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CLIMATE CHANGE FOR SUSTAINABLE LAND MANAGEMENT IN CENTRAL ASIA

7.- Cities, Air Quality and Human Health

Urban Climate, Air Pollution and Health Co-Benefits

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1. SUMMARY OF KEY IDEAS

This article introduces the relationship between urban climate, air pollution and human health, with a particular focus on Central Asia. Cities are not only places where people live and work. They are also modified climate systems where buildings, roads, transport, energy use, industry, waste, land cover and vegetation influence temperature, air circulation, emissions and exposure to environmental risks.

The lesson explains how urban heat islands form, why cities often experience higher temperatures than surrounding rural areas, and how urban surfaces affect the exchange of heat, moisture and pollutants with the atmosphere. These processes are directly linked to climate change because higher regional temperatures can intensify heat stress in cities.

Air pollution is analysed as a major urban environmental and public health challenge. The lesson introduces particulate matter, nitrogen dioxide, ozone, sulfur dioxide, carbon monoxide and black carbon, explaining their main sources and health effects. It also highlights the interaction between air quality and climate change: many sources of air pollution are also sources of greenhouse gases.

Special attention is given to Central Asian cities, where winter heating, transport emissions, industrial activity, dust, dryland surroundings and rapid urban development create specific risks. These challenges are not only technological; they are also related to land use, housing quality, energy systems, mobility, governance and social vulnerability.

Finally, the lesson presents the concept of health co-benefits. Climate action can reduce greenhouse gas emissions while also improving air quality, reducing heat exposure, increasing physical activity, improving urban liveability and protecting vulnerable groups. Sustainable Land Management is relevant because urban expansion, peri-urban vegetation, green belts, soil sealing, dust control and contaminated land redevelopment all influence urban climate and health outcomes.

2. LEARNING OBJECTIVES

By the end of this article, the student will be able to:

- Explain how urban form and land cover influence local climate.
- Define the urban heat island effect and identify its main causes.
- Identify the main pollutants affecting air quality in urban areas.
- Explain the relationship between climate change, air pollution and human health.
- Describe why particulate matter is particularly important for public health.
- Identify vulnerable groups exposed to heat and air pollution.

- Analyse urban air quality challenges in Central Asian cities.
- Explain the concept of health co-benefits of climate action.
- Propose urban planning and Sustainable Land Management measures that reduce heat and pollution.
- Identify indicators for monitoring urban climate, air quality and health risks.

3. INTRODUCTION

Cities are central to the climate challenge. They concentrate people, infrastructure, energy consumption, transport, waste generation, economic activity and exposure to environmental risks. At the same time, cities can be powerful centres of climate action because many mitigation and adaptation measures can be implemented locally.

Urban climate differs from rural climate. Buildings, asphalt, concrete, traffic, heating systems, reduced vegetation and limited ventilation modify temperature, humidity, wind and air quality. These changes can produce urban heat islands, where city centres remain warmer than surrounding rural areas, especially during calm nights and heatwaves.

Air pollution is one of the most important environmental health risks in cities. It is produced by vehicles, heating, industry, power generation, construction, waste burning, dust resuspension and other activities. In many urban areas, climate change and air pollution interact. Higher temperatures can intensify heat stress and influence the formation of some pollutants, while poor air quality can increase the vulnerability of people with respiratory or cardiovascular conditions.

For Central Asia, this topic is especially relevant. Cities such as Almaty, Tashkent, Bishkek, Dushanbe, Astana and Ashgabat face different combinations of air pollution, winter heating demand, traffic congestion, industrial emissions, dust, rapid urban growth and climate extremes. Many cities are also surrounded by drylands, mountains, irrigated areas or degraded land, which influence dust transport, ventilation and local climate.

This lesson connects urban climate, air quality and health with Sustainable Land Management. Although cities are often treated as separate from land management, urban and peri-urban land use strongly affects environmental conditions. Soil sealing, vegetation loss, poor waste management, uncontrolled urban expansion and degraded peri-urban land can increase heat, dust, flooding and pollution exposure. Conversely, green infrastructure, urban trees, restored peri-urban landscapes and cleaner mobility can deliver important climate and health benefits.

4. URBAN CLIMATE AND THE CITY–LAND–ATMOSPHERE SYSTEM

Urban climate refers to the climatic conditions created or modified by the presence of a city. It includes temperature, humidity, wind, radiation, rainfall patterns and air quality. These conditions are shaped by the interaction between built surfaces, human activities and the atmosphere.

Cities modify the land surface. Natural soils and vegetation are replaced by buildings, roads, roofs and paved areas. These materials absorb, store and release heat differently from natural surfaces. Cities also generate heat directly through vehicles, industry, heating, cooling systems and other energy uses.

As shown in Figure 1, the urban climate system is controlled by several interacting factors: built surfaces, reduced vegetation, transport emissions, energy use, waste heat, limited air circulation and regional climate conditions.

