducing evaporative cooling. Sensitivity to thirst diminishes, increasing the likelihood of dehydration without clear warning signals. Cardiac capacity decreases, limiting the ability of the circulatory system to

redistribute blood to the skin for cooling. Kidney function, which plays a central role in maintaining fluid and electrolyte balance, also loses its functional reserve with age. Each of these changes is part of normal biological ageing; however, their significance becomes pronounced when ambient temperatures rise beyond levels that the body can cope with comfortably.

In conditions of extreme heat, the ageing body must compensate across several systems at once. Heart rate increases in an effort to sustain circulation and cooling, placing additional strain on an already-burdened cardiovascular system. Breathing becomes more demanding as hot air, often carrying higher pollutant loads, irritates the respiratory tract. Dehydration reduces blood volume and impairs cognitive function, increasing the risk of confusion and collapse. These effects are further complicated by the widespread use of medications among older adults: diuretics accelerate fluid loss; beta blockers limit heart-rate responsiveness; and some antidepressants and antihypertensive drugs interfere with thermoregulation. Taken together, these factors narrow the margin within which the body can adapt safely to heat.

Long-term epidemiological data reflect the consequences of these interactions. *The Lancet Countdown* reports that heat-related mortality among people aged 65 and above has increased by 167% since the 1990s, reflecting the pace at which environmental conditions are shifting beyond the range within which ageing bodies are well-equipped to handle multi-organ stress.

Why heat tolerance declines with age

With advancing age, several physiological mechanisms that support heat regulation become less efficient. Reduced sweating limits evaporative cooling. Blunted thirst perception delays hydration. Lower cardiac reserve restricts circulatory adjustment. Declining kidney function compromises fluid balance. When these changes are combined with chronic disease and medication use, the ability to respond to sustained heat exposure is significantly reduced, increasing the risk of heat exhaustion, heatstroke, and multi-organ stress.

Heat as a social and environmental vulnerability

Whereas physiology shapes the body's response to heat, social conditions often determine whether exposure to heat becomes life threatening. Older adults are more likely to live alone, particularly in urban settings in which family structures have shifted towards being nuclear owing to migration, employment patterns, and increased longevity. As a result, many of the elderly spend long periods without regular social contact or supervision.

Living alone during a heatwave increases risk in several ways. Early signs of dehydration or heat exhaustion may go unnoticed. There may be no one to encourage rest, hydration, or cooling measures. Access to timely medical care may be delayed because symptoms are underestimated or mobility is limited. Social isolation thus transforms environmental exposure into acute vulnerability.

Housing conditions further compound this risk. Many older adults reside in dwellings that were constructed without consideration for extreme heat. Tin roofs, uninsulated concrete walls, and limited cross ventilation trap heat indoors, often resulting in indoor temperatures several degrees higher than those outside. In such environments, fans provide little relief when ambient air is already hot. Air conditioning remains unaffordable for many older adults who rely on pensions or informal income, and even when air-conditioners are available, concerns about electricity costs limit their prolonged use.

Access to healthcare represents another critical factor. During periods of extreme heat, travel itself becomes physically taxing. Older adults may avoid leaving their homes until symptoms become severe. Delays in seeking care allow mild dehydration or heat exhaustion to escalate rapidly into heatstroke, cardiac events, or renal failure.

Geographies where heat and age intersect

Heat exposure varies significantly across regions, shaped by climate, land use, and settlement patterns. In India, climate projections predict a sharp increase in the frequency, duration,

and intensity of heatwaves across large parts of the country. Both urban and rural areas face distinct, although interconnected, risks.

Urban centres experience what are known as heat island effects, driven by dense construction, extensive concrete surfaces, reduced tree cover, and high levels of vehicular and industrial emissions. Cities such as Delhi, Ahmedabad, Chennai, and Hyderabad retain heat during the day and release it slowly at night, resulting in elevated night-time temperatures. For older adults, sustained night-time heat prevents physiological recovery from daytime exposure, leading to cumulative stress over successive days. Poorly ventilated housing and lack of insulation further increase the exposure to indoor heat.

Rural areas face different challenges. Agricultural livelihoods often require outdoor work during hours of peak heat. Healthcare facilities are fewer and located farther away. Water scarcity compounds the risk of dehydration. Older adults frequently assume caregiving roles within extended households, adding physical strain during heat emergencies. In both settings, age amplifies the effects of environmental exposure.

