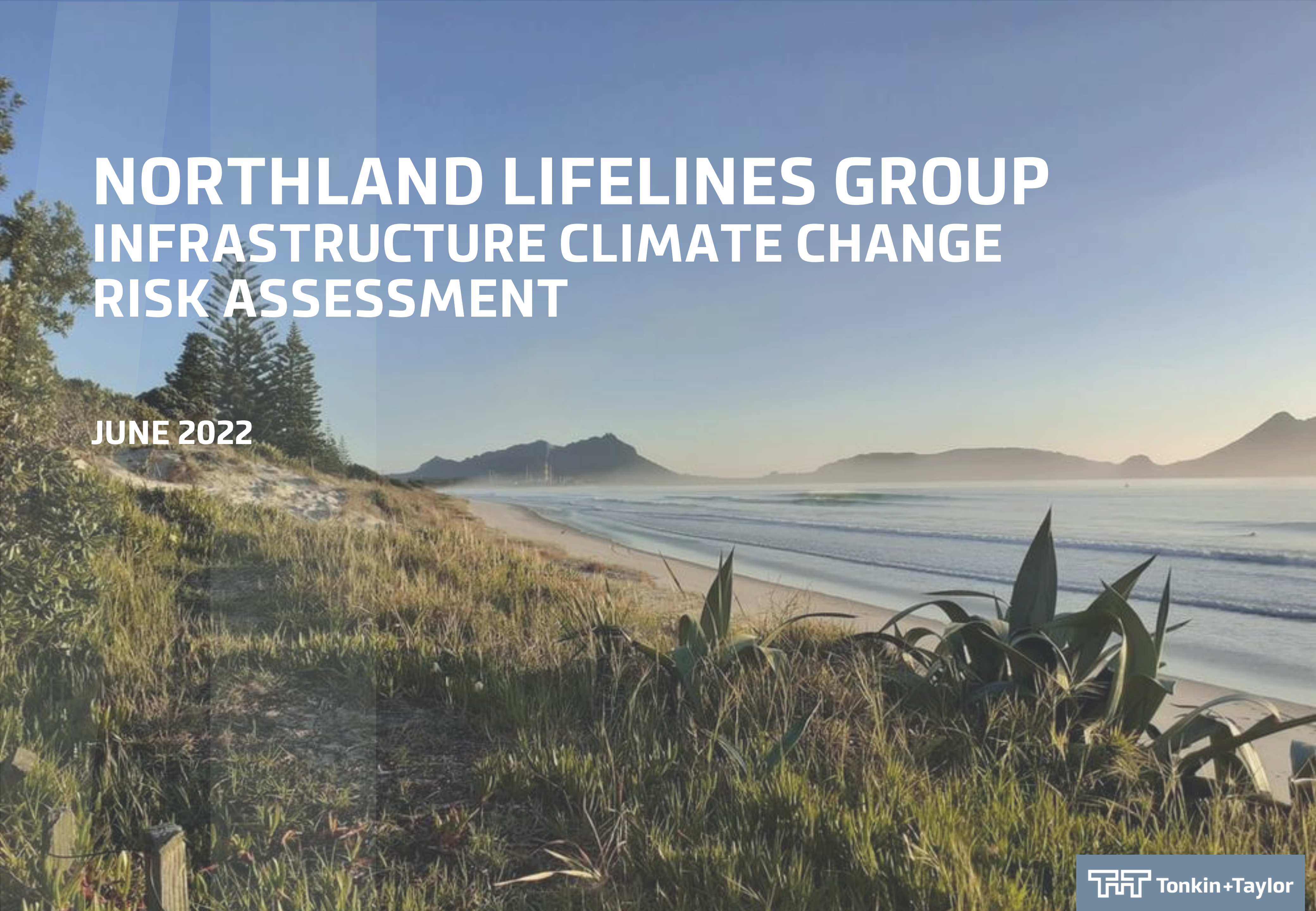

NORTHLAND LIFELINES GROUP
INFRASTRUCTURE CLIMATE CHANGE RISK ASSESSMENT

JUNE 2022

Tonkin+Taylor

Document control

This report, version 1.0, has been issued to Northland Regional Council.

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Applicability

This document has been prepared for the exclusive use of our client Northland Regional Council and members of the Northland Lifelines Group, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client and members of the Northland Lifelines Group, without our prior written agreement.

The results in this document are for comment from the Northland Lifelines Group and are subject to change, and as such, should not be relied upon.

SUMMARY

Key project information

- The project aim is to understand the risks arising from future climate changes to Northland’s lifelines infrastructure (Energy, Communications, Transport, Three Waters), and how these may change over time.
- A non-spatial impact screening was undertaken prior to the spatial analysis to identify key focus areas for the spatial assessment.
- 76 of the 344 NLG critical sites are exposed to at least one hazard, and 18 sites exposed to two. There is a higher proportion of critical sites exposed to fluvial flooding compared to other coastal hazards across the three time horizons, associated with the larger hazard areas.
- The energy sector has the largest length of exposed lines, with 2,200 km identified as exposed to fluvial flooding. However, this is primarily associated with overhead lines, with impacts limited to access issues rather than physical damage.
- Highest exposure for all sectors associated with flooding with approximately 15% of point assets within each sector exposed across all time horizons.
- Project limitations included limited temporal datasets, inconsistencies with asset data supplied, and asset duplicates.

Future next steps which the Northland Lifelines Group should consider include:

- Assessing the potential service impacts arising from at risk assets.
- Interrogate heatmaps and establish hazard based hotspots to further focus adaptation efforts
- Prioritise high and extreme assets, establishing adaptation actions and associated costs
- Site level investigations for top risks within each sector
- Incorporation of remaining NLG Organisations’ data
- Develop an asset information standard to reduce data manipulation for assessments
- Acquire better spatial flood hazard information to refine risk ratings, increasing the number of scenarios modelled.
- Use polygons (footprints) for all assets assessed in future.

Contents

Overview and methodology

KEY TERMS

Adaptation: The process of adjustment to actual or expected climate and its effects.

Asset: The physical hardware (e.g. pipes, wires), software and systems to own, operate and manage Lifelines Utilities (energy, transport, telecommunications, water).

Consequence: Consequence is defined as the effect, result, or outcome of something occurring. Consequences can be both positive and negative, however for this assessment the use of the term focuses on negative consequences directly associated with an impact asset.

Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Hazard: The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.

Lifeline Utilities: Lifeline utilities are entities that provide essential infrastructure services to the community such as water, wastewater, transport, energy and telecommunications.

Mitigation (of climate change): A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Representative concentration pathway (RCP): A suite of future scenarios of additional radiative heat forcing at Earth's surface by 2100 (in Watts per square metre), which is the net change in the balance between incoming solar radiation and outgoing energy radiated back up in the atmosphere. Each RCP can be expressed as a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC for its Fifth Assessment Report (AR5) in 2014.

KEY TERMS

Resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and Transformation. Note this is closely related to the concept of adaptation.

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

OVERVIEW AND METHODOLOGY

PROJECT AIM AND OBJECTIVE

The project aim is to understand the risks arising from future climate changes to Northland's lifelines infrastructure, and how these may change over time.

The focus of the assessment was on direct climate change impacts on lifeline utility assets.

The objectives of the project were to:

- Confirm an ***appropriate risk assessment framework/methodology*** to identify, quantify and prioritise climate related risks to infrastructure assets
- ***Assess the impacts and risks*** relating to potential ***climate change hazards*** on Northland's lifelines infrastructure assets
- Develop ***recommendations for future climate change work*** relating to Northland Lifeline Utilities

The intended use of the project information is to:

- Inform more detailed lifeline utility planning for climate change.
- Inform emergency management planning for future state hazards.
- Inform more detailed community planning being undertaken by local authorities.
- Raise awareness of the potential impacts of climate change in the lifelines, CDEM and local government sectors.

RISK ASSESSMENT SCOPE

The risk assessment was based on RCP 8.5 (following recommendations within the National Climate Change Risk Assessment (NCCRA) Framework). RCP 8.5 is a high-end, high emissions scenario that is useful for testing the outer bounds of climate risks. There were two components of the risk assessment, non-spatial analysis and geospatial analysis.

Non-geospatial analysis was undertaken for temperature/drought, fluvial flooding, coastal inundation, coastal erosion and extreme weather events (such as wind and storms).

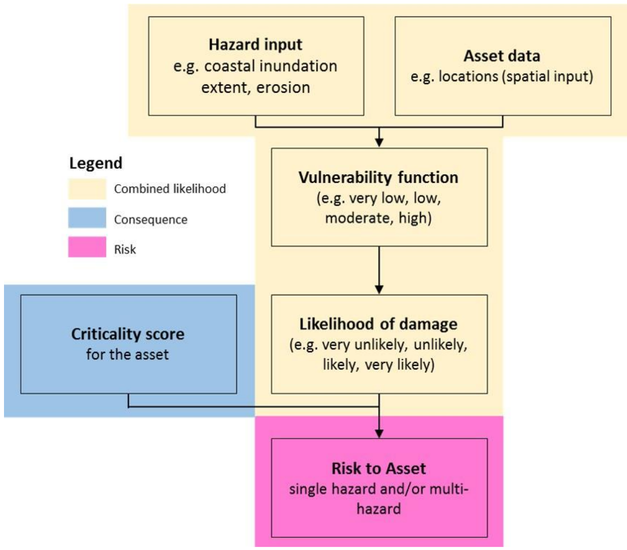
Geospatial analysis was undertaken for three hazards which were identified as having the largest risk profile in the non-spatial analysis: coastal erosion, coastal inundation and flooding.

The three time horizons assessed included present, mid-term (2080), and long term (2130)

ASSESSMENT METHOD

The risk framework established for this project is based on AS5534:2013 (Climate change adaptation for settlements and infrastructure – A risk-based approach), which utilises likelihood and consequence to quantify risk (see key terms). We have adapted the AS5534 framing of risk to provide integration with the Intergovernmental Panel on Climate Change's (IPCC's) framework for risk, associated with hazard, exposure and vulnerability (utilised in the NCCRA Framework).

The flowchart of the assessment method is shown below, illustrating the spatial assessment steps. The yellow area illustrates the steps to generate the *combined likelihood of damage* score (combining hazard exposure and vulnerability data). This is then integrated with *criticality* (blue) to give a *risk* score (pink).



VULNERABILITY AND CRITICALITY

To establish a vulnerability score for each asset class, information was elicited from workshops held in December 2021 and January 2022. These workshops identified key asset classes within each sector and captured information around vulnerability criteria across each identified asset class.

A four-point scale vulnerability rating was applied at the asset class level. Where there was more detailed information in terms of an individual asset's vulnerability (i.e., based on its material or condition), a vulnerability rating was derived to provide a more refined vulnerability rating.

Combined likelihood is the combination of hazard likelihood and vulnerability scores and defines the likelihood of damage that an asset may receive from a particular hazard.

Criticality is defined by the consequence of the asset failing and how severe the impact would be. A five-point scale criticality score rating was provided based on the three approaches:

1. Utilise asset criticality provided by each organisation at the asset level
2. Utilise asset information as a proxy for criticality, as agreed with workshop participants (i.e., ONRC)
3. Deriving a criticality score at the asset class level from project team experience.

THE RISK ASSESSMENT STEPS EXPLAINED

Building on the flow chart on page 8, each step of the assessment process is documented below.

1. An asset is assessed against a hazard and given a *hazard likelihood* rating.

Likelihood	Qualitative Description (non- spatial)	Quantitative Description (spatial)
Very likely	Very often, expect this to occur in any given year	For project specific definition, refer to Page 15.
Likely	Quite often, this could occur in any given year	
Unlikely	May happen, this could occur but is not expected	
Very unlikely	Rare, this is not expected to occur.	

2. This is combined with the *vulnerability* rating for that asset class and hazard combination.

Vulnerability	Score
High	4
Moderate	3
Low	2
Very Low	1

3. *Hazard likelihood* and *vulnerability* ratings are combined to provide a *combined likelihood of damage* rating.

Category	Score
VL- Very likely	4
L- Likely	3
U- Unlikely	2
VU- Very unlikely	1

4. Taking the *combined likelihood of damage* with *criticality* provides risk.

Risk	Rating
Extreme	5
High	4
Moderate	3
Low	2
Insignificant	1

Calculating Combined Likelihood Of Damage

Combined likelihood			Hazard likelihood			
			Very Unlikely	Unlikely	Likely	Very Likely
			VU	U	L	VL
Vulnerability Score	Very low	1	1VU	1U	1L	1VL
	Low	2	2VU	2U	2L	2VL
	Moderate	3	3VU	3U	3L	3VL
	High	4	4VU	4U	4L	4VL

Calculating Risk

Risk			Criticality				
			Very low	Low	Moderate	High	Very high
			1	2	3	4	5
Combined likelihood	Very unlikely	VL	1VU	2VU	3VU	4VU	5VU
	Unlikely	UL	1UL	2UL	3UL	4UL	5UL
	Likely	L	1L	2L	3L	4L	5L
	Very likely	VL	1VL	2VL	3VL	4VL	5VL

RISK ASSESSMENT

Spatial analysis of the three hazards was undertaken using a two-step approach:

1. Binary assessment of whether an individual asset was exposed for the three time horizons

2. If exposed, a hazard likelihood rating was established for each time horizon.

We provide summaries of risk, broken down by:

- Four key lifelines sectors
- Lines, points and area asset classes
- Key individual assets per sector.

