

2024

Central Asia Resilient and Low Carbon Cities CARL-Cities

Kazakhstan Uzbekistan Kyrgyz Republic Tajikistan Turkmenistan





Main Objective

Increase the understanding of urban challenges and identify potential actions to advance the development of low-carbon climate resilient cities and regions in Central Asia.

CARL Cities - Central Asia

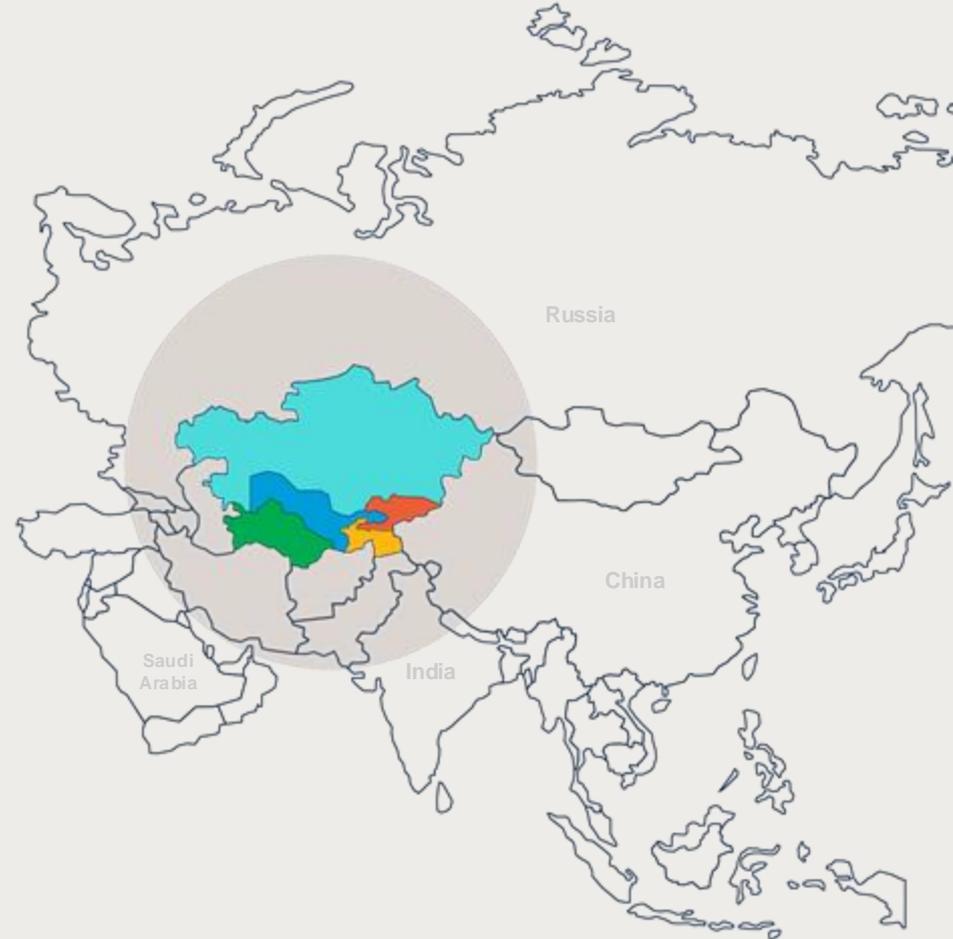
Specific objectives

- Identify the **current state and challenges** of the Central Asian Cities.
- Suggest general **policies and strategies for low-carbon urban development**.
- Assess and **recommend investments** and policy options for 5 cities.



Context

- **Kazakhstan**, **Kyrgyz Republic**,
Tajikistan, **Turkmenistan**, **Uzbekistan**
- Landlocked region
- Lack access to the oceanic routes
- Post-soviet economy
- Population growth is strong but is unevenly distributed among countries.



Cities in Central Asia

Classification based on population, socioeconomic and political significance.

Kazakhstan

National-level cities
(population > 1 million)

Oblast-level cities (population
> over 50,000)

District-level cities (population
of at least 10,000)

Kyrgyz Republic

Large cities
(population > 100,000)

Medium cities
(population > 50,000)

Small cities
(population < 50,000)

Tajikistan

Large cities
(population > 250,000)

Big cities
(population > 100,000)

Medium cities (population >
20,000)

Small cities (population <
20,000)

Turkmenistan

Cities with province-level
rights (population > 500,000)

Cities with district-level rights
(populations > 30,000)

Cities under district control
(populations > 8,000)

City Settlements (population
over 2,000 that have reached
a certain level of
development)

Uzbekistan

Large cities
(population > 1 million)

Major cities
(population > 250,000)

Big cities
(population > 100,000)

