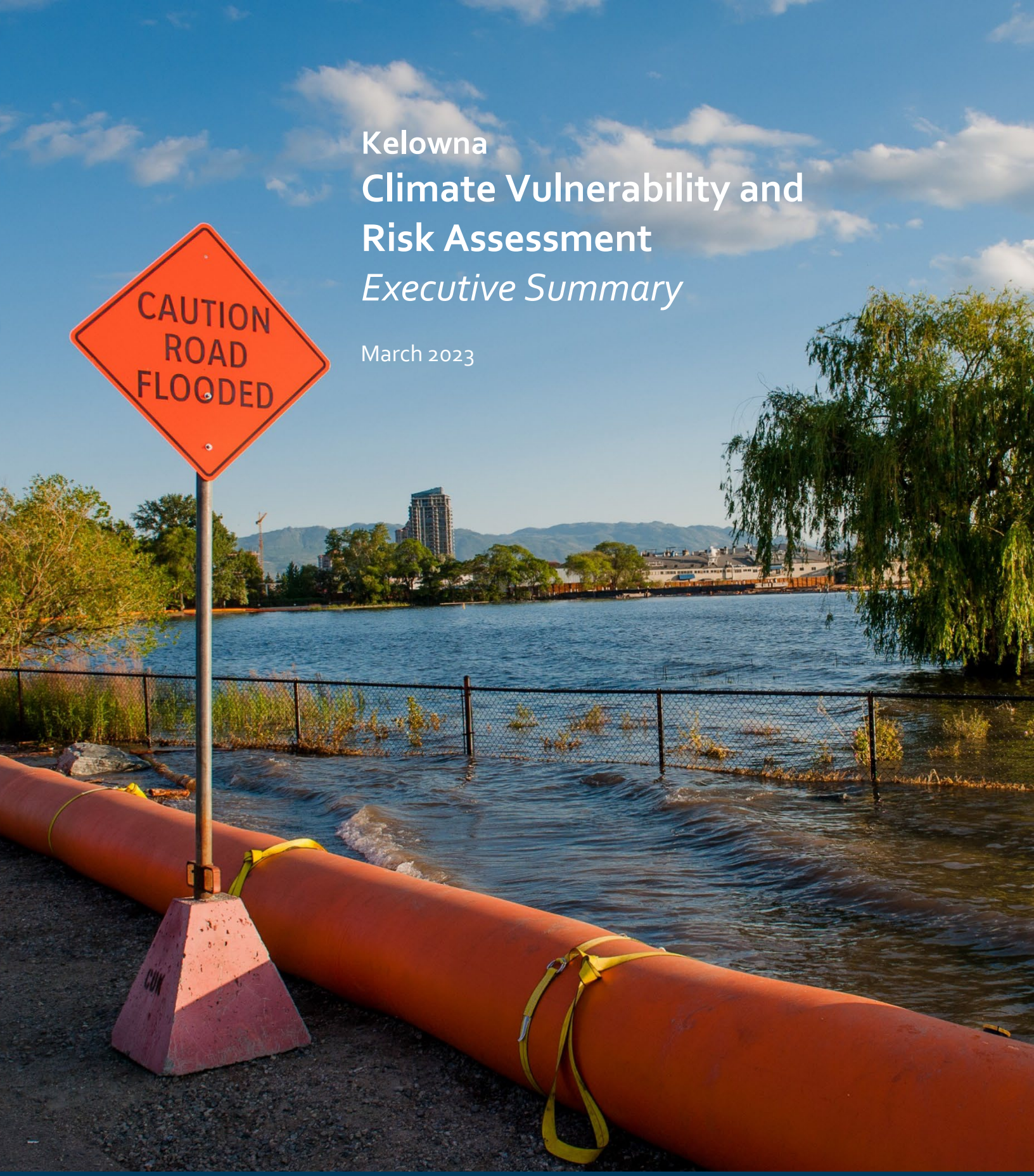


Kelowna
Climate Vulnerability and Risk Assessment
Executive Summary

March 2023

SSG SUSTAINABILITY SOLUTIONS GROUP

City of Kelowna

Executive Summary

The Climate Vulnerability and Risk Assessment Study (CVRA) describes the scope of Kelowna's community adaptation challenge by modelling the natural and built hazard risks and vulnerabilities to existing buildings, infrastructure and people, and planned growth, out to 2070. As the climate changes, Kelowna must be prepared with adapted and resilient city systems and infrastructure to protect people and ecosystems, and to enable speedy recovery after severe climate events. At the same time, Kelowna's population is growing, requiring new buildings and infrastructure. Decisions as to how and where these elements are constructed must be informed by climate change impact adaptation thinking.

This analysis, together with the GHG Modelling Study completed earlier, will help inform the *Climate Resilient Kelowna Strategy* which will include a series of actions the community can undertake to reduce GHG emissions and prepare to adapt to climate change.

Expected Local Climate Changes

Human-caused climate change is already affecting the local climate, causing heat domes, droughts, wildfires and flooding. The *Climate Projections for the Okanagan Region* (2020) report models the local changes the Okanagan climate is expected to experience in the coming decades including:

- Warmer temperatures year-round;
- Summers that are considerably hotter and drier;
- Increased duration of the growing season;
- Warmer winter temperatures;
- Increased precipitation across all seasons except summer; and
- Shifting seasons.

These expected changes will result in wilder, wetter, and weirder weather. The weather will be increasingly unpredictable and events like winter storms, droughts, flooding, and wildfires will be more common and more severe.

These climate change impacts pose a threat to ways of life in Kelowna. They will interrupt electricity delivery and personal and freight transportation activities. They will cause damages to personal and public properties. They will interfere with tourism and agricultural industries. As greenhouse gas emissions continue to increase, the severity and frequency of disruptions will worsen.

Demographic Changes

Kelowna's climate change challenges will continue to grow as the city grows. The city's population could reach almost 250,000 people by 2070, an increase of 100,000 people from today. It is anticipated that it will require nearly 50,000 additional dwelling units to accommodate the increase in population. The homes, buildings, infrastructure, and vehicles required to house and move more people will add pressure to the natural ecosystems that regulate the local climate.

