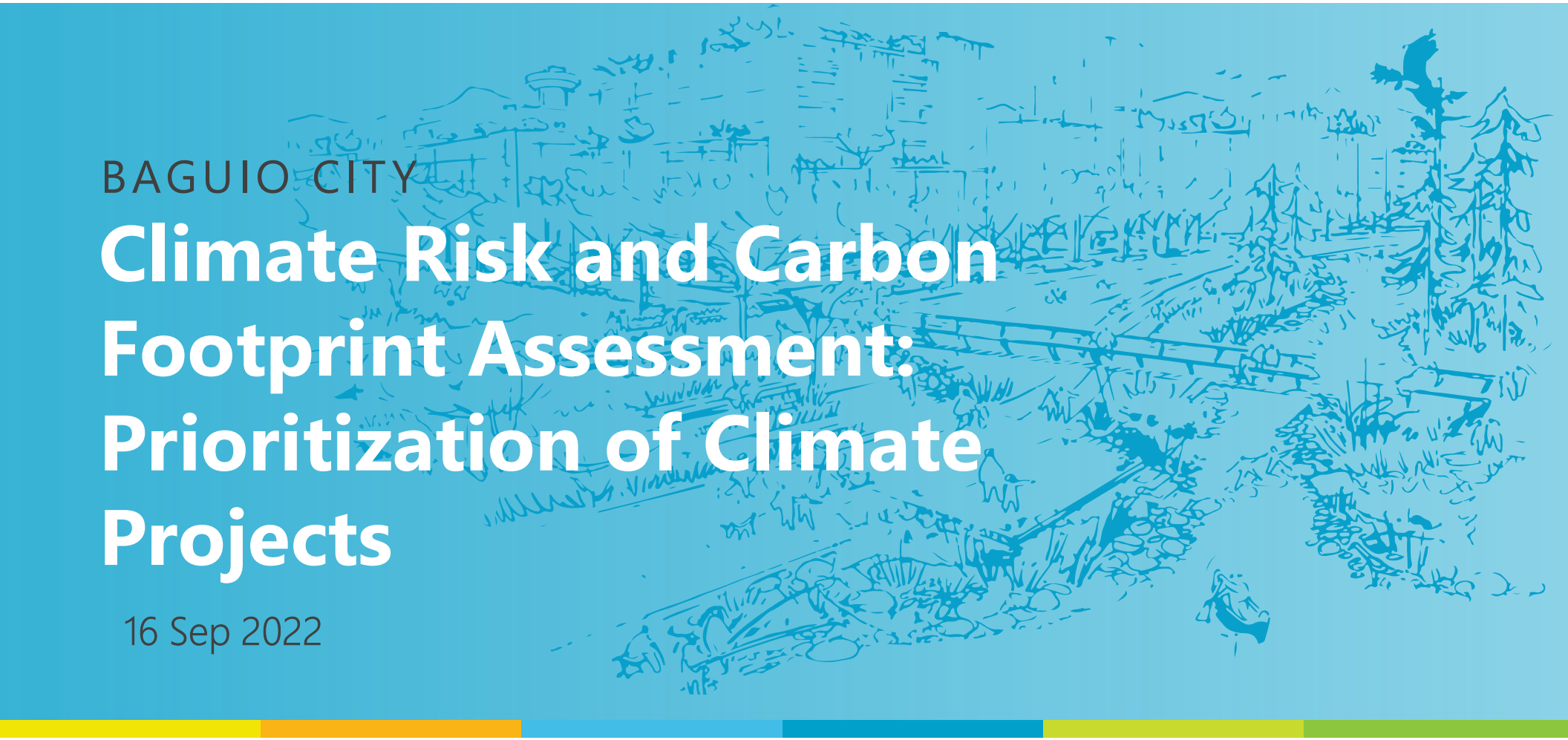


BAGUIO CITY

Climate Risk and Carbon Footprint Assessment: Prioritization of Climate Projects

16 Sep 2022

Michael Lindfield, Urban Planning and Development Specialist (Consultant), SDCC
Olga Chepelianskaia, Climate Finance Specialist - Urban Climate Investment Plans (Consultant), SDCC
Lynell Sta. Ines, Climate Change Urban Sector Specialist (Consultant), SDCC
Thuy Trang Dang, Senior Urban Development Specialist

ADB

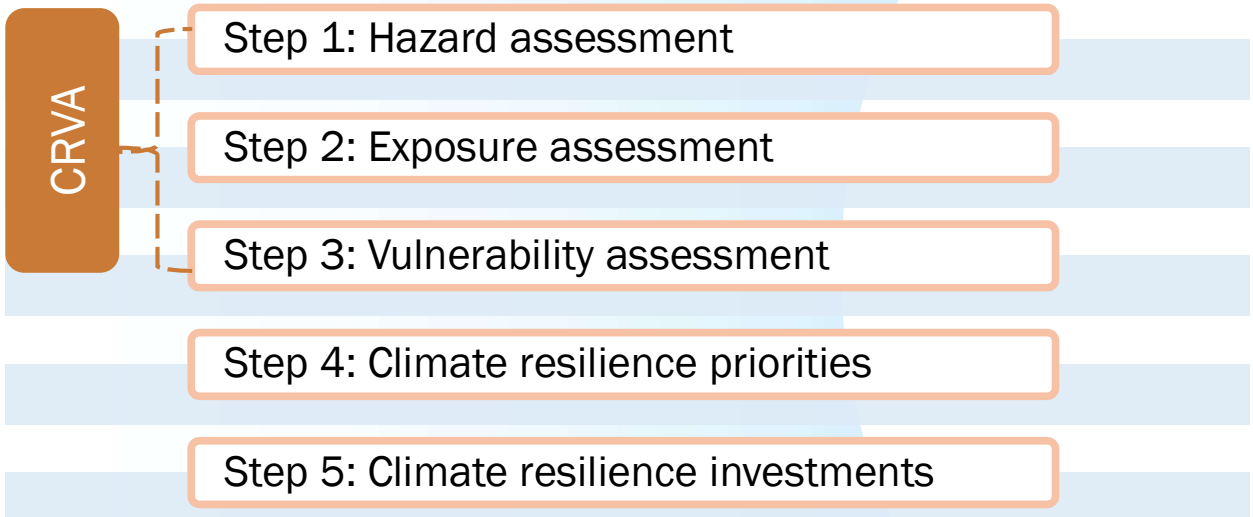
Baguio City Low Carbon and Resilient Development: Comprehensive Assessment