Urban heat islands and night-time risk

Studies by the Indian Institute of Tropical Meteorology show that densely built urban areas can record night-time temperatures 3–5 °C higher than surrounding regions. Elevated night-time heat limits the body's ability to recover from daytime exposure, particularly among older adults, increasing the likelihood of cumulative physiological stress and adverse health outcomes during prolonged heat events.

Heat as a multi-system health stressor

Extreme heat affects multiple organ systems simultaneously, creating a complex clinical picture (Table 3). Cardiovascular effects are among the most immediate. Heat increases heart rate and blood viscosity, raising the risk of clot formation. Older adults with pre-existing hypertension, diabetes, or heart disease face a

higher likelihood of arrhythmia and cardiac events during heatwaves.

Table 3 Major health effects of extreme heat in older adults

System affected	Typical consequences
Cardiovascular	Elevated heart rate, arrhythmia, increased clotting risk
Respiratory	Breathlessness, inflammation of airway, infection
Renal	Dehydration, acute kidney injury
Cognitive	Confusion, delirium, cognitive decline
Neural	Sleep disruption, anxiety, mood changes

Respiratory effects are also significant. Hot air often carries higher concentrations of pollutants, exacerbating asthma and chronic obstructive pulmonary disease. Inflammation of the airways increases susceptibility to infection. Renal stress is common, as dehydration reduces kidney perfusion and contributes to acute kidney injury, particularly among individuals with existing renal disease or those taking diuretics.

Neurological and cognitive effects are increasingly documented. High temperatures are associated with confusion, memory lapses, and worsening symptoms among people living with dementia. Mortality during heatwaves is especially high in this group, reflecting the combined effects of physiological vulnerability and impaired self-care.

Heat and air pollution as a combined threat

Extreme heat often coincides with high air pollution. Rising temperatures accelerate chemical reactions that increase ground-level ozone, and stagnant air traps particulate matter. In cities such as Delhi, heatwaves frequently overlap with spikes in ozone concentrations and $PM_{2.5}$ (particulate matter with a diameter of

2.5 micrometres or smaller). For older adults whose respiratory and cardiovascular systems may already be compromised, this combination significantly increases health risks.

Research by the Public Health Foundation of India indicates that incremental increases in particulate matter are associated with higher rates of emergency hospitalization among older adults during heat events. Polluted air increases respiratory effort, disrupts sleep, and slows recovery from heat stress, extending the duration and severity of illness.

Healthcare systems under heat stress

Extreme heat places healthcare systems under significant strain. During heatwaves, the numbers of ambulance calls rise sharply, emergency departments become overcrowded, and power outages disrupt cooling systems and medical equipment. Healthcare workers themselves are exposed to heat stress, reducing system resilience.

Most hospitals were designed under climatic assumptions that no longer hold. Passive cooling, green roofs, energy-efficient ventilation, and dedicated heat emergency protocols remain limited. As populations age, healthcare facilities will increasingly serve as critical points of intervention during climate extremes. Climate adaptation in healthcare infrastructure is therefore an essential component of preparedness.

Ethical and policy implications

Projections indicate that heat exposure among older adults could double by mid-century, affecting hundreds of millions of people globally. This convergence of demographic ageing and climate extremes raises ethical questions about responsibility and protection. Older adults did not shape current emission trajectories, yet they bear a disproportionate share of the health burden.

Towards heat-resilient ageing

Heat resilience begins with acknowledging biological limits and

social realities. Housing must mitigate heat exposure. Healthcare systems must anticipate climate-linked geriatric needs. Cities must reduce the build-up of heat through design and planning. Communities must ensure that older adults are not left alone during extreme events.

In earlier societies, elders were regarded as custodians of memory and experience. In a warming world, they now stand on the frontlines of climate impact. Protecting them from extreme heat reflects a collective preparedness for the future and a commitment to dignity across the life course.

When the environment ages you: climate, pollution and the biology of growing old

On an unusually warm winter morning in Chennai, 72-year-old Nagarajan walks slowly towards the neighbourhood park, pausing every few minutes to steady his breathing. Until a few years ago, this walk was part of a brisk daily routine: now, it requires careful pacing. He attributes the change not only to age, but to the heat, the dust, and the persistent haze that has become part of the city's air. His experience reflects a growing recognition within scientific research and public health practice—namely that the environment actively influences how the ageing process itself unfolds.