Climate Change Hazards and Impacts

The CVRA examines climate hazards today and in 2070. Although a time span ending in 2070 is longer than typical community planning guidelines, it is used as climate projections typically extend to this time horizon or beyond, with the largest changes typically projected to happen towards the end of the time span. Further, many of the decisions made in the shorter term will determine the scale of risk the community will face in the future.

Three climate hazards were quantitively assessed: extreme heat, wildfire, and flooding, by mapping the hazards and modelling their potential impact on Kelowna's people and infrastructure, now and in 2070. Four other hazards were qualitatively

assessed: landslides, water security, invasive species, and extreme cold. The impacts of these hazards to the community are summarized in Table A.

Multi-hazard Indexes

Climate hazards do not occur in isolation. For example, heat waves and wildfires are often simultaneous, coupled with concerns about water security and drought. By combining the relative risk from each of the three quantitatively modelled hazards (extreme heat, wildfire, and flooding), the cumulative risk to different areas of Kelowna can be understood. A risk rating for each of the three hazards for each zone of the city was assigned, these risks were then summed to give a combined hazard risk and are mapped in Figure A for today and 2070. Each of the maps compares the relative degree of risk for each zone of the City. Note that the risk ranking is calculated relative to all other zones, and a high-risk zone in the present day might be a medium-risk zone in 2070 when compared to all zones in each time period.

Over the coming decades, the number of areas of Kelowna that will be exposed to multiple risks due to the changing climate will increase, particularly in the urban and core areas of the city. Notably, most of the urban downtown area is expected to experience increased risk of multiple hazards. Kelowna's rural and suburban neighbourhoods will experience the least multi-hazard risk change over the next 50 years, which bodes well for the neighbourhoods and critical infrastructure located there.

Areas along rivers and the lakeshore will primarily experience increased flood risk. Downtown will also experience flood risk as well as increased heat risk from an enhanced urban heat island effect. Wooded areas and areas adjacent to forests will primarily experience increased forest fire risk.