TA 9748 activities in Baguio City

Activities

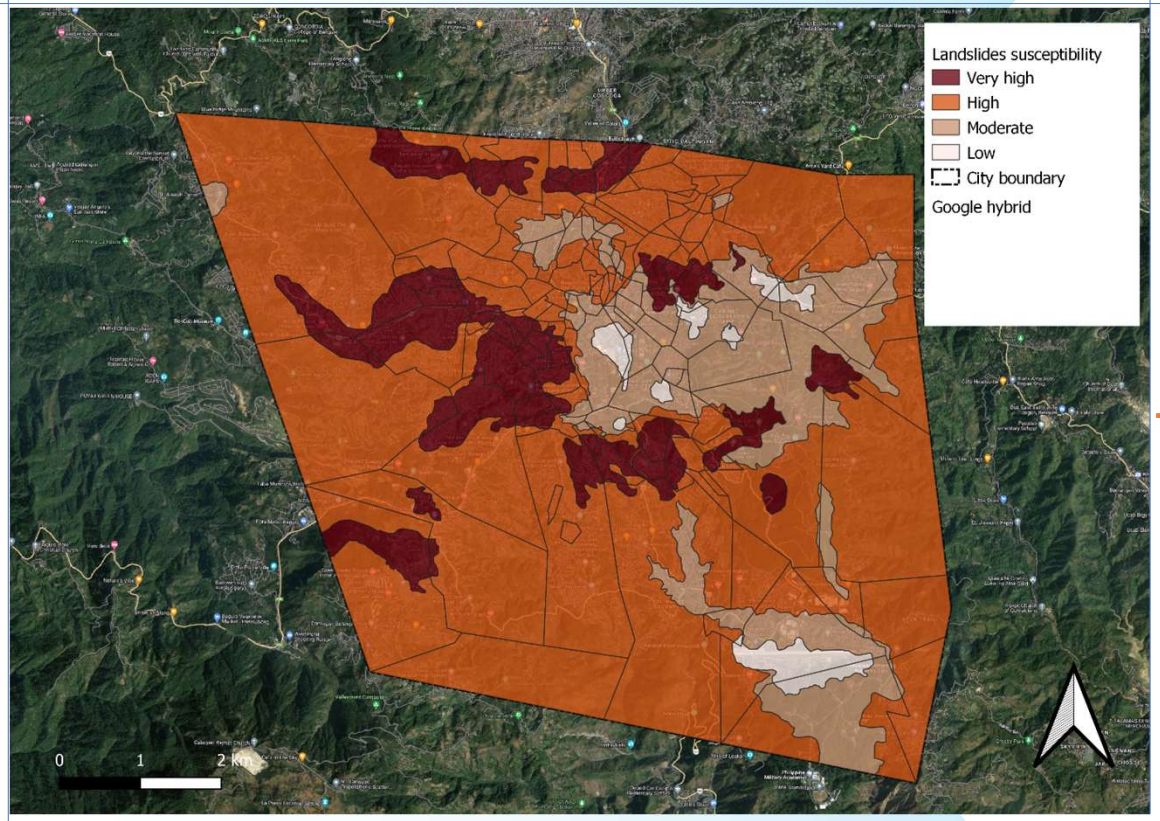
- Initial hydrological modelling and climate risk and vulnerability assessment
- Carbon footprint assessment
- Infrastructure investment pipeline
- Capacity building on methodologies adopted for GHG emissions inventory, CRVA and investment pipelining and financing

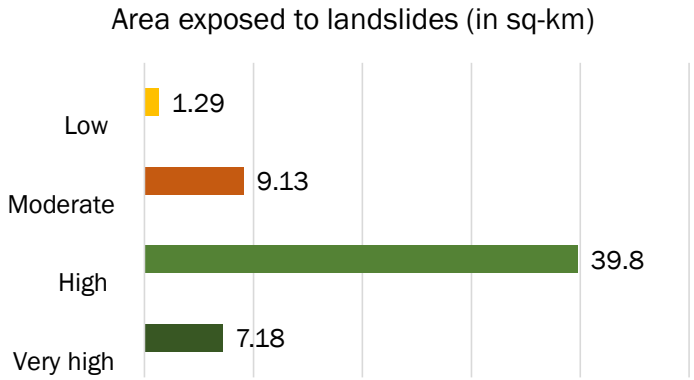
CRVA

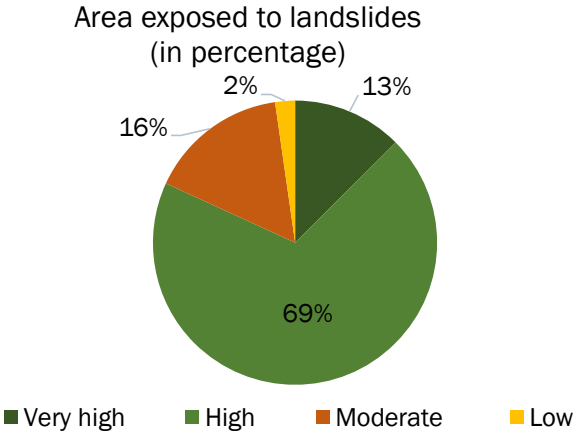


Source: UNICITI

Hazard risk maps – Landslides





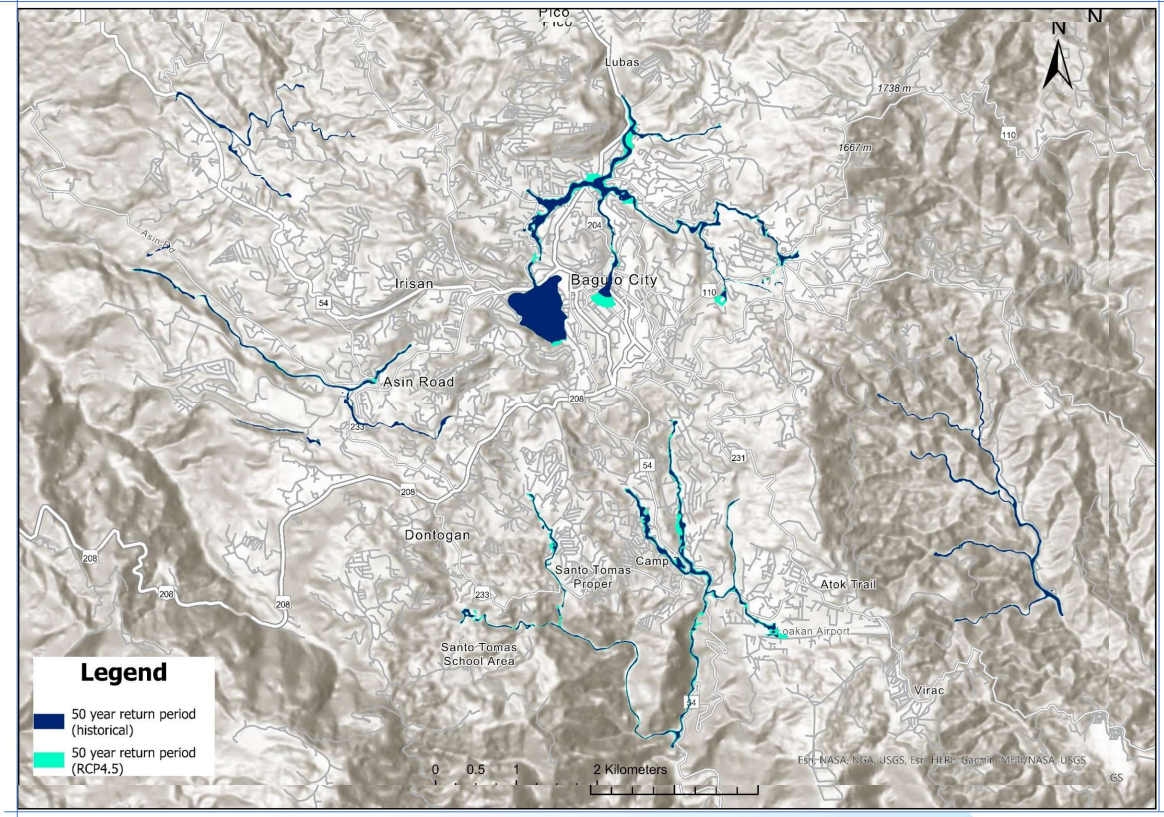


13% of the city: very high susceptibility to landslides (7.18 sq-km)