In cities such as Delhi, where severe air-quality episodes have become an annual feature of winter months, the cumulative impact on older populations is increasingly visible. For more than a decade, prolonged periods of hazardous air quality have coincided with short-term mitigation measures that offer limited relief. Although the effects are felt across age groups, older adults bear a disproportionate burden, reflected in higher rates of respiratory distress, cardiovascular events, cognitive decline, and functional limitation. These patterns point to a shift in how ageing must be understood. Ageing is no longer driven solely by the passage of time or individual biology but is increasingly shaped by environmental exposure.

Over the past decade, research across diverse fields – epidemiology, molecular biology, and environmental health – has

challenged the assumption that ageing is governed only by genetics and lifestyle. Extreme heat, chronic air pollution, and sustained environmental stress are now recognized as factors that influence the pace of biological ageing. This section examines the emerging science of environmental ageing, explains why older adults are particularly sensitive to exposures, and explores what this means for public health systems, urban planning, and social policy.

Beyond chronological age: understanding biological age

Age has traditionally been measured by years lived. This measure, known as chronological age, remains useful for demographic analysis. However, advances in biomedical research have introduced a complementary concept: biological age. Biological age reflects the condition of cells, tissues, and organ systems and is influenced by genetic expression, inflammation, metabolic function, and cumulative stress.

Environmental exposure plays a significant role in shaping biological age. Prolonged exposure to heat, air pollution, ultraviolet radiation, and poor ambient air quality accelerates cellular damage and disrupts repair mechanisms. As a result, individuals of the same chronological age can exhibit markedly different biological profiles depending on where and how they live.

In 2025, researchers at the University of Southern California studying adults aged 56 and above found that individuals living in consistently hotter regions exhibited biological ageing equivalent to up to 14 additional months, even after accounting for socio-economic status, lifestyle, and pre-existing health conditions. These findings suggest that climate conditions are not merely contextual factors but active determinants of ageing at the molecular level.

Accelerated biological ageing is associated with earlier onset of chronic diseases, increased systemic inflammation, weakened immune response, reduced resilience to physical stress, and earlier functional decline. In practical terms, this means that two

individuals of the same age may experience vastly different health trajectories depending on their environmental exposures.

Chronological age and biological age
Chronological age refers to the number of years lived since birth. Biological age reflects the condition of cells and organ systems and may advance faster or more slowly depending on genetic, lifestyle, and environmental factors. Research increasingly shows that environmental stressors such as heat and air pollution can accelerate biological ageing, particularly among older adults.

Air pollution as a driver of accelerated ageing

Air pollution is now recognized as more than a respiratory hazard. Long-term exposure to particulate matter and gaseous pollutants influences cellular ageing processes across multiple systems. Fine particulate matter, particularly $PM_{2.5}$, along with ozone and oxides of sulfur and nitrogen, contributes to oxidative stress that damages DNA, impairs mitochondrial function, shortens telomeres, and sustains systemic inflammation.

Telomere shortening is a well-established marker of biological ageing. Studies across Europe, India, and East Asia consistently show that adults exposed to high levels of air pollution exhibit shorter telomeres and earlier onset of age-related diseases. These effects are cumulative, intensifying over time.

Older adults carry a higher burden of pollution-related damage. Ageing immune systems respond less effectively to inflammatory stress. Pre-existing conditions such as hypertension, diabetes, chronic obstructive pulmonary disease, and cardiovascular disease magnify vulnerability. In heavily polluted cities including Delhi, Kanpur, Kolkata, Beijing, and Mexico City, these mechanisms translate into higher rates of hospitalization, functional decline, and cognitive impairment among older populations.

Climate extremes and the ageing brain

The brain is particularly sensitive to environmental stress. Emerging evidence links both heat exposure and air pollution to

accelerated cognitive ageing. During heatwaves, older adults commonly experience memory lapses, reduced attention, disorientation, and worsening of existing dementia. The brain's capacity to regulate temperature declines with age, increasing susceptibility to heat-induced inflammation and impaired neural signalling.

Air pollution compounds this risk. Fine particles are small enough to cross the blood–brain barrier, triggering neuroinflammation and contributing to the formation of beta amyloid plaques associated with neurodegenerative diseases. Long-term exposure is increasingly linked to faster cognitive decline, earlier onset of Alzheimer and Parkinson diseases, and higher risk of a stroke.

