ENVIRONMENTAL HAZARDS IN CITIES

STRUCTURE

- INTRODUCTION + DEFINITIONS
- CAUSES OF ENVIRONMENTAL HAZARDS
- IMPACTS ON SOCIETY AND THE ENVIRONMENT
- POSSIBLE SOLUTIONS
- SPECIFIC EXAMPLES
- CONCLUSION

TYPES OF ENVIRONMENTAL HAZARDS

1. AIR POLLUTION

= harmful substances (PM, NO_2, SO_2)

2. WATER POLLUTION

= contamination of water bodies that is harmful to living beings

3. FLOODING RISKS

= likelihood of urban areas being filled by water due to factors like poor drainage, heavy rainfall and urbanization

4. URBAN HEAT ISLANDS

= increase in temperature caused by the built environment (asphalt, concrete)

CAUSES OF ENVIRONMENTAL HAZARDS

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URBANIZATION

= PROCESS THROUGH WHICH NON-URBAN AREAS ARE TRANSFORMED INTO URBAN SPACES, CHARACTERIZED BY THE GROWTH OF CITIES AND TOWNS

NATURAL LANDSCAPES

HIGH DENSITY INFRASTRUCTRUE ZONES

- Buildings
- Roads
- Utilities to accommodate the population and demand for resources

PROBLEMS:

a) Heavy natural resource use

b) Loss of natural ecosystems

c) Pollution

d) Urban water runoff

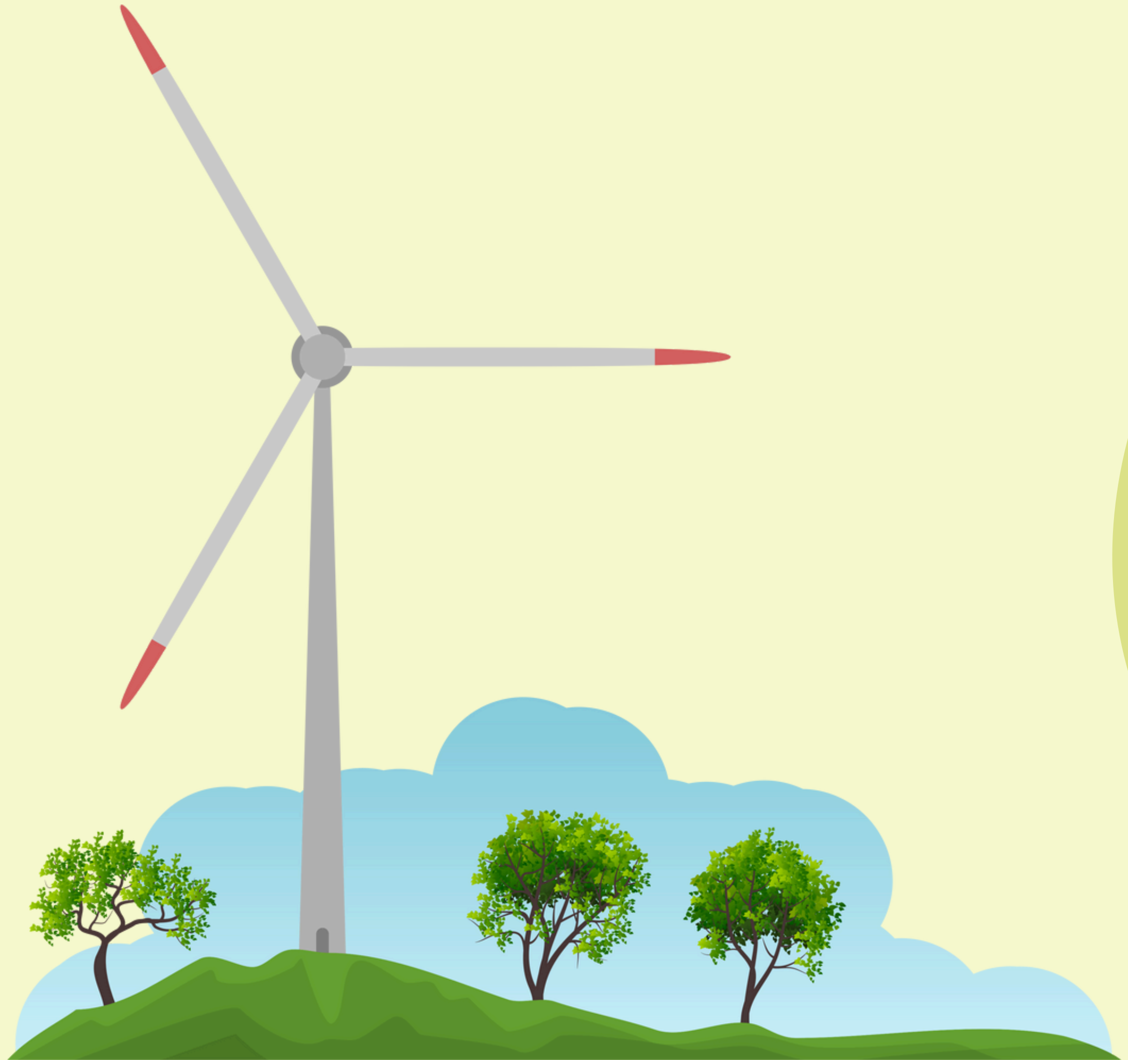
e) Waste

INDUSTRIAL ACTIVITIES

URBANIZATION → INCREASED INDUSTRIALIZATION

PROBLEMS:

a) Tons of waste
b) Resource drain
c) Pollution
d) Energy consumption
e) Landfills



Industrial waste

Adversity to health

- **Non-hazardous waste**
  Minimal risk to human health and the environment
- **Hazardous waste**
  Toxic, corrosive, flammable, or reactive, posing significant health and environmental risks

Source

- Manufacturing waste
- Chemical waste
- Mining waste

Physical state

- Solid waste
- Liquid waste
- Gaseous waste

Composition

- **Organic waste**
  Biodegradable materials
- **Inorganic waste**
  Non-biodegradable materials

Persistence

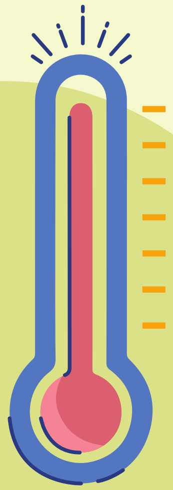
- **Persistent waste**
  Waste that remains in the environment for long periods and resists degradation
- **Non-persistent waste**
  Waste that breaks down or decomposes relatively quickly in the environment

LOCAL PRACTISES

TRANSPORTATION

- Fastest-growing greenhouse gas emitter
- One of the main contributors to the issue of high air pollution in the cities
- Third largest source of CO2 emmisions
- Growing need to construct pavements in cities ---> heating practises

LOCAL PRACTISES



HEATING PRACTISES

- Increasing paved surfaces ----> worsening heat islands
- Water runoff carries pollutants into water bodies, harming water quality

WASTE MANAGEMENT

- poor management is significant source of GHG emissions
- approximately 3-5 % of total GHG emissions in cities
- poor management ----> water contamination through runoff

CLIMATE CHANGE

- Cities = main contributors to climate change

- High concetration of people and activities ----> major consumers of energy and sources of GHG emissions

- more than one-half, up to two thirds of global energy consumption

- Approximately half to 80 % of global GHG emissions

CLIMATE RISKS:

- Rising sea levels
- Extreme rainstorms
- Heatwaves

SOURCES

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IMPACTS ON SOCIETY AND ENVIRONMENT

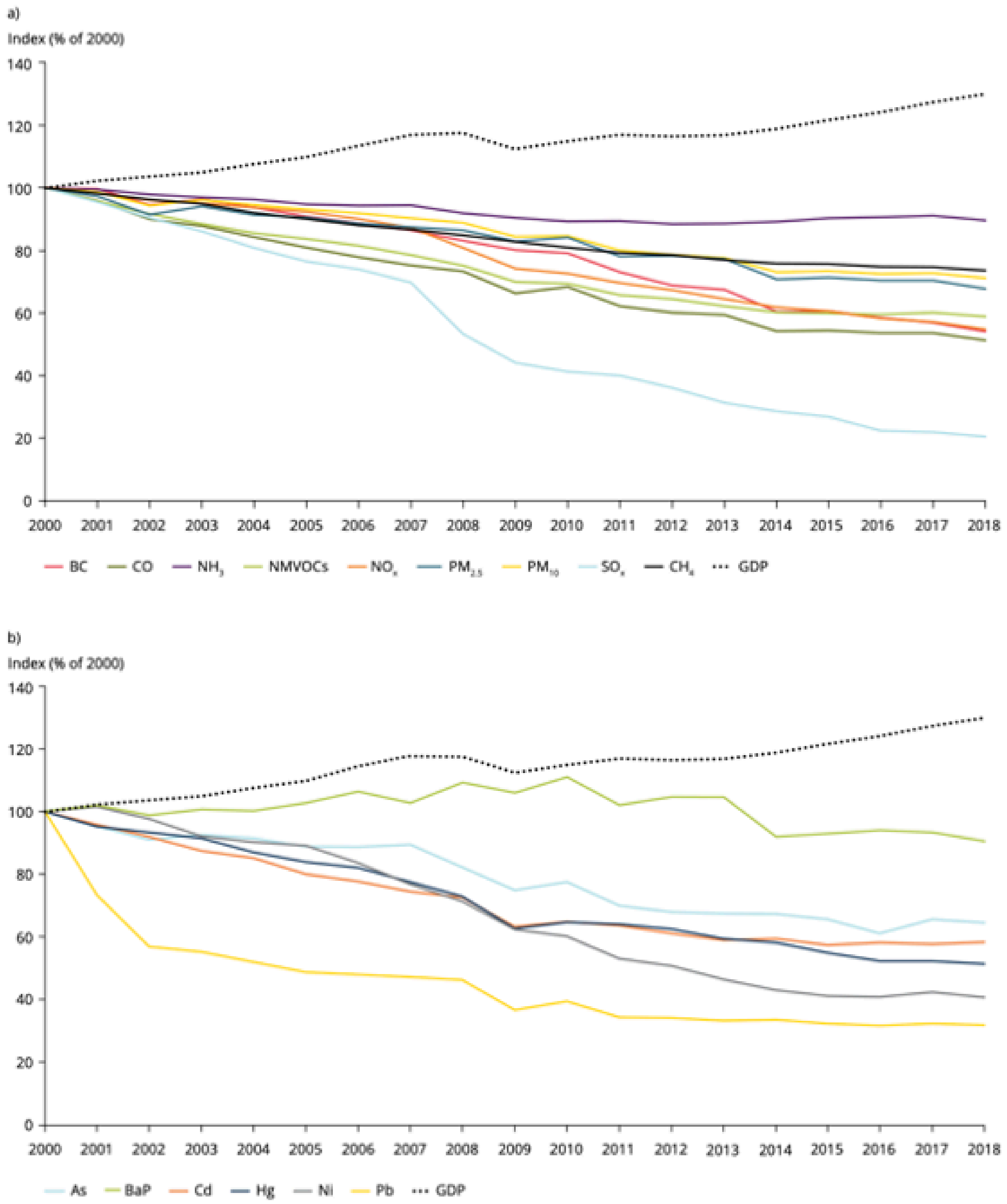
PUBLIC HEALTH

- Air pollution
- Noise pollution
- Factors of residental spaces
- Heat islands
- Some more: drinking water, solar radiation, extreme weather

AIR POLLUTION

- Particulate matter (PM), nitrogen dioxide (NO2) and ozone (O3)
- Respiratory and cardiovascular diseases
- European Environment Agency (EEA) reports – improvement

Figure 3.1 **Development in EU-28 emissions, 2000-2018 (% of 2000 levels): (a) SO_X, NO_X, NH_3, PM_{10}, $PM_{2.5}$, NMVOCs, CO, CH_4 and BC; (b) As, Cd, Ni, Pb, Hg and BaP. Also shown for comparison is the EU-28 GDP (expressed in chain-linked volumes (2010), % of 2000 level)**



Note: CH_4 emissions are total emissions (as set by the Intergovernmental Panel on Climate Change (IPCC) sectors 1-7) excluding those from land use, land use change and forestry (sector 5).

Sources: EEA (2020e, 2020f); Eurostat (2020b).