69% of the city: high susceptibility (39.8 sq-km)

Landslides exposure map is sourced from SPADE

Hazard risk map : Floods



Criteria for flood exposure

1. Hydraulic and hydrodynamic modelling: HEC HMS and HEC RAS

2. **Rainfall data over 2031-2060**

3. **C**alculated **flood extend** for 2, 25 and 50 year return periods under historical, RCP 4.5 and RCP 8.5 scenarios

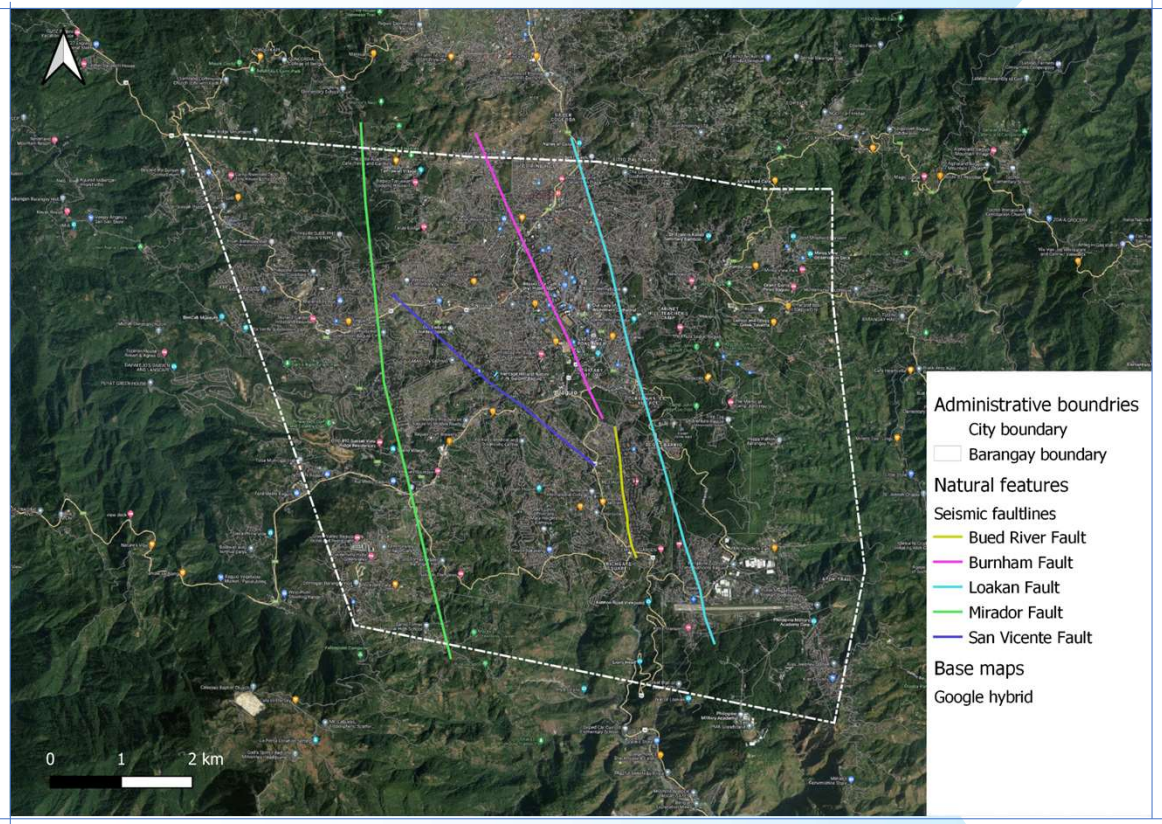
4. **Flood exposure categories** based on return period: city likely prepare for lower return periods

5. S**patial extents** of floods for different climate scenario were merged for each return period

Exposure level	Return period	Flood extent
High exposure	50 year	Historical+ RCP 4.5 scenario + RCP 8.5 scenario
Medium exposure	25 year	
Low exposure	2 year	

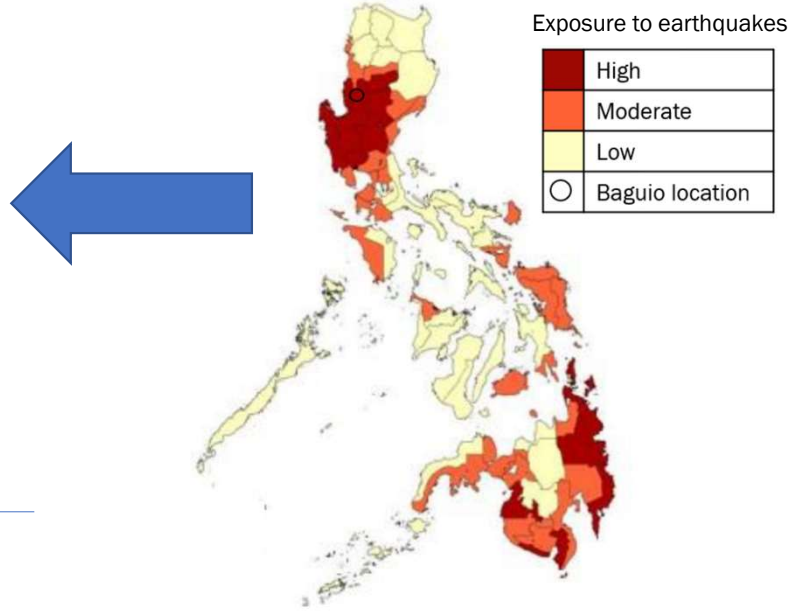
6. **Urban floods**: Observed flood instances correlate with low DEM