PARTICIPATING ORGANISATIONS

An extensive data collection process from Northland Lifelines Utilities was undertaken from November 2021 to March 2022. Of the 21 organisations engaged with, 21 responded with data (or have usable data through the NLG Critical Sites List). The level of information provided by each organisation varied in completeness and structure.

The assessment includes over one million individual assets (as points, lines and polygons).

Sector	Respondents	Percentage of datasets with vulnerability information	Percentage of datasets with criticality information
Energy	5 (100%)	10%	0%
3 Waters	3 (100%)	67%	67%
Transport	6 (100%)	17%	33%
Teleco	5 (100%)	0%	20%

Note that many organisations provided partial information, however percentages reflect organisation responses.

Omapere Wharf and Boat Ramp (Northland New Zealand, 2021)

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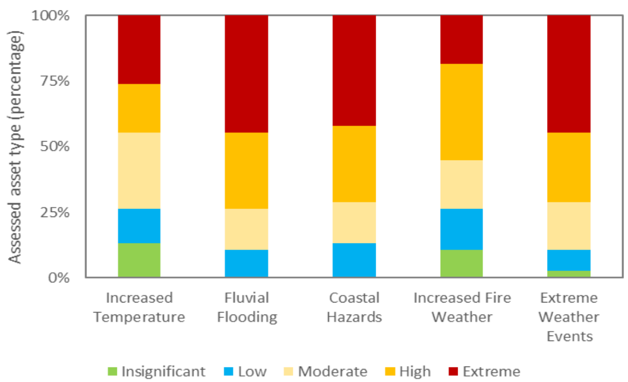
Non-spatial impact screening

NON-SPATIAL IMPACT SCREENING

The impact screening aimed to identify key focus areas to be taken forward for spatial assessment within this Lifelines Infrastructure Climate Change Risk Assessment. Focus was given to differing asset classes within each lifelines sector, considering both the combined likelihood of damage (as a product of hazard exposure and vulnerability) along with criticality at the asset class level.

No spatial component is considered in the impact screening and **therefore assumes that all assets are exposed** to each hazard, providing a static view of impact that is agnostic of time horizon. Ratings for vulnerability and criticality were established by stakeholder elicitation and agreed during a review period.

The screening identified that the transport sector has the highest impact profile (shown by the highest orange and red in the table across). With exposure being the driving change in risk over time, this reinforces the need for a spatial assessment to better understand risk across all sectors and asset classes.



Fluvial (river) flooding and coastal hazards were identified as having the largest risk profile, reinforcing the taking them forward for focused geospatial assessment.

		IMPACT				
	ASSET	Increased Temperature	Fluvial Flooding	Coastal Hazards	Increased Fire Weather	Extreme Weather Events
ENERGY	Conductor above ground	Moderate	Low	Low	Low	Extreme
	Conductor underground	Low	Moderate	Moderate	Low	High
	Poles	Insignificant	Moderate	Moderate	Low	Moderate
	Transformers and ground mounted assets	Low	High	High	Insignificant	Moderate
	Sites	Moderate	Extreme	Extreme	High	High
	Pipes	High	Extreme	Extreme	Moderate	Moderate
	Buildings/facilities	Moderate	High	Moderate	Moderate	Moderate
TELCO	Poles	Low	Moderate	High	High	Extreme
	Cables/Ducts	Extreme	Extreme	Extreme	Extreme	Extreme
	Cabinets, Pits & Pedestals	Extreme	Extreme	Extreme	Extreme	High
	Manholes	Low	Moderate	Moderate	Low	Low
	Exchange buildings/Data centres	Extreme	Extreme	Extreme	Extreme	Extreme
	Office & Buildings	Low	High	Moderate	Moderate	Low
TRANSPORT	Road	Extreme	Extreme	Extreme	Moderate	Extreme
	Bridge	Moderate	Extreme	Extreme	Moderate	Extreme
	Footpath	Moderate	Low	Low	Insignificant	Moderate
	Airport	Extreme	Extreme	Extreme	Extreme	Extreme
	Seaport	High	High	Extreme	High	Extreme
	Drainage	Insignificant	Moderate	Moderate	Moderate	High
	Retaining wall/Sea wall	Moderate	Extreme	Extreme	Extreme	Extreme
	Railway tracks	Extreme	Extreme	High	Extreme	Extreme
	Railway Tunnels	High	Extreme	High	High	Extreme
	Railway Signals and Communications	Extreme	Extreme	Extreme	High	Extreme
	ITS	Extreme	Extreme	Extreme	High	Extreme
WATER	Structure	High	Extreme	Extreme	High	Extreme
	Pipes	High	Extreme	Extreme	High	High
	Manholes	Insignificant	Low	Low	Insignificant	Insignificant
	Pumps	Moderate	High	High	Low	High
	Buildings/facilities	Moderate	High	High	High	High
	Reservoir	Moderate	High	High	Moderate	High
	Stopbanks	Insignificant	Moderate	Low	Insignificant	Moderate
	Treatment facilities	High	High	High	High	Extreme
	Inlet/Outlet	Moderate	High	High	High	Moderate
	Groundwater Source	High	High	High	High	High
	Valves	Insignificant	Low	Low	Low	Low
	Plant Structures	Moderate	High	High	High	High
	Water Intake	Extreme	Extreme	Extreme	Extreme	Extreme
	Open Channels	Extreme	Extreme	Extreme	High	Extreme

Note that while extreme weather events normally focuses on winds and storms, stakeholders also included landslides when considering ratings.

Geospatial hazard data and associated limitations

GEOSPATIAL HAZARD DATA

Northland Regional Council provided the following hazard layers for the risk assessment which were used for hazard likelihood scenarios. This is important to understand the limitations of the spatial assessment.

Hazard	Layer Name	AEP	Time Horizon	Climate Change scenario
Fluvial Flooding		10% AEP	Present Day	
		2% AEP	Present Day	
		1% AEP + CC	Present Day	
Coastal erosion	CEHZ1	66% AEP	2080	0.33 m SLR (RCP 8.5M)
	CEHZ2	5% AEP	2130	0.85 m SLR (RCP 8.5M)
	CEHZ3	5% AEP	2130	1.17 m SLR (RCP 8.5H+)
Coastal inundation		Present Day MHWS-10	Present Day	
	CFHZ0	1% AEP	Present Day	
		MHWS-10	2080	0.6 m SLR
	CFHZ1	2% AEP	2080	0.6 m SLR (RCP 8.5M)
		MHWS-10	2130	1.2 m SLR
	CFHZ2	1% AEP	2130	1.2 m SLR (RCP 8.5M)
	CFHZ3	1% AEP	2130	1.5 m SLR (RCP 8.5H+)

Differing hazard scenarios were considered to determine a hazard likelihood where possible. A two-step process was applied to assess hazard likelihood, firstly to:

• Assess whether an asset is exposed or not, then;

• Taking forward those assets that are identified as exposed to a given hazard and providing a rating of the hazard likelihood.

The two-step approach to assessing hazard likelihood was achieved for both coastal inundation and coastal erosion (refer to table below for criteria). To quantify hazard likelihood a four-point scale was used: **very likely, likely, unlikely** and **very unlikely**.

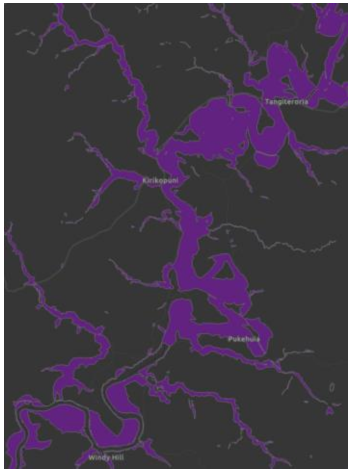
Given that climate change has not been accounted for in all hazard scenarios (e.g. fluvial flooding), differing scenarios have been used to reflect likelihoods across timeframes.

Time Horizon	Hazard	Very unlikely	Unlikely	Likely	Very likely
Present Day	Fluvial/pluvial (river / surface) flooding	1% AEP + CC		2% AEP	10% AEP
	Coastal inundation (inc. sea level rise)	2% AEP + 0.6m SLR	1% AEP		
	Coastal erosion	2080 66% 0.33m SLR			Present day
2080	Fluvial/pluvial (river / surface) flooding		1% AEP + CC		2% AEP
	Coastal inundation (inc. sea level rise)	1% AEP +1.2m SLR		2% AEP +0.6m SLR	
	Coastal erosion	2130 5% 0.85m	2080 66% 0.33m SLR		Present day
2130	Fluvial/pluvial (river / surface) flooding			1% AEP + CC	
	Coastal inundation (inc. sea level rise)	1% AEP + 1.5m SLR	1% AEP + 1.2m SLR	2% + 0.6m SLR	1% AEP
	Coastal erosion	2130 5% 1.17m SLR	2130 5% 0.85m SLR	2080 66% 0.33m SLR	

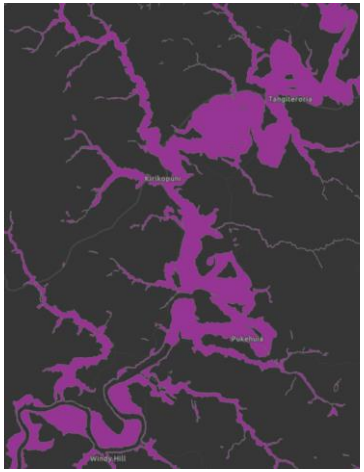
Note gaps in likelihood are a result of limited temporal hazard data provided.

FLUVIAL HAZARD LAYERS

Three Annual Recurrence Interval (ARI) fluvial hazard layers were provided. The extent of these across the region are shown to the right, with a snapshot of each ARI below.

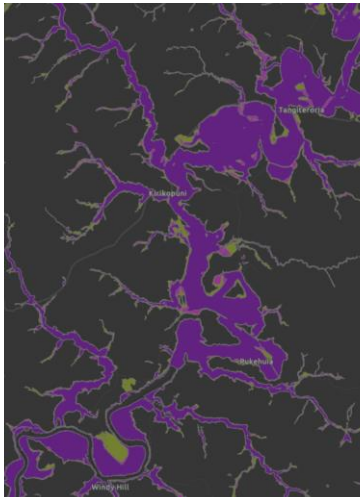


10 Year

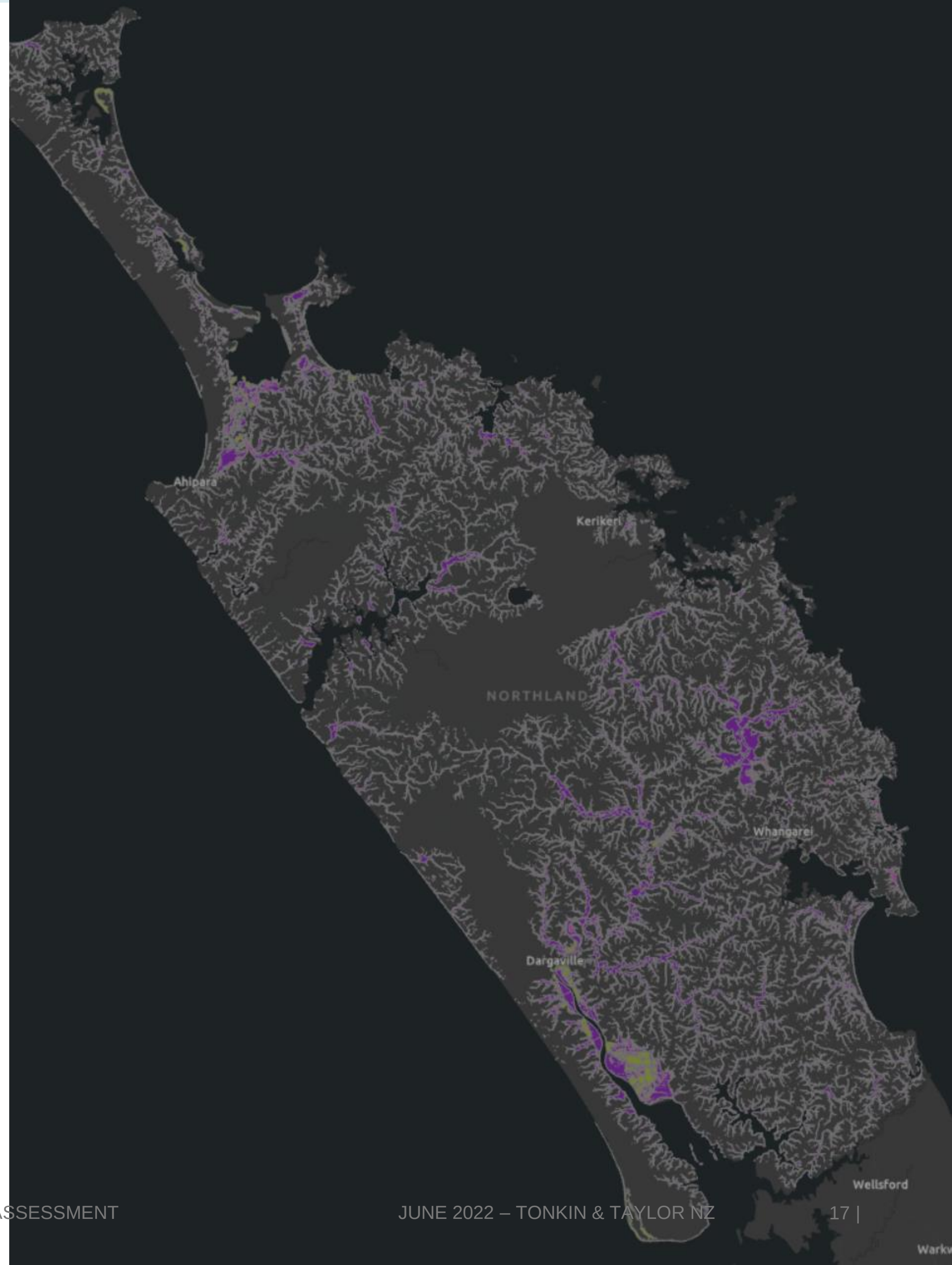


50 Year

100 Year + CC



All Layers



COASTAL HAZARD LAYERS (EROSION AND INUNDATION)

The layers provided for coastal erosion and coastal inundation are shown below. The hazard layer names are those used by Northland Regional Council.