Some of Kelowna's critical infrastructure is in areas that are expected to experience multi-hazard risk. Reservoirs, distribution stations, treatment plants, and certain electrical/substation elements could be at increased risk of compromise.

Summary

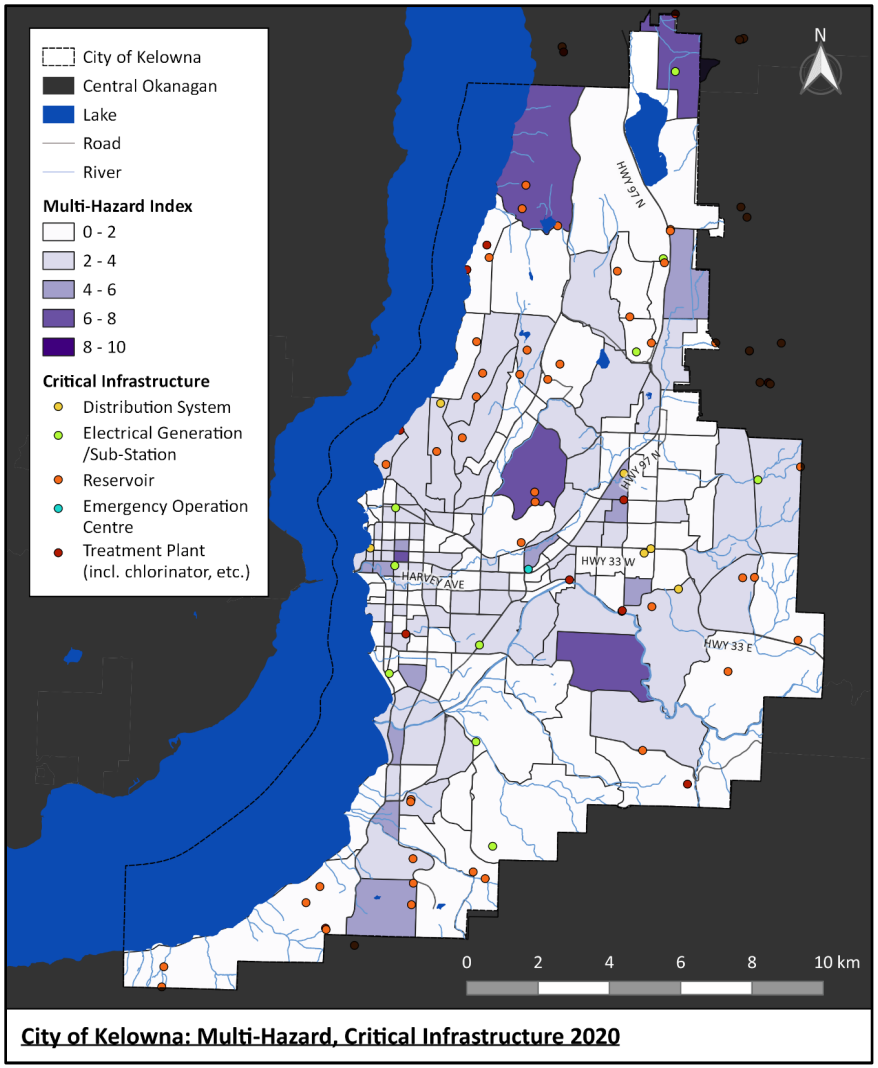
As global atmospheric GHG emissions increase and the climate continues to change, the frequencies and extents of several major climate hazards could impact Kelowna over the next 50 years. Almost every Kelowna neighbourhood is at risk of at least one climate change threat and many of the most populous neighbourhoods are at risk of multiple hazards. Risk is elevated by continued population growth, placing greater numbers of people, buildings, and critical infrastructure in potentially vulnerable areas across Kelowna.

Now that the current and future risks are known, Kelowna can determine adaptation and readiness actions. These actions will be identified and modelled in the next phase of work, defining their costs, damage reduction impacts, and how successful they will be at removing people from risk.