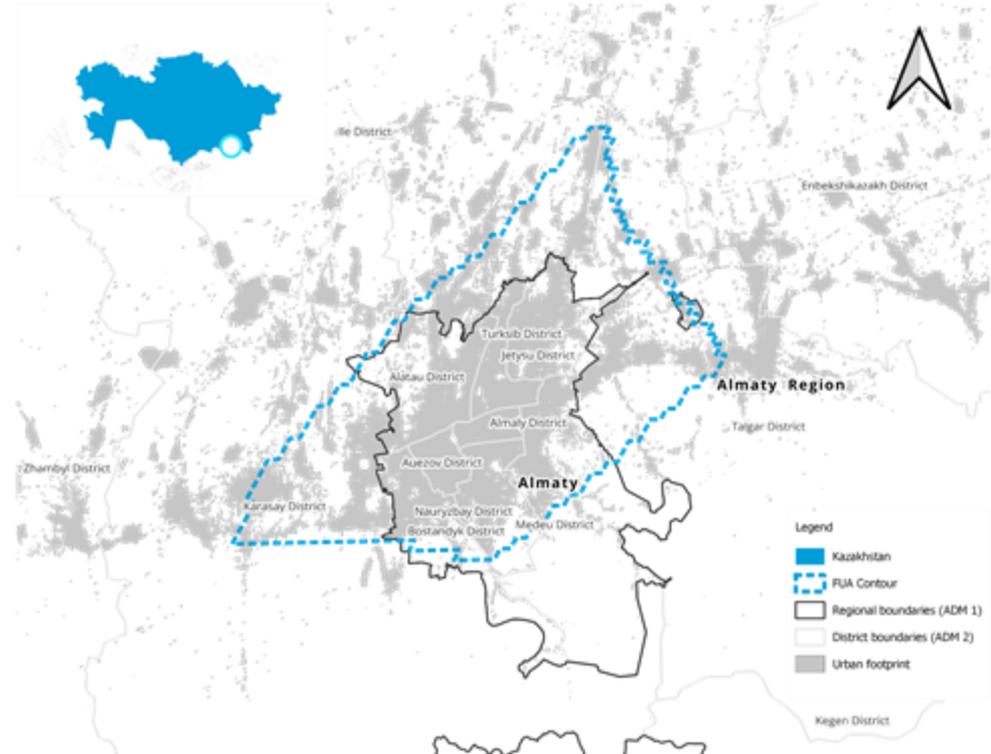
Medium cities
(population > 50,000)

Small cities
(population < 50,000)

Study areas

The study areas are based on the **functional urban areas (FUA)** which represent the commuting area of urban centers.

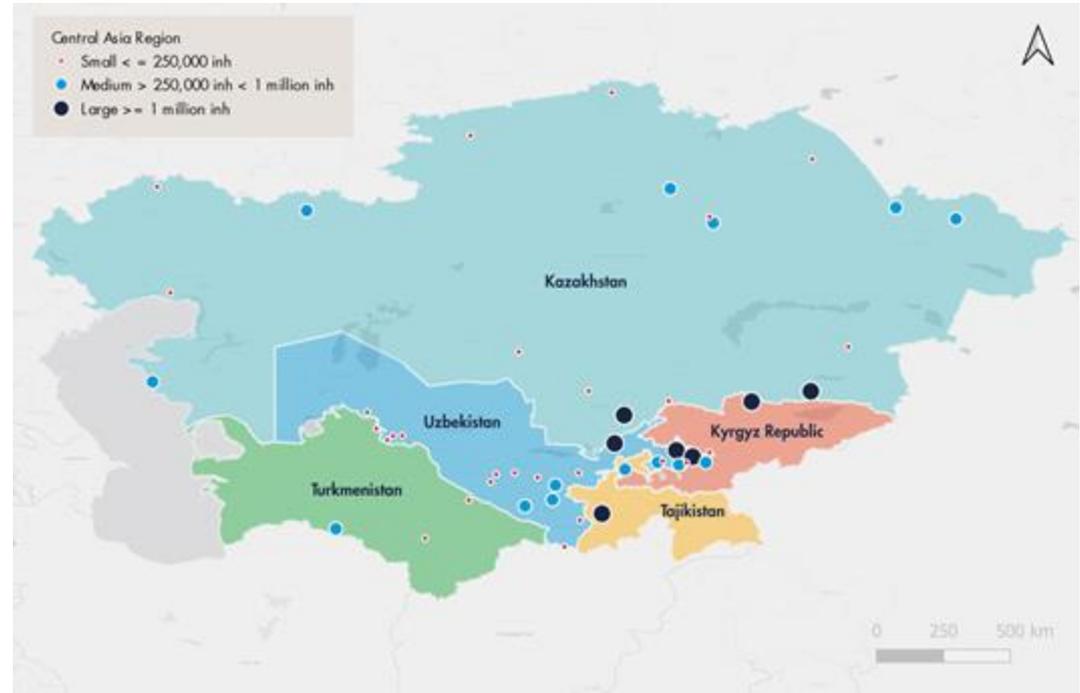
Utilizing the Functional Urban Area (FUA) as a study area facilitates the identification of changes and dynamic processes (i.e urban expansion) occurring in and around each settlement.



Study areas

All study areas with a population larger than **150,000 inhabitants** were selected for a macro assessment.

The Macro assessment analyzed the **48 cities** with several indicators to establish a baseline performance in terms of **urban development, vulnerability to climate-related hazards, and GHG emissions.**



Macro Assessment

We developed methods to construct urban profiles in terms of climate-related disasters and hazards, GHG emissions, and urban development trends.



Urban form



Accessibility to
urban amenities



GHG
emissions



Economic activity



Environment



Macro Assessment Information and data sources



1. Urban footprint (km²)

This indicator refers to the **total built-up area** of a city or urban area, including streets, buildings, open space, infrastructure and urban amenities.

Pesaresi, Martino; Politis, Panagiotis (2022): [GHS-BUILT-S R2022A - GHS Built-up surface grid](#), derived from Sentinel2 composite and Landsat, multitemporal (1975-2030). European Commission, Joint Research Centre [\[Dataset\]](#)



2. Land cover (%)

This indicator is a proxy of land use, and it is calculated by dividing the area of land cover surface by the total area of the study area.