For older adults living in environments characterized by both extreme heat and high pollution, these risks accumulate. Physiological ageing accelerates while cognitive resilience diminishes, increasing dependence and reducing the quality of life.

Environmental stress and cognitive ageing
Research indicates that sustained exposure to high temperatures and air pollution is associated with increased neuroinflammation, reduced brain volume in key regions, and accelerated cognitive decline. Older adults with existing cognitive impairment face particularly high risks during periods of extreme environmental stress.

The heat–pollution–ageing feedback loop
Climate change intensifies pollution events through mechanisms such as ozone formation, dust mobilization, wildfire smoke, and atmospheric stagnation. Heat and pollution reinforce each other, creating conditions that accelerate biological ageing.

For older adults, this interaction produces a feedback loop. Heat increases exposure to pollution, and pollution increases oxidative stress and inflammation. These processes accelerate cellular ageing, which, in turn, reduces heat tolerance and physiological reserve. Reduced tolerance increases the likelihood

of illness and disability during subsequent heat events.

This heat–pollution–ageing triad is emerging as a significant but underrecognized challenge to public health, particularly in regions in which demographic ageing coincides with rapid environmental change.

Unequal burdens of environmental ageing

Environmental ageing is shaped by social and economic context. Older adults living in congested urban neighbourhoods with poor ventilation and proximity to traffic or industrial activity experience higher cumulative exposure. Limited access to healthcare and cooling further accelerates biological ageing.

Older women often face compounded risksdue to lower lifetime incomes, higher prevalence of anaemia and malnutrition, and greater exposure to indoor heat. In rural areas, heat combined with water scarcity accelerates dehydration, renal stress, and exhaustion. Parents of migrants living alone in rural or peri-urban areas frequently manage household labour without support, lack cooling devices, and have limited access to preventive care. In these settings, environmental stress accumulates gradually and often goes unnoticed.

Lived experiences of environmental ageing

Clinical observations increasingly reflect these patterns. In the Marathwada region of Maharashtra, farmers in their fifties often present with health profiles more typical of individuals in their late sixties, including chronic fatigue, joint degeneration, and kidney strain. Repeated exposure to extreme summer temperatures has led clinicians to describe this pattern as thermal ageing.

In the Delhi National Capital Region, older homemakers who spend most of their time indoors also show markers of accelerated ageing. Chronic indoor pollution from cooking fuels, dust infiltration, residues of traffic-related pollutants, and inadequate ventilation contribute to sustained exposure even in the absence of outdoor activity.

Along India's eastern coastline, older adults in Odisha and Andhra Pradesh face recurrent cyclones, high humidity, and saltwater intrusion. These conditions place sustained stress on cardiovascular and renal systems, increasing rates of hypertension and dehydration.

Implications for public health and policy

Environmental ageing reshapes how societies must approach health and welfare. Healthcare systems need to integrate environmental exposure into geriatric assessment, including heat vulnerability, pollution burden, hydration status, and cognitive impact. Urban planning must recognize that biological age is influenced by the built environment and must incorporate cooling measures, green corridors, shaded public spaces, and improved indoor ventilation into it.

Social protection systems must move beyond income support alone. Subsidies for cooling, clean-air shelters, targeted heat-alert systems, and community support networks are necessary as buffers against environmental stress. Without these measures, gains in life expectancy risk being offset by years lived in poor health.

Ageing in the Anthropocene

Traditional narratives of ageing emphasized individual choices related to diet, exercise, and lifestyle. Emerging evidence requires a broader perspective. If environmental conditions shape biological age, then clean air functions as an anti-ageing intervention, urban cooling becomes a form of geriatric care, and climate mitigation emerges as a longevity policy.

Older generations lived through periods when seasons were more predictable and environmental thresholds less frequently breached. Today, older adults stand at the intersection of an ageing body and an increasingly stressed planet. The environment reflects the cumulative choices societies have made. It also offers an opportunity. With informed action, environmental conditions can become protective rather than harmful, slowing the pace of

ageing and supporting longer and healthier lives.