AIR POLLUTION: PREMATURE DEATHS

Table 10.1 **Premature deaths attributable to $PM_{2.5}$, NO_2 and O_3 exposure in 41 European countries and the EU-28, 2018**

Country	Population (1 000)	$PM_{2.5}$ Annual mean (a)	$PM_{2.5}$ Premature deaths (b)	NO_2 Annual mean (a)	NO_2 Premature deaths (b)	O_3 SOMO35 (a)	O_3 Premature deaths (b)
Austria	8 822	13.6	6 100	17.7	790	6 731	420
Belgium	11 399	12.7	7 400	20.4	1 200	4 298	350
Bulgaria	7 050	21	12 500	19.0	1 100	3 765	320
Croatia	4 105	18	5 100	13.8	90	6 342	250
Cyprus	1 216	14.5	620	23.5	210	6 844	40
Czechia	10 610	18.3	10 900	15.5	300	6 946	580
Denmark	5 781	10.5	3 100	9.8	10	3 866	150
Estonia	1 319	7	610	7.1	< 1	2 793	30
Finland	5 513	5.9	1 700	8.6	< 1	2 351	90
France	64 456	10.6	33 100	15.9	5 900	5 274	2 300
Germany	82 792	12.3	63 100	19.1	9 200	5 674	4 000
Greece	10 741	18.3	11 800	21.0	3 000	7 157	650
Hungary	9 778	18.3	13 100	17.0	850	5 892	590
Ireland	4 830	7.8	1 300	11.0	50	2 556	60
Italy	60 484	15.5	52 300	20.1	10 400	6 490	3 000
Latvia	1 934	12.1	1 800	11.9	70	2 732	60
Lithuania	2 809	12.8	2 700	12.3	10	3 096	90
Luxembourg	602	10	210	20.2	40	4 604	10
Malta	476	12.5	230	10.4	< 1	5 498	10
Netherlands	17 181	12	9 900	20.4	1 600	3 620	410
Poland	37 977	21.7	46 300	15.6	1 900	5 095	1 500
Portugal	9 794	8.4	4 900	15.4	750	4 672	370
Romania	19 531	17.6	25 000	19.3	3 500	3 683	730
Slovakia	5 443	18.2	4 900	14.8	40	6 129	230
Slovenia	2 067	15.8	1 700	14.5	50	6 494	100
Spain	44 452	10.2	23 000	19.4	6 800	5 841	1 800
Sweden	10 120	6.1	3 100	8.7	< 1	3 465	240
United Kingdom	66 274	10	32 900	18.9	6 000	2 307	1 000
Albania	2 870	21.6	5 000	14.7	100	5 601	180
Andorra	75	8.5	30	18.1	< 1	6 593	< 1
Bosnia and Herzegovina	3 503	26.4	5 100	13.9	90	5 218	150
Iceland	348	4.7	60	10.4	< 1	1 999	< 1
Kosovo	1 799	28.2	4 000	17.0	90	3 922	80
Liechtenstein	38	8.6	20	16.5	< 1	7 045	< 1
Monaco	38	12.6	20	25.0	10	7 686	< 1
Montenegro	622	20.5	640	15.0	10	5 630	30
North Macedonia	2 075	30.7	3 000	19.0	130	3 533	50
Norway	5 296	6.4	1 400	10.0	40	3 128	90
San Marino	34	13.3	30	14.4	< 1	6 700	< 1
Serbia	7 001	26.3	14 600	17.3	430	3 500	280
Switzerland	8 484	9.8	3 500	17.6	270	7 214	350
EU-28 total	**507 558**	**13.2**	**379 000**	**17.8**	**54 000**	**4 970**	**19 400**
All countries total	**539 742**	**13.5**	**417 000**	**17.6**	**55 000**	**4 962**	**20 600**

Notes: (a) The annual mean (in μg/m^3) and the SOMO35 (in μg/m^3·days), expressed as population-weighted concentration, is obtained according to the methodology described by ETC/ATNI (2020d) and references therein and not only from monitoring stations.

(b) Total and EU-28 premature deaths are rounded to the nearest thousand (except for O_3, nearest hundred). The national totals are rounded to the nearest hundred or ten.

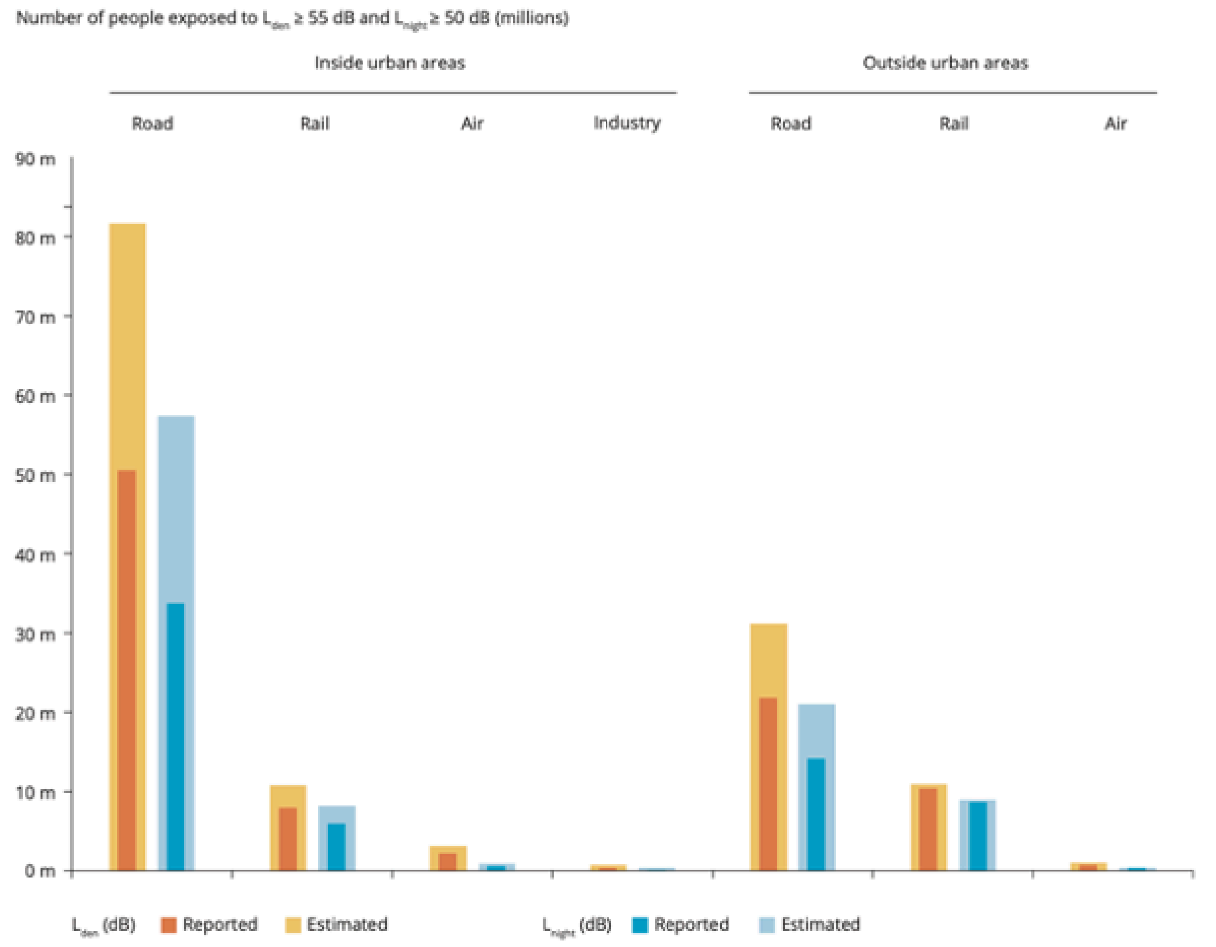
NOISE EXPOSURE

Table 2.1 Population exposure to environmental noise, based on areas covered by strategic noise maps in 2017, EEA-33 (Turkey not included)

		Number of people exposed to $L_{den} \geq 55$ dB (million)		Number of people exposed to $L_{night} \geq 50$ dB (million)	
		Reported	**Estimated**	**Reported**	**Estimated**
Inside urban areas	Road	50.6	81.7	33.8	57.5
	Rail	7.9	10.7	6.0	8.1
	Air	2.2	3.1	0.6	0.9
	Industry	0.3	0.8	0.2	0.4
Outside urban areas	Road	21.8	31.1	14.2	21.1
	Rail	10.4	10.9	8.7	9.0
	Air	0.8	1.1	0.4	0.4

Notes: Based on data submitted up until 1 January 2019 for the 2017 END submission of strategic noise mapping. Reported data refer to data submitted by countries and estimated data refer to data gap-filled because of incomplete reporting.

Figure 2.1 **Population exposure to environmental noise based on areas covered by strategic noise maps in 2017, EEA-33 (Turkey not included)**

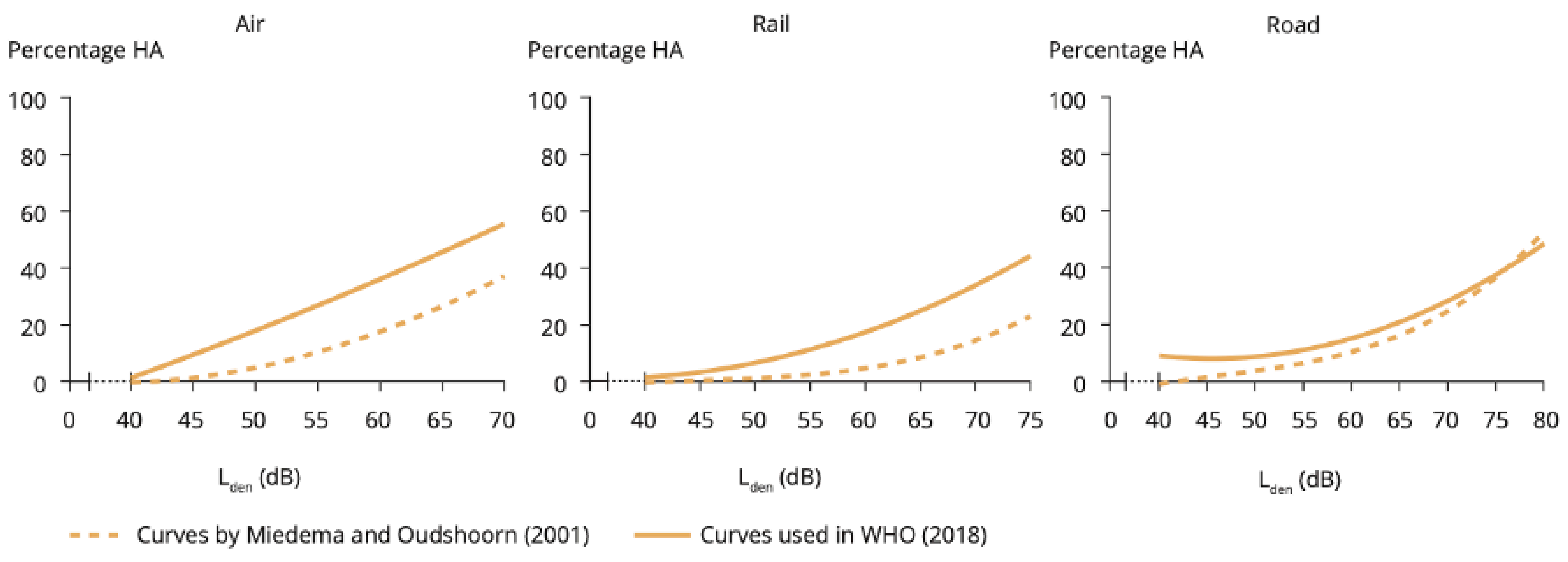


Sources: EEA (2019c, 2019d).