Coastal Erosion Hazard Layers

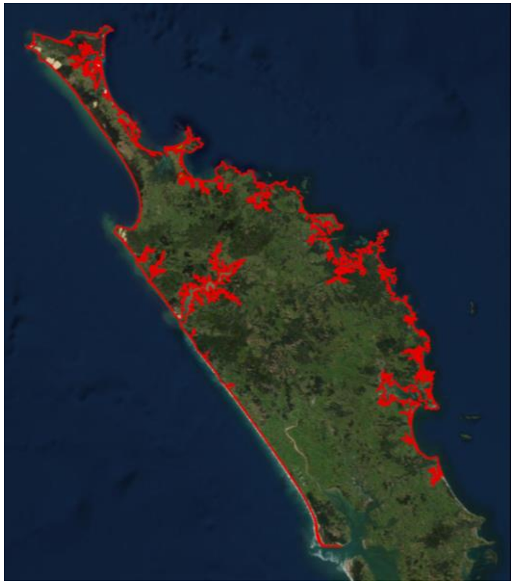
All layers (with enlarged scale)

Dark blue: CEHZ1- 66% AEP at 2080 0.33m SLR

Medium blue: CEHZ2 – 5% AEP at 2130 0.85m SLR

Light blue: CEHZ3 – 5% AEP at 2130 1.17m SLR

Coastal Inundation Hazard Layers



All layers (with enlarged scale)

CFHZ0 **Dark** (most likely) - 1% AEP Present day

CFHZ1 – 2% AEP at 2080 0.6m SLR

CFHZ2 – 1% AEP at 2130 1.2m SLR

CFHZ3 **Light** (least likely) – 1% AEP at 2130 1.5m SLR

ASSESSMENT LIMITATIONS

This assessment utilised available information provided by Lifeline Utilities representatives, including hazard and asset data along with their expert view on asset vulnerability and criticality. Given the number of differing organisations, and resulting variation in completeness of information, numerous assumptions and associated limitations were noted to enable this assessment, both in relation to asset, hazard and criticality information.

For hazard data, limited temporal datasets results in difficulty in quantifying uncertainty into the future with regards to risk. Fluvial flooding provides a good example of this, with exposed assets not increasing through the three time-horizons. This is a result of having only three modelled scenarios (or ARIs), which are utilised to understand likelihood across all three time-horizons.

For asset data, inconsistencies in supplied information limits the assessment. This includes both the spatial location of asset data, and the underlying information around vulnerability and criticality. To manage this, vulnerability and criticality ratings were established at the asset class level (e.g., poles are more vulnerable to flooding than overhead conductors). Information at the individual asset level was then included (where available) as a variant.

Attempts were made to remove duplicate information wherever possible, however it is noted that where organisations provided datasets with multiple entries of the same site, these may be double counted in the results. Conversely, where organisations do not have their assets recorded within the databases, these will have not been assessed.

Using Taipa Transfer Station as an example, the provided spatial location of the asset is a point, rather than its footprint (polygon). This site should be identified as exposed to fluvial flooding. However, as the point does not intersect with the hazard layer, the geospatial analysis did not consider this asset exposed.

Furthermore, when considering sites and locations, no allowances are made for the site level mitigations that could be in place (such as finished floor levels). Sites could be identified as exposed and at risk, however there are site level mitigation measures that reduce the risk, which are not accounted for.

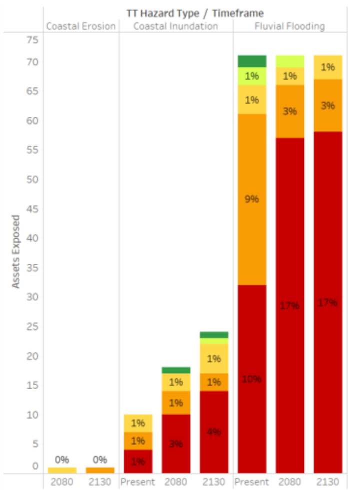
Critical sites summary

RISK TO CRITICAL SITES

Northland Lifelines Group maintain a list of critical infrastructure and community sites, with their own three-tier criticality rating of nationally, regionally and locally significant.

HIGH AND EXTREME RISK LOCATIONS

Of the 344 critical sites identified by Northland Lifelines Group, 76 sites are exposed to at least one hazard, and 18 sites are exposed to two. These sites are concentrated near the main towns. There is a higher proportion of critical sites exposed to fluvial flooding compared to other coastal hazards across the three time horizons, associated with the larger hazard areas.



Key findings include:

- Assets rated high (4) and extreme (5) risk are concentrated in areas of higher populations. 67 of these sites are ***from fluvial flooding***, 17 sites from ***coastal inundation*** and 1 site from ***coastal erosion***.
- 32 sites are identified at extreme (5) risk of ***fluvial flooding*** in the present day. This is made up of:
  - *12 Emergency service sites*
  - *4 Energy sub-station sites*
  - *14 Water sites (primarily pumps)*
  - *1 Telecommunications site*
- Three water pumps and one energy site are identified at extreme (5) risk to ***coastal inundation*** in present day: *East Coast Wastewater PS 8, Robert Street PS, Whangārei Heads PS and Mangawhai Zone Substation*
- One Emergency Services site is exposed to ***coastal erosion***, rated as moderate (3) risk in 2080 and major (4) risk by 2130:
  - *FNDC - South Hokianga Memorial Hall- Opononi*

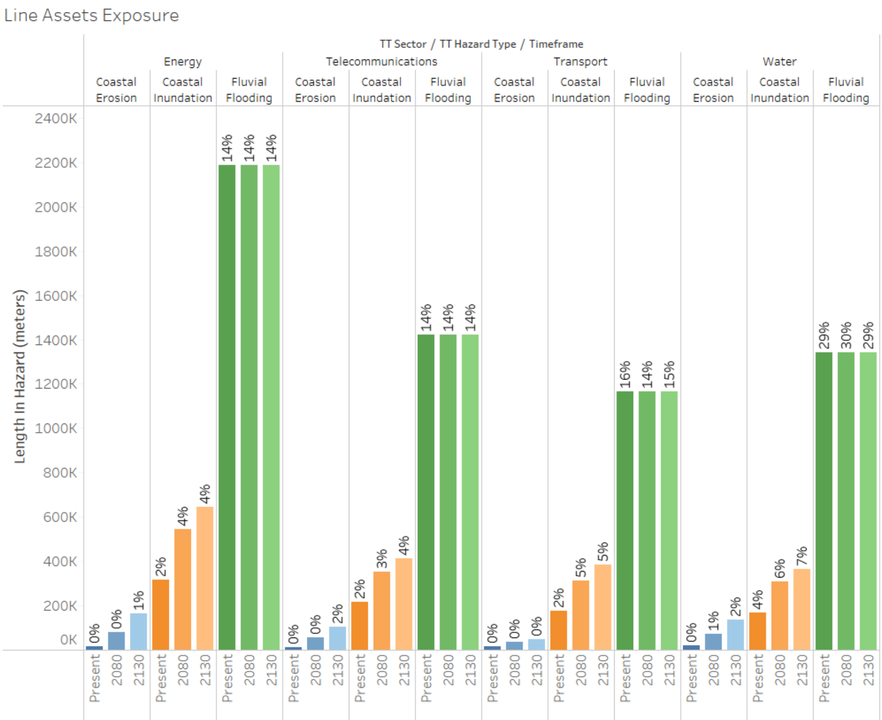
Note transport sector assets limited to three airports and one seaport within the critical sites list.

Spatial risk assessment

SPATIAL RISK ASSESSMENT

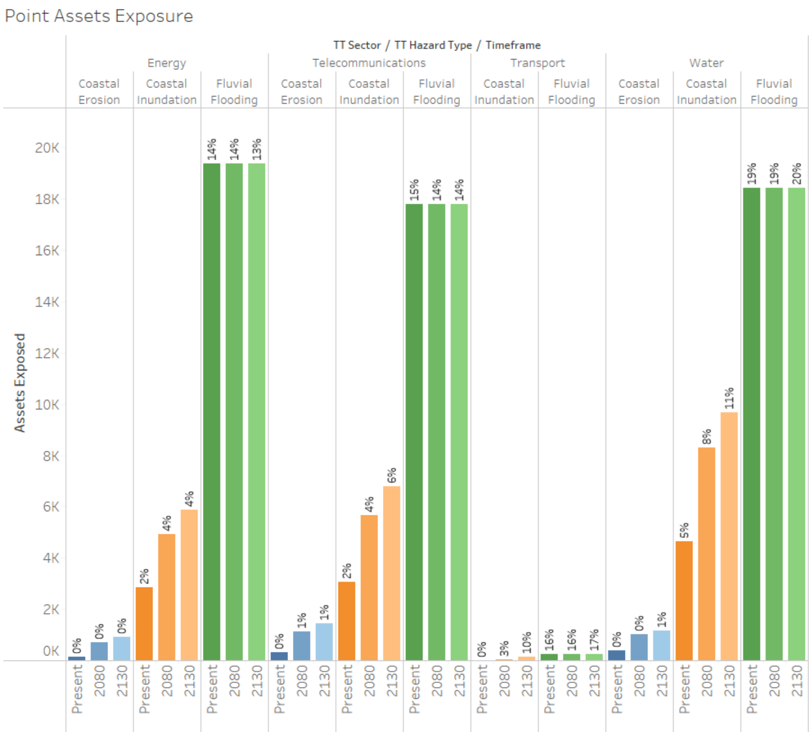
This high level spatial risk assessment involved overlaying asset data with hazard layers. The risk assessment primarily focused on asset damage, however, in some cases, risk reflects disruption of access to the asset (as opposed to damage). The vulnerability of underground assets to damage (from inundation) varies by asset type and will be primarily associated with scour, along with increased prevalence of water ingress (e.g. for wastewater networks). For those underground and overground assets (e.g. overground conductors) that are not exposed or physically damaged, a risk rating is still provided, noting that this reflects risk of disruption to access.

EXPOSURE ASSESSMENT SUMMARY (POINT AND LINE ASSETS)



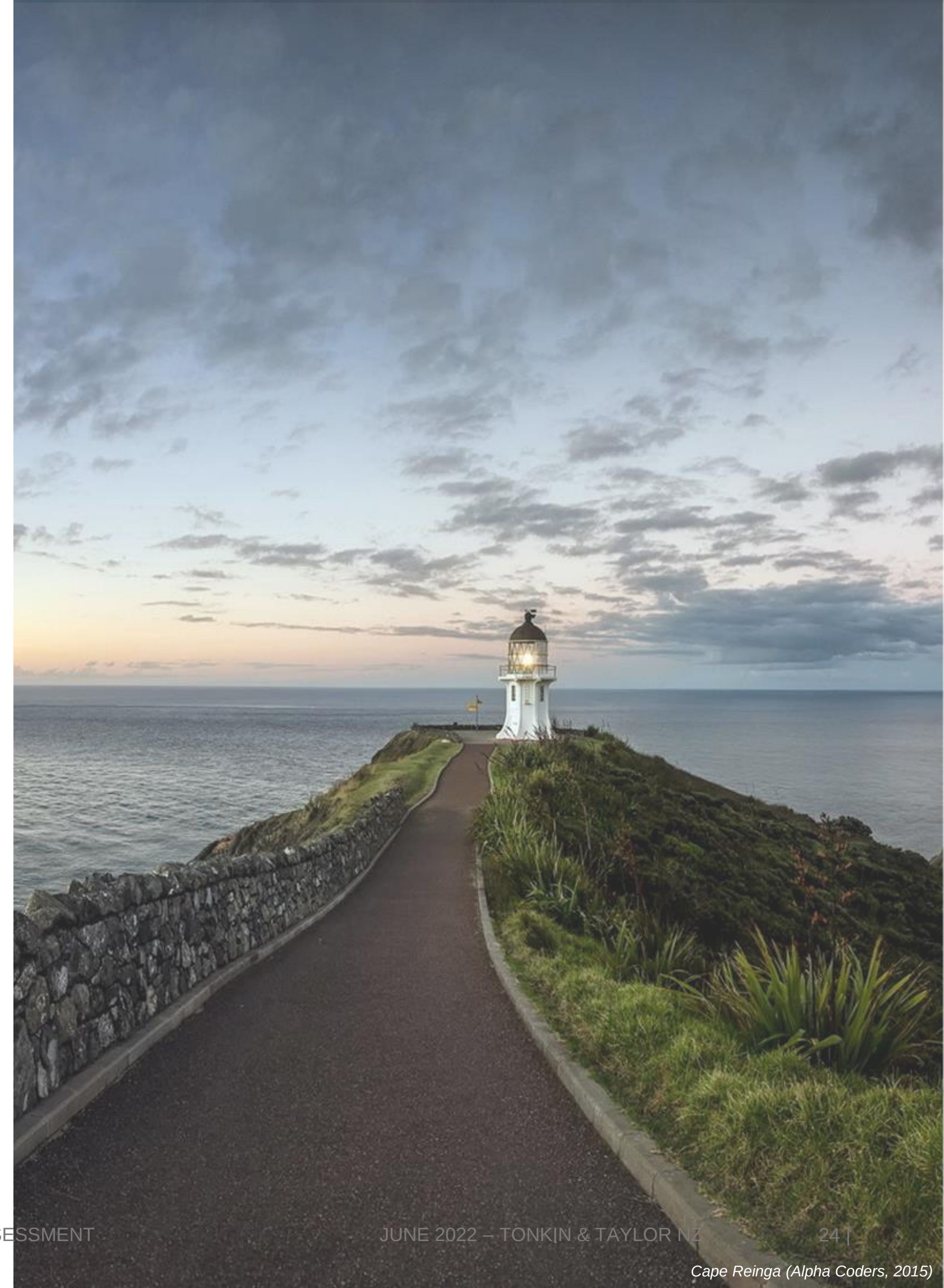
Key trends for line assets in the exposure assessment:

- The energy sector has the largest length of exposed lines, with 2,200 km identified as exposed to fluvial flooding. However, this is primarily associated with overhead lines, with impacts limited to access issues rather than physical damage.
- For telecommunications, transport and water line assets, 1,200 - 1,400 km are exposed to fluvial flooding currently.
- For coastal inundation, under 5% of asset lengths are exposed across most sectors, with Water pipes had 7% exposure by 2130.
- Limited assets are exposed to coastal erosion across all sectors, with less than 1% exposed by 2130 for energy, telecommunications and transport sectors.