Systems under strain: healthcare, infrastructure, and social protection

Ageing alters the relationship between individuals and public systems. As people grow older, their dependence on healthcare, housing, transport, water, energy, and social support increases steadily. These systems shape not only access to services, but exposure to environmental risk and the capacity to recover from stress. Climate change intensifies this dependence. Heat, pollution, water scarcity, and extreme weather are rarely encountered directly as abstract forces: they are mediated through the design, reliability, and limits of institutions.

For much of the last century, public systems evolved under relatively stable assumptions. Climatic conditions fluctuated within a familiar and manageable range. Health risks followed predictable seasonal patterns. The proportion of older adults in the population grew gradually, allowing incremental adjustment. These assumptions no longer hold. Climate extremes are now more frequent, more intense, and more prolonged. At the same time, ageing populations are expanding rapidly. The interaction of these trends exposes a structural mismatch between system design and lived reality.

This section examines how climate change and demographic ageing together strain healthcare, housing, infrastructure, and social protection systems. It argues that older adults experience climate stress not only through their bodies, but through the weakening alignment between institutional capacity and environmental demand. What emerges is slower response, uneven protection, and growing inequity.

Why systems matter more as societies age

Across the life course of an individual, reliance on public systems follows a predictable curve. In early adulthood, individuals interact sporadically with healthcare, transport, and welfare institutions. With advancing age, these interactions become more

frequent and more consequential. Management of chronic diseases, support for mobility, adequate housing, and secure incomes increasingly depend on reliable institutions.

Climate change amplifies this dependence. Environmental stress increases the frequency with which older adults require medical attention, reliable cooling, clean water, stable electricity, and safe transport. The margin for error narrows. A delayed ambulance, a power outage, an overheated home, or disrupted water supply carry greater consequences for an ageing body than for a younger one.

In India, this interaction unfolds within a compressed demographic transition. The number of adults over 60 is projected to more than double by mid-century. Many will age in cities designed for speed and density rather than thermal comfort. Others will remain in rural areas where infrastructure investment has lagged behind and climate variability is intensifying. Systems designed around episodic stress must now operate under chronic pressure.

Ageing does not simply increase demand—it changes the nature of demand. Climate stress in older adults rarely presents as a single problem but appears as intertwined medical, social, and infrastructural needs. Systems built in silos struggle to respond effectively.

Healthcare systems: designed for episodes, confronted with permanence

Healthcare systems are often the first to register climate stress. During heatwaves and severe pollution episodes, hospitals admissions related to the following problems surge, with older adults accounting for a disproportionate share of the admissions: dehydration, heat exhaustion, cardiovascular instability, respiratory distress, renal injury, and acute confusion. The surge reflects both physiological vulnerability and the prevalence of chronic diseases.

These surges also reveal design assumptions embedded within healthcare systems. Emergency services are structured to manage

short-term spikes rather than sustained periods of elevated demand. Clinical pathways are often organized around single-organ diagnoses, whereas climate stress in older adults manifests as a multi-system compromise. Staffing models assume environmental neutrality, even as healthcare workers themselves operate under heat stress and are exposed to pollution.

Infrastructure compounds these challenges. Many public hospitals rely heavily on mechanical cooling systems that are vulnerable to power disruption during extreme heat. Passive cooling features, insulation, and energy-efficient ventilation remain unevenly distributed, particularly in older facilities. During prolonged heat events, cooling systems operate continuously, increasing the risk of failure and escalating operating costs.

Ageing intensifies the consequences of these constraints. Older patients often need to be under observation for longer periods and require careful medication management and extended recovery periods. During climate extremes, length of hospital stays increases and discharge routines become more complex as patients return to environments that remain unsafe. What emerges is not only congestion, but gradual degradation in care quality.

Healthcare planning has historically treated climate as an external variable. The convergence of ageing and climate change demands a different approach, one that integrates environmental exposure into geriatric care, facility design, workforce planning, and surge capacity.

Housing and the built environment as unacknowledged health systems

For older adults, housing is not merely shelter—it is the primary environment under which climate exposure accumulates. The elderly spend longer time indoors because of their reduced mobility, chronic illness, and caregiving responsibilities. As a result, the thermal performance of housing becomes a determinant of health.

Much of India's housing stock was constructed without attention to thermal comfort or ventilation. Tin roofs, dense

concrete walls, and limited airflow trap heat during the day and release it slowly at night. Indoor temperatures frequently exceed those outdoors, particularly in low-income housing and informal settlements. For older adults, prolonged exposure to indoor heat delays physiological recovery and increases the strain on their heart and kidneys.