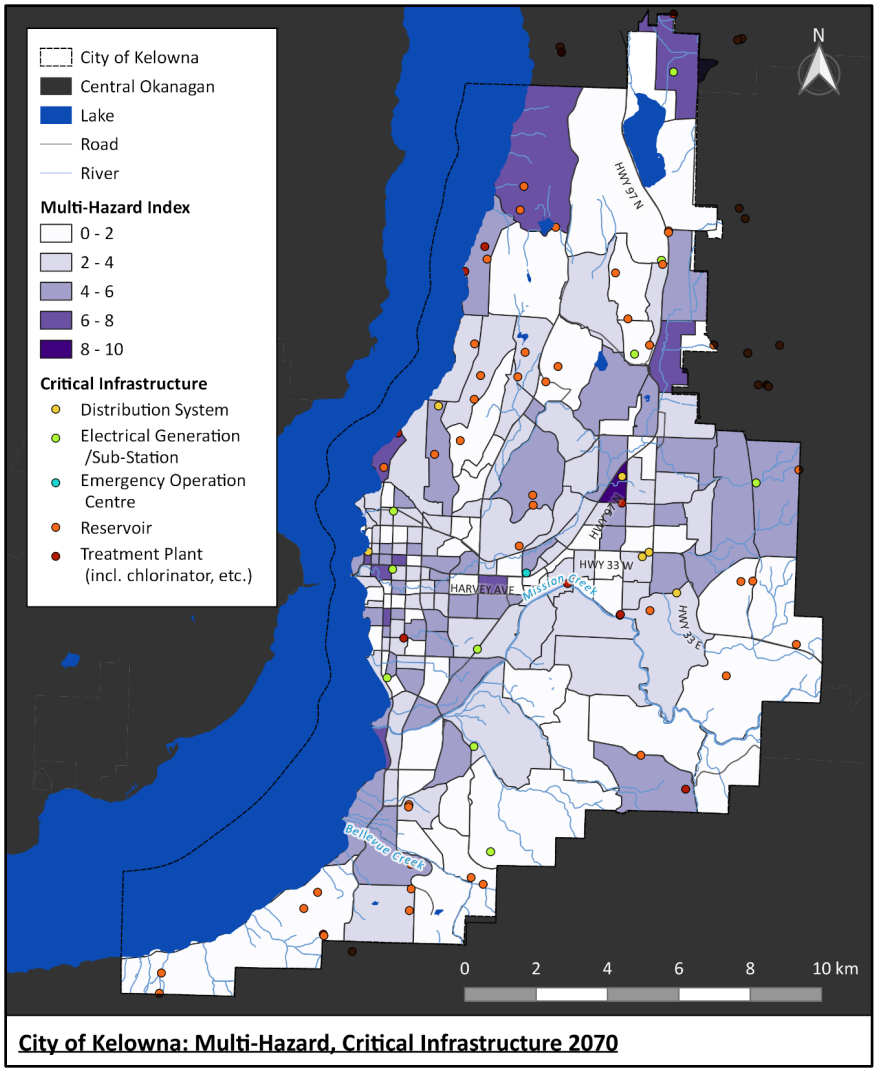
Table A: Summary of potential hazard impacts driven by climate change in Kelowna