Key trends in the point assets exposure assessment:

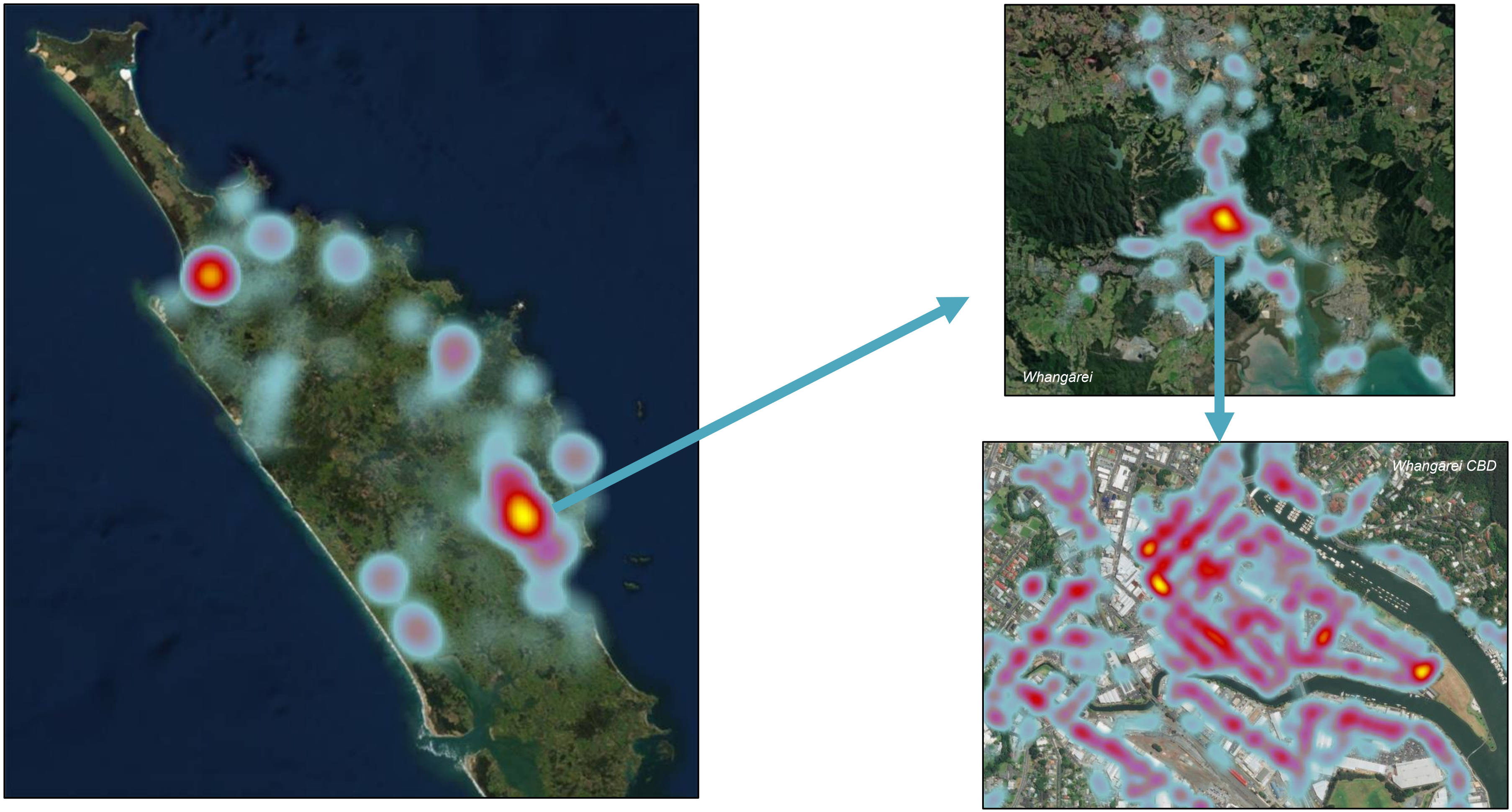
- Highest exposure for all sectors associated with flooding with c.15% of point assets within each sector exposed across all time horizons.
- This equates to over 18,000 point assets for each of the energy, water and telecommunications sector assets.
- Less than 6% of all sector assets are exposed to coastal flooding across future scenarios (up to 2130), bar the water sector where 11% of point assets are exposed by 2130.
- Limited assets are exposed to coastal erosion across all sectors, with less than 1% exposed by 2130.



Cape Reinga (Alpha Coders, 2015)

FOCUSING ON HIGH AND EXTREME RISKS

On a regional scale, a map was created to visualise areas which had a higher concentration of assets at high and extreme risk. The map suggests that there are more assets at high and extreme risk in more densely populated areas.

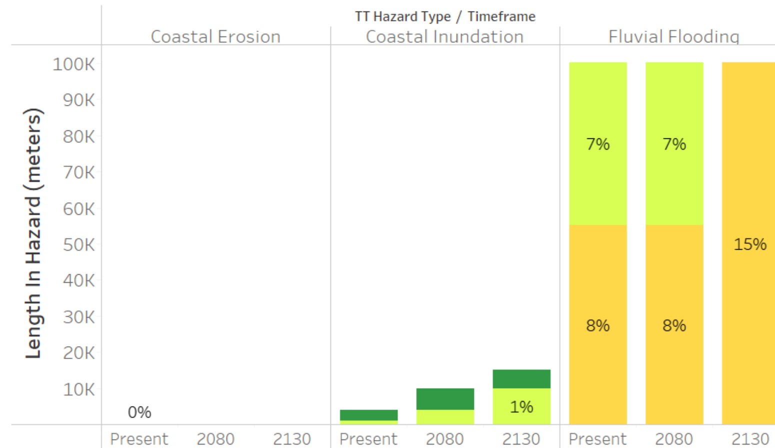


TRANSPORT ASSETS

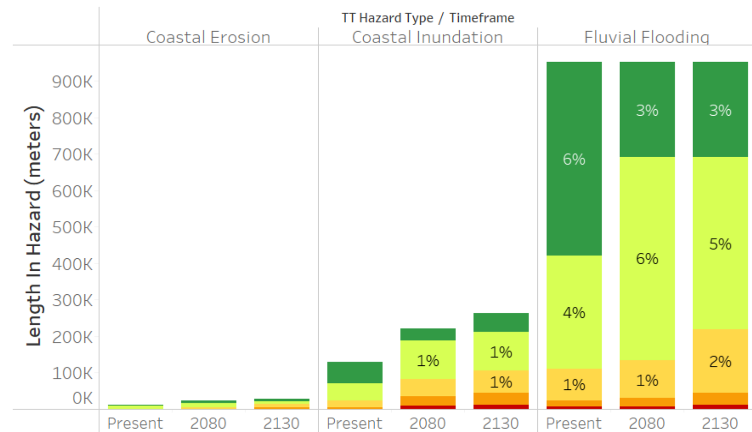
A significant proportion of transport assets are exposed and at risk of fluvial flooding, across the three time horizons considered. The complete assessment of transport asset classes can be found in Appendix A. Key findings of the risk assessment included:

- 950 km of roads are exposed and at risk to fluvial flooding, with 50 km at high or extreme risk by 2130.
- For railways, approximately 100 km of track is exposed to fluvial flooding, which is all at moderate or lower risk across all time horizons.
- Bridges are shown to have a high risk profile with respect to coastal and fluvial flooding. This is largely due to them being physically located within floodplains (which they have specifically been designed for). Further site specific analysis would be required to understand specific risk levels for bridges in relation to future climate conditions.

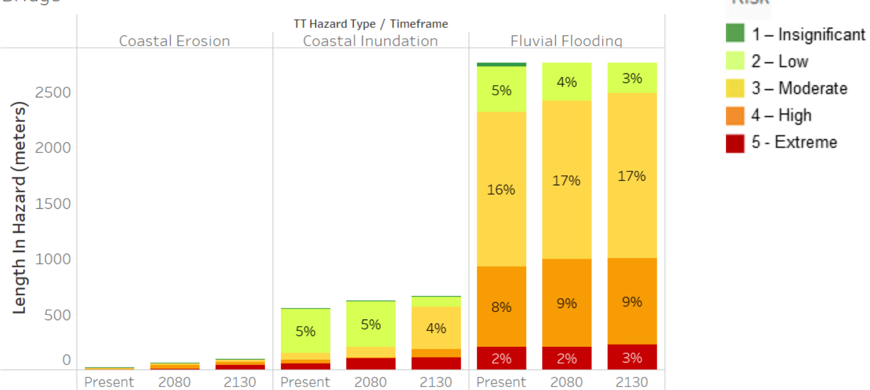
Railway Track



Road



Bridge

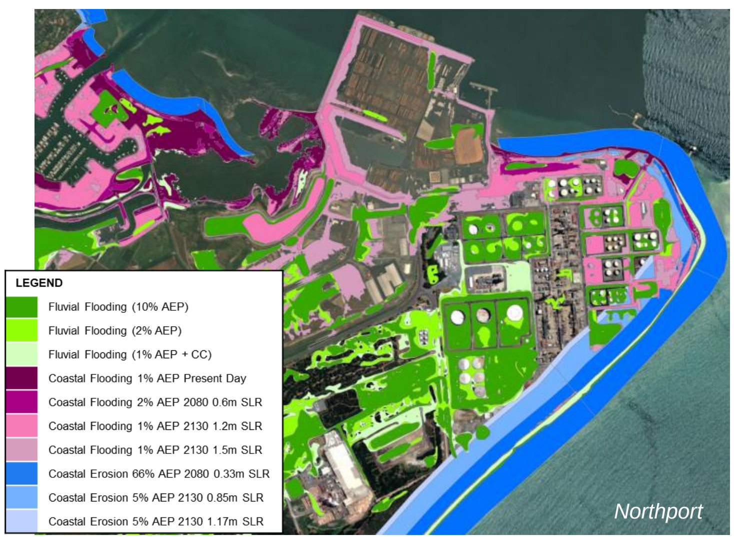


CRITICAL TRANSPORT ASSETS IN FOCUS

Northport is New Zealand's northern most commercial port and is located at Marsden Point. It is a significant part of the freight network in Northland and the North Island. Northport will be exposed to coastal inundation under future climate scenarios and a disruption to port operations may cause significant economic losses for the region. As indicated in the table below, in the 2130 scenario, Northport is likely to be at moderate risk to coastal inundation.

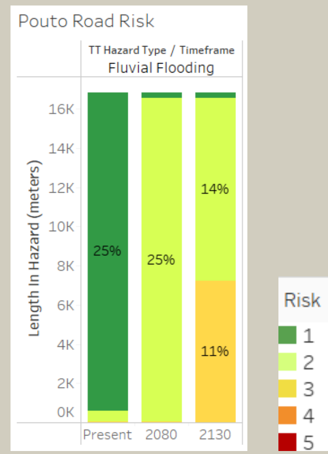
Northport	Present day	Mid-term (2080)	Long term (2130)
Fluvial flooding	N/A	N/A	N/A
Coastal inundation	N/A	N/A	
Coastal erosion	N/A	N/A	N/A

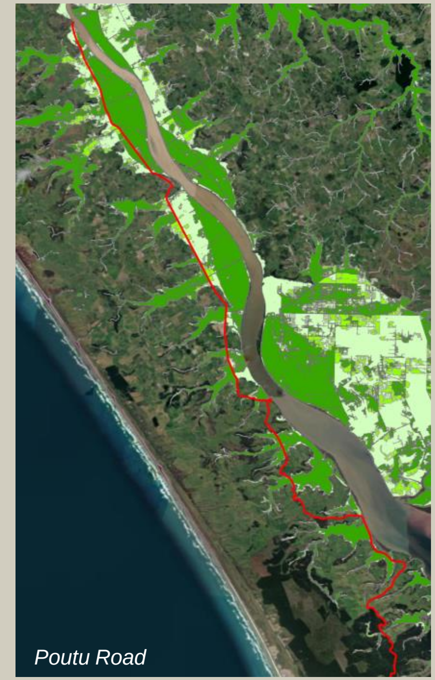
Insignificant | Low | Moderate | High | Extreme



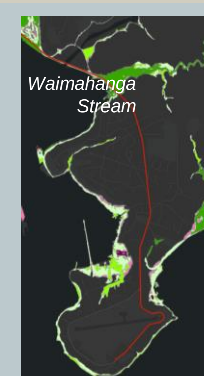
Pouto Road has been labelled as "one of the great anchors of Kaipara" and provides residential access, as well as economic and tourism benefits. Pouto Road is exposed to fluvial flooding.