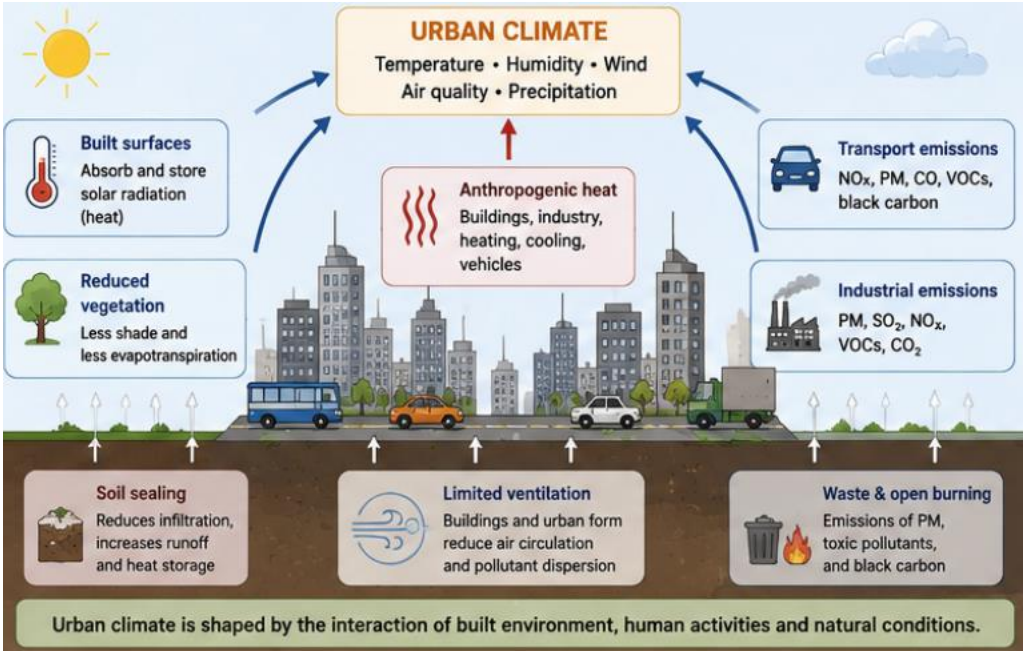


Figure 1. Urban climate system

4.1. Cities as modified climate systems

Cities are not passive recipients of climate conditions. They actively modify the local atmosphere.

The main urban climate controls include:

- Surface materials.
- Building density.
- Street orientation.

- Vegetation cover.
- Soil sealing.
- Traffic intensity.
- Heating and cooling systems.
- Industrial activities.
- Waste management.
- Topography.
- Wind corridors.
- Nearby mountains, rivers or deserts.

In Central Asia, topography can be especially important. Cities located in valleys or near mountains may experience limited ventilation during stable atmospheric conditions. This can trap pollutants near the surface, especially in winter.

4.2. Urban heat islands

The urban heat island effect occurs when urban areas are warmer than surrounding rural areas. This difference is usually stronger at night because buildings and pavements release heat stored during the day.

Urban heat islands are caused by:

- Dark surfaces that absorb solar radiation.
- Reduced vegetation and evapotranspiration.
- Heat storage in buildings and roads.
- Waste heat from vehicles and buildings.
- Narrow streets that reduce ventilation.
- Limited open soil and water surfaces.
- High building density.

Climate change can intensify the health risks associated with urban heat islands. A warmer regional climate increases the baseline temperature, while urban heat adds an additional local stress.



Urban heat islands are not only a comfort problem. They can increase heat-related illness, raise cooling energy demand, worsen ozone formation, reduce labour productivity and increase risks for older people, children, outdoor workers and people with chronic diseases

4.3. Urban surfaces, energy balance and ventilation

Urban surfaces affect the energy balance of the city. Asphalt and concrete often have low reflectivity and high heat storage capacity. They absorb solar energy during the day and release it slowly at night.

Vegetation has the opposite effect. Trees and green spaces provide shade and cool the air through evapotranspiration. Soil and vegetation also support water infiltration, which can reduce runoff and moderate local temperatures.

Ventilation is also essential. Air movement helps remove heat and pollutants. Dense urban forms can block wind, while well-planned streets, parks, river corridors and open spaces can act as ventilation pathways.



Think about a dense urban neighbourhood with little vegetation and heavy traffic. How would temperature, air quality and human comfort differ from a neighbourhood with trees, parks and less traffic?

5. AIR POLLUTION IN URBAN ENVIRONMENTS

Air pollution occurs when harmful substances are present in the air at concentrations that may affect human health, ecosystems, buildings or climate. In urban areas, air pollution is closely linked to energy, transport, heating, industry, waste and land-use patterns.

Urban air pollution is not always visible. Some pollutants, such as smoke and dust, can be seen. Others, such as nitrogen dioxide, ozone or fine particulate matter, may not be obvious but can still affect health.

Table 1 summarises the main pollutants discussed in this lesson, their typical urban sources and their relevance for climate and health.

Table 1. Main urban air pollutants, sources and health relevance.

Pollutant	Typical urban sources	Health relevance	Climate relevance
PM2.5	Combustion, heating, vehicles, industry, dust	Respiratory and cardiovascular disease	Some components warm or cool climate
PM10	Road dust, construction, soil dust, combustion	Respiratory irritation and lung effects	Dust affects radiation and visibility
NO_2	Traffic, combustion, heating, industry	Respiratory effects, asthma aggravation	Precursor of ozone and secondary particles
O_3	Formed in atmosphere from NOx and VOCs	Respiratory impacts, crop damage	Greenhouse gas and air pollutant
SO_2	Coal, heavy fuel, industrial combustion	Respiratory irritation, acid deposition	Forms sulfate particles
CO	Incomplete combustion	Reduces oxygen transport in blood	Indirect climate effects
Black carbon	Diesel, biomass burning, coal, waste burning	Component of PM2.5	Strong short-lived climate warmer

5.1. Main air pollutants

Particulate matter is one of the most important urban pollutants. PM10 refers to particles with a diameter smaller than 10 micrometres. PM2.5 refers to finer particles smaller than 2.5 micrometres. PM2.5 is especially concerning because it can penetrate deep into the lungs and enter the bloodstream.

Nitrogen dioxide is mainly associated with combustion, especially road transport and heating systems. It can irritate the airways and contribute to the formation of ozone and secondary particles.