Cooling options are constrained by affordability, availability of electricity, and higher utility bills. Older adults living on fixed incomes often use cooling devices sparingly even during extreme heat. In rural areas, housing may offer little protection from heat, and water scarcity limits basic cooling measures. Housing policy has prioritized quantity and affordability over thermal resilience or comfort of the elderly.

Retrofitting existing housing stock presents governance challenges. Programmes addressing energy efficiency, housing quality, and climate adaptation operate independently, rarely considering the specific needs of older residents. As a result, housing remains an unacknowledged extension of healthcare infrastructure, shaping exposure without being integrated into health planning.

Urban infrastructure and the geography of exclusion

Urban infrastructure mediates everyday exposure to climate stress. Transport systems determine whether older adults can access healthcare during extreme heat. Public spaces influence social interaction and mobility. Water and electricity systems provide the basic conditions for cooling, hydration, and medical care.

Extreme heat disrupts mobility. Public transport becomes physically taxing, waiting areas lack shade, and footpaths offer little protection from sun. Older adults limit their movements, increasing isolation and delaying care. Public spaces designed without thermal comfort discourage outdoor activity, weakening informal social networks that provide support.

Utilities face heightened demand during climate extremes. Electricity supply becomes critical for cooling and medical

devices. Water access becomes essential for hydration and hygiene. Outages or shortages disproportionately affect older adults, whose physiological reserves are limited. These failures are not evenly distributed. Neighbourhoods with limited green cover, poor maintenance, and older infrastructure experience greater disruption.

Urban planning has historically prioritized efficiency and growth. Climate adaptation efforts often focus on flood control or emissions reduction, with limited attention to how ageing shapes vulnerability. The geography of exclusion becomes visible where infrastructure does not account for bodies that move more slowly, require longer and more frequent rest, and depend on environmental stability.

Social protection systems: income without environmental security

Social protection systems play a central role in supporting older adults, yet the systems remain poorly aligned with environmental risk. Pensions, healthcare subsidies, and income transfers address economic insecurity, but do little to offset heat exposure, pollution, or poor housing that makes the elderly more vulnerable.

Environmental stress imposes costs that are not captured within existing welfare frameworks. Cooling expenses, transport related to healthcare during extreme weather, adaptive home modifications, and increased medication place additional strain on fixed incomes. For older women, who often have lower lifetime earnings and higher caregiving burdens, these costs compound vulnerability.

Rural and urban contexts differ, but both reveal gaps. In rural areas, social protection may be limited in coverage and difficult to access, and environmental stress accelerates health decline. In urban settings, nominal access to services does not translate into environmental safety. Social protection systems remain reactive, prioritizing consequences over exposure, or treatment over prevention.

Integrating environmental considerations into welfare design requires recognizing that cooling, clean air, and safe housing are

not optional comforts but essential components of security. Without this recognition, income support alone cannot prevent climate-driven decline in healthcare.

Fragmentation as the core institutional failure

Across healthcare, housing, infrastructure, and welfare, there is a common pattern—fragmentation. Responsibilities for climate adaptation, ageing, health, housing, and social protection are distributed across ministries and agencies with limited coordination. No single institution holds responsibility for the intersection of ageing and climate risk.

As a result, older adults fall between mandates. Climate policies focus on emissions, disasters, or urban resilience without addressing age-specific vulnerability. Ageing policies emphasize income and healthcare without accounting for environmental exposure. Incremental reforms within individual sectors fail to address cumulative risk.

This fragmentation reflects a conceptual separation between environment and ageing, between physical systems and social care. Climate change renders this separation untenable.

Towards climate-ready, age-aware systems

Responding to the strain on systems requires a shift from reactive adjustment to anticipatory design. Healthcare systems must integrate environmental exposure into geriatric care, facility planning, and workforce support. Housing policy must recognize thermal resilience as a health intervention. Urban infrastructure must prioritize thermal comfort, accessibility, and reliability. Social protection must address environmental costs alongside income security.

These changes require coordination across sectors and levels of governance. Local institutions, community networks, and informal support systems play a critical role in identifying risk and delivering support. Metrics of success must extend beyond service delivery to include exposure reduction and functional well-being.

Older adults should not be treated as a special case. They

represent the future demographic norm. Systems that function for ageing populations under climate stress will be more resilient for all.