Brown, C.F., Brumby, S.P., Guzder-Williams, B. et al. [Dynamic World](#), Near real-time global 10 m land use land cover mapping. Sci Data 9, 251 (2022). [doi:10.1038/s41597-022-01307-4](https://doi.org/10.1038/s41597-022-01307-4)



3. Population density (inh/km²)

Population density indicator considers the number of inhabitants per square kilometer.

Schiavina M., Freire S., MacManus K. (2022): [GHS-POP R2022A - GHS population grid multitemporal \(1975-2030\)](#). European Commission, Joint Research Centre [\[Dataset\]](#)

Macro Assessment Information and data sources



4. Settlement fragmentation

This indicator measures the level of fragmentation of settlement's urban footprint and includes the classification of urban development patterns.¹

¹ Urban settlement fragmentation is the lack of continuity and contiguity of the urban footprint, resulting in built-up area patches or islands.

Pesaresi, Martino; Politis, Panagiotis (2022): [GHS-BUILT-S R2022A - GHS Built-up surface grid](#), derived from Sentinel2 composite and Landsat, multitemporal (1975-2030). European Commission, Joint Research Centre [\[Dataset\]](#)



5. Accessibility to urban amenities (%)

Accessibility is measured as the percentage of the population living within the coverage area of urban facilities and amenities.²

² Area accessible on foot within a specified distance from urban amenities, such as a school, park, or public transit station. The distance thresholds vary for each type of urban amenity, as defined in the methodological annex.

Schiavina M., Freire S., MacManus K. (2022): [GHS-POP R2022A - GHS population grid multitemporal \(1975-2030\)](#). European Commission, Joint Research Centre [\[Dataset\]](#)

[OpenStreetMap Contributors](#). "Urban amenities data." OpenStreetMap. Retrieved [2023], from [Export | OpenStreetMap](#) .



6. Job-housing balance (jobs/inh)

The job-housing balance indicator is the share of the study area population living in economic hotspots.³

³ Defined as the zones within the study area with high economic activity

Elvidge, C.D, Zhizhin, M., Ghosh T., Hsu FC, Taneja J. Annual time series of global [VIIRS nighttime lights](#) derived from monthly averages:2012 to 2019. Remote Sensing 2021, 13(5), p.922, doi:10.3390/rs13050922

[OpenStreetMap Contributors](#). "Urban amenities data" OpenStreetMap. Retrieved [2023], from [Export | OpenStreetMap](#) .

Macro Assessment Information and data sources



7. Accessibility to bus stops and bicycle parking (%)

Accessibility is captured as a proxy through the percentage of the population living within the coverage area of urban structured public transportation.⁴

⁴ Area accessible on foot within a specified distance from bus stops and bicycle parking stations. The distance thresholds vary for bus stops and bicycle parking, as defined in the methodological annex.

OpenStreetMap Contributors. "Bus stop and bicycle parking data." OpenStreetMap. Retrieved [2023], from [Export | OpenStreetMap](#).



8. Urban greenery (km²/inh)

This indicator will examine the area of greenery in the urban areas from satellite imagery and compare it with Open Street Maps (OSM) data to estimate the total greenery surface of the study area.

OpenStreetMap Contributors. "Parks data." OpenStreetMap. Retrieved [2023], from [Export | OpenStreetMap](#)

Pesaresi M., P. Panagiotis (2022): **GHS-BUILT-C R2022A** - GHS Settlement Characteristics, derived from Sentinel2 composite (2018) and other GHS R2022A data. European Commission, Joint Research Centre [\[Dataset\]](#)



9. Urban heat island (°C)

This indicator estimates the percentage of the population living within urban heat islands (UHI) zones.⁵

⁵ Urban heat islands (UHIs) were defined as zones within the study area exhibiting a **land surface temperature** (LST) exceeding the local average by at least 2°C.

Fick, S.E. and R.J. Hijmans, 2017. **WorldClim 2**: new 1 km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37 (12): 4302-4315.

Macro Assessment Information and data sources



10. GHG emissions (ton CO₂/ inh)

The analysis will consider the annual estimation of fossil CO₂ and non-CO₂ GHG (CH₄, N₂O and F-gases) emissions expressed in CO₂ per capita.

Monforti Ferrario, Fabio; Crippa, Monica; Guizzardi, Diego; Muntean, Marilena; Schaaf, Edwin; Lo Vullo, Eleonora; Solazzo, Efsio; Olivier, Jos; Vignati, Elisabetta (2021): [EDGAR v6.0 Greenhouse Gas Emissions](#). European Commission, Joint Research Centre (JRC) [\[Dataset\]](#)

[Forest greenhouse gas emissions](#). [Global Forest Watch](#)



11. Exposure to hazards (%)

The percentage of people residing within areas prone to pluvial flooding, earthquakes, and landslides.⁶

⁶ The methodological annex provides more details on the definition of risk-prone areas.

Scaini, C. (2022). [Central Asia Hazard maps](#). Regional maps for earthquakes, fluvial and pluvial floods, and landslide hazards developed as part of the Strengthening Financial Resilience and Accelerating Risk Reduction in Central Asia program (SFRARR). World Bank (WB), Global Facility for Disaster Reduction and Recovery (GDFRR). [\[Dataset\]](#)



12. Air pollution (ton PM_{2.5}/ inh)

The indicator is calculated by dividing the total amount of PM_{2.5} and PM₁₀ emissions by the total settlement population.