It is noted that the risk rating for Pouto Road varies along its entire length. On average, it is at low risk to fluvial flooding in the present, 2080 and 2130 scenarios.





Whangārei District Airport is not exposed to fluvial flooding, coastal inundation or coastal erosion. Access from the north of the airport is exposed at Waimahanga Stream, where flooding occurs (Riverside Dr/ Onerahi Rd).



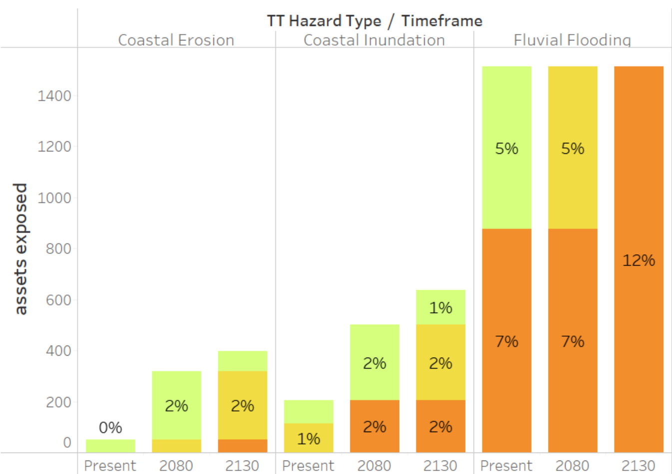
ENERGY ASSETS

2,200km of energy line assets and 19,000 energy point assets are exposed to fluvial flooding. The results of the risk assessment of the energy sector can be found in Appendix B. Key findings of the assessment included:

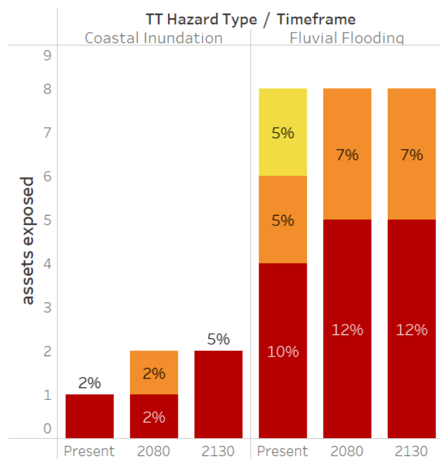
- ~1,500 transformers and ground-mounted assets are at risk of fluvial flooding. All are at high risk by 2130, 12% of the overall asset count.
- ~17,000 poles are at risk of fluvial flooding, with ~16,000 at high or extreme risk by 2130.
- There are 8 energy sites exposed to fluvial flooding, these are all at high or extreme risk across the 2080 and 2130 scenarios.

Sites include communication sites, load control sites and zone substations for electricity, along with transmission sites for natural gas and sub-sites for fuel.

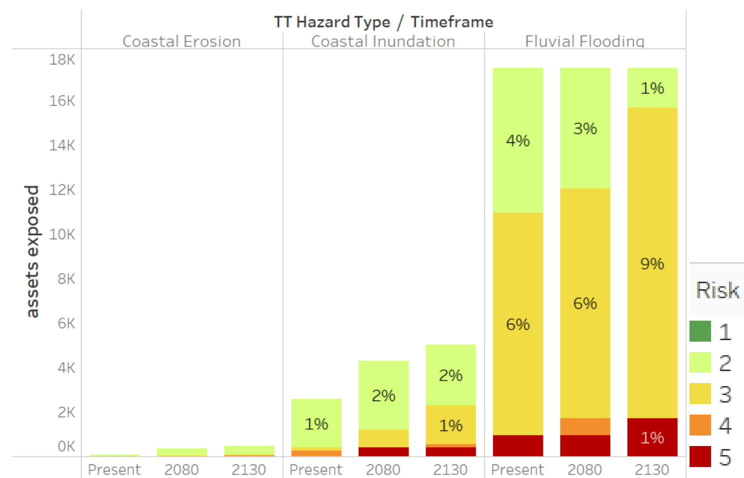
Transformers & Ground-Mounted Assets



Sites



Poles

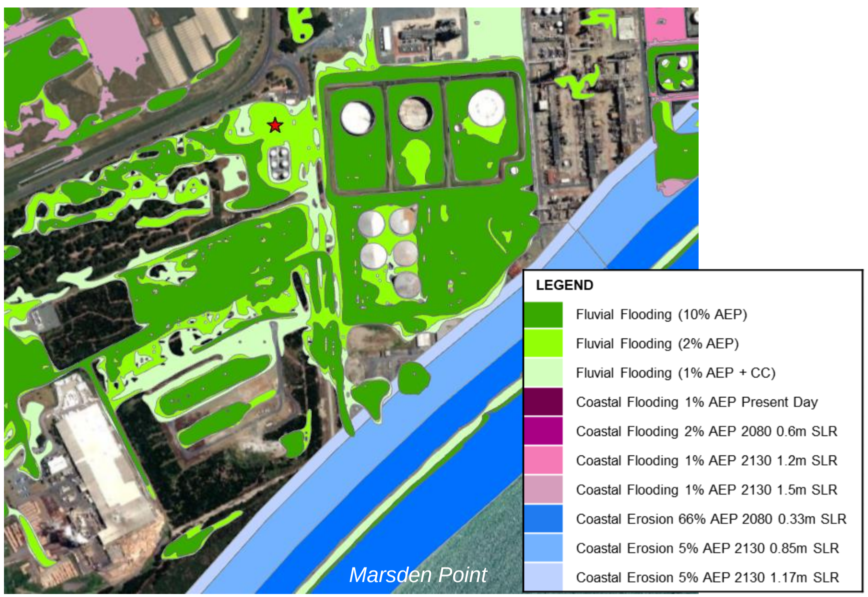


CRITICAL ENERGY ASSETS IN FOCUS

Marsden Point Terminal (Mair Road) imports refined fuel. The storage tanks create a buffer between the supply and the distribution vehicles. This terminal is exposed to fluvial flooding and its failure would interrupt the region's fuel stations. In the present day, the site is at high risk to fluvial flooding. However, by 2080, the site is at extreme risk.

Marsden Point Terminal	Present day	Mid-tem (2080)	Long term (2130)
Fluvial flooding			
Coastal inundation	N/A	N/A	N/A
Coastal erosion	N/A	N/A	N/A

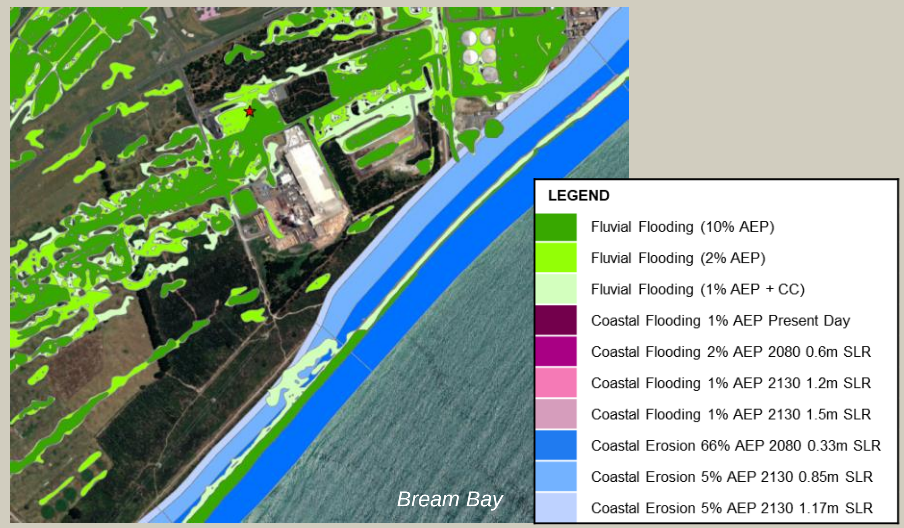
Insignificant | Low | Moderate | High | Extreme



Bream Bay GXP and Substation is an important link for Northland. Bream Bay Substation is exposed to fluvial flooding. The impact of failure includes loss of power to the terminal, port operations and 1,325 customers. In the present day, 2080 and 2130 scenarios, Bream Bay GXP and Substation are likely to be at high risk to fluvial flooding.

Bream Bay GXP & Substation	Present day	Mid-tem (2080)	Long term (2130)
Fluvial flooding			
Coastal inundation	N/A	N/A	N/A
Coastal erosion	N/A	N/A	N/A

Insignificant | Low | Moderate | High | Extreme



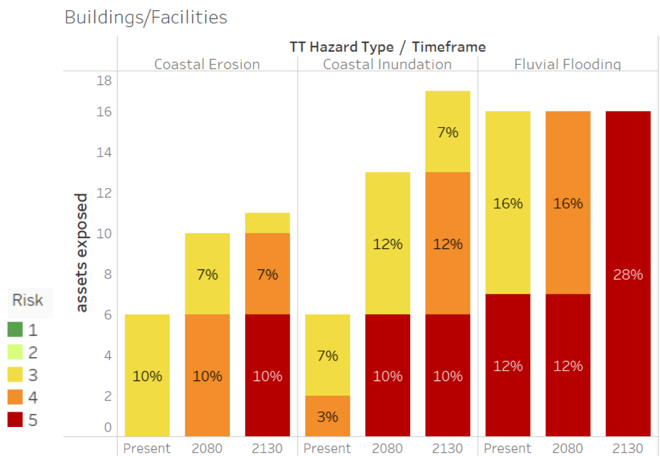
WATER ASSETS

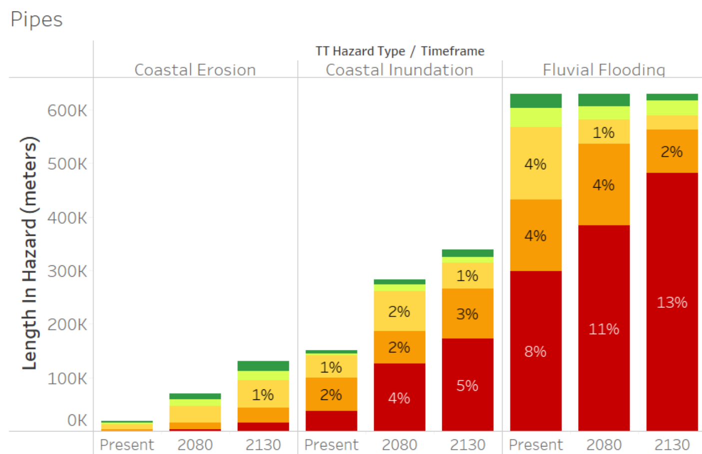
Water sector assets include assets relating to drinking water, wastewater, stormwater and flood protection. Approximately 30% of water line assets and over 20% of water point assets are at risk of fluvial flooding. The remaining results of the risk assessment of the water sector can be found in Appendix C.

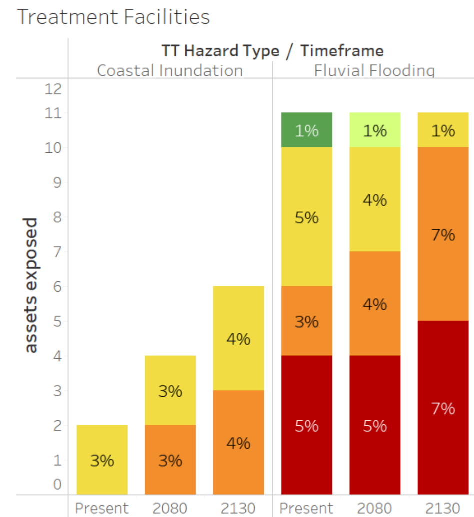
THREE WATERS ASSETS

Three water assets include pipes, treatment facilities, buildings/facilities, manholes, valves, pumps, inlets/outlets. Key findings include:

- 17 buildings/sites are at risk of coastal inundation by 2130. 13 of these are at high or extreme risk.
- ~500 km of pipes are rated at extreme risk of fluvial flooding by 2130. This risk is associated with high exposure, high criticality, and increased vulnerability to scour. Given that the majority of pipes are underground, this risk associated with scour is considered conservative and will require further refinement at an organisational level.
- Treatment facilities are at risk of both coastal inundation and fluvial flooding. 14% of treatment facilities are identified as at extreme or high risk of fluvial flooding by 2130.