NOISE IMPACTS

- Children – reading impairment
- Adults – annoyed by noise, sleep disturbance
- About 48 000 new cases of ischaemic heart disease
- About 12 000 premature deaths

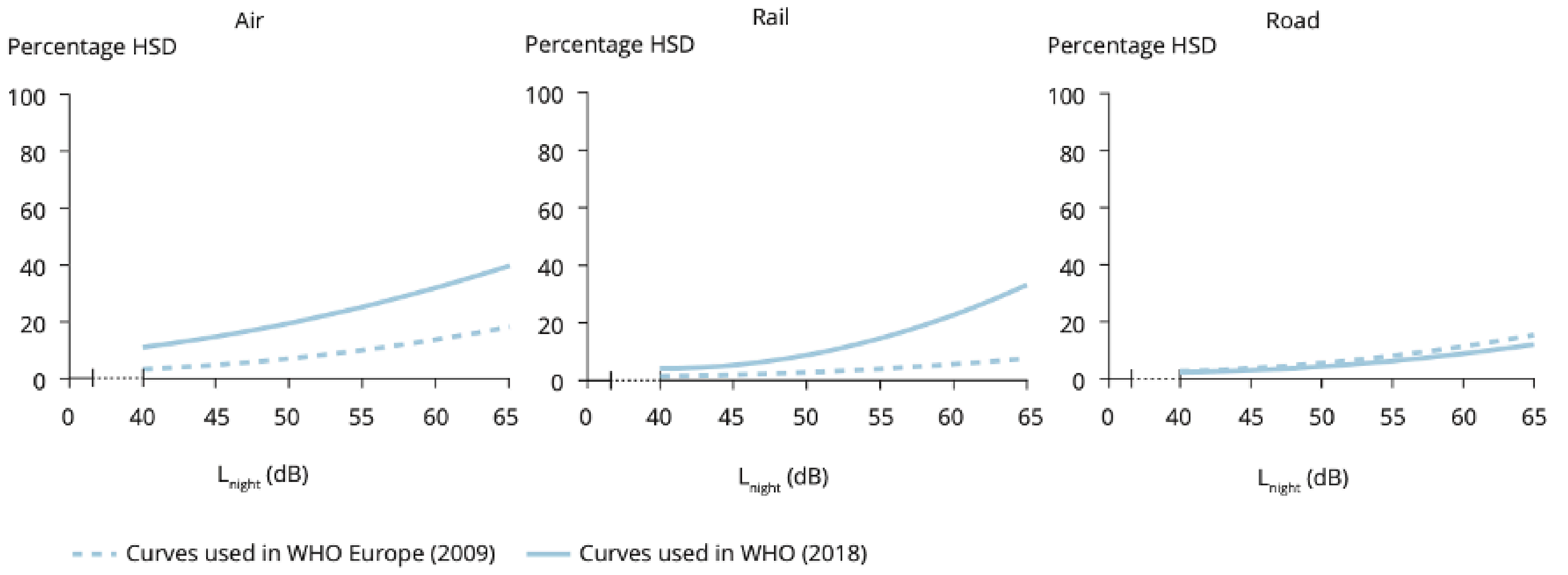
Figure 3.1 **Estimated percentage of people in the category 'Highly Annoyed (HA) by noise for air, road and rail traffic' according to the WHO environmental noise guidelines**



Note: Dashed lines show the previous curves used by the EU from Miedema and Oudshoorn (2001).

Source: Guski et al. (2017).

Figure 3.2 **Estimated percentage of people in the category 'Highly Sleep Disturbed (HSD) by noise for air, road and rail traffic' from the WHO environmental noise guidelines**



Note: Dashed lines show previous curves from *Night-Noise Guidelines for Europe* (WHO Europe, 2009).

Source: Basner and McGuire (2018).

Table 3.5 **Estimated number of people suffering from various health outcomes due to environmental noise in 2017, EEA-33 (Turkey not included)**

		High annoyance	High sleep disturbance	Ischaemic heart disease	Premature mortality ([a])	Cognitive impairment in children
Inside urban areas	Road	12 525 000	3 242 400	29 500	7 600	
	Rail	1 694 700	795 500	3 100	800	
	Air	848 300	168 500	700	200	9 500
	Industry	87 200	23 400	200	50	
Outside urban areas	Road	4 625 500	1 201 000	10 900	2 500	
	Rail	1 802 400	962 900	3 400	900	
	Air	285 400	82 900	200	50	2 900
	Total ([b])	**21 868 500**	**6 476 600**	**48 000**	**12 100**	**12 400**

Notes: ([a]) Refers to mortality due to ischaemic heart disease.

([b]) There may be double counting for annoyance and sleep disturbance because of the combined effects of multiple sources. It is estimated to be no more than 13 % for annoyance and 16 % for sleep disturbance. Double counting for ischaemic heart disease and mortality is estimated to be negligible (ETC/ACM, 2018)

FACTORS OF RESIDENTIAL SPACES

Rezidental air contaminations

- Factors
- Sick building syndrome

Lightening (artificial)

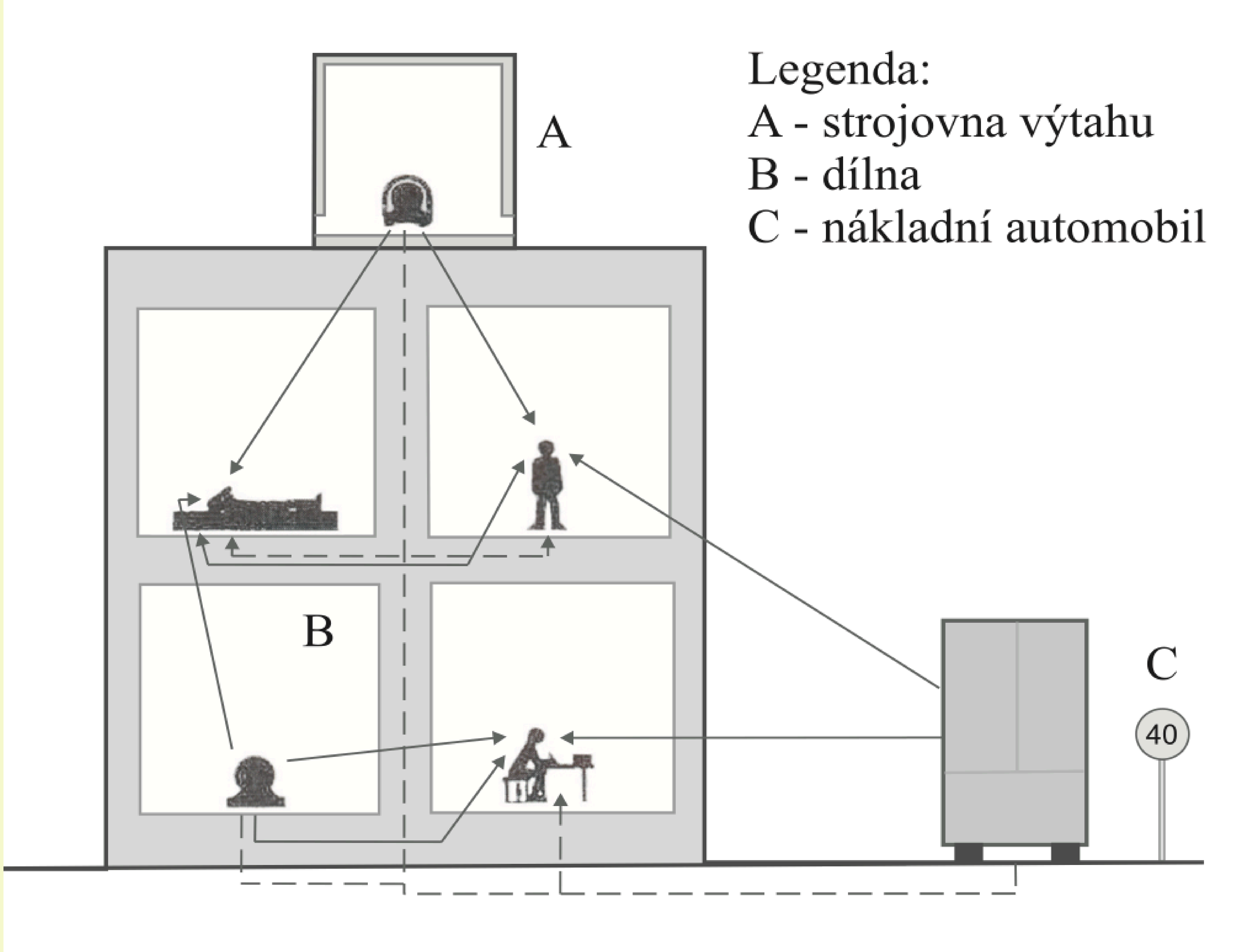
- Biological factors - hypothalamus, melatonin
- Intensity, color, type

Radon

- = heaviest naturally occurring chemical element in the noble gas group

Noise and vibrations

- Vibration sources located in buildings can be divided into three groups


Legenda:
A - strojovna výtahu
B - dílna
C - nákladní automobil
A
B
C
40

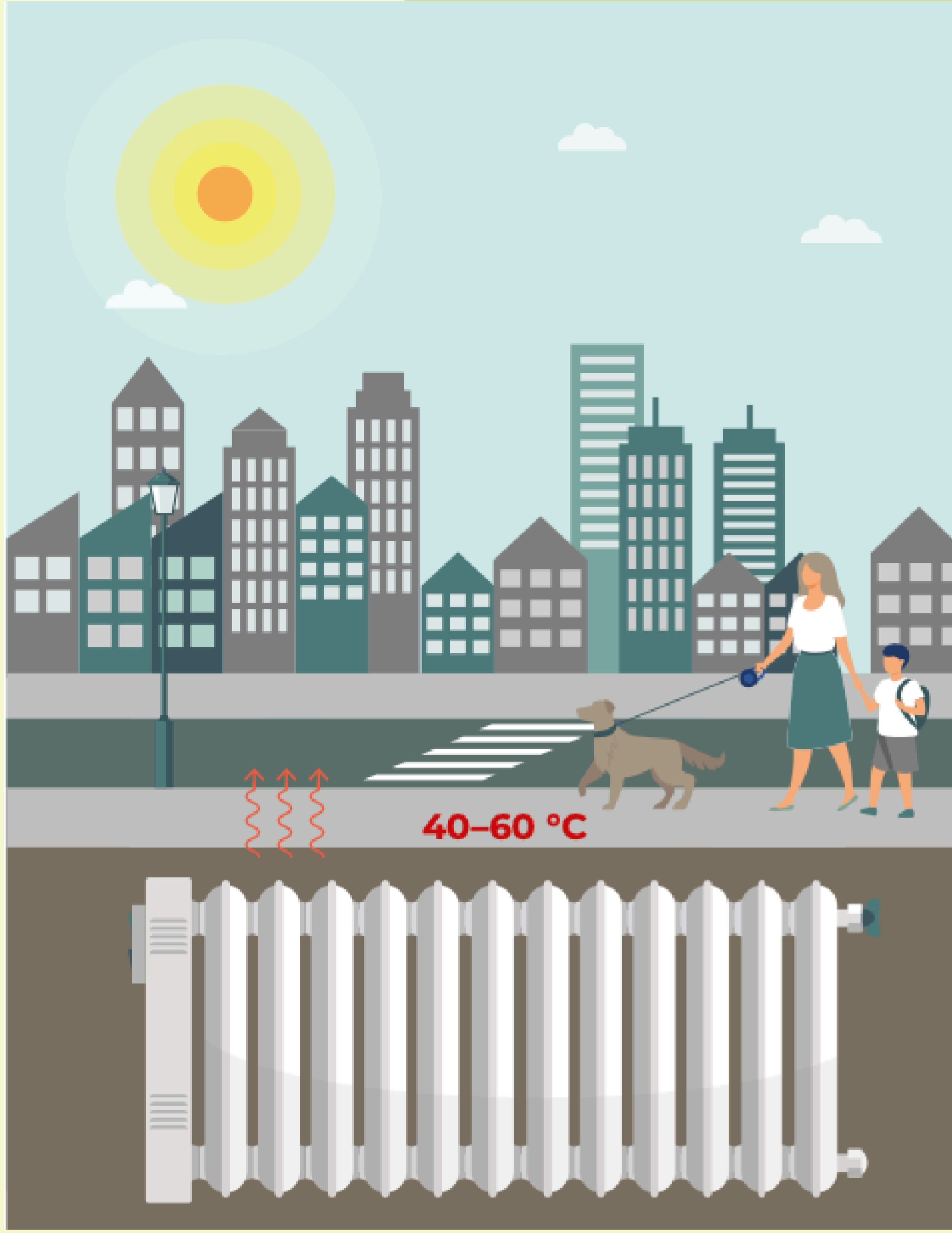
HEAT ISLANDS

- Families with young children
- Seniors
- Workers
- Drivers...