Ozone at ground level is not emitted directly. It forms through chemical reactions involving nitrogen oxides and volatile organic compounds in the presence of sunlight. Ozone pollution can be stronger during warm, sunny conditions.

Sulfur dioxide is associated with sulfur-containing fuels, coal burning and some industrial processes. It can form secondary particles and contribute to respiratory problems.

Black carbon is a component of fine particulate matter produced by incomplete combustion. It is important because it affects both health and climate.

5.2. Main emission sources in cities

The main urban emission sources include:

- Road transport.
- Coal or biomass heating.

- Power generation.
- Industrial facilities.
- Construction activities.
- Road dust resuspension.
- Waste burning.
- Diesel generators.
- Domestic cooking and heating.
- Fuel storage and distribution.
- Agricultural burning near cities.
- Dust from degraded peri-urban land.

The relative importance of these sources varies by city and season. For example, winter heating may dominate in cold cities, while dust and ozone may be more important during dry or hot periods.

5.3. Seasonal patterns and winter pollution

In many Central Asian cities, winter air pollution is a major concern. Heating demand increases, and some households or district systems may rely on coal or other solid fuels. At the same time, cold stable air can reduce vertical mixing. When air is trapped near the surface, pollutants accumulate.

Winter inversions can be particularly problematic in valley cities. During an inversion, colder air remains near the ground and warmer air sits above it, preventing upward dispersion of pollutants.

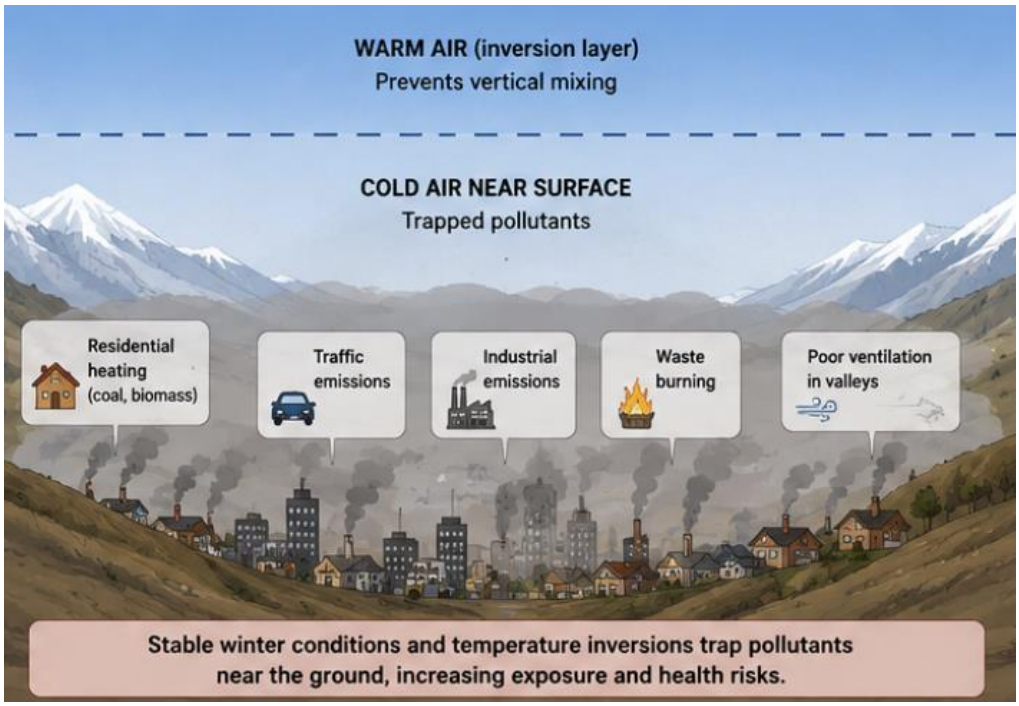


Figure 2. Seasonal urban air pollution diagram showing winter heating emissions, temperature inversion, trapped pollutants and human exposure.

WARNING Adaptation measures can create new environmental problems if they are not well designed. For example, increasing irrigation to protect crops from heat may worsen water scarcity or salinity. Expanding pesticide use to control climate-driven pests may increase soil and groundwater pollution.

6. CLIMATE CHANGE, AIR QUALITY AND HUMAN HEALTH

Climate change and air pollution are connected environmental health challenges. They share many sources, such as fossil fuel combustion, transport, heating and industry. They also interact through atmospheric chemistry and human exposure.

Health impacts depend not only on pollution concentrations or temperature. They also depend on age, health status, housing quality, occupation, income, access to healthcare and public information.

6.1. 6Heat stress and vulnerable populations

Heat stress occurs when the body cannot maintain a safe internal temperature. It can cause dehydration, heat exhaustion, heatstroke and worsening of existing cardiovascular or respiratory conditions.

Urban residents may be more exposed to heat because of heat islands, high building density, limited vegetation and poor housing conditions. People without access to cooling, shaded areas or safe drinking water are particularly vulnerable.

Vulnerable groups include:

- Older people.
- Children.
- Pregnant women.
- People with chronic diseases.
- Outdoor workers.
- Low-income households.
- People living in poorly insulated housing.
- People with limited access to healthcare.
- Migrants and informal workers.
- People living in areas with little vegetation.

6.2. Health impacts of particulate matter and gases

Air pollution affects health through several pathways. Fine particulate matter can penetrate deep into the lungs and contribute to respiratory and cardiovascular disease. Nitrogen dioxide can aggravate asthma and respiratory symptoms. Ozone can reduce lung function and worsen breathing problems. Carbon monoxide can reduce oxygen delivery in the body.