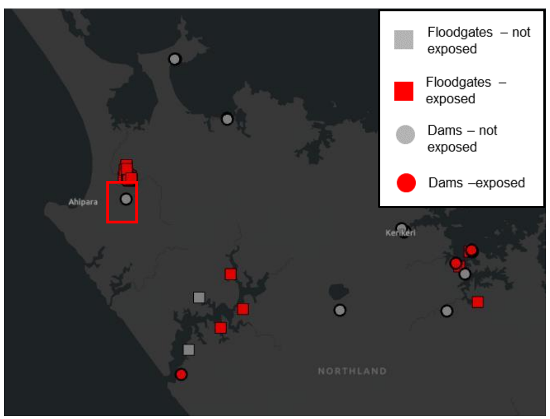
FLOOD PROTECTION ASSETS

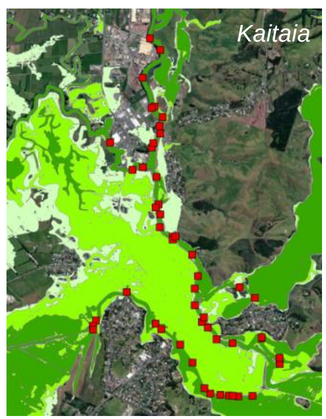
Flood protection assets include stop banks, detention dams, floodgates, flood walls and spillways. These assets are expected to be highly exposed by the nature of the service they provide (i.e. generally located in the floodplain).

Further assessment is required to understand whether these assets are designed to operate effectively with climate change. New assets should be designed with climate change considered.

Far North District Council

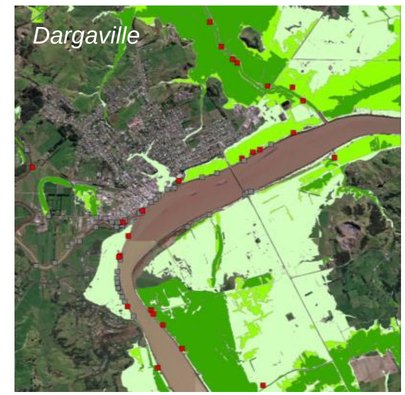
The maps below indicate that the majority of FNDC's flood protection assets are exposed to fluvial flooding.

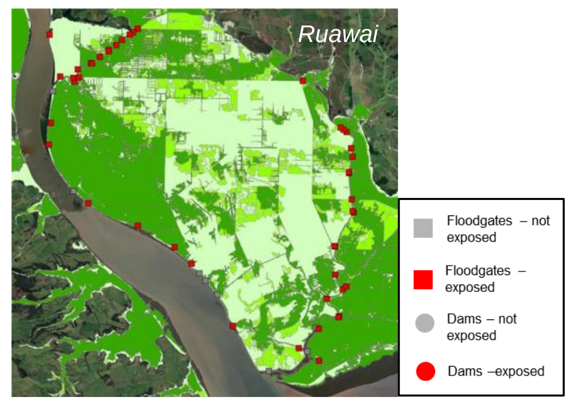




Kaipara District Council

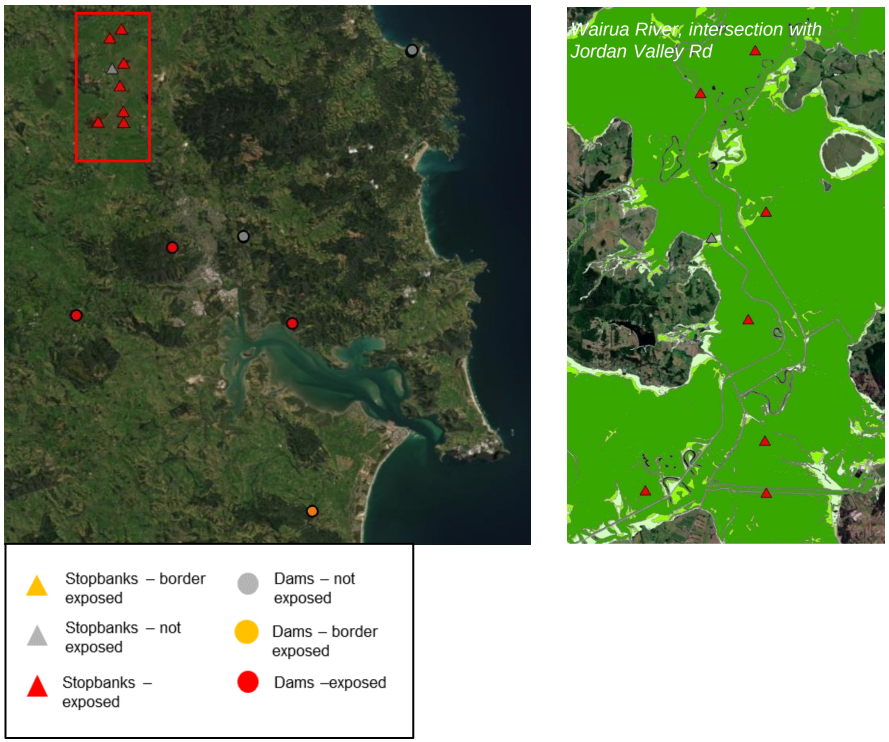
Over 75% of KDC's floodgates are exposed to a hazard. The images below show the extent of exposure some flood protection assets in Kaipara face.





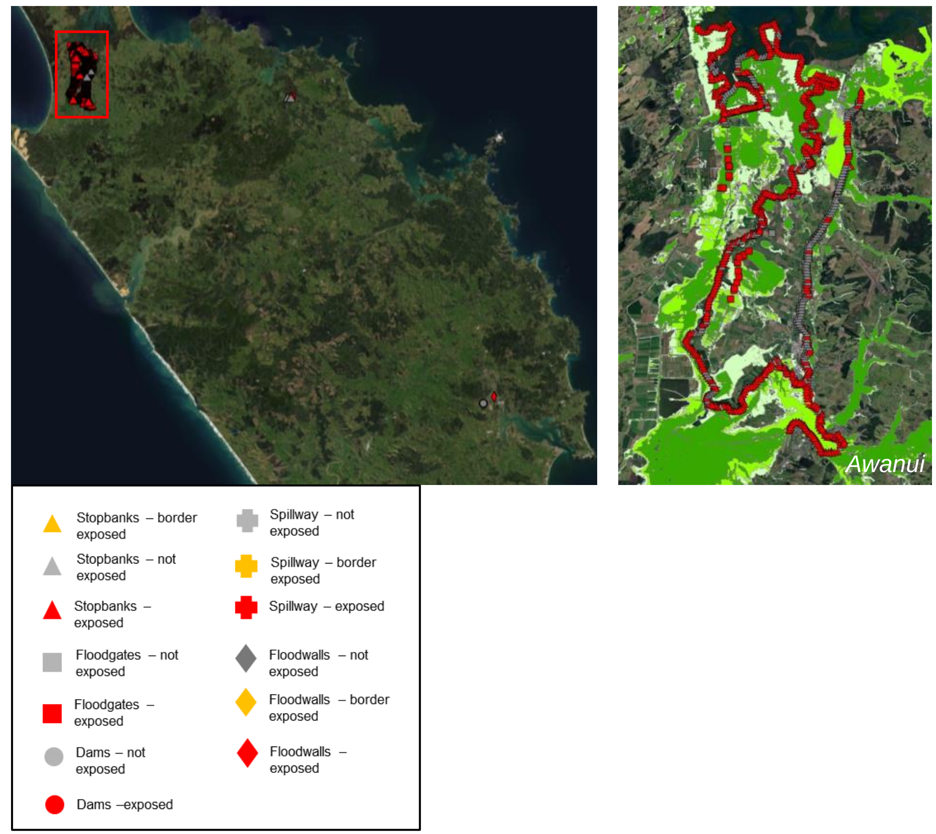
Whangārei District Council

The majority of Whangārei District Council's stopbanks and dams are exposed to fluvial flooding.



Northland Regional Council

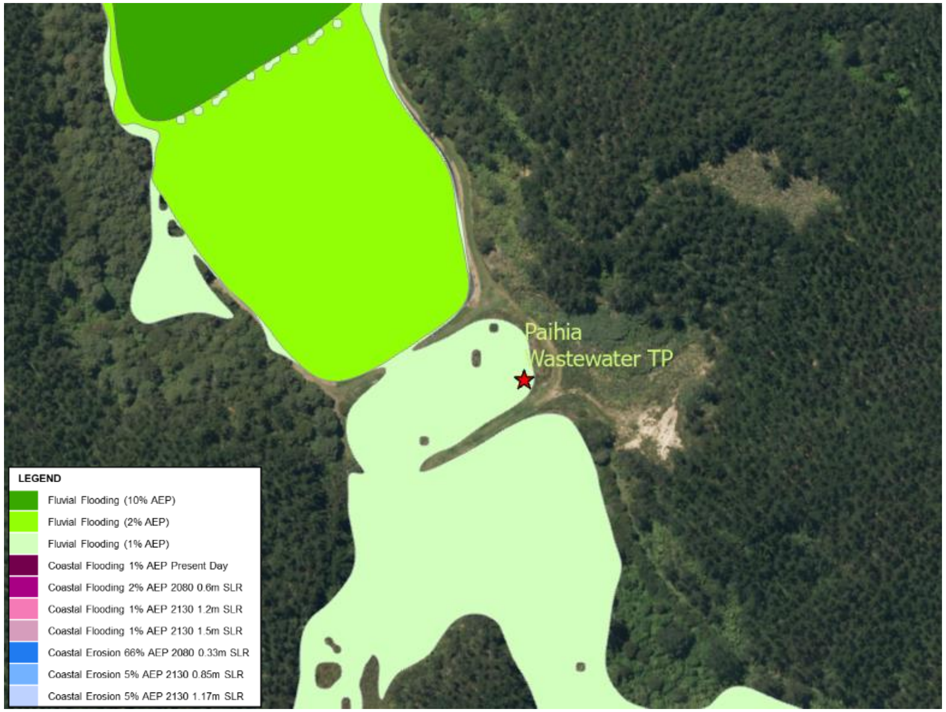
The majority of Northland Regional Council's stopbanks, flood gates and flood walls are exposed to fluvial flooding. The maps below show the exposed assets in the region and a focus on the Awanui area.



CRITICAL WATER ASSET IN FOCUS

The **Paihia Wastewater Treatment Plant** (WWTP) services the communities of Paihia, Waitangi, Opua and Haruru. It is noted that there will be minimal impacts if the WWTP fails as the ponds are able to buffer for long periods.

Paihia WWTP is exposed to fluvial flooding. The risk assessment shows that the WWTP is at moderate risk in the present day, high risk in the 2080 scenario and extreme risk by 2130.



Paihia WWTP (FNDC, n.d.)

Paihia WWTP	Present day	Mid-term (2080)	Long term (2130)
Fluvial flooding	Moderate	High	Extreme
Coastal inundation	N/A	N/A	N/A
Coastal erosion	N/A	N/A	N/A

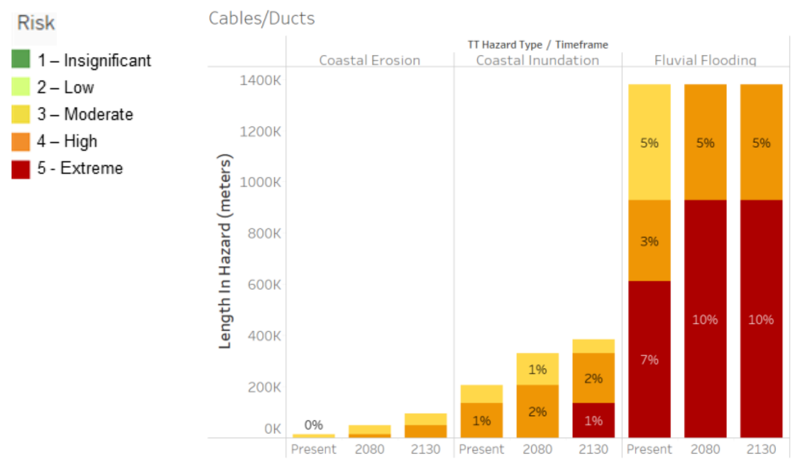
Key: Insignificant | Low | Moderate | High | Extreme

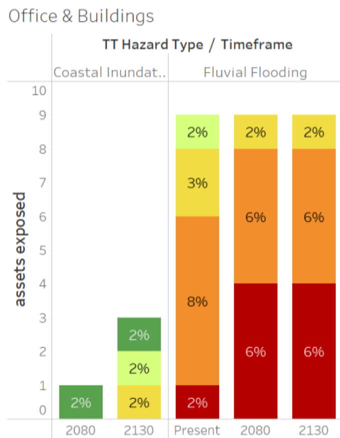
TELECOMMUNICATIONS ASSETS

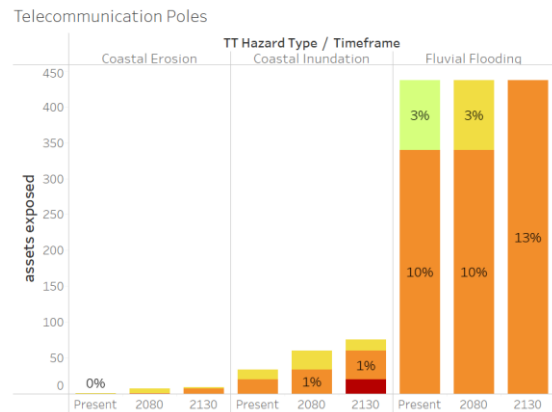
1,400km of line assets and over 17,000 point assets are at risk of fluvial flooding. Similar to the other sectors, more telecommunication assets are at risk of fluvial flooding compared to the coastal hazards. The remining results of the risk assessment of the telecommunications sector can be found in Appendix D. Key findings of the assessment include:

- By 2130, all (~450) telecommunication poles exposed to fluvial flooding will be at high risk.
- Telecommunications cables and ducts are at risk of fluvial flooding. In particular, ~950 km are at extreme risk.
- 9 telecommunications offices & buildings are currently at risk of fluvial flooding. However, 4 of these will be at extreme risk by 2080.