HEAT ISLANDS

Serious health consequences of heat include:

- Heatstroke caused by overheating of the body
- Sunburn caused by direct sunlight
- Overheating causing dehydration, heat exhaustion and fainting
- Breathing difficulties, heat cramps
- Circulatory and cerebral accidents such as heat exhaustion or heat collapse



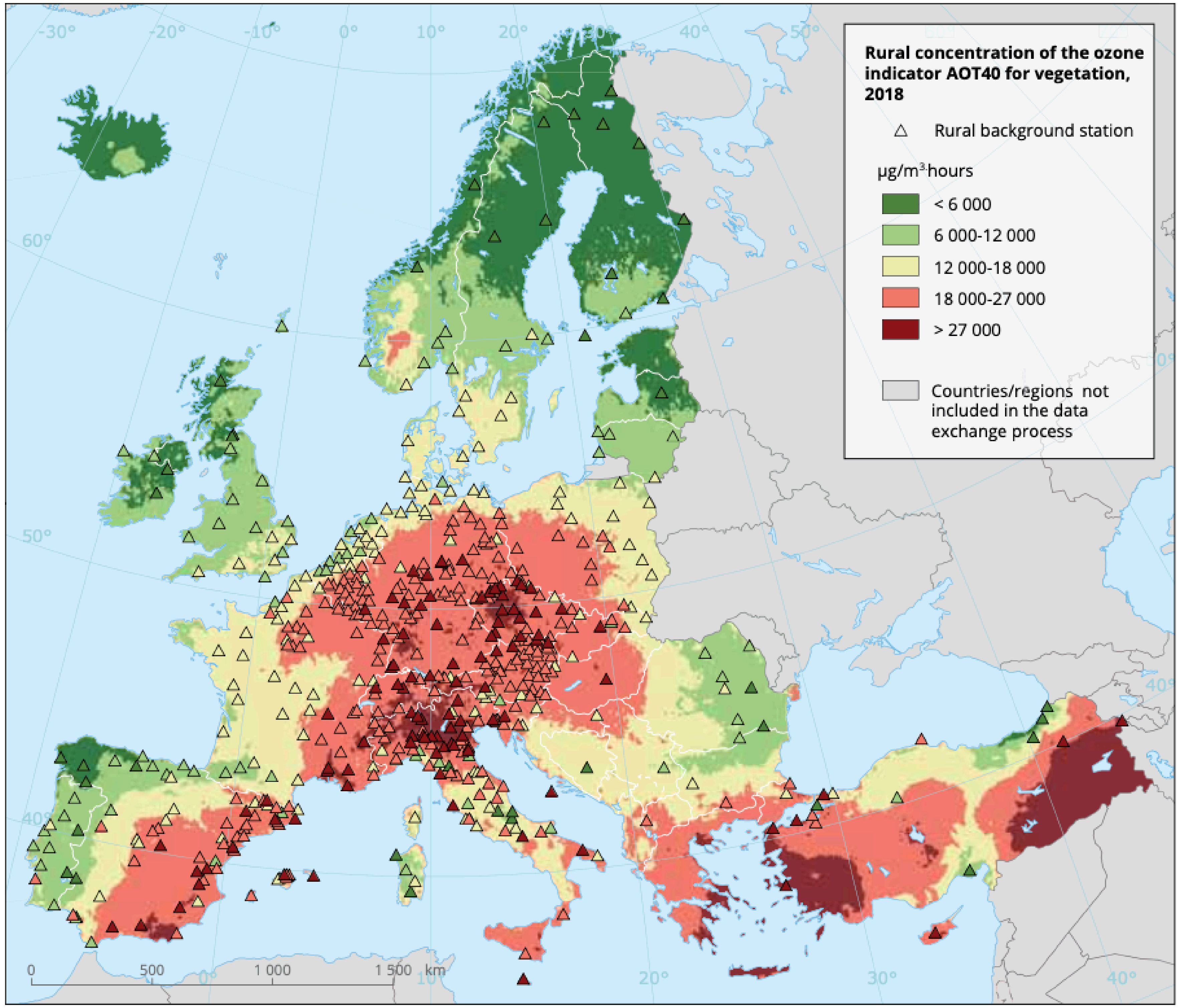
ENVIRONMENTAL DEGRADATION

- Air pollution
- Noise pollution
- Heat islands
- Outcomes

AIR POLLUTION

- Ozone
- Eutrophication
- Acidification
- Nitrogen oxides and sulphur dioxide
- Toxic metals

Map 11.1 Rural background concentration of the O_3 indicator AOT40 for vegetation and crops, 2018

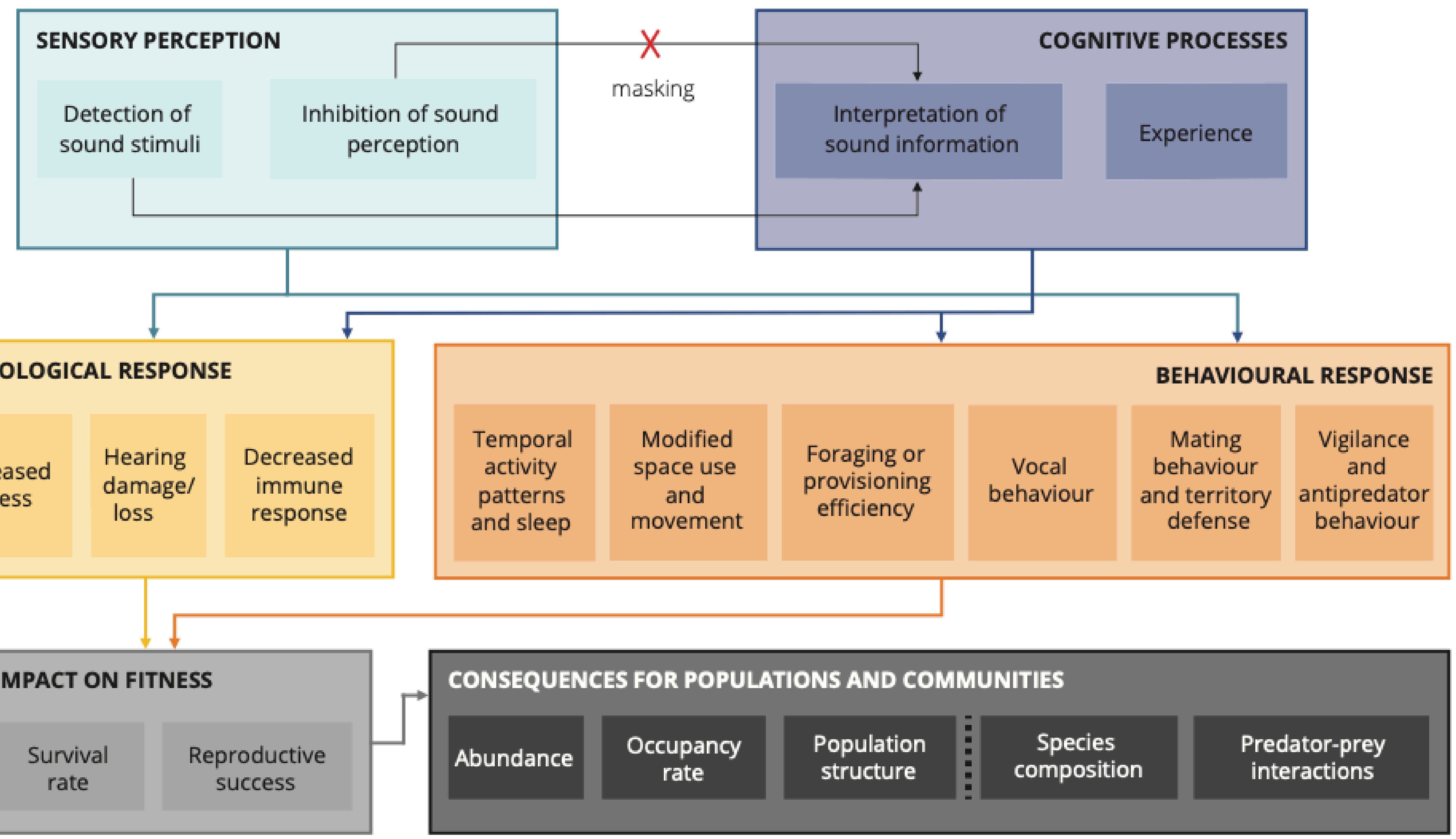


Reference data: ©ESRI

Source: ETC/ATNI (2020d).

NOISE POLLUTION

Figure 5.1 **Mechanisms involved in the impact of anthropogenic noise on wildlife**



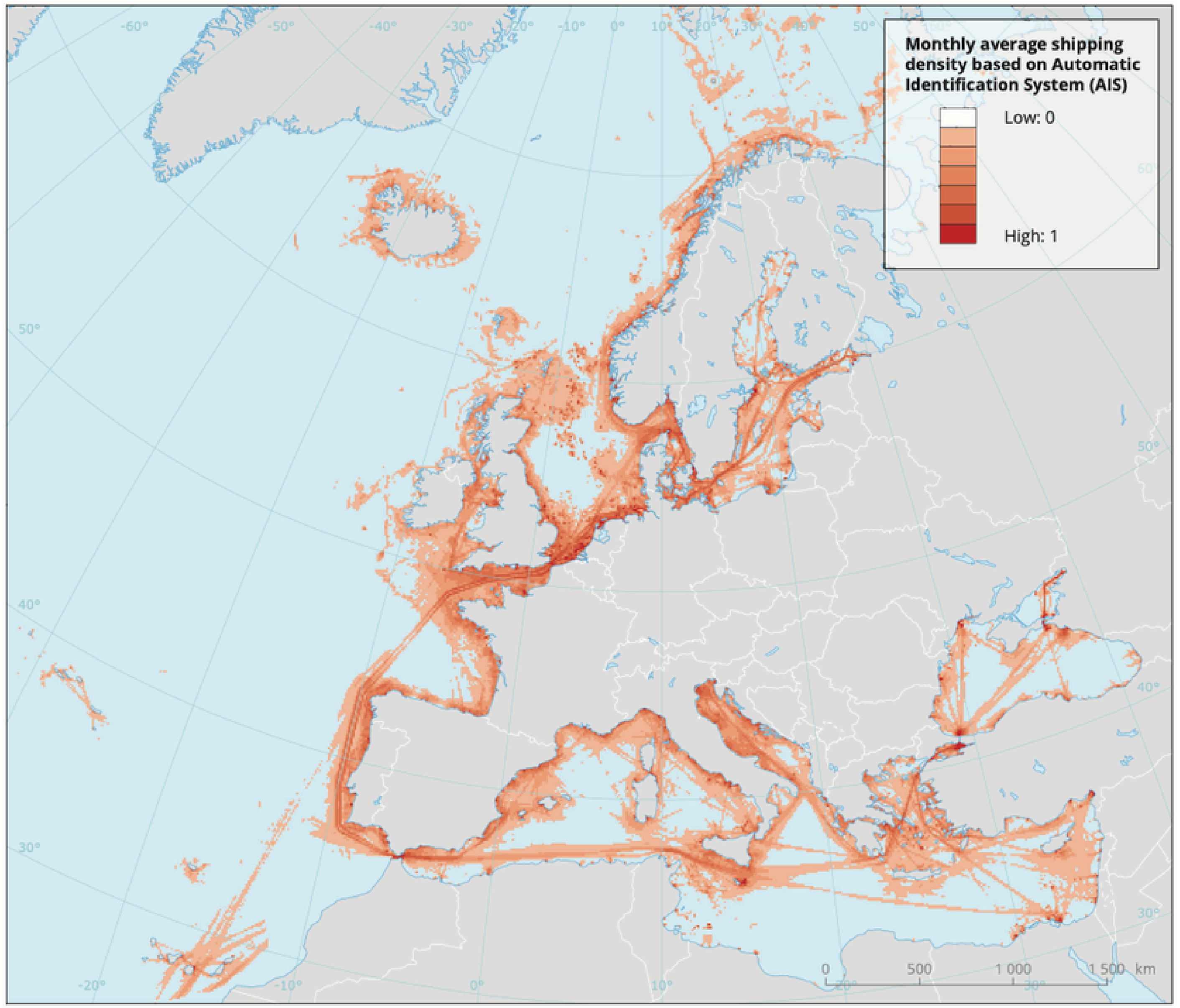
Note: Masking effect: when the noise is close, it reduces an individual's ability to hear the sounds of others.

Source: Adapted from Francis and Barber (2013).

NOISE POLLUTION

- Quietness suitability index
- Underwater noise
- Quiet areas

Map 5.2 Estimated distribution of continuous underwater noise, using shipping traffic density in 2017



Notes: AIS based vessel density dataset used as a proxy for continuous anthropogenic noise. The index is based on the Log transformed monthly average shipping density per 10 × 10 km grid. It is calculated with the number of hours per month that ships spent in each kilometre square.

Sources: EMODnet (2019) and ETC/ICM (2019).