Health outcomes associated with air pollution include:

- Asthma symptoms.
- Chronic bronchitis.
- Reduced lung function.
- Heart disease.
- Stroke.
- Lung cancer.

- Premature mortality.
- Low birth weight and pregnancy risks.
- Increased hospital admissions.
- Reduced labour productivity.

Table 2 links common urban exposures with potential health effects and vulnerable groups.

Table 2. Urban climate and air pollution exposures, health effects and vulnerable groups.

Exposure	Possible health effects	Especially vulnerable groups
Heatwaves	Heat exhaustion, heatstroke, cardiovascular stress	Elderly, children, outdoor workers
PM2.5	Heart disease, stroke, respiratory disease	People with chronic disease, children
NO_2	Respiratory irritation, asthma aggravation	Children, asthmatics, traffic-exposed residents
Ozone	Reduced lung function, respiratory symptoms	Outdoor workers, children, elderly
Dust storms	Eye and respiratory irritation, PM exposure	People with respiratory disease
Indoor solid fuel smoke	Respiratory and cardiovascular impacts	Women, children, elderly

6.3. Combined exposure: heat, pollution and social vulnerability

Urban health risks are often combined. A person may be exposed to heat, air pollution, noise, poor housing and limited healthcare at the same time.

Heat can increase vulnerability to air pollution. During hot periods, people may breathe more rapidly, spend time outdoors, or live in buildings with poor ventilation. High temperatures may also favour ozone formation.

Social vulnerability is critical. Two people living in the same city may experience very different risks depending on income, housing, access to green space, work conditions and health status.

Quick Exercise Choose one vulnerable group, such as elderly people, outdoor workers or children. Identify three urban climate or air pollution risks for this group and propose one practical protection measure for each risk.

7. CITIES IN CENTRAL ASIA: SPECIFIC RISKS AND CHALLENGES

Central Asian cities face a combination of global and regional challenges. They are affected by climate change, air pollution, urban growth, infrastructure needs, energy systems and land degradation.

The region includes cities located in mountains, valleys, steppe zones, desert margins and river basins. Local geography strongly influences climate and air quality. For example, mountain-valley settings may restrict ventilation, while desert margins may increase exposure to dust.

7.1. Rapid urbanisation and infrastructure pressure

Urban populations are growing in many parts of Central Asia. Growth can increase demand for housing, transport, energy, water, waste services and green space.

When urban growth is poorly planned, it can increase:

- Traffic congestion.
- Soil sealing.
- Informal settlements.
- Waste dumping.
- Loss of peri-urban agricultural land.
- Heat exposure.
- Air pollution.
- Flood risk.
- Inequality in access to services.

Urban planning therefore has direct implications for climate resilience and health.

7.2. Heating, transport and industrial emissions

In cold seasons, heating can be a major source of urban air pollution. Coal, low-quality fuels or inefficient heating systems can emit particulate matter, sulfur dioxide, nitrogen oxides and black carbon.

Transport is another important source. Old vehicle fleets, diesel engines, traffic congestion and weak public transport can increase emissions of nitrogen oxides, particulate matter and carbon monoxide.

Industrial sources may also affect air quality, depending on location, technology and regulation. In some cases, industrial emissions interact with residential exposure when facilities are close to populated areas.

7.3. Dust, drylands and land degradation around cities

Dust is a distinctive issue in arid and semi-arid regions. Dust can come from natural deserts, degraded land, construction sites, unpaved roads, dried lakebeds, agricultural fields and waste areas.

Land degradation around cities can increase dust emissions. Loss of vegetation, soil disturbance, abandoned land and poor construction practices expose soil to wind erosion. This creates a direct link between Sustainable Land Management and urban air quality.

As shown in Figure 3, urban air quality in Central Asia can be influenced by both local urban emissions and regional land-based sources such as dust, degraded drylands and exposed soils.