Risk ratings are driven by exposure, vulnerability and criticality. Cables and ducts were considered by NLG participants to have a higher vulnerability to fluvial and coastal hazards than poles, along with an increased criticality. Carrying out further analysis to establish individual poles with higher criticality will provide further refinement of risk.







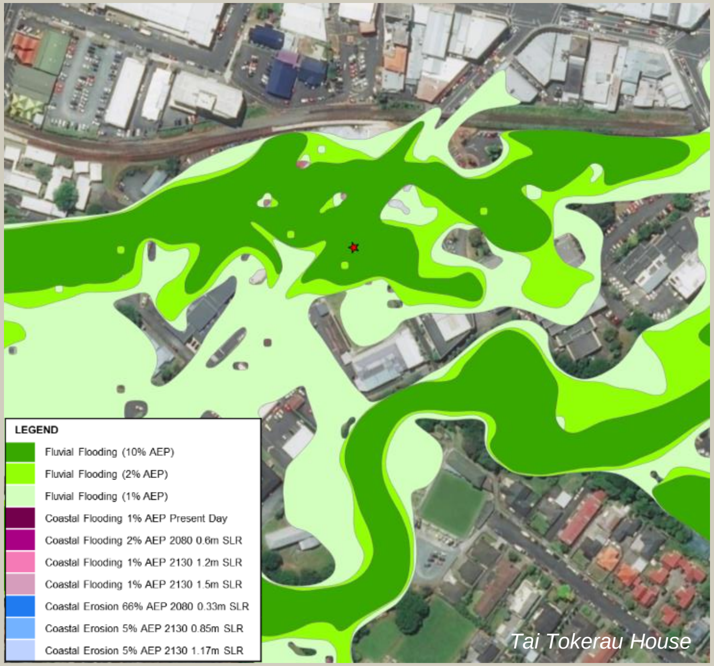
CRITICAL TELECOMMUNICATIONS ASSETS IN FOCUS

Tai Tokerau House is an intermediate transmission linking site between Whangārei and Auckland.

The risk assessments shows that it is at extreme risk to fluvial flooding in the present day, 2080 and 2130 scenarios.

Tai Tokerau House	Present day	Mid-term (2080)	Long term (2130)
Fluvial flooding			
Coastal inundation	N/A	N/A	N/A
Coastal erosion	N/A	N/A	N/A

Insignificant | Low | Moderate | High | Extreme

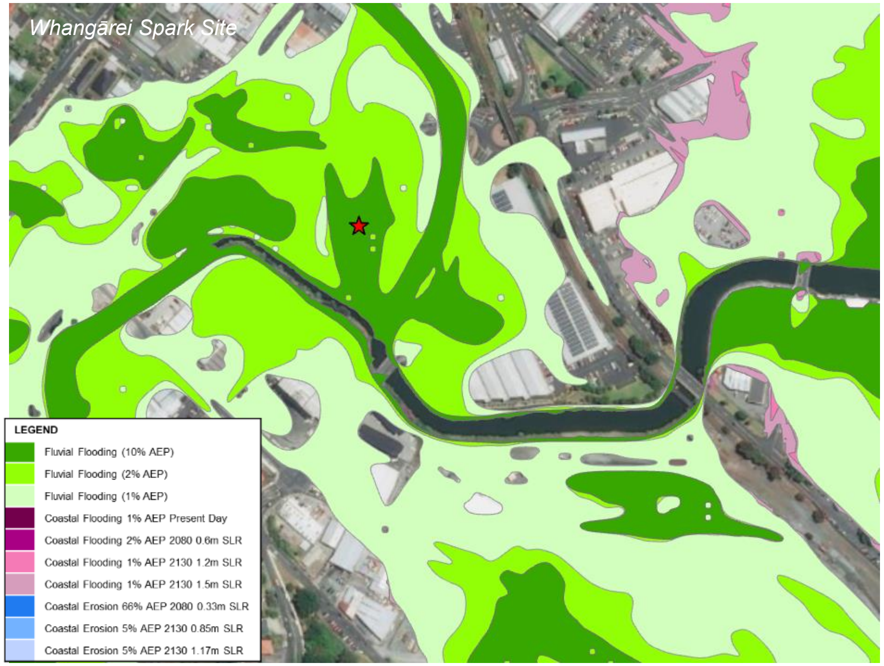


Whangārei Spark Site is a main exchange and is exposed to fluvial flooding.

The risk assessments shows that it is at high risk to fluvial flooding in the present day, 2080 and 2130 scenarios. Failure would impact the Whangārei CBD, hospital, central police station and cell sites.

Whangārei Spark Site	Present day	Mid-term (2080)	Long term (2130)
Fluvial flooding			
Coastal inundation	N/A	N/A	N/A
Coastal erosion	N/A	N/A	N/A

Insignificant | Low | Moderate | High | Extreme



SOLID WASTE ASSETS

Solid waste assets have been assessed for exposure to fluvial flooding, coastal inundation and coastal erosion only. A risk assessment was out of scope. NLG could consider assessing risk to solid waste sites using MfE 2019 closed Landfill Risk Assessment method.

A total of 62 solid waste sites across the region were assessed for exposure, with 19 (30%) exposed to one or more hazards.

Far North District Council solid waste asset exposure

There are 5 of the 23 FNDC solid waste sites exposed to one or more of the three hazards.

Kohukohu Road Refuse Transfer Station is exposed to both fluvial flooding and coastal inundation hazards, as shown in the images below.


Kohukohu Road Refuse Transfer Station


Kohukohu Road Refuse Transfer Station

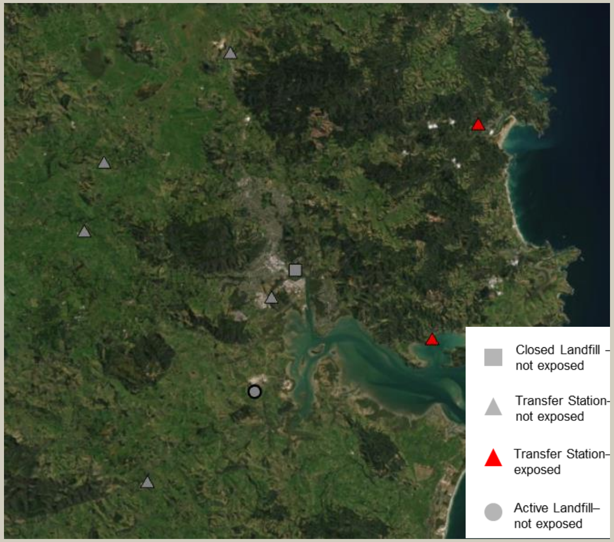
KDC SOLID WASTE EXPOSURE

KDC has 13 of the 28 closed landfill assets which are exposed to fluvial flooding, coastal inundation and coastal erosion.

The image above shows the exposure of several closed landfill assets, with one inserted below shown north of Dargaville.

WDC SOLID WASTE EXPOSURE

WDC has 11 sites with 2 transfer stations (Ngunguru Transfer Station and Parua Bay Transfer Station) exposed to both fluvial flooding and coastal inundation.



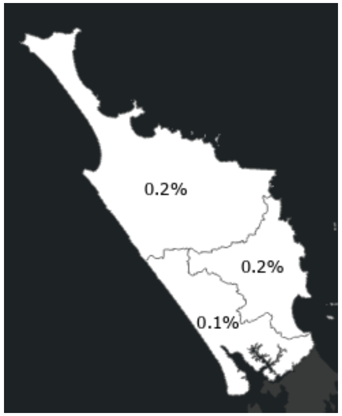
The exposure of Ngunguru Transfer Station to both fluvial flooding (left) and coastal inundation (right) shown below.

DISTRICT & WARD MAPS

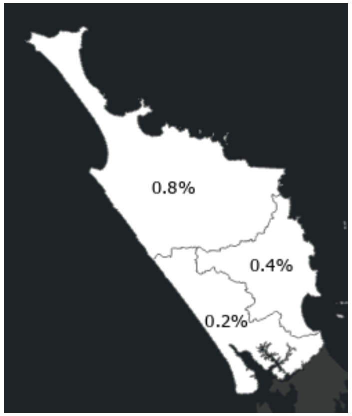
EXPOSURE BY DISTRICT – LINE TYPE ASSETS

The maps show the percentage length of line assets in each district which intersect with the hazard layers.

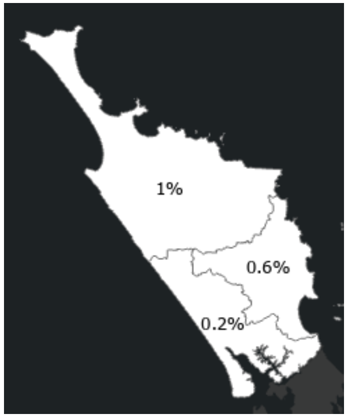
Whangārei and Kaipara have over 15% of line type asset length exposed to fluvial flooding. By 2080, 5% of lifeline assets in Whangārei will be at risk of coastal inundation.



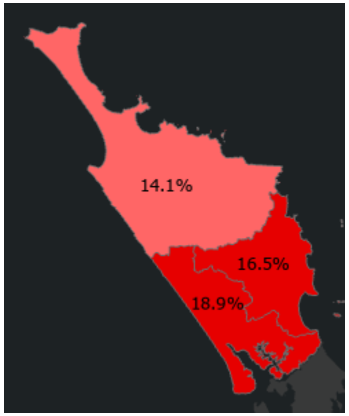
Erosion – Present



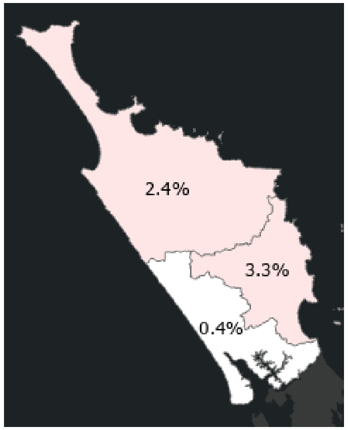
Erosion – 2080



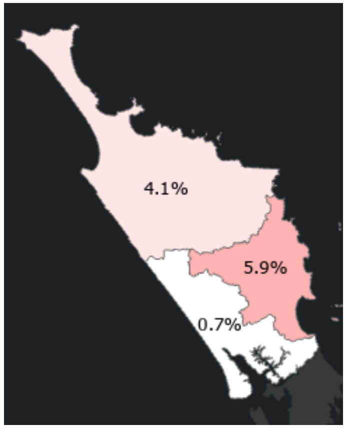
Erosion – 2130



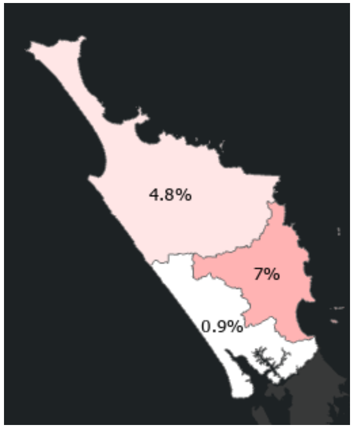
Fluvial Flooding



Inundation – Present



Inundation – 2080

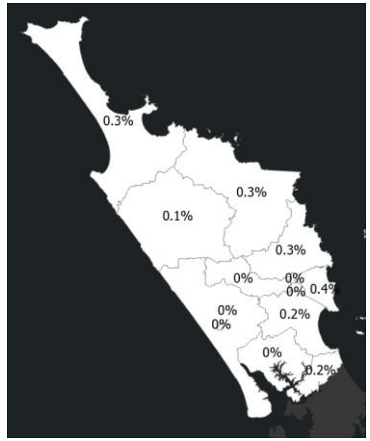


Inundation – 2130

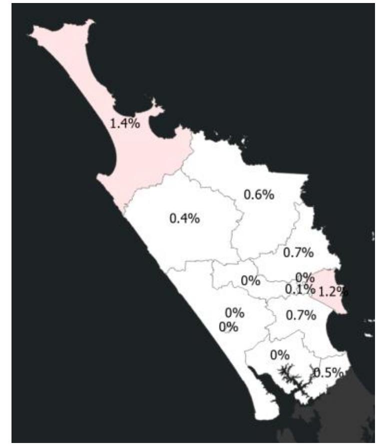
EXPOSURE BY WARD – LINE TYPE ASSETS

The maps below show the percentage length of line assets in each ward which intersect with the hazard layers.

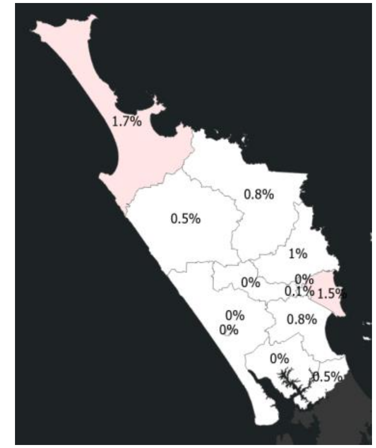
Wards in all three districts have over 20% of the total length of their line type assets at risk of fluvial flooding.