Table 5.1 Effects on terrestrial and marine wildlife due to general background, transport and industrial noise

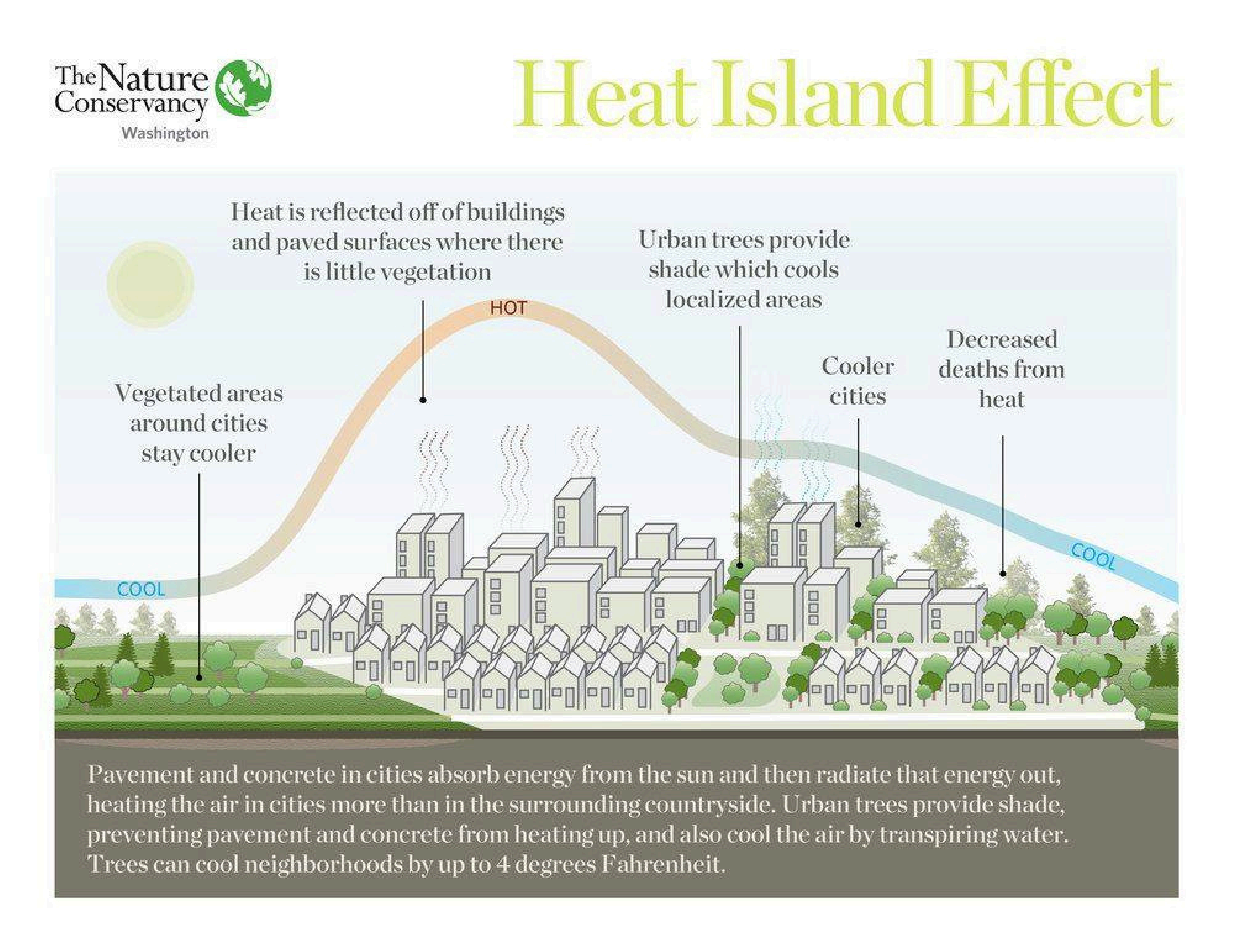
Terrestrial	Birds	Changes in singing and communication behaviour
		Changes in spatial distributions and movements
		Reduced breeding
		Effects on physiological development
		Increased stress levels
		Reduced reproductive success
		Decline in species diversity
		Changes in distribution and abundance.
		Changes in community species
	Mammals	Changes in vocal and communication behaviour
		Reduced foraging
		Increased stress levels
		Reduced reproductive success
	Reptiles and amphibians	Changes in vocal and communication behaviour
		Difficulties in locating mates
	Invertebrates	Changes in mate attraction behaviour
Marine	Fish	Changes in spatial distributions and movements
		Changes in territorial and social behaviour
		Reduction in detection of communication signals
		Increased stress hormones
		Temporary hearing loss and damage to ears
		Reduction in local abundance and catch rate
	Mammals	Changes in vocal and communication behaviour
		Changes in time spent feeding and milling
		Loss of communication space
		Changes in spatial distributions and movements
		Increased stress hormones
		Shift in hearing thresholds
	Invertebrates	Increase in larvae settlement
		Disruption of foraging and anti-predator behaviour
		Damage to sensory systems
		Development delay and body modifications

Physiological response
Behavioural response
Impact on fitness
Consequences for population and communities

Sources: Adapted from Francis and Barber (2013) and Shannon et al. (2016).

HEAT ISLANDS

- Dryness
  - Not retaining enough water
  - Evaporation of water
- Bad air circulation
- Surroundings



OUTCOMES

Loss of natural habitats and degradation

- Temperature stress
- Vegetation changes

Altered Behaviour and Phenology

- Migration patterns
- Reproductive Cycles

Spread of invasive species

- Migration (change of climate, resource stress)

Limited resources for wildlife

- Water stress
- Food stress

ECONOMIC COSTS

- Direct economic costs
    - Disaster recovery
- Productivity losses
    - Productivity of workers
    - Disruptions to supply chain
- Rising energy and resource costs
    - Higher energy demand
    - Water management costs
- Costs to urban businesses and markets
    - Property devaluation
    - Insurance
    - Tourism losses
- Indirect economic costs
    - Public health expenses
    - Migration and housing needs

SOURCES

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POSSIBLE SOLUTIONS

PARTICIPATIVE ACTIVITY 1

A VISION FOR SUSTAINABLE CITIES OF THE FUTURE

What do you think a sustainable city of the future should looks like?

What should it contains?

What would make you feel good there?

PARTICIPATIVE ACTIVITY 2

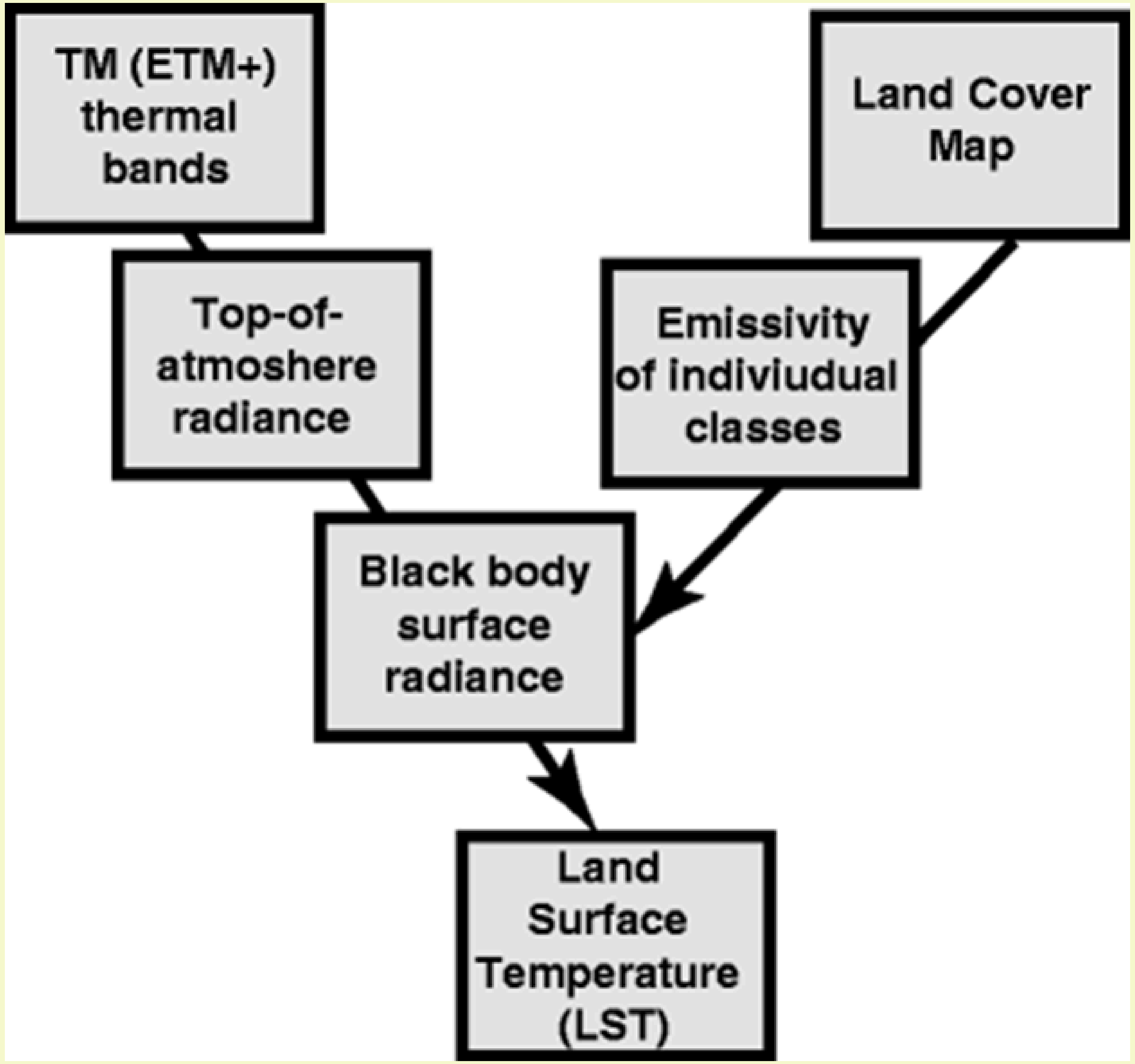
1. choose one example of a possible solution
2. find a discussion partner and lightly present your chosen example to each other
3. take it back and find another one to introduce to the other partner again

EXAMPLES IN CR

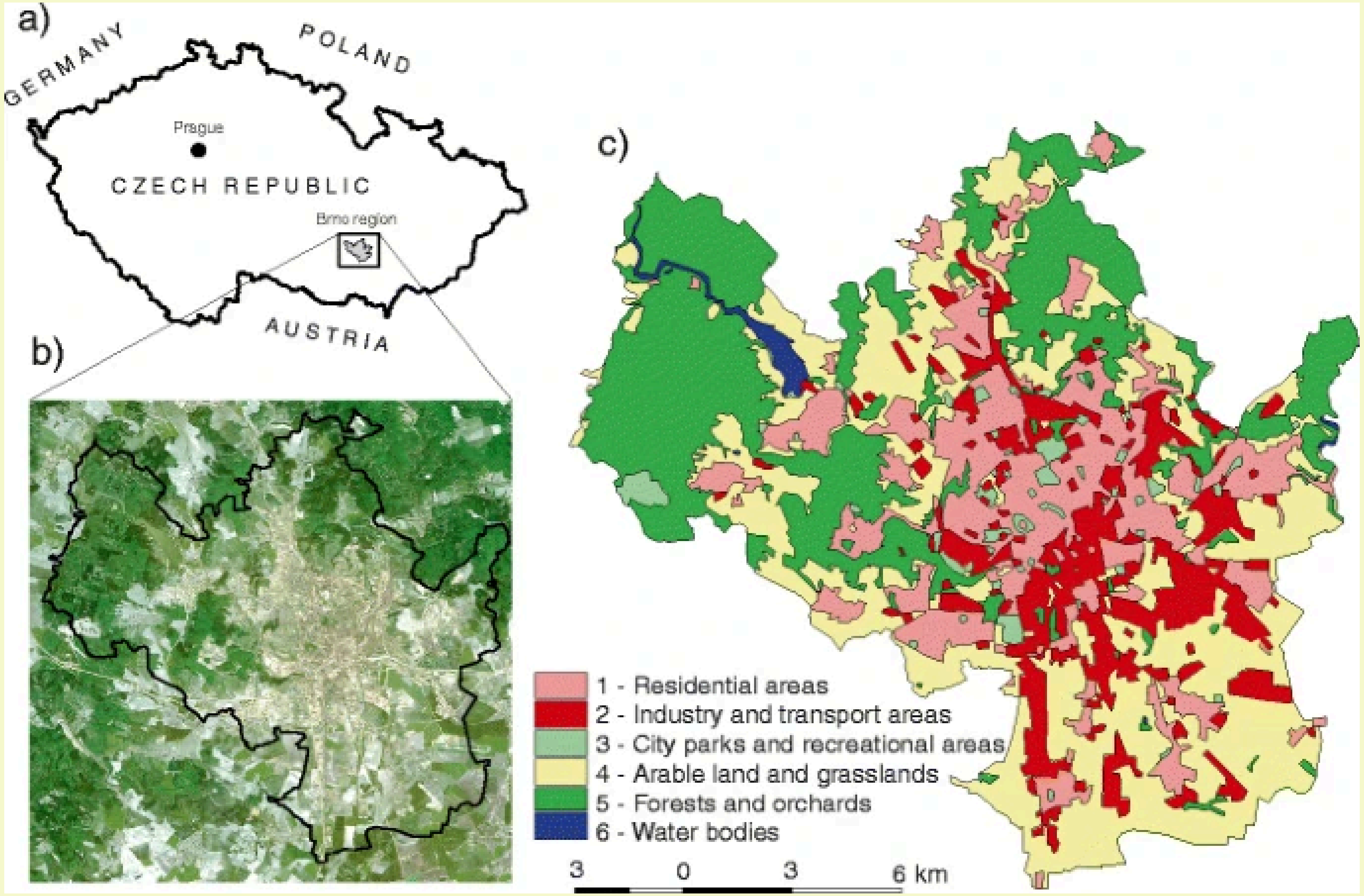
The surface urban heat islands in the city of Brno