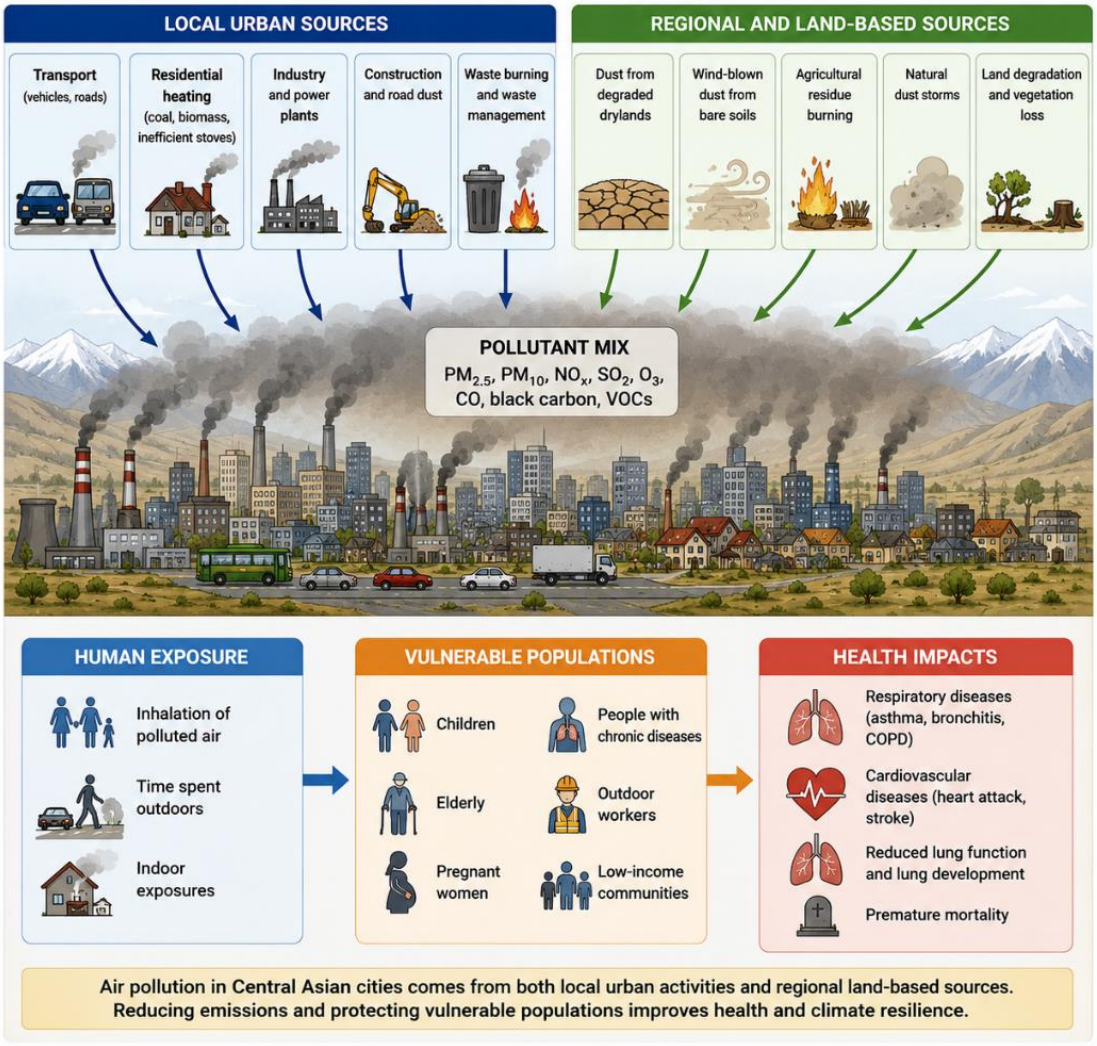


Figure 3. Central Asian city exposure diagram showing urban emissions, winter heating, traffic, industrial sources, surrounding drylands, dust transport and vulnerable populations.

7.4. Water scarcity and urban greening constraints

Urban greening is often recommended for heat reduction and air quality improvement. However, in Central Asia, water scarcity must be considered carefully.

Green infrastructure should be designed using:

- Drought-tolerant species.
- Native or locally adapted vegetation.
- Efficient irrigation.
- Mulching and soil improvement.
- Reuse of treated wastewater where safe and regulated.
- Protection of existing trees.
- Shading strategies that do not require excessive water.
- Green spaces located where vulnerable populations need them most.

Urban greening must not create unsustainable water demand. It should support both climate resilience and responsible water management.

Did you know..? Trees cool cities not only by providing shade. They also cool the air through evapotranspiration. However, in water-scarce regions, tree selection and irrigation management are essential to avoid increasing pressure on limited water resources

8. HEALTH CO-BENEFITS OF CLIMATE ACTION

A health co-benefit is a positive health outcome produced by a measure designed primarily for another purpose, such as reducing greenhouse gas emissions or adapting to climate change.

In cities, many climate actions produce immediate health benefits. For example, reducing fossil fuel combustion lowers greenhouse gas emissions and also reduces air pollution. Promoting walking and cycling reduces transport emissions and also increases physical activity. Urban trees reduce heat exposure and improve liveability.

Figure 4 summarises the main pathways through which urban climate action can produce health co-benefits.