		POTENTIAL IMPACTS				
Hazard	**Changes to hazard due to climate change**	**Infrastructure & Critical Infrastructure**	**Services**	**People**	**Environment**	**Economy**
Extreme Heat 	• á average temperatures • á heat waves and heat domes • Hotter nights	• á importance of grid stability • Road and airport runway deterioration and disruptions • â hours available for road and infrastructure repairs	• á peak electricity demand • á hospitalizations • á demand for cooling centers	• á population exposed to Health Canada heat thresholds (25% today to almost 100% in 2070) • Highest heat risk in Urban Centres and Core Area neighbourhoods	• â air quality • Tree canopy loss	• â agriculture crop yields and quality • Unhealthy outdoor working conditions • Construction and maintenance sector disruption • â tourism in the summer
Wildfire 	• Drier landscape from warmer weather • Longer fire season • á wildfire fuel from heat stress	• Transportation network disruptions • Electricity grid disruptions	• á strain on emergency services • Contaminated drinking water	• ~3 times more people exposed to areas with potential of high to extreme wildfire behavior • Hillside development areas are most exposed to areas of extreme wildfire behavior	• â tree canopy • á soil erosion • â air quality • Ecosystem and habitat destruction	• â tourism • Destroyed crops • Unhealthy working conditions due to air quality
Flooding 	• á total precipitation (all seasons except summer) • á winter & spring temperatures affect peak flows during spring freshet	• Bridges and culverts at risk of overtopping during a 200-yr flood event causing road closures • 40 critical infrastructure assets at risk during 200-500 year very rare flood event (e.g. City Hall, Hospital, Wastewater Treatment Facility, and schools)	• Transportation network disruptions from road closures • Lift stations, water, and wastewater treatment facilities disruptions • Electricity disruptions (e.g electrical substation at risk during a 50-100 year rare flood event)	• ~2 times more people at risk of being impacted by a 200-500 year very rare flood event	• á soil erosion on stream banks and lake foreshore • á chance of debris and chemical contaminants in water	• ~25% increase in potential financial impact by 2070 during a 50-100 year rare flood event

		POTENTIAL IMPACTS				
Hazard	Changes to hazard due to climate change	Infrastructure & Critical Infrastructure	Services	People	Environment	Economy
Landslides 	• á severe storms with intense precipitation can á slope instability. • Drought can compromise vegetation health, á slope instability.	• Transportation network disruptions	• Access via roads may be disrupted • Contaminated freshwater	• Population within low slope stability areas have higher probability of being exposed to a landslide event	• Natural landscapes compromised • âecosystem connectivity • â water quality	• Financial losses for individuals, businesses, and governments due to building or infrastructure loss
Water Security 	• á average temperatures • â snow pack • á growing season • á in consecutive dry days	• Impacts to water supply and storage	• Water supply availability for agricultural irrigation • Water supply availability for catastrophic events (i.e. wildfire)	• Residential water supply disruptions • Water restrictions enforcement	• âgroundwater recharge due to changes in soil during dry periods can reduce water infiltration • â water availability for ecosystems	• Agricultural production disruption due water shortages • Competition for water use from users
Invasive Species 	• á presence of invasive species • â biodiversity • á influence on other climate hazards (e.g. wildfire)	• Invasive species can encourage conditions that á vulnerability to other climate hazards like landslides, flooding, and wildfire which all pose substantial risk to infrastructure	• Changes to the regulatory functions of the natural environment will put more stress on human systems (e.g., increased need for air conditioning if the cooling effect of local plants is reduced)	• áinvasive insects, pose a nuisance risk as well as a vector-borne disease risk (e.g. mosquitos carrying West Nile virus)	• â ecosystem biodiversity and impacting ecosystem functions	• Agricultural production disruption • â natural resource yields • Eco-tourism disruption
Extreme Cold 	• Disrupted polar vortex as the polar jet stream shifts further south	• Water supply (water main breaks/leaks)	• Transportation network disruptions (e.g. increased de-icing required) • á stress on health facilities	• Health impacts due to exposure (windburn, frostbite, hypothermia) • á demand on energy systems to provide heat	• Changes in the frost line • á potential for freezing rain/ice storms • á iced surfaces	• Disruption to outdoor labour (risk of exposure)



City of Kelowna: Multi-Hazard, Critical Infrastructure 2020



City of Kelowna: Multi-Hazard, Critical Infrastructure 2070

Figures A (left), B (right). Multi-hazard index and critical infrastructure location, by traffic zone, for flooding, heat, wildfire, and landslide vulnerability for present day (A) and 2070 (B). Each hazard is awarded a score which is based on population affected (per capita) per traffic zone. Score values are within the range from 1 to 5 depending on the quintile the results falls in, where a value of 5 represents the highest population affected (per capita). The final index value is normalized on a scale from 1 (low) to 10