- May 24, 2001, mean air temperature, 17.6 °C; minimum, 8.4 °C; maximum, 23.3 °C

- June 15, 2006, mean air temperature, 20.6 °C; minimum, 10.6 °C; maximum, 25.9 °C

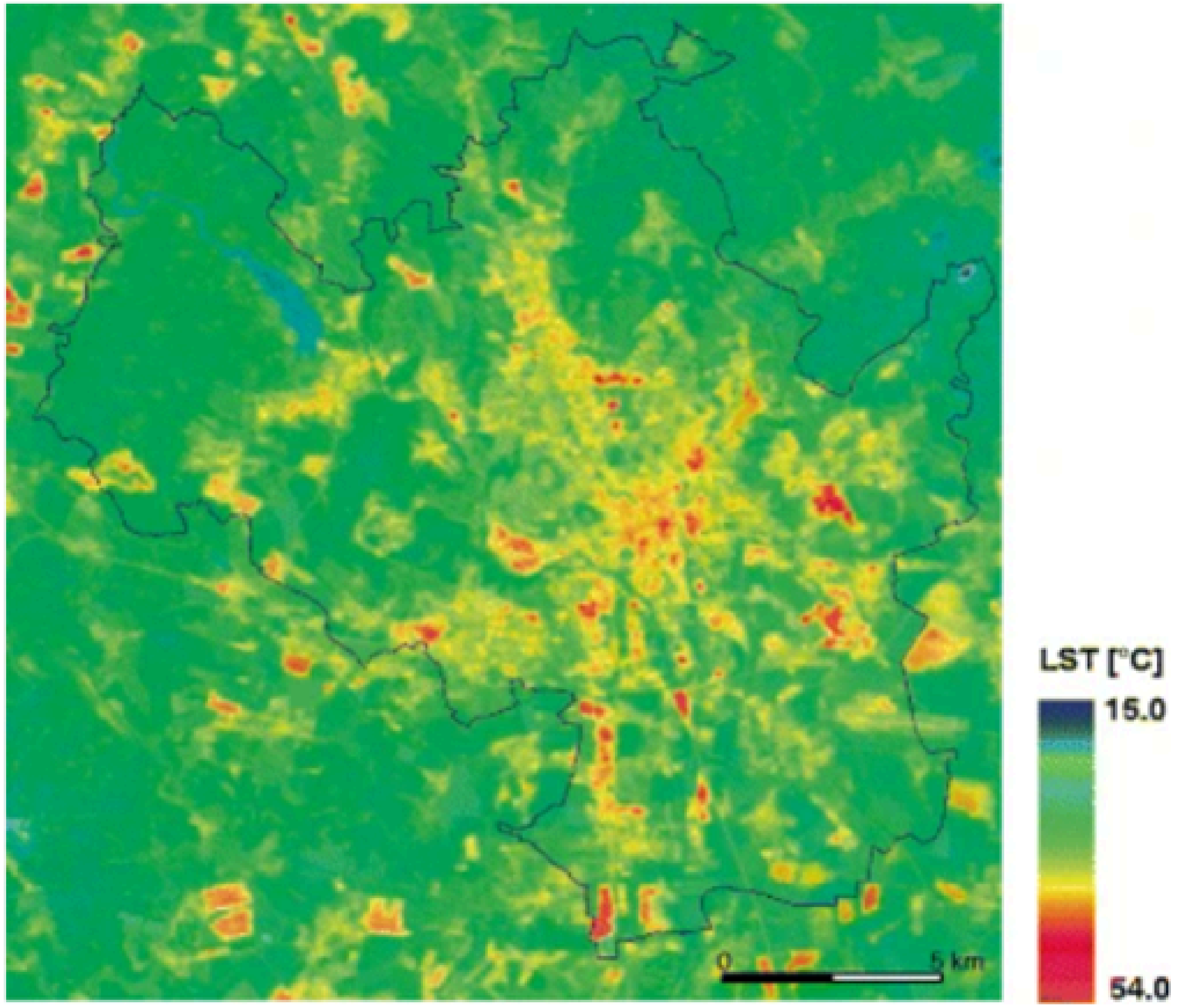


flowchart summarizing basic steps of LST derivation from infrared imagery

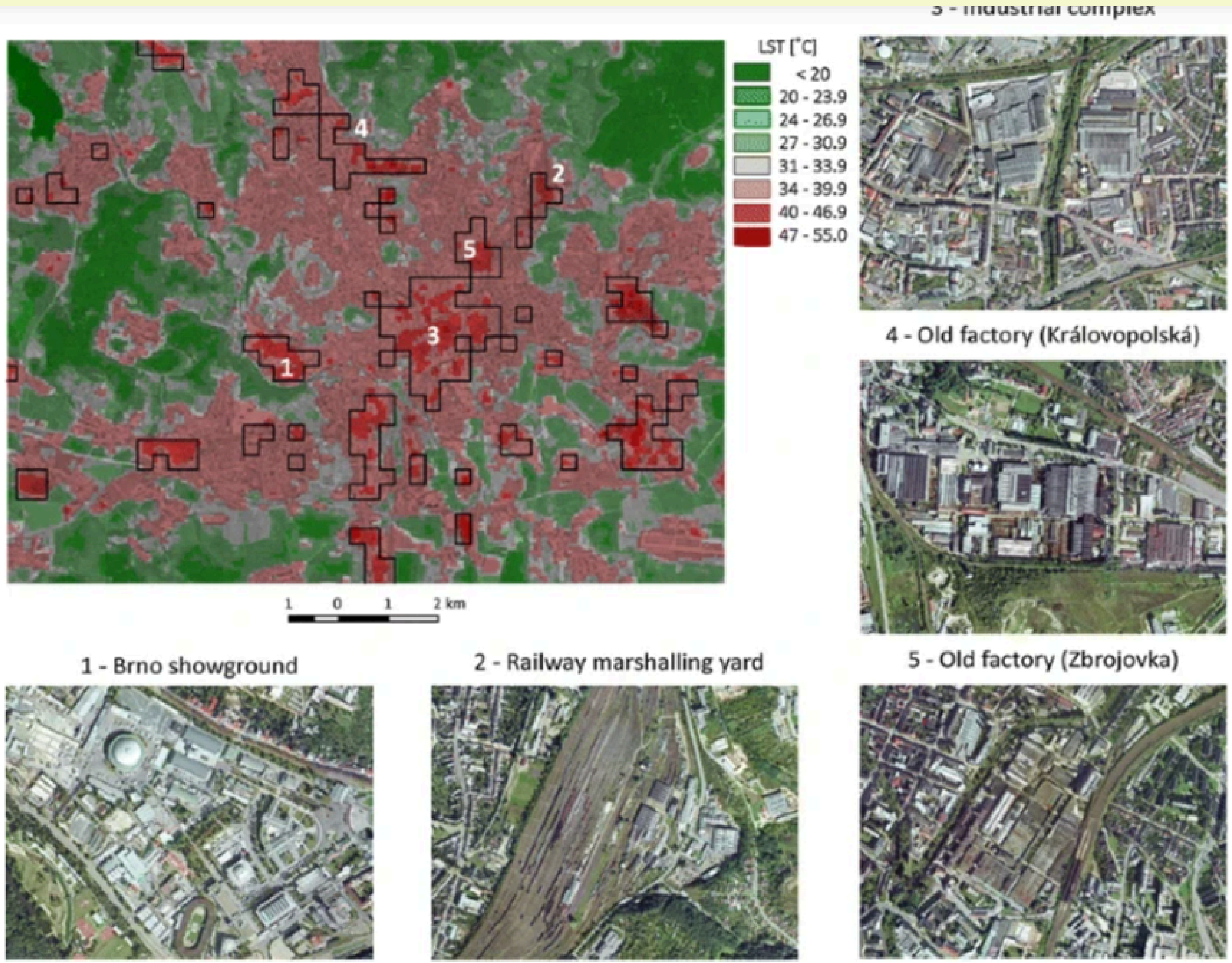


- residential 20%
- industrial 14%
- arable land, grasslands 34%
- forests 29%
- parks and water bodies 1%

Fig. 3

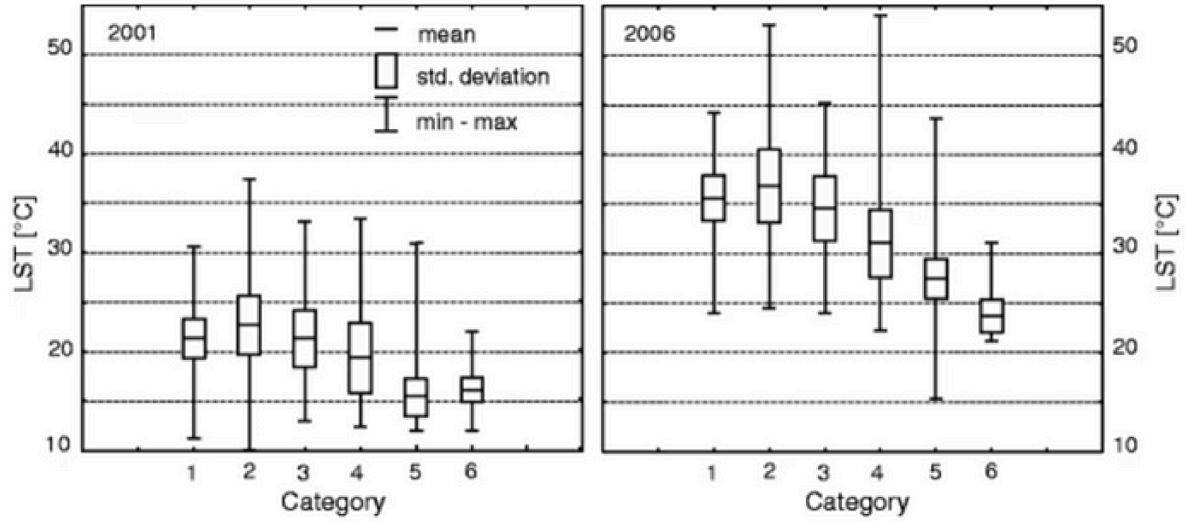


Spatial variability of LST values within the Brno region; LST derived from Landsat thermal imagery acquired on June 24, 2006



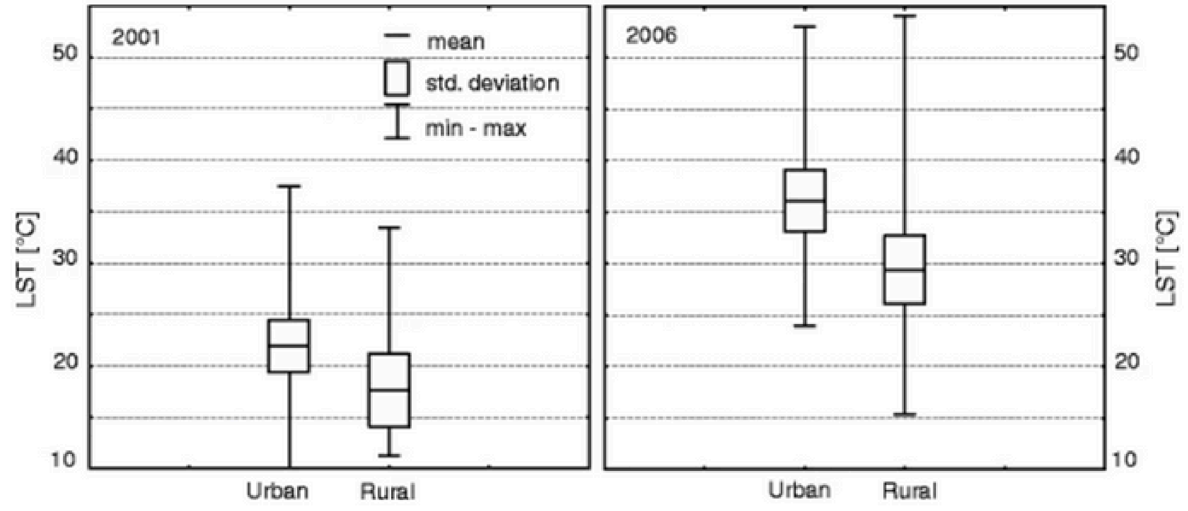
Spatial distribution of LST in the center of Brno. *Black lines* mark surround with LST higher than the mean + 2 SD. *Individual numbers* indicate the positions of selected "hot spots" with character of land cover as presented on the accompanying aerial photographs