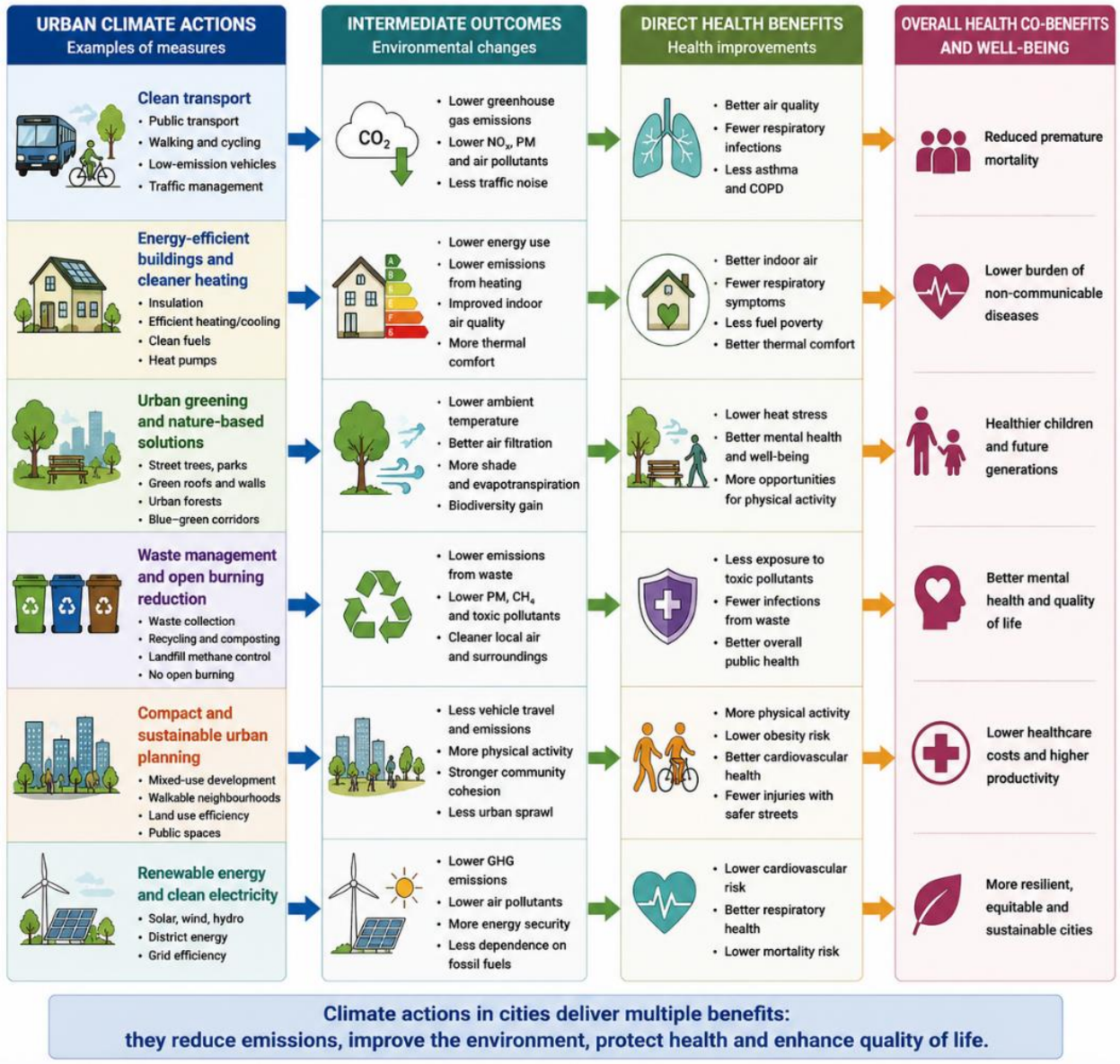


Figure 4. Health co-benefits pathway diagram

8.1. What are health co-benefits?

Health co-benefits are important because they make climate action more immediate and visible. Climate mitigation is sometimes perceived as a long-term global benefit. Health co-benefits are local, near-term and directly relevant to citizens.

Examples include:

- Cleaner air.
- Fewer respiratory symptoms.
- Reduced heat stress.
- More physical activity.
- Safer streets.
- Reduced noise.
- Better mental health.
- Improved access to green spaces.
- Lower healthcare costs.
- Higher productivity.

8.2. Clean transport

Transport measures can produce strong co-benefits.

Examples include:

- Improving public transport.
- Creating safe walking routes.
- Developing cycling infrastructure.
- Reducing traffic congestion.
- Promoting low-emission vehicles.
- Restricting highly polluting vehicles.
- Improving fuel quality.
- Designing compact, mixed-use neighbourhoods.

Clean transport reduces emissions and can increase physical activity. It can also improve access to jobs, schools and services if planned equitably.

8.3. Energy-efficient buildings and cleaner heating

Buildings influence both climate and health. Poorly insulated buildings require more heating in winter and more cooling in summer. Inefficient heating can produce high emissions and indoor air pollution.

Useful measures include:

- Building insulation.
- Efficient heating systems.
- Cleaner fuels.
- District heating modernisation.
- Heat pumps where feasible.
- Solar thermal systems.
- Passive cooling.
- Shading.
- Ventilation improvements.
- Energy poverty reduction.

Cleaner heating is especially relevant for cold Central Asian cities where winter pollution is a major issue.

8.4. Urban greening and nature-based solutions

Urban greening includes parks, street trees, green corridors, urban forests, green roofs, restored riverbanks and peri-urban green belts.

Benefits include:

- Cooling through shade and evapotranspiration.
- Reduced heat exposure.
- Improved mental health.
- More recreational space.
- Dust reduction.
- Stormwater management.
- Biodiversity support.
- Carbon storage.
- Improved urban aesthetics.

Green infrastructure should be designed as a network, not as isolated decorative spaces. It should connect neighbourhoods, protect vulnerable groups and support ecosystem functions.

8.5. Waste management and open burning reduction

Poor waste management affects air quality and climate. Open burning of waste releases particulate matter, black carbon, toxic compounds and greenhouse gases.

Improving waste management can reduce emissions and health risks. Measures include:

- Regular waste collection.
- Separation of organic waste.
- Composting where appropriate.
- Recycling.
- Safe landfill operation.
- Methane management.
- Elimination of open burning.
- Public awareness.
- Enforcement against illegal dumping.

In peri-urban areas, waste management is also linked to land quality and soil pollution.

Table 3. Urban climate actions and health co-benefits.

Urban action	Climate benefit	Health co-benefit	SLM connection
Cleaner public transport	Lower fuel emissions	Less PM and NO_2 exposure	Reduces road pressure and land take
Building insulation	Lower energy demand	Warmer homes, less fuel poverty	Reduces heating emissions
Urban trees	Cooling and carbon storage	Less heat stress, better well-being	Protects soil and urban biodiversity
Green belts	Dust and heat reduction	Cleaner air and recreation	Controls peri-urban land degradation
Waste burning control	Lower black carbon and pollutants	Less smoke exposure	Reduces soil and waste pollution
Compact urban planning	Lower transport demand	More walkability	Reduces soil sealing and sprawl



Which urban climate action would bring the greatest health benefit in your city: cleaner transport, cleaner heating, urban greening, waste management or dust control? Explain your answer

9. SUSTAINABLE LAND MANAGEMENT AROUND CITIES

Urban climate and air quality are strongly influenced by land use inside and around cities. Sustainable Land Management is therefore relevant not only in rural areas, but also in urban and peri-urban landscapes.