Hazard risk maps: Earthquakes



Seismic fault lines in Baguio; Source: SPADE

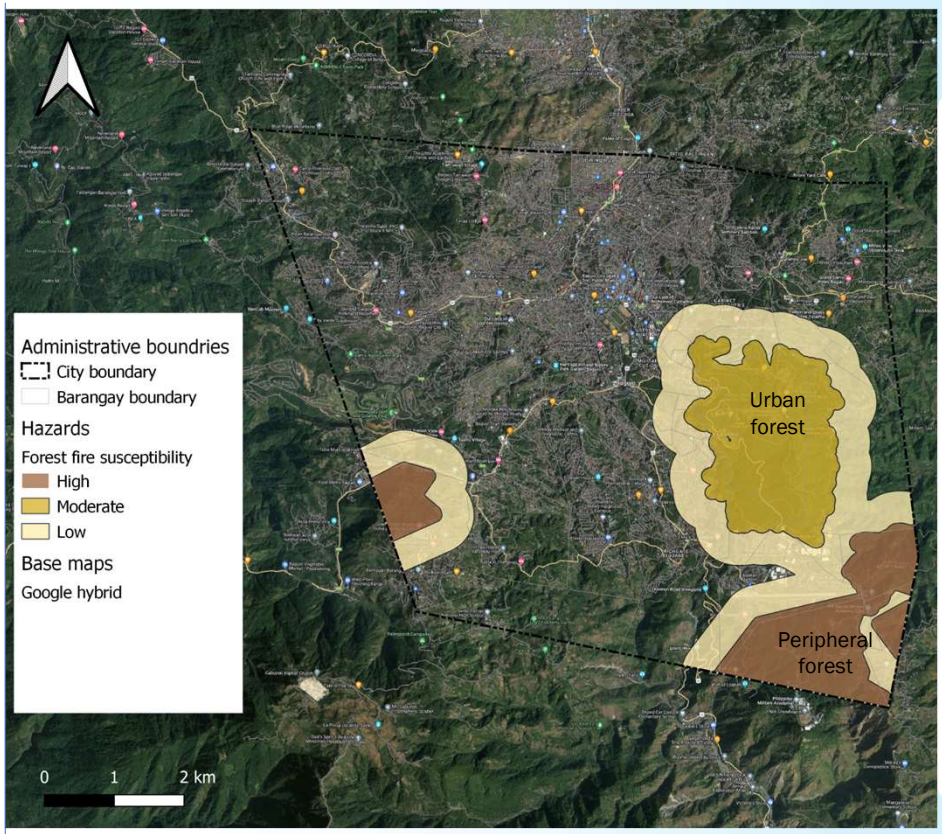
- Baguio lies in the high-risk seismic zone (National Structural Code of the Philippines, 2010)
- 5 fault lines in the city + 2 major lines outside the city



Earthquake exposure map of the Philippines
Source: National Structural Code of the Philippines

- The entire city is equally exposed to earthquakes

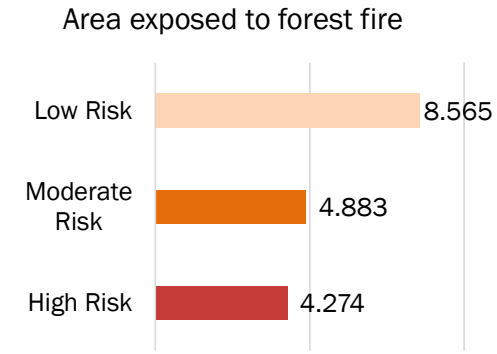
Hazard risk maps: Forest fires

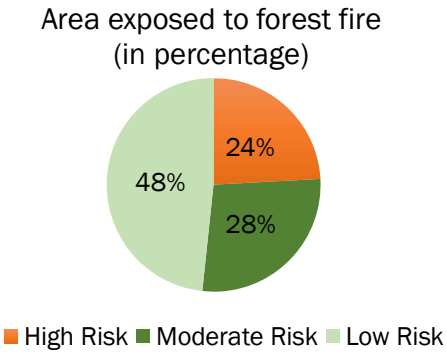


7% of the city under high future exposure to forest fire (4.2 sq-km)

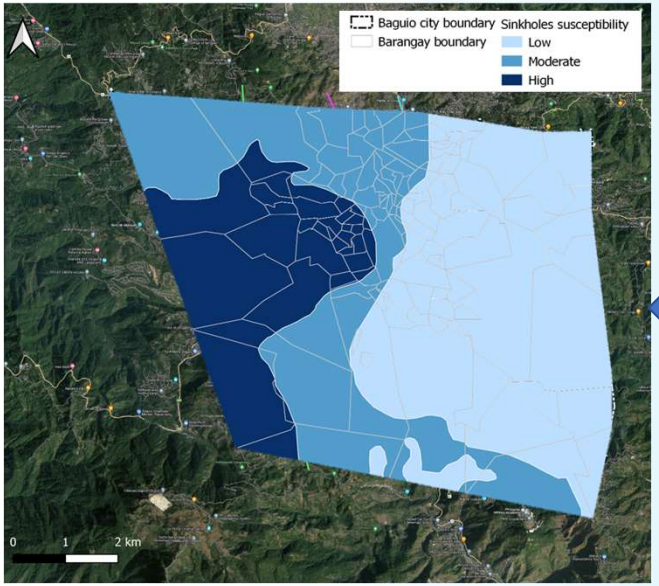
- Criteria for developing forest fire exposure map

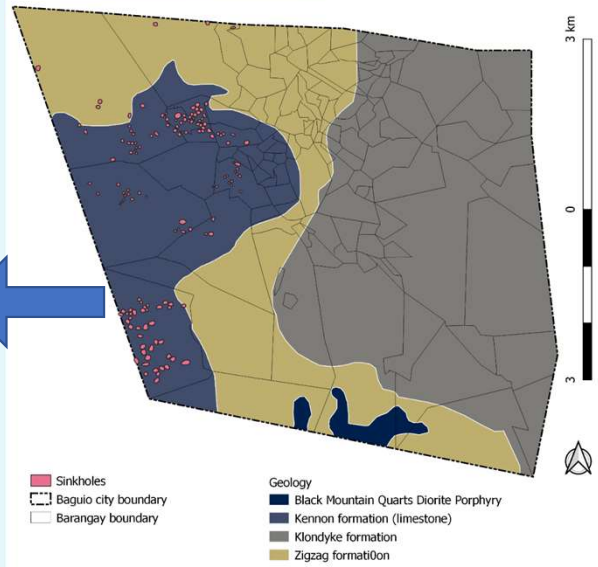
Exposure level	Criteria	Description
High	Peripheral forests and 100 m buffer	Peripheral forests and adjacent 100 area are highly prone to forest fire exposure. Chances of forest fire higher in these forests for their connectivity with the forest lands of Benguet province
Moderate	Urban forests and 100 m buffer	Urban forests and vicinity have medium forest fire risk because the isolated nature of this forest reduces the chances of forest fires.
Low	560 m buffer from the forest boundaries	Forest fire particles are spotted upto a distance of 560 m (Pereira, J. C., Pereira, J., Leite, A. L., & Albuquerque, D. (2015). Nature of consequences is mainly health and breathing-related complications.