Fig. 4



Box plots of LST values for individual land cover classes

Fig. 5



Intensity of surface UHI in Brno region defined as the difference between urban and rural areas for two analyzed scenes

CONCLUSIONS

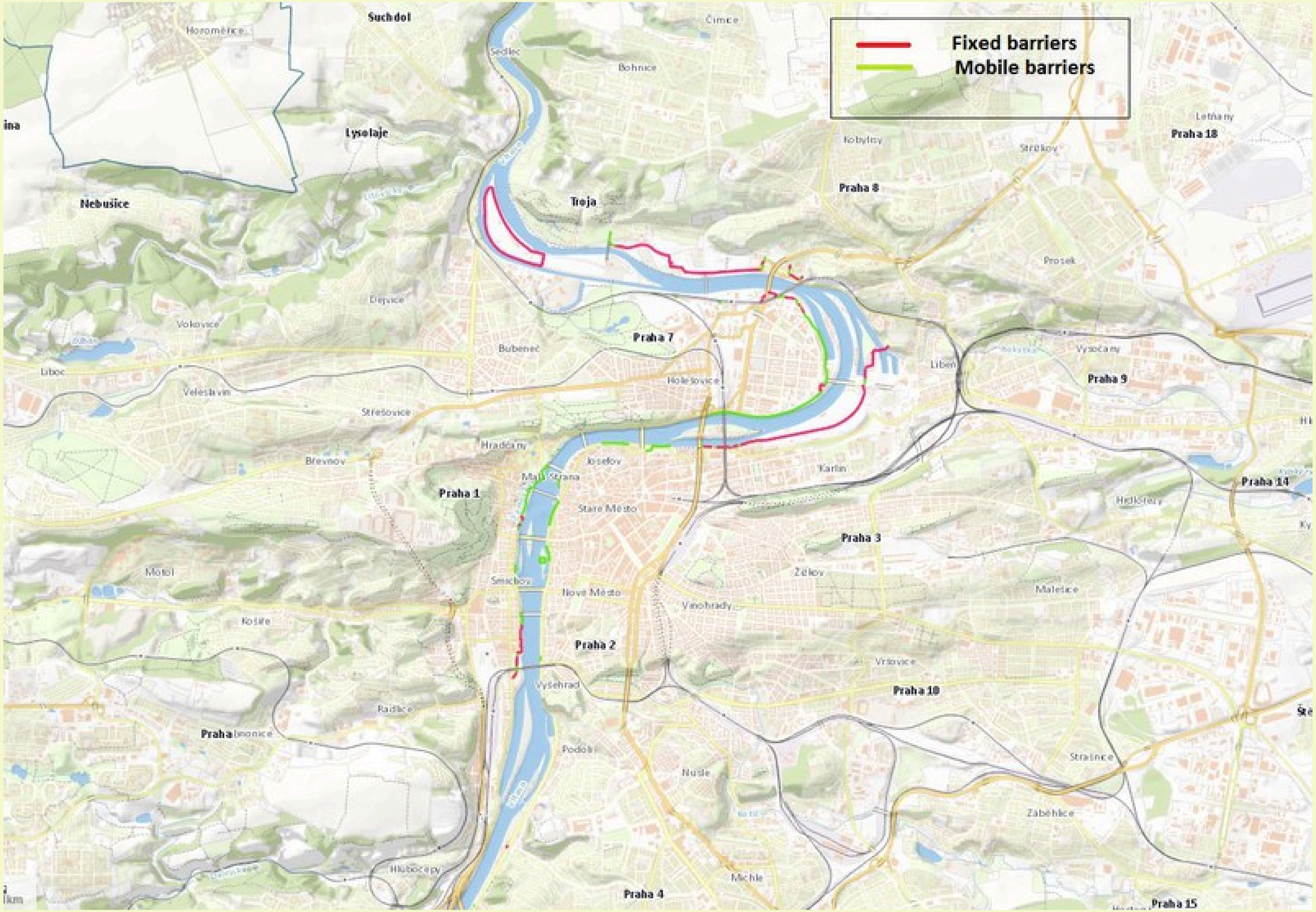
- Surface UHI intensity reaches 4.2 °C for 2001 and 6.7 °C for 2006
- Arable land exhibits high variability, with very high maximum surface temperatures comparable to those of industrial areas, especially for the 2006 image (fields with low percentages of vegetation cover)
- Positive feedback loop
- Vegetation cover explains the majority of LST-variability

Realisation of flood protection measures for the city of Prague

- Reaction to 1997 and 2002 (Q500) floods LINK
- Damage of 1 billion euro/24 billion czk

Grey measures (engineering infrastructure):

- Fixed barriers (levees, dykes, earth mounds, solid concrete walls) constructed along the Vltava River. For instance, closure at Čertovka (Old Town), which is a steel sliding door, 23.5 m length, 4.9 meters height, and weighting 45 tonnes
- Mobile barriers (workers regularly trained, yearly testing)
- Other measures, as closures, pumping systems and safety valves in the canalisation network along the Vltava River



- before measures 57.5 km2 was threatened by floods
- 52.5 km2 became protected

Green and blue measures:

- revitalization of smaller streams in the city
- slow down the runoff and reduce the man-made modifications of riverbeds
- enhancing landscape permeability
- part of the Prague Climate Change Adaptation Strategy (2020)

- The estimated total cost amounts to 145.94 Million EUR (2013)
- Total net avoided damage costs are (in Million EUR) between 168 (Q20) and 2,003 (Q500)
- Grey (80 year lifespan), green indefinite
- Proved themselves during 2013 floods

Limiting factors:

- property rights
- protection of cultural and historical heritage, which led to for example using different materials for the measures in the city center (stone over stainless steel, visual side also important)
- conflicting views

Responsibility?

- Ministry of Agriculture and Ministry of Environment for green measures
- Stakeholders for city adaptation measures: Prague City Hall, Vltava River Basin (company), affected Prague districts, political representatives, the Czech Hydrometeorological Institute + other companies

Transportation in Brno

BRNO IS A CITY EASY TO LIVE IN (EVEN WITHOUT A CAR)

In 2050, Brno ranks first in the chart rating the quality of life in cities. 480 thousand satisfied citizens live in there; they are not forced to leave the city for clean air even on their days off. Brno is a city where it is easy to live without a car. It is a city of short trips with interconnected and consistent modes of transport. Mobility is the main political issue as a foundation stone of the quality of life in the city, and for 35 years already, the city residents have been actively involved in the topic of urban mobility with creative suggestions. Being a senior or handicapped in Brno does not mean any limitation of travel habits. In the long term, the city has been making the transport system more efficient in a conceptual and coordinated manner. The ease, possibility and speed of travel are the main objectives of transport planning. At the same time, the city is capable, on the basis of a broad data basis, to respond flexibly in the area of mobility to trends not only in transport but also in demography, economy and migration of population.

1.

MODAL SPLIT BETWEEN SUSTAINABLE MODES OF TRANSPORT (PUBLIC TRANSPORTATION, CYCLING AND PEDESTRIAN TRAFFIC)

STRATEGIC OBJECTIVES

- Increase the share of public transport, cycling and pedestrian traffic in the modal split
- Increase the integration of sustainable modes of transport (share of multimodal routes) and accelerate public transportation (travel speed on reference journeys taken by public transportation higher by 15% in 2030)
- Increase the number of households not in possession of a car (by 20% by the year 2050)

2.

ROAD COMMUNICATION NETWORK OF THE CITY AND QUALITY OF PUBLIC SPACES

STRATEGIC OBJECTIVES

- Not to increase the capacity of the road communication network for individual motor car traffic in the central part inside the city after completion of the construction of the protective transport system (maintaining of the total number of parking places in the broader centre of the city on the level of the actual need)
- Increase accessibility and attractiveness of sustainable modes of transport in the city and its hinterland (for example suburban railways), (the share of suburban railways on reference journeys will grow by 20% by the year 2030 to the detriment of individual motor car traffic)
- Increase the number and quality of public spaces (increase in the percentage of inhabitants of the city satisfied with public spaces by 30% by the year 2030)

3.

ORGANISATION AND CONTROL OF TRAFFIC AND OF THE DEMAND FOR TRANSPORT

STRATEGIC OBJECTIVES

- Combine traffic and spatial planning, implement principles of integrated traffic planning including strengthening of the importance of telematic systems
- Implement comprehensive planning of the transport of employees and visitors to big enterprises and institutions, including projects generating traffic (for example plans of mobility for shopping centres, compulsory corporate plans of mobility for organisations with more than 100 employees by the year 2020, and with more than 50 employees by the year 2025)
- Implementing education, training, raising awareness in the area of urban mobility and information of traffic participants

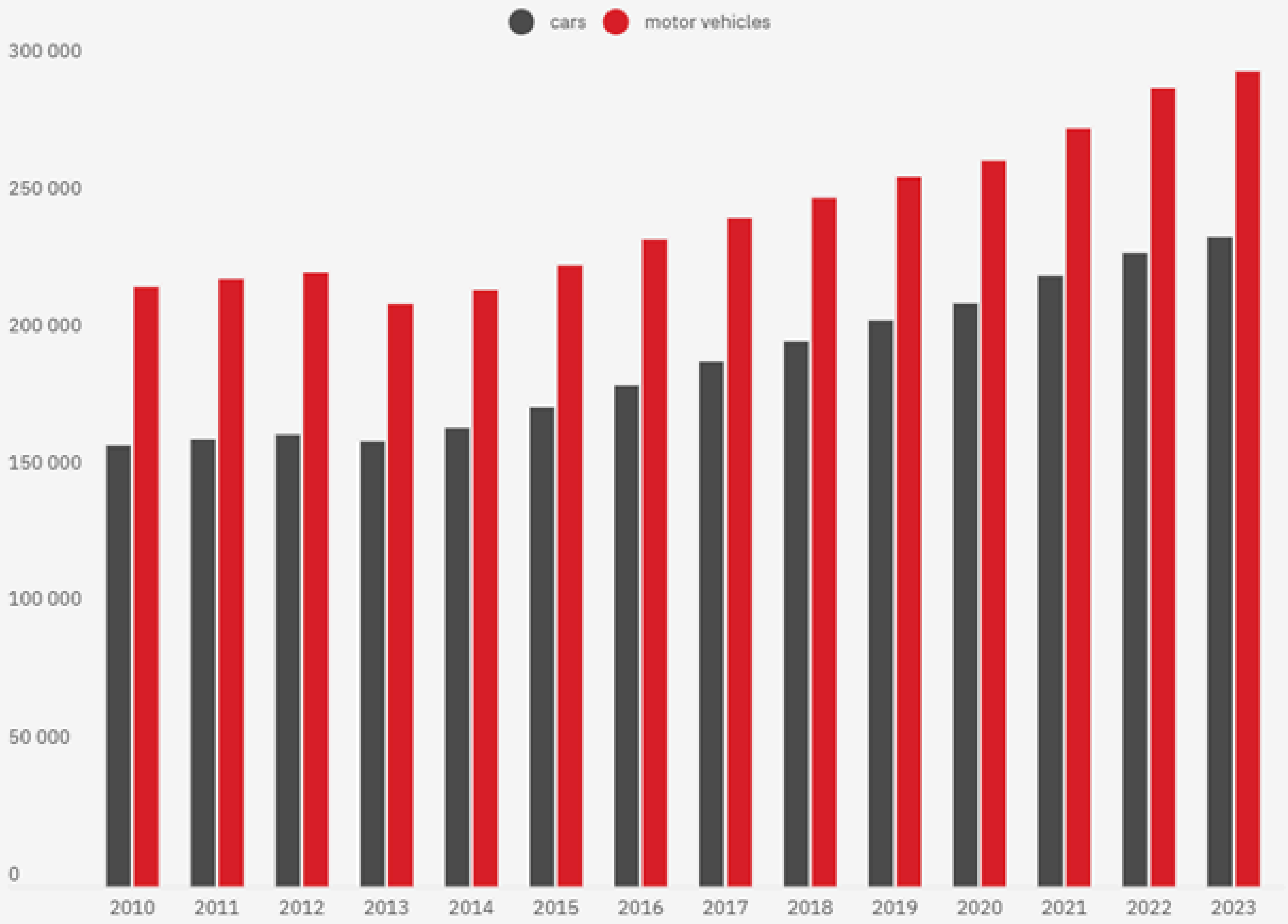
4.