Monforti Ferrario, Fabio; Crippa, Monica; Guizzardi, Diego; Muntean, Marilena; Schaaf, Edwin; Lo Vullo, Eleonora; Solazzo, Efsio; Olivier, Jos; Vignati, Elisabetta (2021): [EDGAR v6.0 Greenhouse Gas Emissions](#). European Commission, Joint Research Centre (JRC) [\[Dataset\]](#)



Macro Assessment Key Findings

Cities in Central Asia largely display an unsustainable spatial expansion pattern, facing high exposure to climate-related hazards exacerbated by climate change, and a significant emission of greenhouse gases

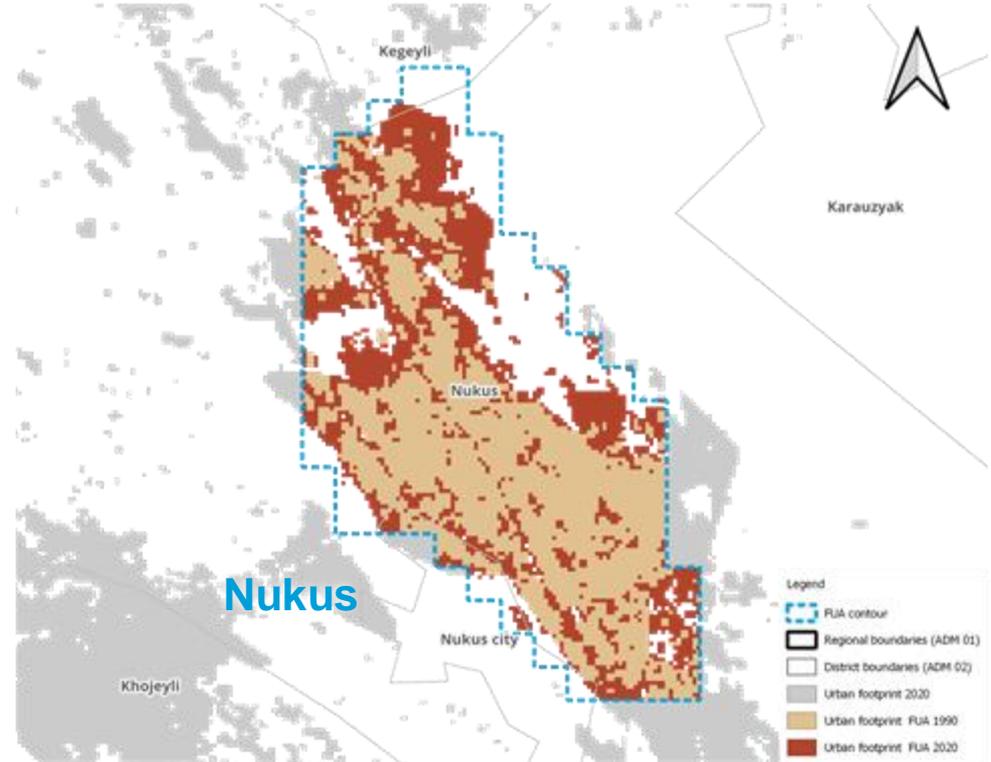
CARL Cities - Central Asia

Urban form Urban footprint

Central Asia is urbanizing and expanding rapidly.

Between 1990 and 2020, the analyzed urban settlements expanded on average by **36.2 percent**, accounting for a total land consumption of 545 km².

The top five cities with the highest increase in urban footprint between 1990 and 2020 were **Nukus** at 112 percent, followed by **Shymkent** at 109.8 percent, **Dashoguz** at 91.7 percent, **Astana** at 91.6 percent, and **Oral** at 67.6 percent.



Pesaresi, Martino; Politis, Panagiotis (2022): GHS-BUILT-S R2022A - GHS Built-up surface grid, derived from Sentinel2 composite and Landsat, multitemporal (1975-2030). European Commission, Joint Research Centre [Dataset]