Hazard maps: Sinkholes



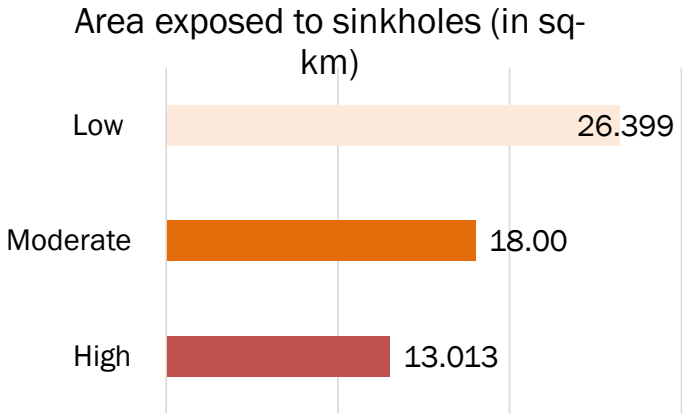


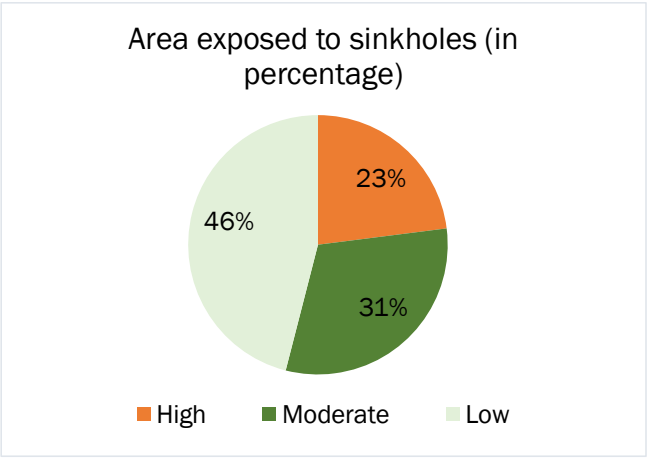
Criteria for developing sinkhole exposure map

Exposure level	Criteria	Resulting geological formations
High	Geological formations with highest number of sinkholes	- Kennon formation (limestone)
Medium	Geological formations with sparse sinkholes	- Zigzag formation
Low	Geological formations with no sinkholes	- Black mountain quarts diorite porphyry - Klondyke formation

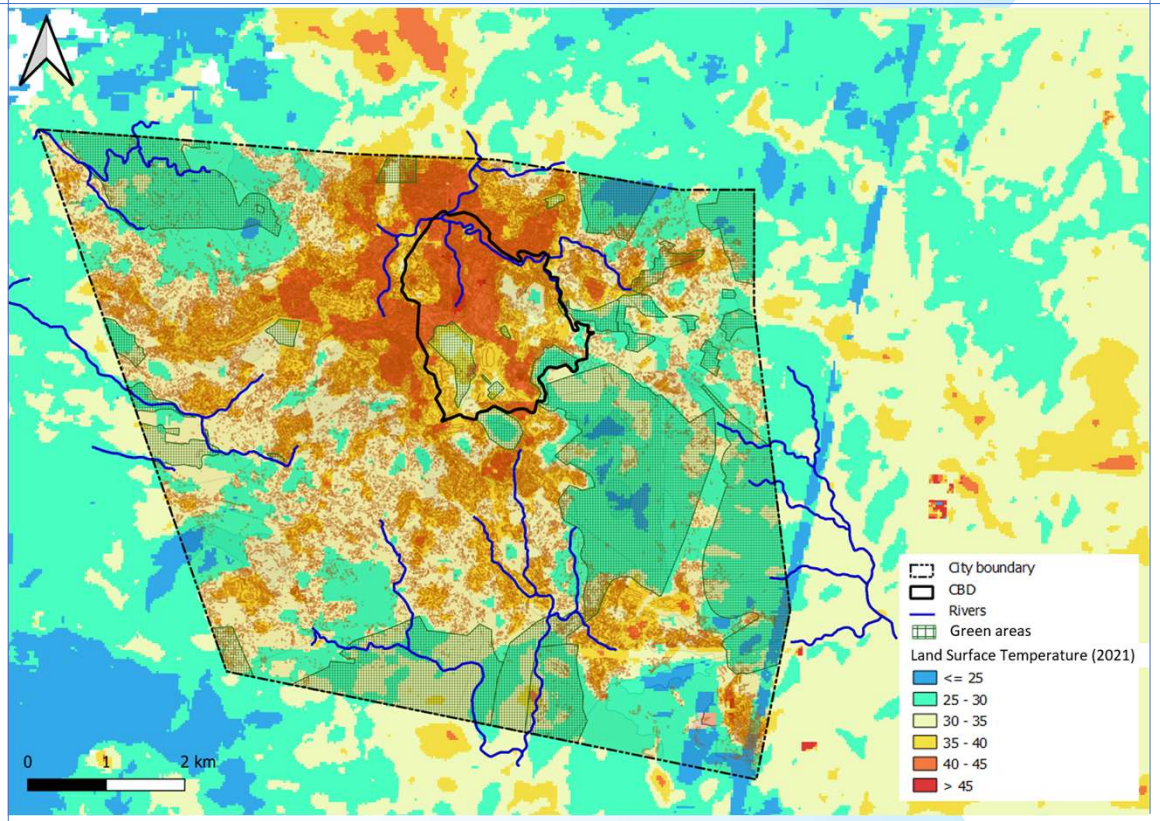
Overlay of sinkholes and geological formations in Baguio; source: UNICITI

23% or 13 km^2 of city area is highly exposed





Hazard risk map: Urban Heat Island



Land Surface Temperature (LST) map of Baguio confirming UHI in city; source: UNICITI