9.1. Urban expansion and soil sealing

Urban expansion often converts agricultural land, grassland or natural soil into buildings, roads and paved areas. This process is called soil sealing. Soil sealing reduces:

- Water infiltration.
- Soil biological activity.
- Local cooling.
- Food production potential.
- Carbon storage.
- Groundwater recharge.
- Habitat connectivity.

It can increase:

- Surface runoff.
- Flood risk.
- Urban heat.
- Infrastructure costs.
- Loss of peri-urban agriculture.
- Dependence on transport.

Managing urban expansion is therefore a Sustainable Land Management issue.

9.2. Green belts, peri-urban agriculture and dust control

Green belts and peri-urban vegetation can reduce dust, buffer urban heat and protect land from uncontrolled development. They can also provide recreation, local food production and biodiversity benefits.

In dry climates, green belts must be designed carefully. The aim is not to create water-demanding landscapes, but to stabilise soils, reduce dust and provide shade using appropriate species and land management practices.

Peri-urban agriculture can also contribute to local food security, but it must be protected from contaminated soil, wastewater risks and air pollution deposition.

9.3. Brownfields, contaminated land and redevelopment

Brownfields are previously developed or contaminated sites that may be abandoned or underused. They can include former industrial areas, workshops, fuel storage sites, landfills or railway yards.

Redeveloping brownfields can reduce pressure for urban expansion into agricultural or natural land. However, redevelopment must include contamination assessment and remediation when needed.

This creates a connection between urban planning, soil pollution and climate action. Reusing already developed land can limit sprawl, but it must be done safely.



Urban greening projects should not ignore soil contamination. Planting community gardens, playgrounds or parks on former industrial land without soil testing can create exposure risks.

10. PLANNING TOOLS AND POLICY RESPONSES

Urban climate, air quality and health risks require integrated planning. Technical measures are important, but they must be supported by institutions, regulations, monitoring, finance and public participation.

10.1. Air quality monitoring

Air quality monitoring provides the evidence needed to identify pollution levels, trends and sources. Monitoring may include fixed stations, mobile sensors, satellite data, emission inventories and citizen science.

A good monitoring system should answer:

- Which pollutants exceed standards?

- Where are the hotspots?
- Which seasons are worst?
- Which sources contribute most?
- Which populations are exposed?
- Are policies improving conditions?

Monitoring data should be public and understandable.

10.2. Heat-health action plans

Heat-health action plans help cities prepare for extreme heat. They may include:

- Heat alerts.
- Public communication.
- Cooling centres.
- Protection of outdoor workers.
- Checks on elderly people.
- Shaded public spaces.
- Water access.
- Emergency medical preparedness.
- Urban greening priorities.
- Building cooling strategies.

Heat action plans should focus on the most vulnerable neighbourhoods and groups.

10.3. Low-emission planning

Low-emission planning aims to reduce air pollution and greenhouse gas emissions together. It may include transport, heating, buildings, industry, waste and urban form.

Measures include:

- Low-emission zones.
- Cleaner public transport.
- Building efficiency standards.
- Cleaner heating systems.

- Industrial emission controls.
- Waste burning bans.
- Renewable energy integration.
- Compact city planning.
- Green infrastructure networks.

10.4. Public information and behavioural change

Public information helps people reduce exposure and support policy change. However, information alone is not enough if people lack alternatives.

For example, telling people not to use polluting heating is ineffective if cleaner heating is unaffordable. Telling people to avoid traffic pollution is difficult if they must walk near busy roads to reach work or school.

Effective behavioural change requires enabling conditions: affordable transport, clean energy, accessible green spaces and trusted information.



Design a simple one-week public information campaign for a city during a winter air pollution episode. Include: target group, key message, communication channel and one practical action citizens can take.

11. MONITORING URBAN CLIMATE, AIR QUALITY AND HEALTH

Monitoring urban climate and health requires combining environmental, health and social indicators. Pollution concentration alone is not enough. A city must also understand who is exposed, where they live, what health risks they face and what adaptation options are available.

11.1. Environmental indicators

Environmental indicators may include:

- PM2.5 concentration.
- PM10 concentration.
- NO_2 concentration.
- Ozone concentration.

- Number of days exceeding air quality standards.
- Land surface temperature.
- Heatwave days.
- Urban tree canopy cover.
- Green space per inhabitant.
- Soil sealing percentage.
- Traffic intensity.
- Winter heating fuel use.
- Dust episode frequency.

11.2. Health and vulnerability indicators

Health and vulnerability indicators may include:

- Heat-related hospital admissions.
- Respiratory hospital admissions.
- Cardiovascular mortality.
- Asthma prevalence.
- Age distribution.
- Share of population over 65.
- Children living near major roads.
- Outdoor worker exposure.
- Households using solid fuels.
- Access to healthcare.
- Access to green space.
- Housing quality.
- Energy poverty.

11.3. Integrated urban resilience indicators

Integrated indicators combine environment, exposure and vulnerability. For example, a neighbourhood with high PM2.5, low income, many elderly residents and little green space should be considered a priority for action.

Table 4 proposes an integrated monitoring framework for urban climate, air quality and health.

Table 4. Suggested indicators for urban climate, air quality and health monitoring.

Indicator group	Example indicators	Use in policy
Air quality	PM2.5, PM10, NO_2, O_3	Identify pollution hotspots
Urban heat	Land surface temperature, heatwave days	Plan cooling measures
Land cover	Tree canopy, green space, soil sealing	Guide SLM and urban greening
Exposure	Population near roads or industrial areas	Prioritise interventions
Health	Respiratory admissions, heat illness	Track health impacts
Social vulnerability	Age, income, housing quality	Protect vulnerable groups

Figure 5 presents the same logic visually, showing that urban resilience depends on the intersection between environmental hazards, population exposure and social vulnerability.