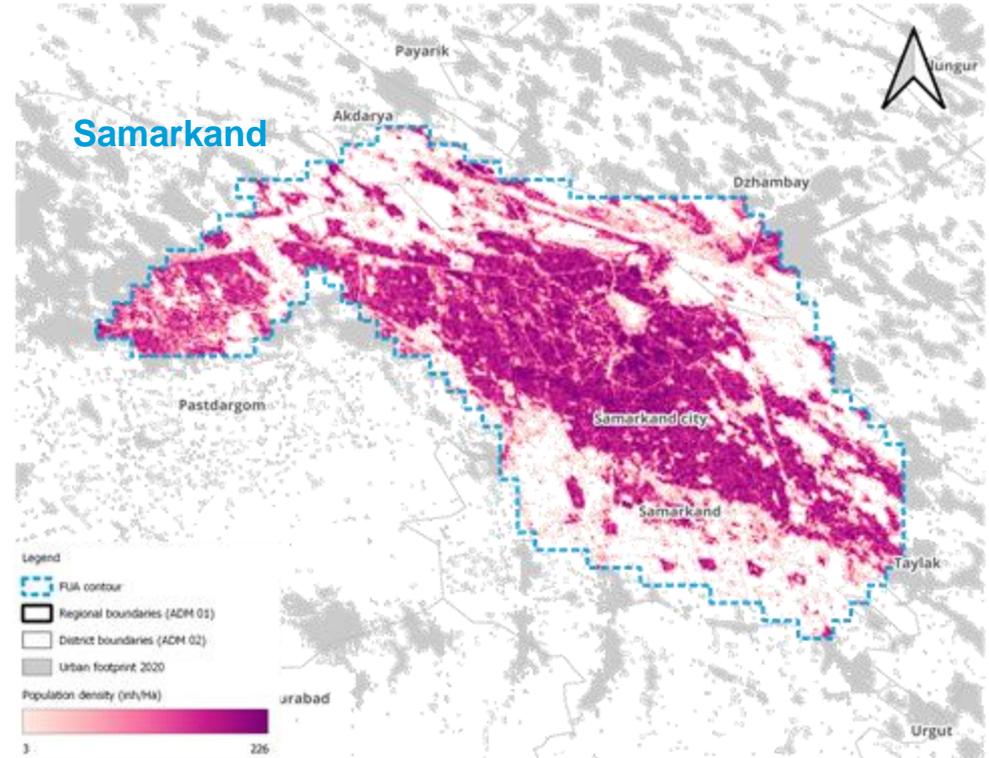


Urban form Population density

The **loss of densification** stands as a challenge in the region.

The average relative population density of the 48 analyzed urban areas is 1,594 inhabitants per square kilometer. **Lower population densities are more characteristic of smaller cities.**

The settlements of **Petropavl** and **Oral** had the lowest population densities, while **Dushanbe, Bishkek, and Tashkent** had the highest



Schiavina M., Freire S., MacManus K. (2022): GHS-POP R2022A - GHS population grid multitemporal (1975-2030). European Commission, Joint Research Centre [Dataset]

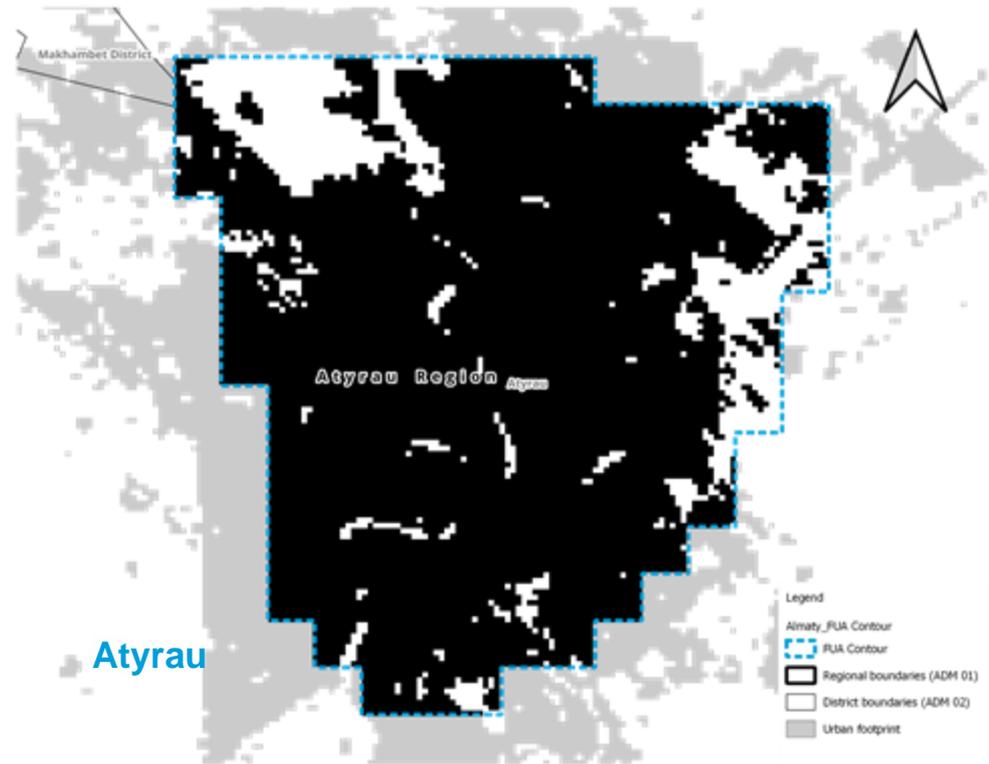
Urban form Settlement fragmentation

The urban areas of Central Asia largely display a **non-sustainable spatial expansion pattern**.

The dispersed urban expansion in the region is characterized by **leapfrog and scattered development**.

Approximately **58 percent** of the studied urban areas show a **leapfrog development** pattern, and **39 percent** are characterized by **scattered development**.

Only **3 percent** display a continuous **peri-urban expansion**.