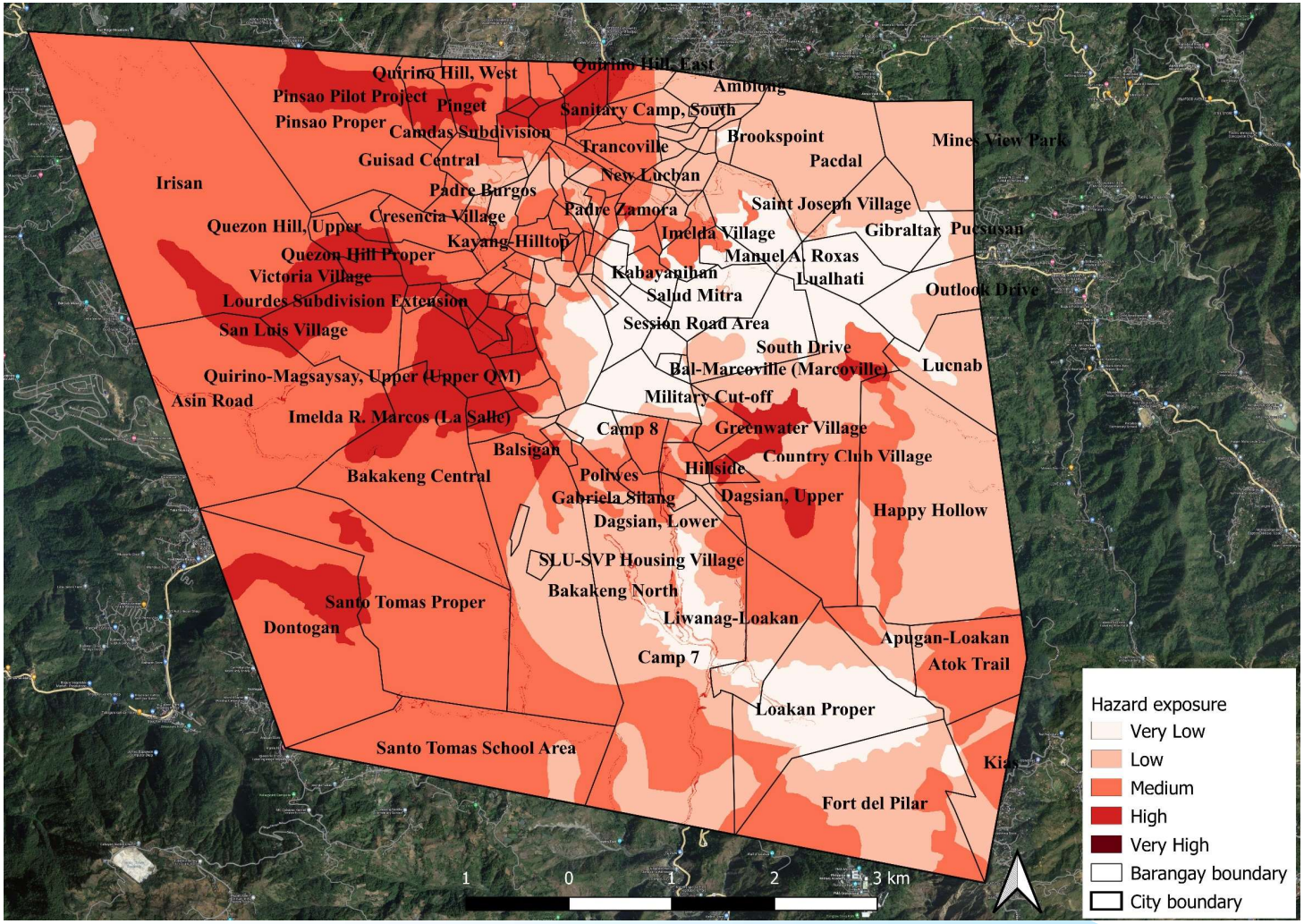
Criteria for developing UHI map

- Land Surface temperature (LST) map developed from Landsat-8 images for 2021
- Annual median of LST approach implemented in the Google Earth Engine (GEE)

Temperature variations

- < 25 degrees C – in forest areas and wetlands
- > 45 degrees C – very small pockets in the CBD
- Colder temperatures are observed in:
  - Vegetated areas that include parks, gardens, and forests
  - Wetlands
  - Low-density built-up areas

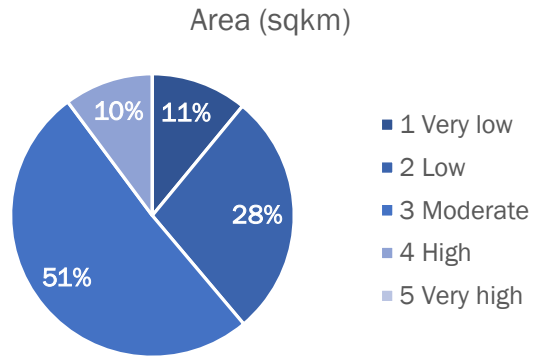
Multi-hazard risk map



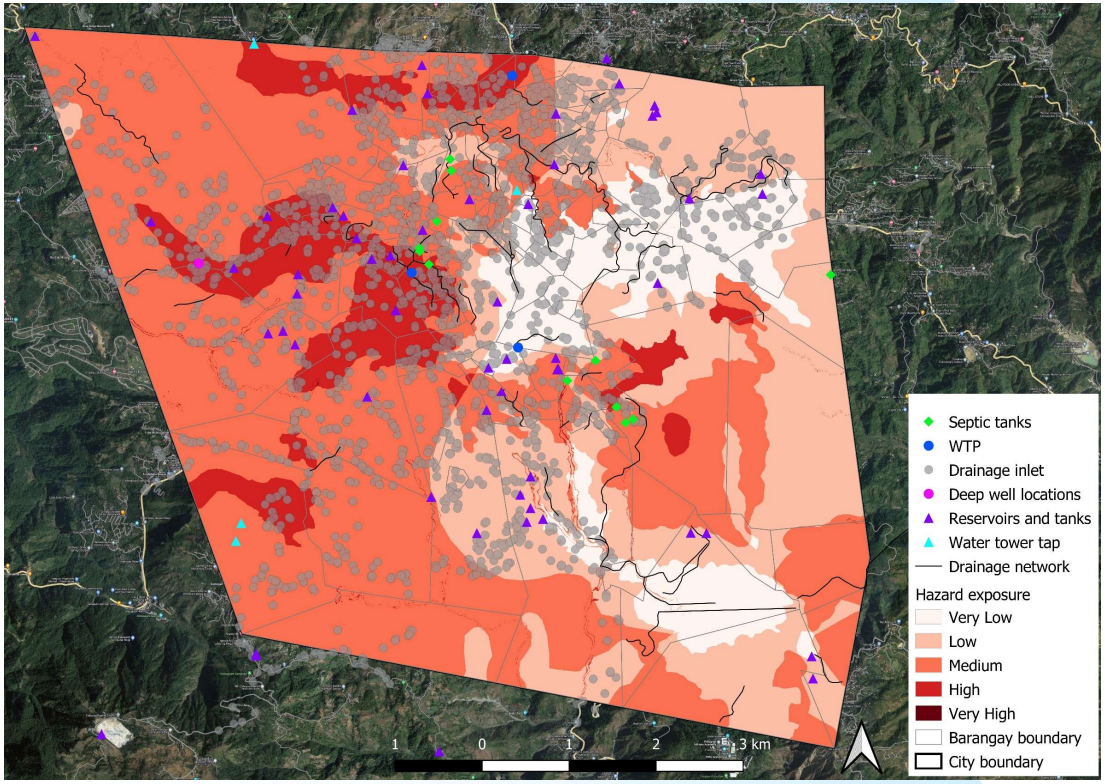
Multi-hazard exposure

- 10% area under **very high exposure:** flood 50 year return period
- 11% area under High exposure

➢ Greenwater Village, Quezon Hill Proper, Victoria Village, Lourdes Subdivision Extension, San Luis Village, Santo Tomas Proper barangays have high exposure due to multi-hazard



Climate Risk and Vulnerability Analysis: Multi-hazard exposure analysis at Barangay Level



Water supply and wastewater management sector exposure to multi-hazard
Source: UNICITI