Did you know..? A city can reduce average pollution and still leave some neighbourhoods highly exposed. This is why spatial monitoring is important. Environmental improvement should be assessed not only by city averages, but also by who benefits and who remains at risk

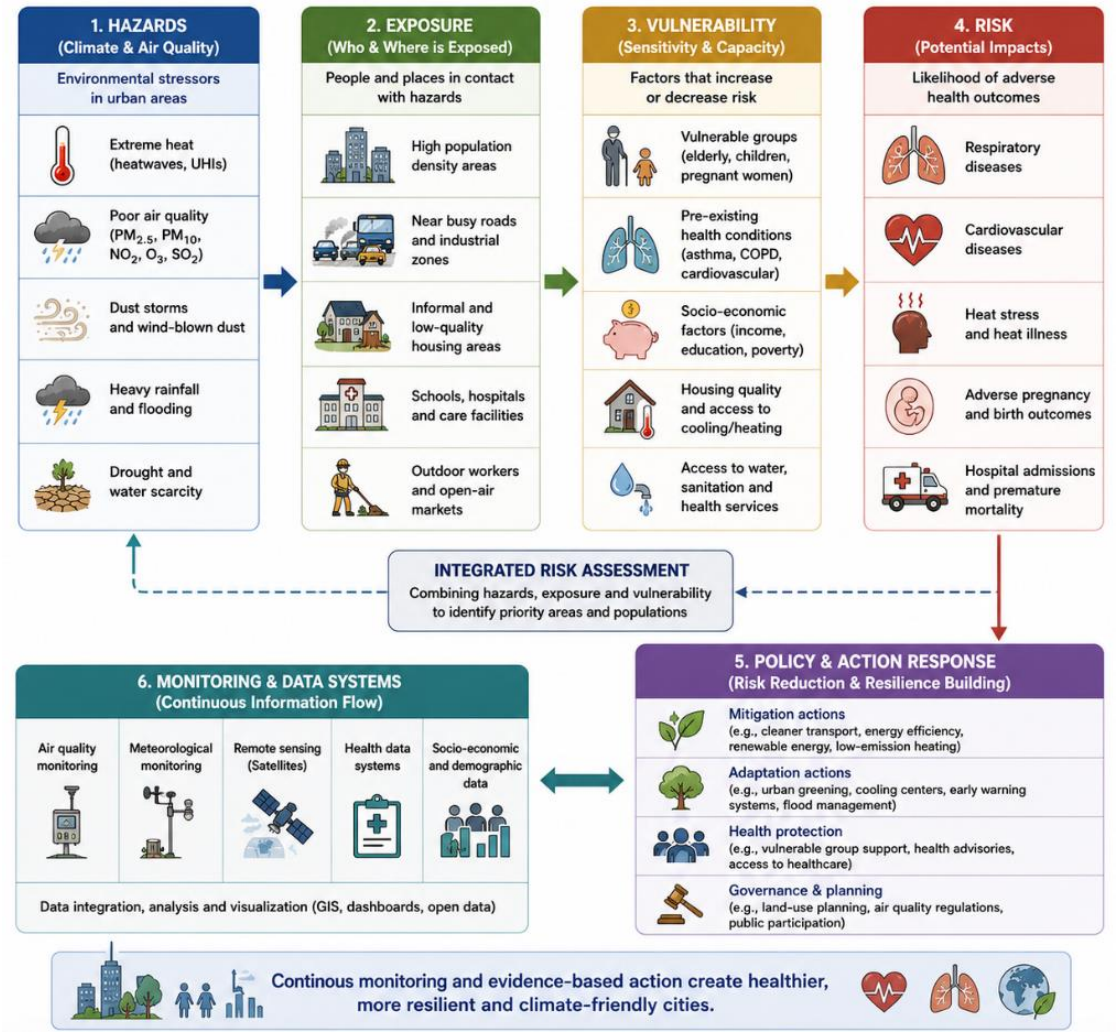


Figure 5. Integrated urban climate–air quality–health monitoring framework linking hazards, exposure, vulnerability and policy response.

12. CONCLUSIONS

Urban climate, air pollution and human health are closely connected. Cities modify local climate through buildings, roads, soil sealing, energy use, transport and reduced vegetation. These changes can intensify heat exposure, reduce ventilation and increase vulnerability to pollution episodes.

Air pollution remains one of the most important urban environmental health risks. Particulate matter, nitrogen dioxide, ozone, sulfur dioxide, carbon monoxide and black carbon affect respiratory and cardiovascular health. Their impacts are especially serious for vulnerable groups such as children, elderly people, outdoor workers and people with chronic diseases.

In Central Asia, urban air quality and heat risks are shaped by regional conditions: cold winters, heating emissions, traffic, industrial activity, valley topography, dust, surrounding drylands and rapid urban growth. These factors make air quality management a public health, climate and land management issue.

Climate action can generate significant health co-benefits. Cleaner transport, cleaner heating, energy-efficient buildings, urban greening, better waste management and reduced open burning can lower greenhouse gas emissions while improving air quality, reducing heat stress and improving urban liveability.

Sustainable Land Management is relevant because cities depend on land decisions. Soil sealing, urban sprawl, peri-urban degradation, dust sources, green belts, brownfield redevelopment and urban vegetation all influence climate and health outcomes. Urban resilience therefore requires integrated planning across climate policy, air quality management, public health and land-use governance.

The central message of this lesson is that urban climate action should not be evaluated only by tonnes of carbon dioxide reduced. It should also be assessed by cleaner air, cooler streets, healthier citizens, safer neighbourhoods, protected soils and more resilient urban ecosystems.

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