Pesaresi, Martino; Politis, Panagiotis (2022): GHS-BUILT-S R2022A - GHS Built-up surface grid, derived from Sentinel2 composite and Landsat, multitemporal (1975-2030). European Commission, Joint Research Centre [Dataset]



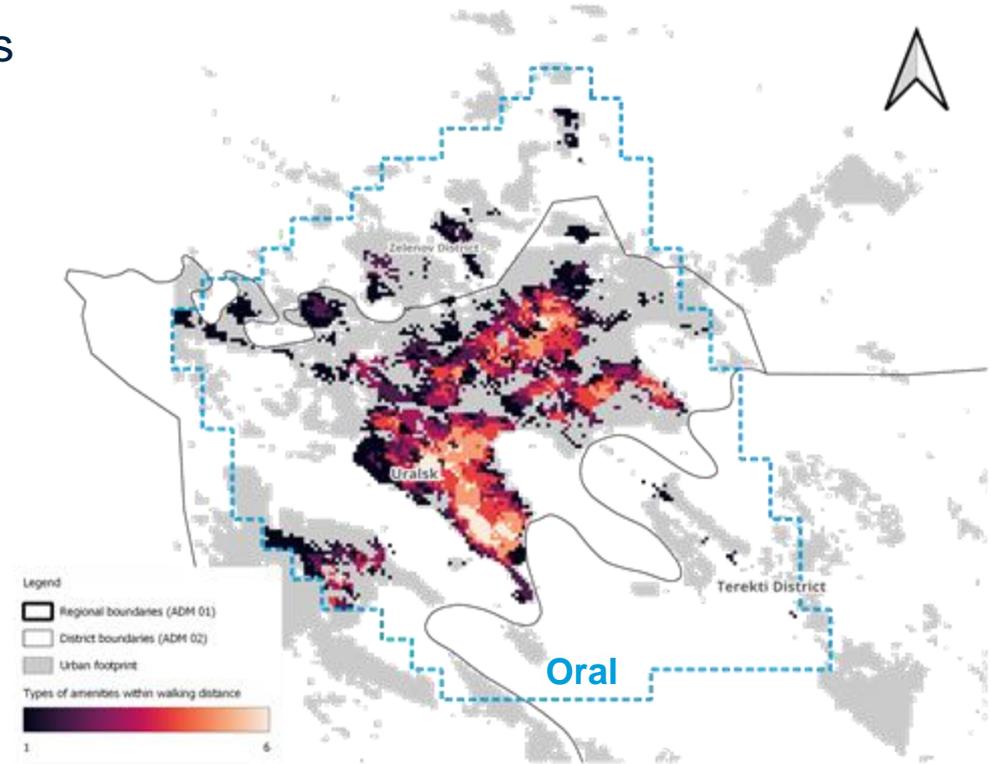
Urban form

Walking accessibility to social infrastructure and urban amenities

Almost all of the urban areas that were studied across Central Asia have **critically low access** to urban services and amenities.

In general, all urban settlements obtained **low proximity to hospitals, sports and cultural facilities**.

Bishkek seems to experience the highest proximity to urban amenities in the region; it is followed by **Oral, Semey, Ashgabat, and Taldykorgan**. These study areas obtained good results on **health, schools, and public spaces**.



Schiavina M., Freire S., MacManus K. (2022): GHS-POP R2022A - GHS population grid multitemporal (1975-2030), European Commission, Joint Research Centre [Dataset]

OpenStreetMap Contributors. "Urban amenities data." OpenStreetMap. Retrieved [2023], from Export | OpenStreetMap.



Urban environment

Exposure to hazards

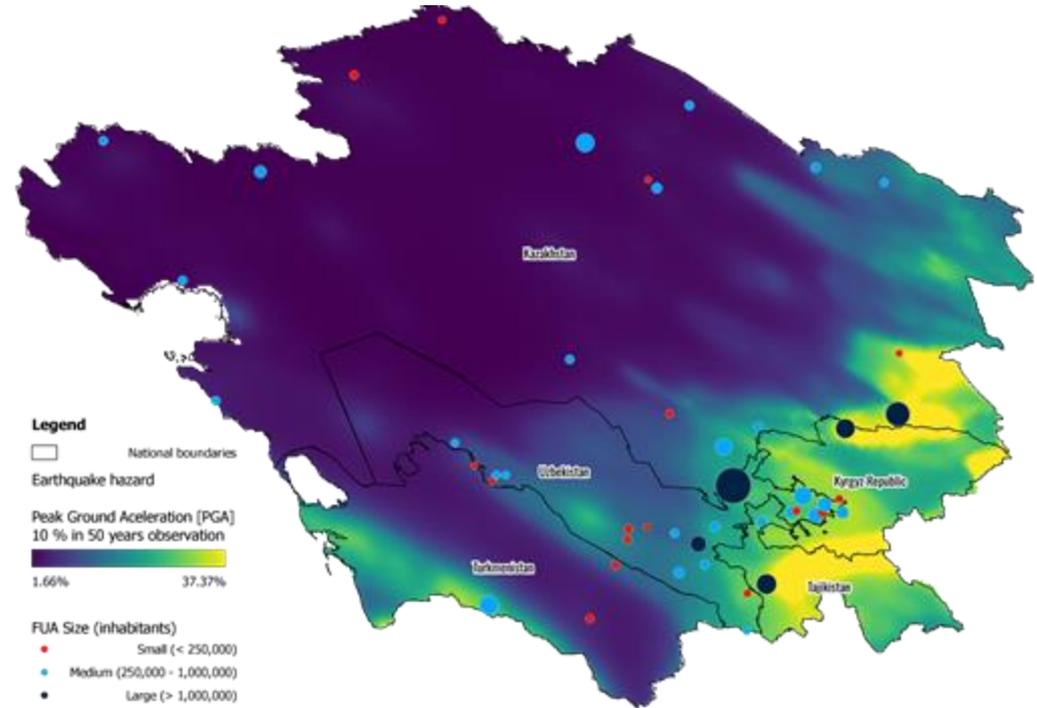
Earthquakes are a major hazard in Central Asia.

75 percent of the population of the analyzed urban settlements lives within **earthquake-prone areas**.