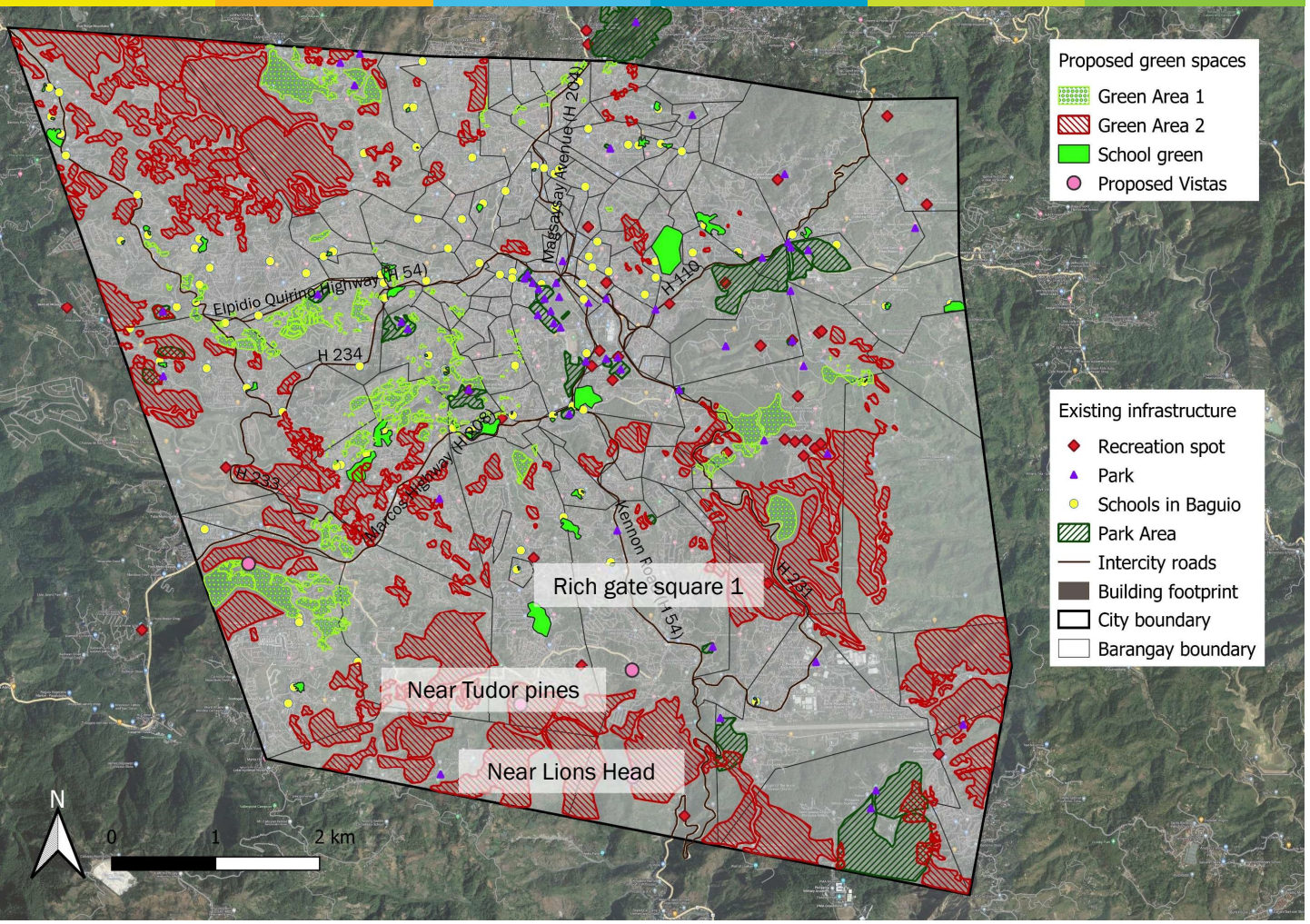
Water supply and management and Wastewater Management

- **Reservoirs and tanks** – **20** reservoirs are located in high to medium exposure zone are prone to infrastructural damage. A vegetation buffer around the water source can prevent water contamination from organic matter present in slope-runoffs.
- **Deep well – 1** of them is located high exposure area and need to be monitored for contamination during floods and rainfall induced landslides. The sinkhole hygiene in the proximity must be maintained to prevent ground water contamination.
- **Communal septic tanks and WTP –** Almost all of them are located high to very high exposure areas. They must be prevented from blockages due to sedimentation and debris flow.
- **Drainage inlets** - They must be regularly maintained to preserve their utility for peak rainfall seasons.

Also water retention technique in proximity can aid them during peak seasons.

Key Solutions with Spatial Analytics

e.g. Nature Based Solutions to hazard exposures



Green urbanism to address floods and landslides

Green areas - priority 1

- High exposure zones
- Residential parks , green corridors, bioswales

Green areas - priority 2

- Medium exposure + in transition zones
- Self reliant townships, slope parks, eco parks

School educational green

- Open areas in academic institutions
- Rain gardens, infiltration basins, detention ponds

Key Solutions Overview
Blue green co-benefit-based development

- **Reviving rivers** as part of the city through riverfront development
- Developing self-reliant satellite town or campus on the principle of blue green infrastructure
- Promoting decentralized through creating new tourist location