PROTECTION OF INHABITANTS AGAINST NEGATIVE IMPACTS OF TRAFFIC, HIGH ENERGY CONSUMPTION OF TRAFFIC

STRATEGIC OBJECTIVES

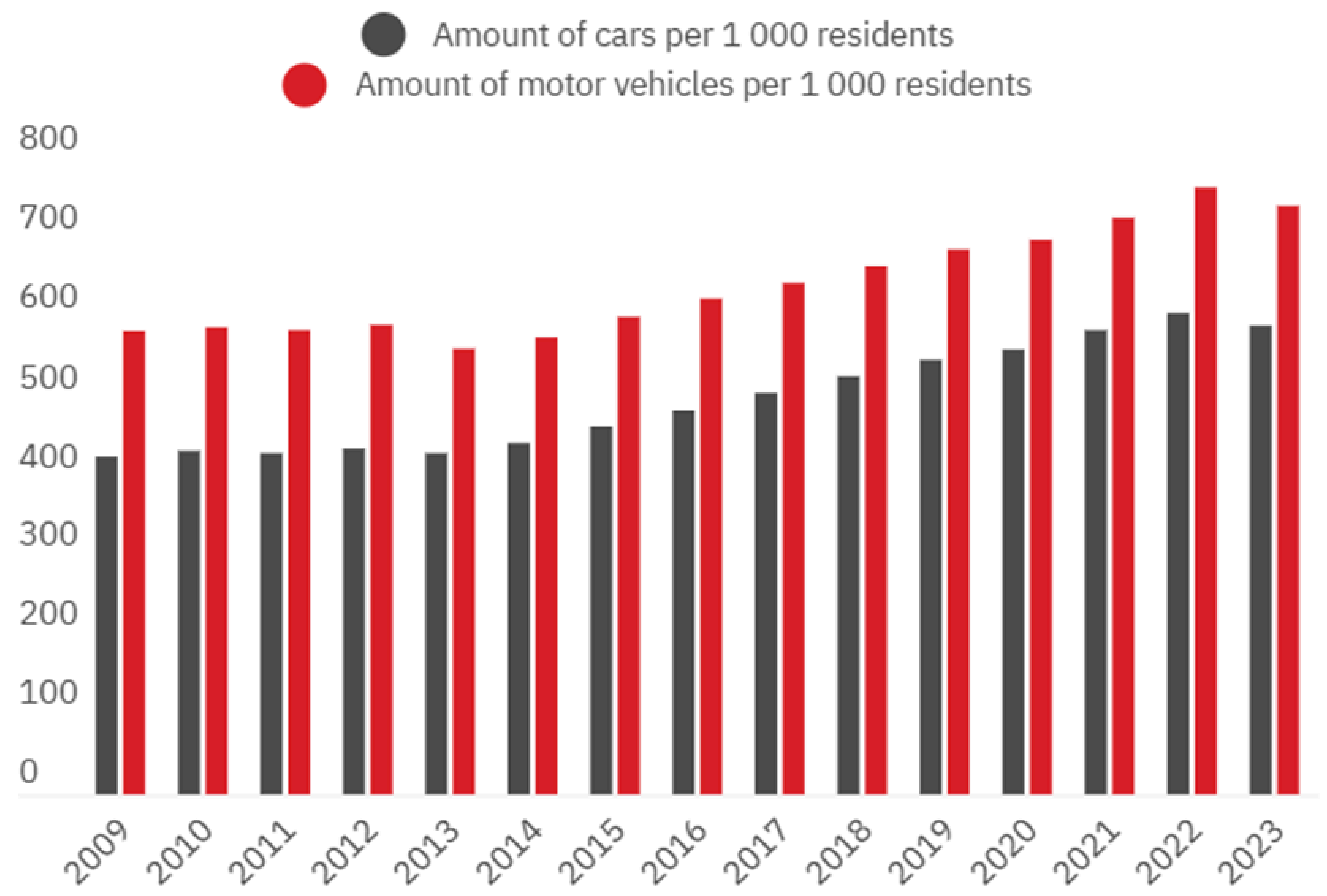
- Reduce the number of traffic accidents (fulfil national objectives, for example reduction of the number of victims of traffic accidents to one half compared to the year 2015 by the year 2025)
- Reduce the number of inhabitants suffering from above-the-limit noise from traffic (by the year 2025, less than 5% of the population of the city should suffer from above-limit noise from traffic)
- Reduce emissions of greenhouse gases and reduce the energy consumption of transport per passenger (a fourfold reduction in greenhouse gas emissions by the year 2050 compared to the year 2010, or: 1 tonne equivalent of CO_2 per person per year by the year 2050); decrease in total energy consumption in transport per passenger by 20% by the year 2050)
- Ensure reliability of the transport system in case of emergency situations
- Minimise the negative impacts of city logistics

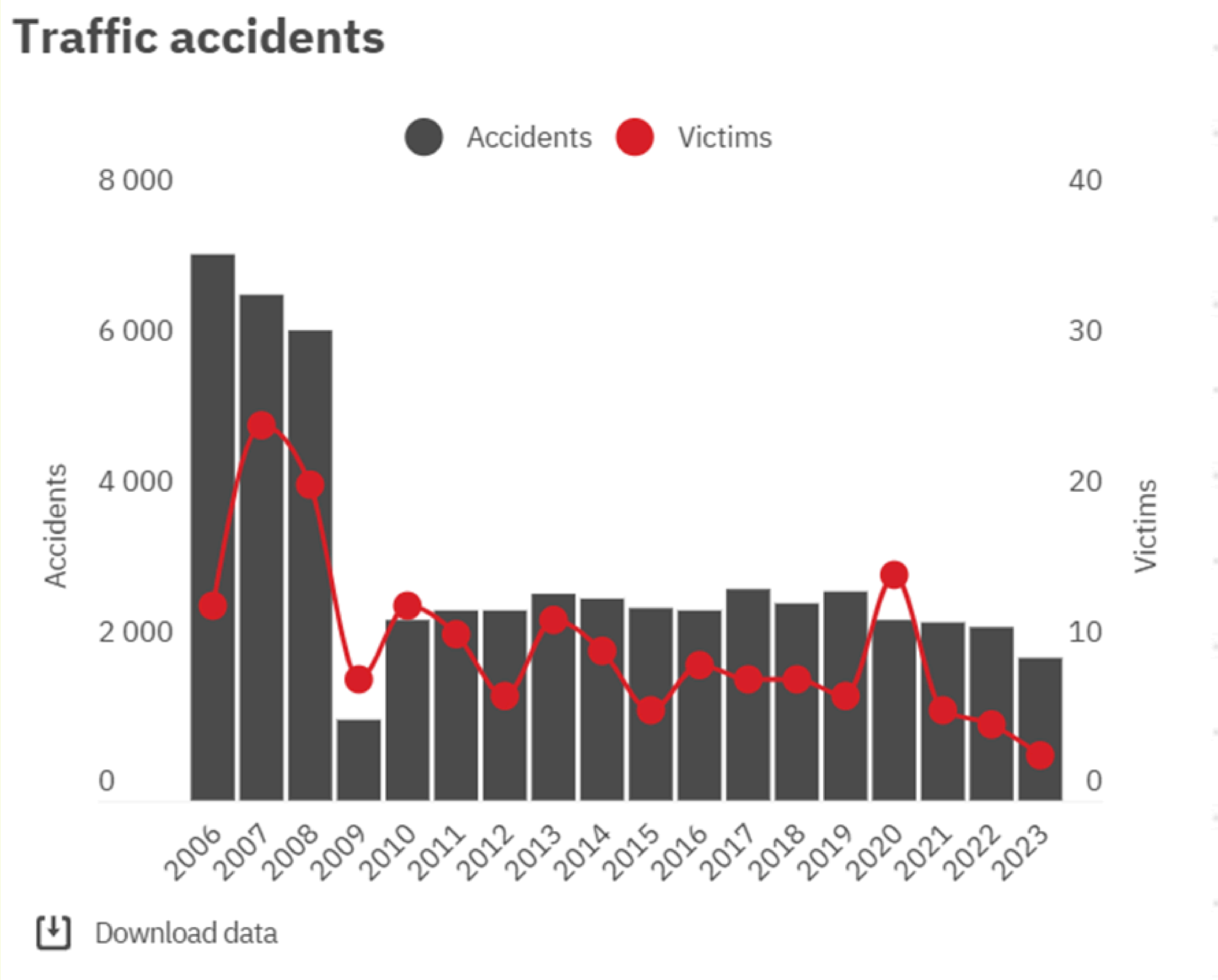
Cars and motor vehicles



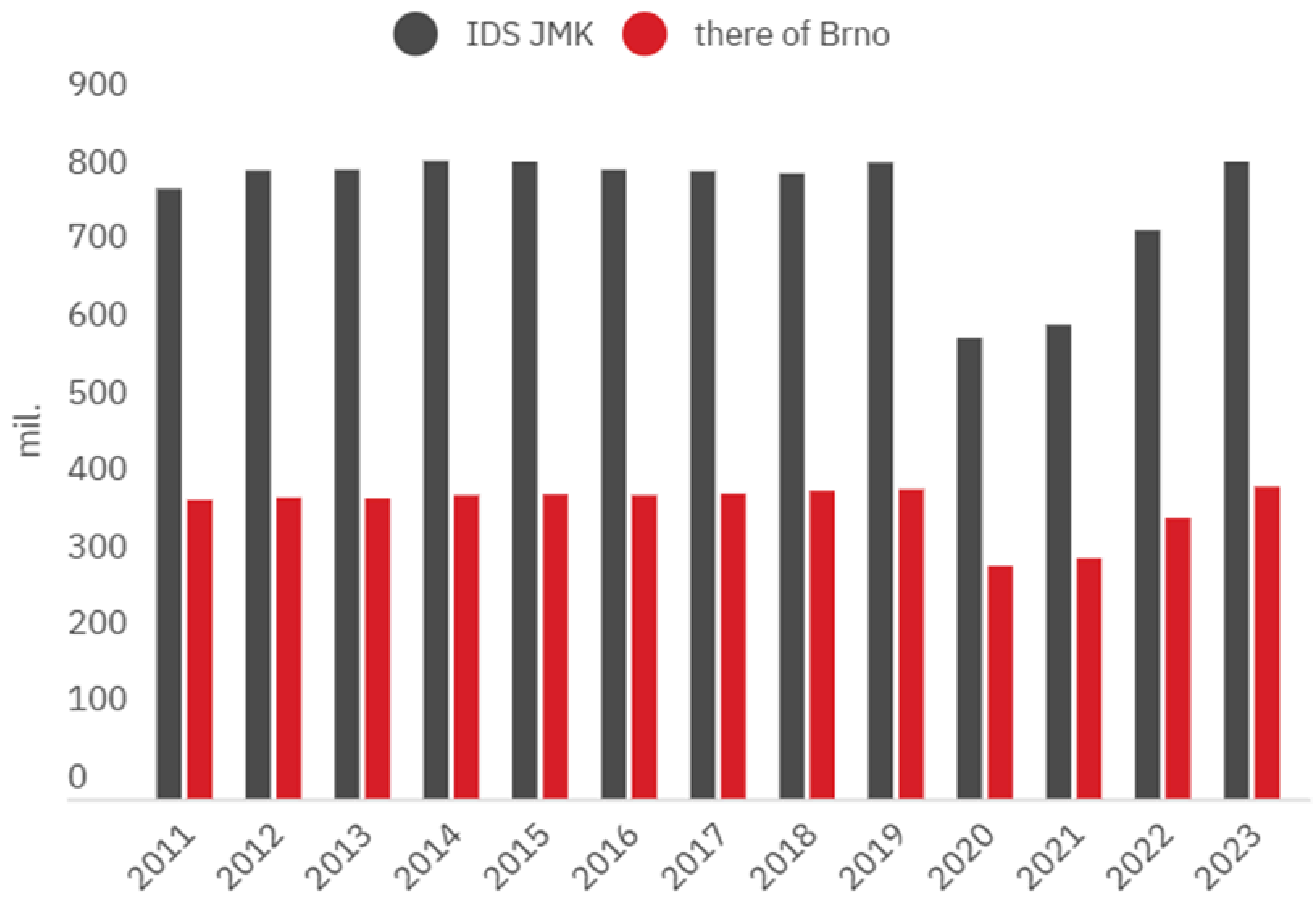
The number of passenger cars in Brno is constantly increasing. The decrease in 2013 was due to the introduction of a new vehicle register, which led to an administrative decrease (change and refinement of the methodology). In the following years, however, the number of passenger cars slowly increased. This increase has been particularly noticeable in recent years, as Brno's roads have reached the limits of their capacity.

Vehicles per 1 000 residents




Traffic accidents
Accidents
Victims
8 000
6 000
4 000
2 000
0
40
30
20
10
0
Accidents
Victims
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Download data

Passengers carried by public transport



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Source: KORDIS JMK, a.s.

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