Conclusion

This book set out to examine two transformations that are often discussed separately but experienced together, namely demographic, defined by longer lifespans and ageing populations, and environmental, defined by rising temperatures, deteriorating air quality, and growing climatic volatility. Through the grey lens, these transformations appear as intersecting forces that shape how people age, how systems perform, and how societies distribute risk and care.

Climate change does not affect older adults solely through dramatic events such as heatwaves, floods, or pollution spikes. Its effects accumulate gradually, through repeated exposure, constrained choices, and declining physiological reserves. Ageing bodies register environmental stress earlier and recover more slowly. What might be tolerable for a younger population becomes consequential for the elderly. In this sense, older adults function as a sensitive indicator of environmental stress, revealing limits that will eventually affect wider populations.

At the same time, the book explains that ageing is not defined only by vulnerability. Older adults carry forms of knowledge, practice, and orientation that remain essential to sustainability. Habits of low consumption, cultures that favour repairs over discarding and buying anew, respect for seasonal rhythms, and community stewardship are not nostalgic remnants of an earlier era—they are adaptive responses shaped by long experience of dealing with limits. Recognizing older adults only as recipients of protection misses this dimension and weakens the broader sustainability conversation.

The scientific evidence reviewed here complicates conventional understandings of ageing. Chronological age alone no longer captures how bodies change over time. Environmental conditions influence biological ageing, shaping the onset of disease, cognitive

decline, and functional limitation. Heat, pollution, and chronic environmental stress alter cellular processes in ways that shorten healthy life expectancy. Ageing, therefore, cannot be understood as a purely individual or biological process. It is increasingly shaped by collective choices about energy use, urban design, housing, and pollution control.

These realities place public systems under strain. Healthcare institutions confront patterns of illness that are multi-systemic and climate-linked. Housing functions as a determinant of exposure rather than protection. Urban infrastructure mediates everyday risk through mobility, utilities, and public space. Social protection systems address income insecurity but remain largely silent on environmental vulnerability. Fragmentation across these domains leaves older adults navigating climate stress through systems not designed to account for their needs.

The Grey Lens brings these threads together. It does not argue for a single policy solution or a new institutional silo. Instead, it offers a way of seeing. It asks whether climate adaptation takes into account ageing bodies. It asks whether policies related to ageing recognize environmental exposure. It asks whether sustainability frameworks acknowledge lived experience across the life course.

This perspective also raises ethical questions. Older adults today are living through environmental conditions shaped by decisions made over decades, often without their participation or consent. They bear a disproportionate share of the health burden associated with climate change, even as they contribute least to its drivers. How societies respond to this imbalance reflects deeper commitments to dignity, fairness, and intergenerational responsibility.

Looking ahead, the relevance of the grey lens will only grow. Populations will continue to age. Climate stress will intensify. The intersection of these trends will shape the demands on healthcare, housing, infrastructure, and social support systems. Whether these systems adapt in anticipatory and inclusive ways will determine not only how long people live, but how well they age.

Ageing with the planet is a material reality. Seeing clearly through the grey lens allows societies to recognize where protection falters, where wisdom resides, and where responsibility lies. In a warming world, such clarity may prove to be one of the most valuable resources available.

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India and much of the world are entering a period defined by two irreversible shifts: a rapidly ageing population and an increasingly unstable climate. Although each has been studied extensively in isolation, their intersection remains insufficiently examined in public discourse and policy. Yet for older adults, climate change is not an abstract future risk—it is a lived reality that shapes health, mobility, dignity, and survival.

The Grey Lens brings ageing and sustainability into the same frame. Drawing on public-health research, climate science, policy analysis, and lived experience from India and across the world, the book examines how rising temperatures, air pollution, and environmental stressors disproportionately affect older adults, also highlighting the often-overlooked role of elders as custodians of ecological knowledge, restraint, and resilience.

Structured across themes of vulnerability, exposure, systems readiness, and stewardship, the book moves beyond crisis narratives to ask deeper questions about justice, responsibility, and intergenerational ethics. It argues that climate resilience cannot be achieved without addressing the realities of ageing, and that policies for older persons must now engage directly with environmental risk.

Written for informed citizens, practitioners, and policymakers, *The Grey Lens* offers a grounded, evidence-based perspective on what it means to grow old in a warming world and why protecting the dignity of older adults is inseparable from protecting the planet itself.

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