The earthquake hazard is particularly high in the **Kyrgyz Republic, and Tajikistan**, since **more than 90 percent of their population is exposed to earthquakes**.

In **Dushanbe, Osh, and Almaty**, the landslide hazard is the second major threat after earthquakes

Pluvial floods pose a significant hazard for 2.5 percent of the population (0.6 million inhabitants).

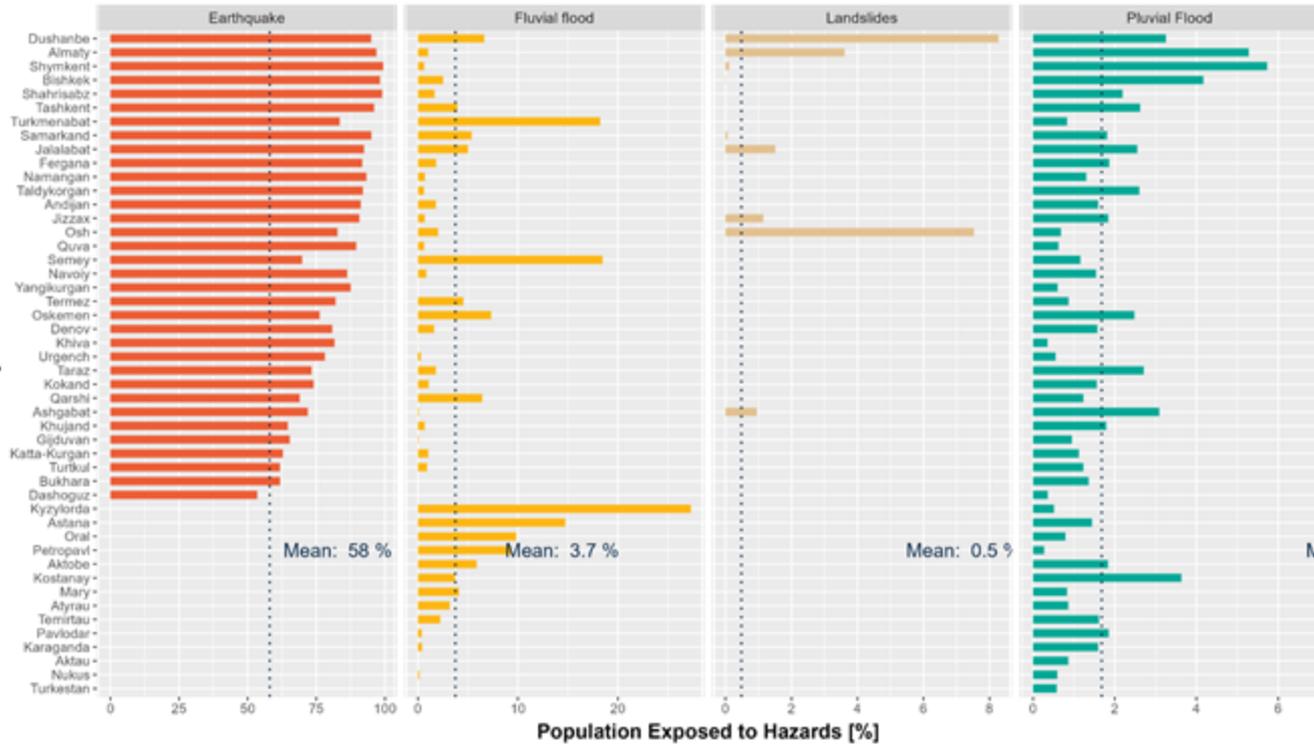


Scaini, C. (2022). Central Asia Hazard maps. Regional maps for earthquakes, fluvial and pluvial floods, and landslide hazards developed as part of the Strengthening Financial Resilience and Accelerating Risk Reduction in Central Asia program (SFRARR). World Bank (WB), Global Facility for Disaster Reduction and Recovery (GFDRR). [Dataset]



Urban environment

Exposure to hazards



Source: GHSL, Population grid multitemporal (2020), SFRARR Central Asia Disaster Risk Assessment, Hazard-prone zones layers.

Earthquakes are the dominant hazard in Central Asia.