Enhanced tourism

Bio retention/ percolation/ water harvesting

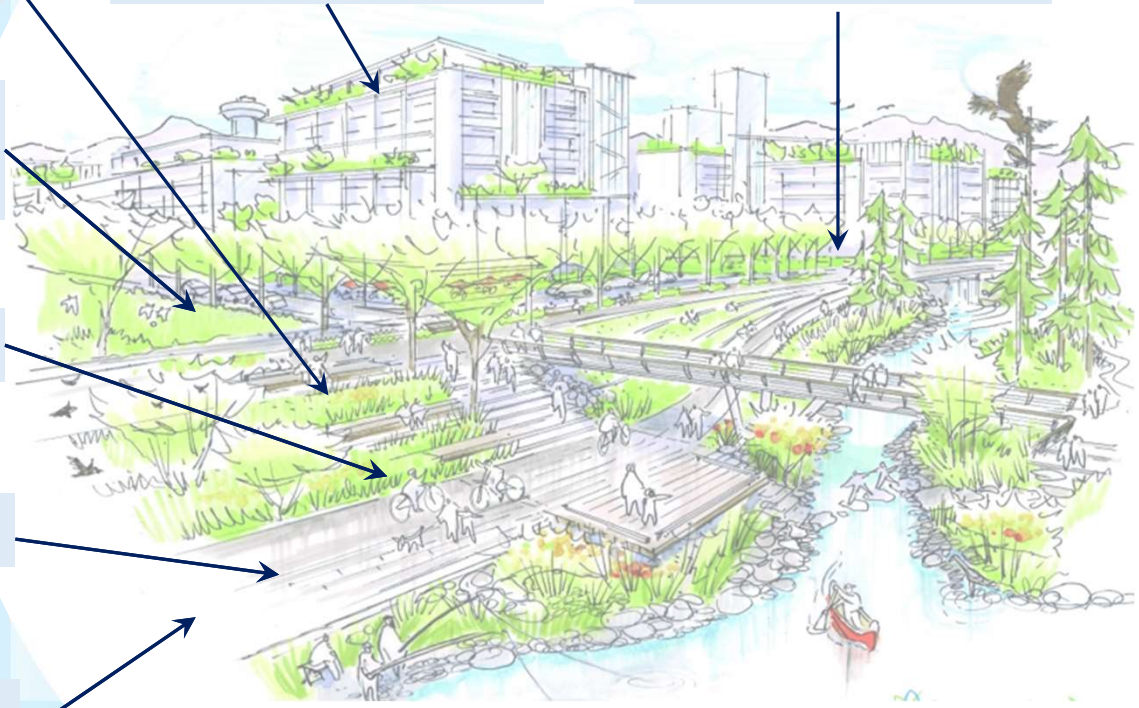
Recreation

Traffic calming

Reduced floods and landslides

Enabling development

Air quality improvement



Rain city strategy

Reduced runoff

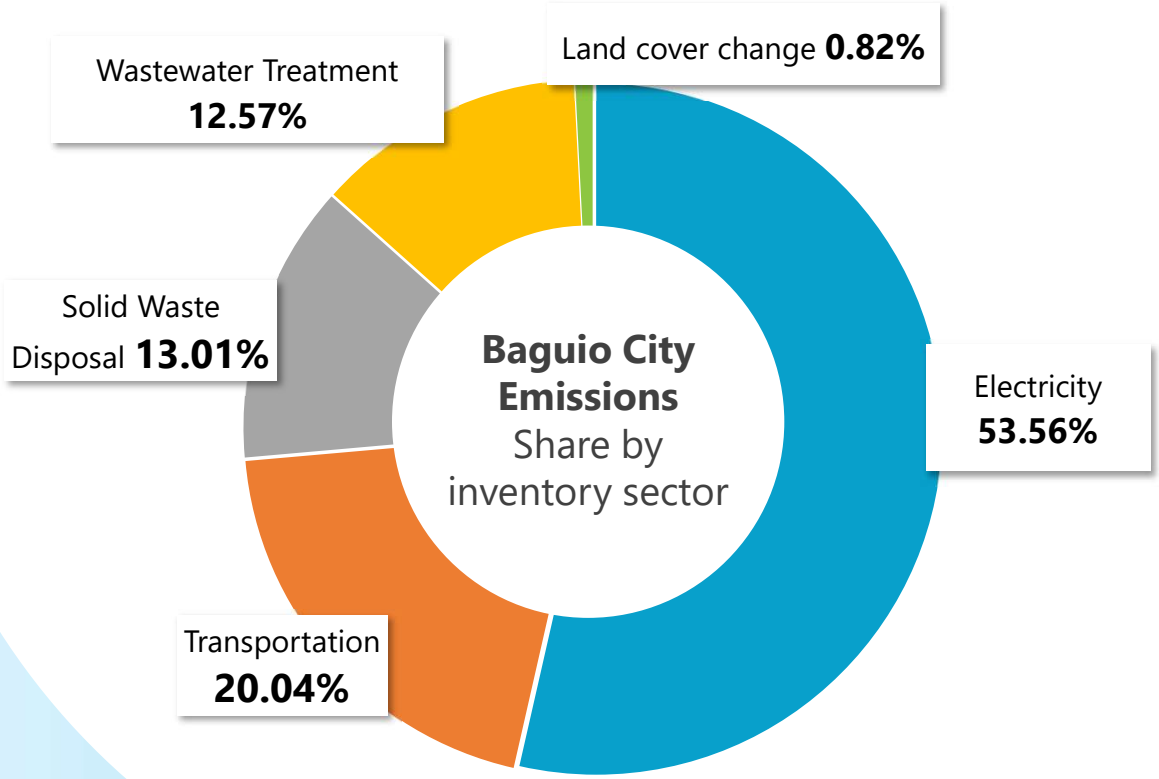
Ways to derive revenues from beneficiaries of resilience measures

GHG Profile Methodology (adaptable to city circumstances)
Emissions – Total

Priorities

- Renewable energy and energy efficiency (increased resilience from varied sources)
- Low carbon transport (pollution reduction)
- GHG reduction form waste – waste water by ADB but solid waste potential (pollution reduction)

629,483 tons of CO_2 equivalent (2018)



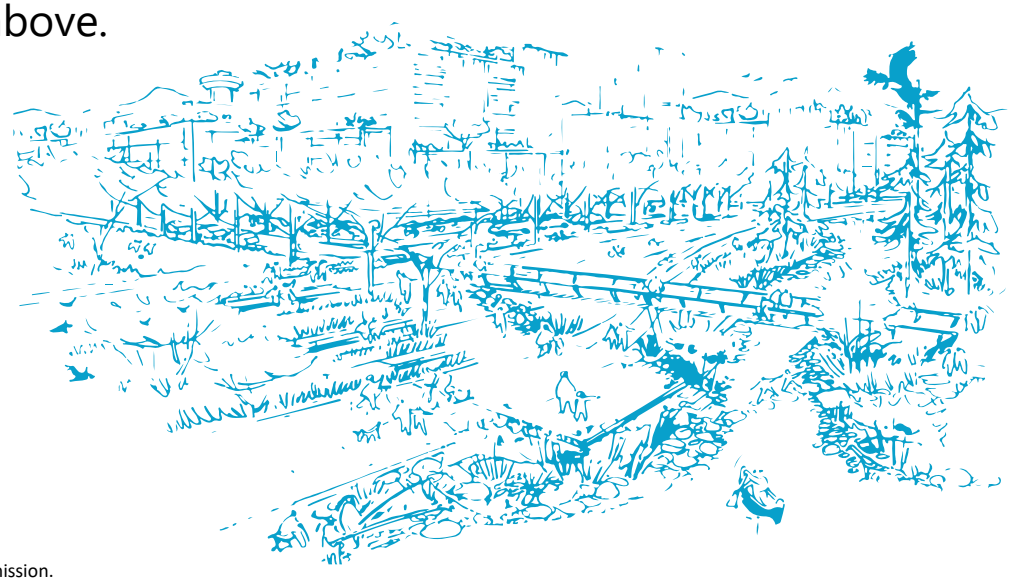
Investment Roadmap and Financing Opportunities

- There is an extensive pipeline of climate-relevant projects that are already identified by the city planning and infrastructure master planning systems.
- None of these projects have yet been formulated in a way that will attract public or private climate-focused finance.
- All are being funded on an ad hoc yearly budget basis with no programmatic approach.
- Consequently "big silver bullet solutions" using PPP are sought.
- There are available sources to support a more programmatic approach to climate project formulation.

- There are a range of feasible potential options for financing the identified program even within the city's constrained borrowing envelope.
- Critical systems needed to support financing of identified projects are:
  - Climate pipeline coordination, data repository and MRV system
  - Climate finance tracking/green budgeting
  - Climate investment project assessment (including PPP assessment) and MRV systems
  - Green procurement systems

Key Recommended Actions for Baguio

- Focus on climate impact in terms of GHG reduction and resilience featuring adaptive reuse and addressing vulnerabilities of low-income communities in low lying and landslide prone areas.
- Provide technical and financing support for a programmatic approach to climate investment moving from ad hoc specific intervention ideas to a list of prioritized, most impactful projects, with clear financing strategies and which generate a maximum co-benefits.
- Build systems and train staff to institutionalize CRVA methodology, the use of GIS-based exposure analysis; and appropriate hydro data collection system (adding to current early warning system).
- Build investment and financing support systems as above.



Thank you!