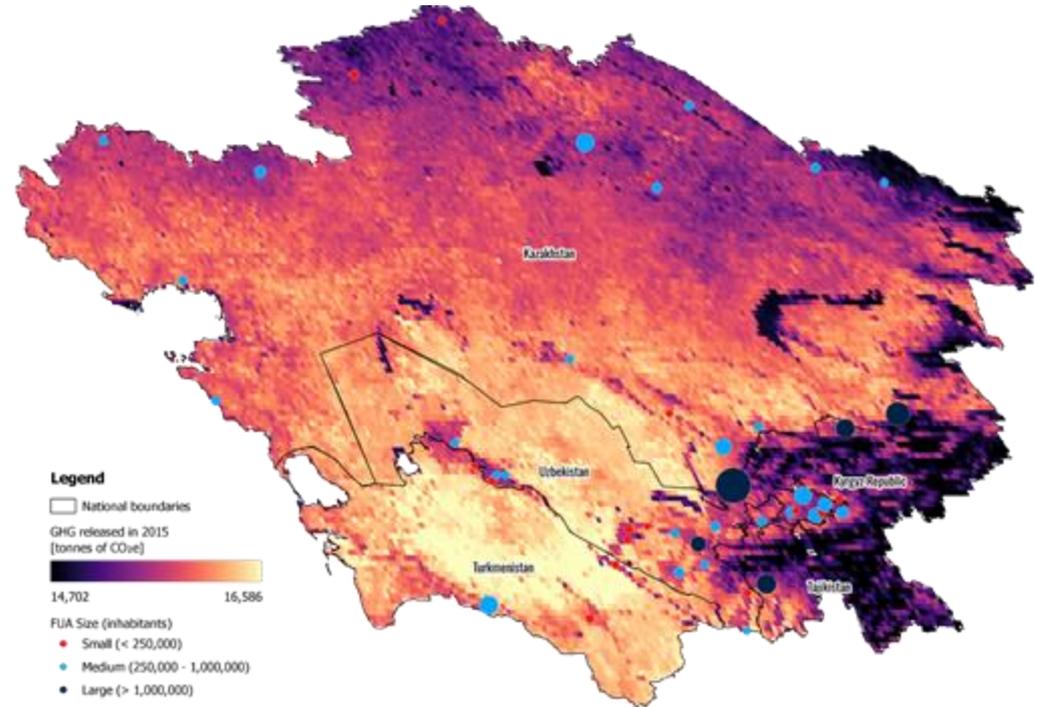
Urban environment CO₂ emissions

The average GHG emissions per capita is **higher** than the regional average.

More than half of the settlements have a GHG emission above the ECA regional benchmark.

The high GHG emission per capita is result of the high carbon intensity of the energy sector.

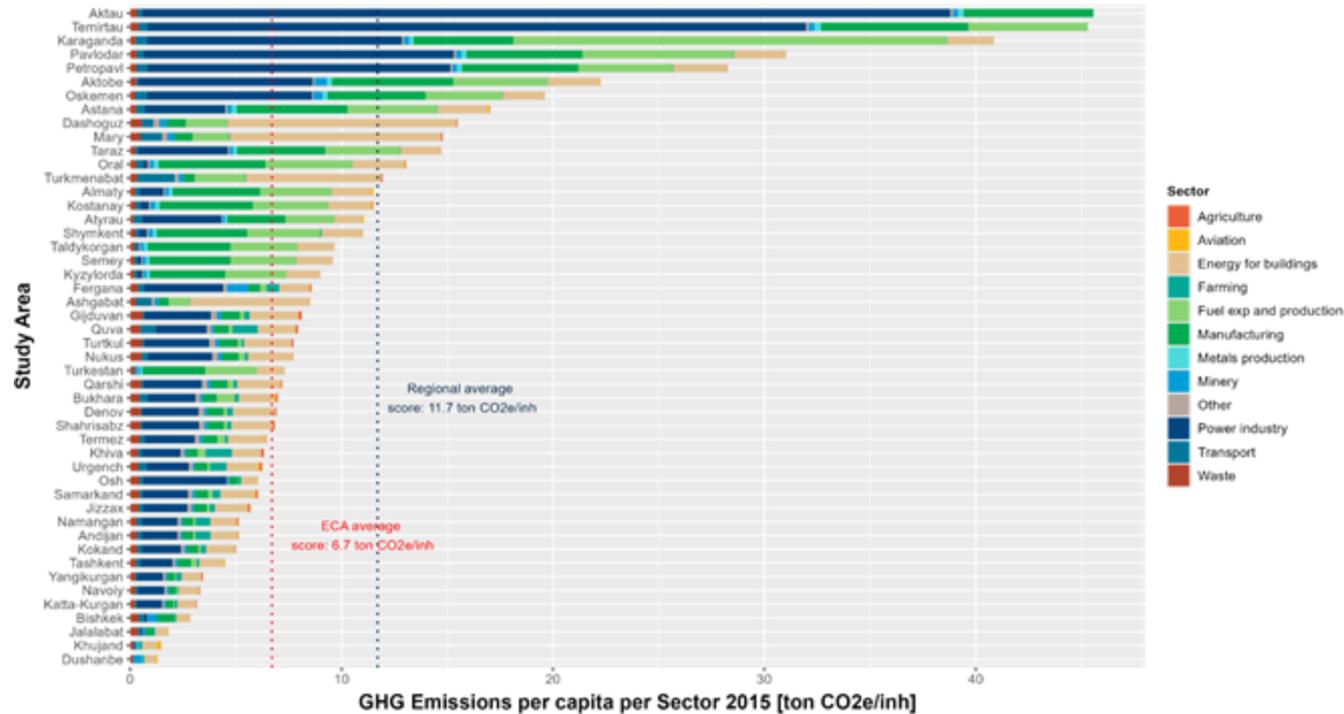
The analyzed urban areas of **Tajikistan and the Kyrgyz Republic** exhibited the **lowest** GHG emissions per capita.



Monforti Ferrario, Fabio; Crippa, Monica; Guizzardi, Diego; Muntean, Marilena; Schaaf, Edwin; Lo Vullo, Eleonora; Solazzo, Efsio; Olivier, Jos; Vignati, Elisabetta (2021); EDGAR v6.0 Greenhouse Gas Emissions. European Commission, Joint Research Centre (JRC) [Dataset]



Urban environment CO₂ emissions



Source: European Comissions, EDGAR v6.0[Dataset](2015).
Global Forest Watch, Forest greenhouse gas emissions(2018).
GHSL, Population grid multitemporal (2015)

The high GHG emission per capita is result of the high carbon intensity of the energy sector.

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