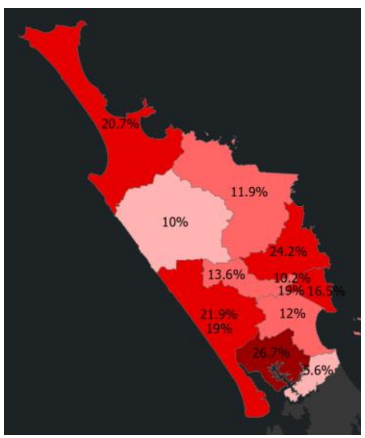
Erosion – Present



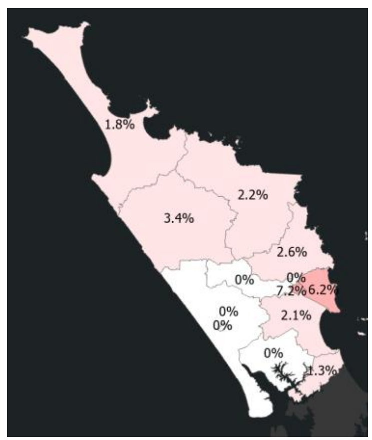
Erosion – 2080



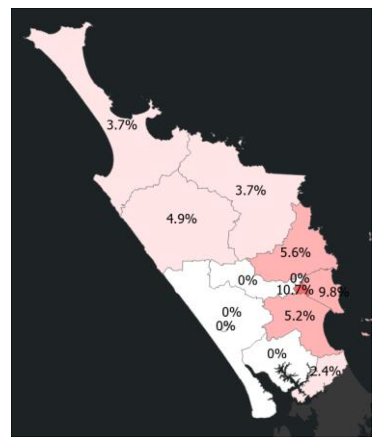
Erosion – 2130



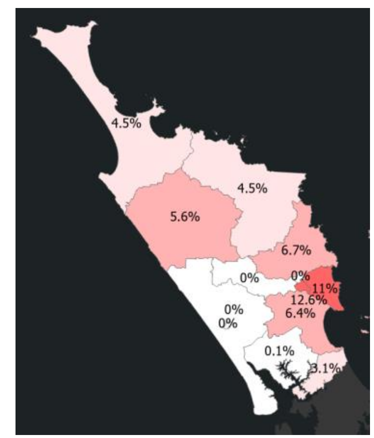
Fluvial Flooding



Inundation – Present



Inundation – 2080

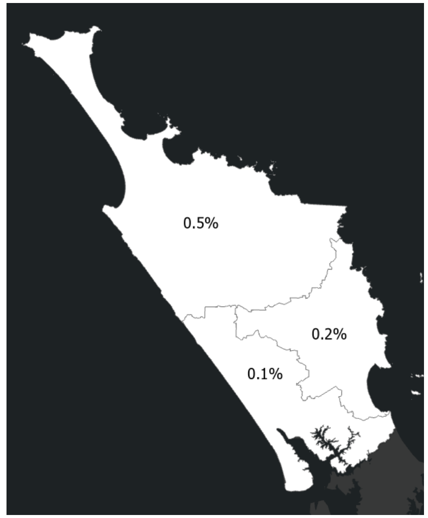


Inundation – 2130

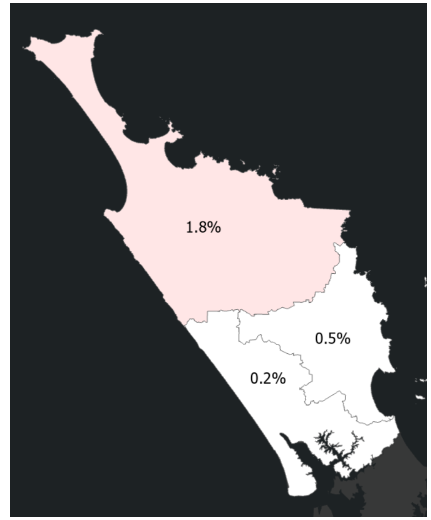
EXPOSURE BY DISTRICT – POINT ASSETS

The maps show the percentage of point type assets in each district which intersect with the hazard layers.

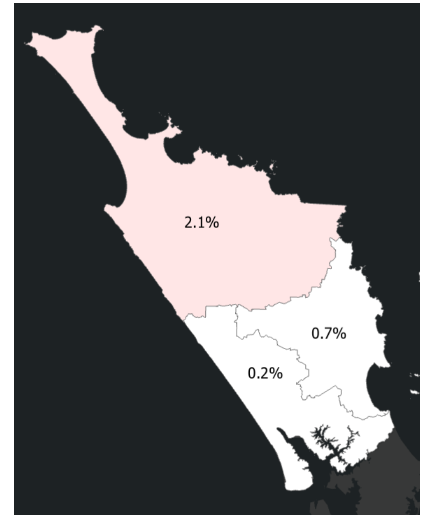
Whangārei and Kaipara have over 15% of point assets exposed to fluvial flooding. By 2080, Whangārei will also have over 5% of the point type assets at risk of coastal inundation.



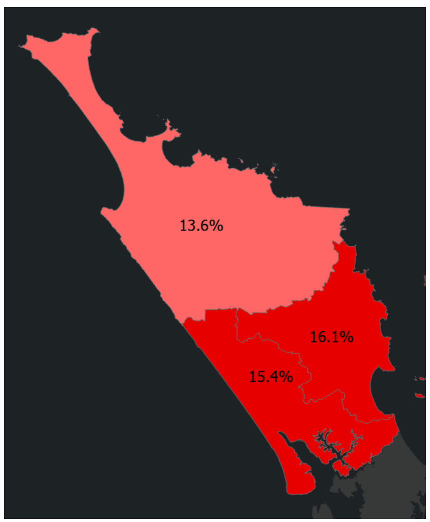
Erosion – Present



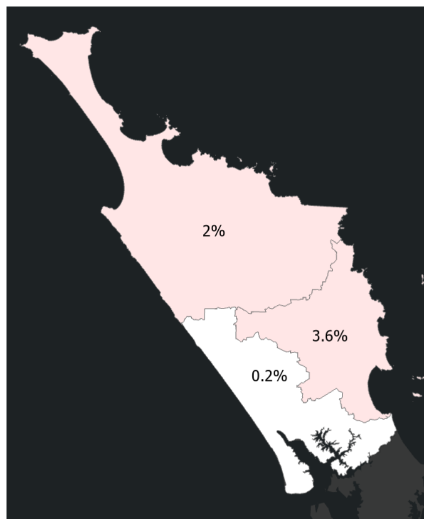
Erosion – 2080



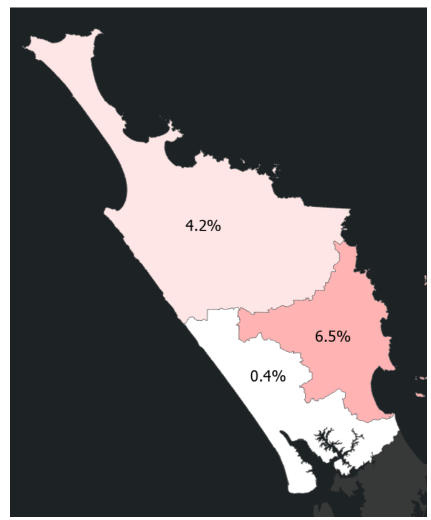
Erosion – 2130



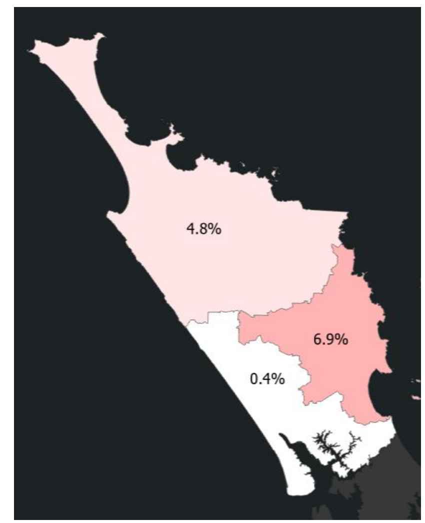
Fluvial Flooding



Inundation – Present



Inundation – 2080

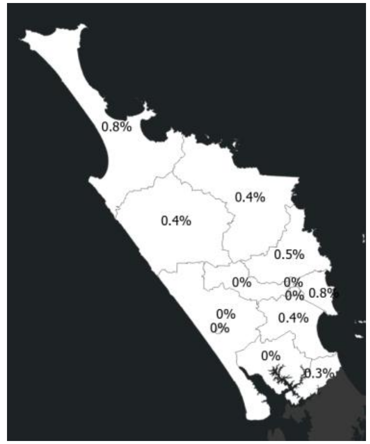


Inundation – 2130

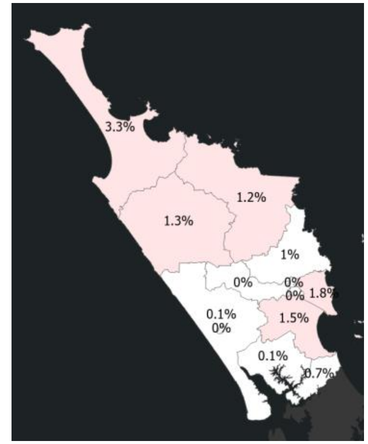
EXPOSURE BY WARD – POINT ASSETS

The maps below show the percentage of point assets in each ward which intersect with the hazard layers.

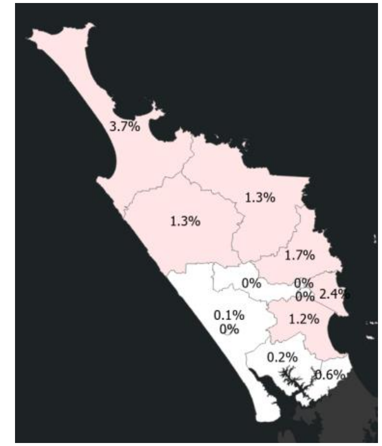
There are wards in all three districts which have over 20% of the point type assets at risk of fluvial flooding. Coastal inundation will proportionally affect more Far North District wards and Whangārei wards more than Kaipara wards. By 2130, three wards in the Far North will have over 1% of point assets at risk of coastal erosion.



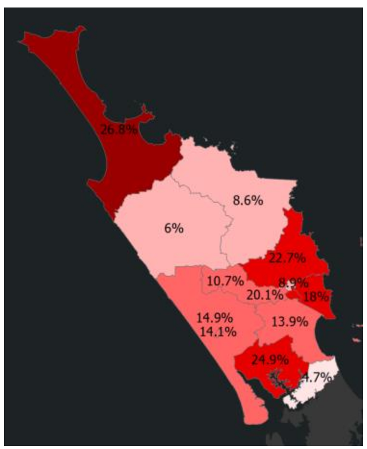
Erosion – Present



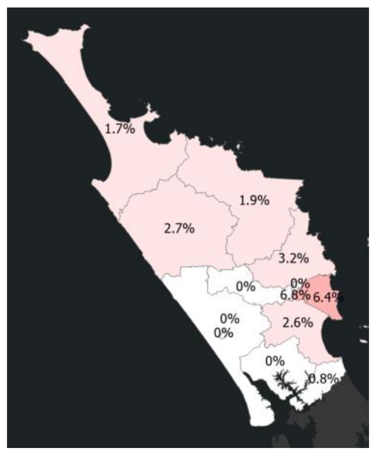
Erosion – 2080



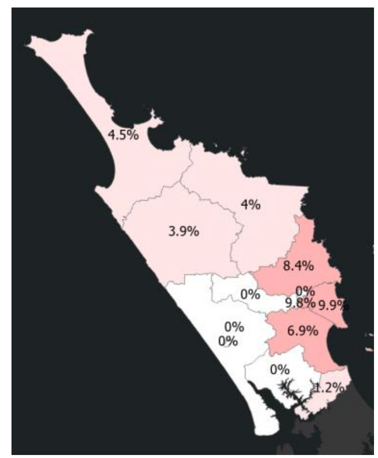
Erosion – 2130



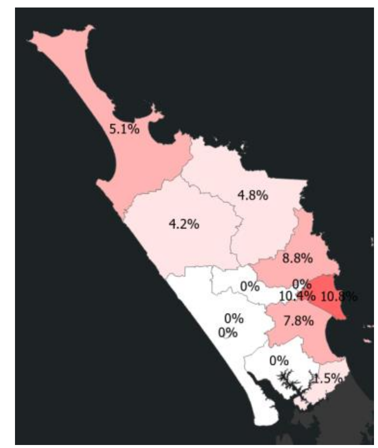
Fluvial Flooding



Inundation – Present



Inundation – 2080



Inundation – 2130

Potential next steps

POTENTIAL NEXT STEPS

This high-level risk assessment has provided Northland Lifelines Group with insights into climate change risk now and into the future.

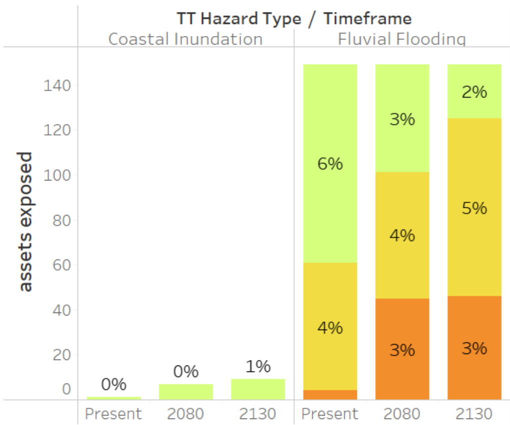
Future next steps which the Northland Lifelines Group should consider include:

- Assessing the potential service impacts arising from at risk assets.
- Interrogate heatmaps and establish hazard based hotspots to further focus adaptation efforts
- Prioritise high and extreme assets, establishing adaptation actions and associated costs
- Site level investigations for top risks within each sector
- Incorporation of remaining NLG Organisations' data
- Develop an asset information standard to reduce data manipulation for assessments
- Acquire better spatial flood hazard information to refine risk ratings, increasing the number of scenarios modelled.
- Use polygons (footprints) for all asset assessed in future.

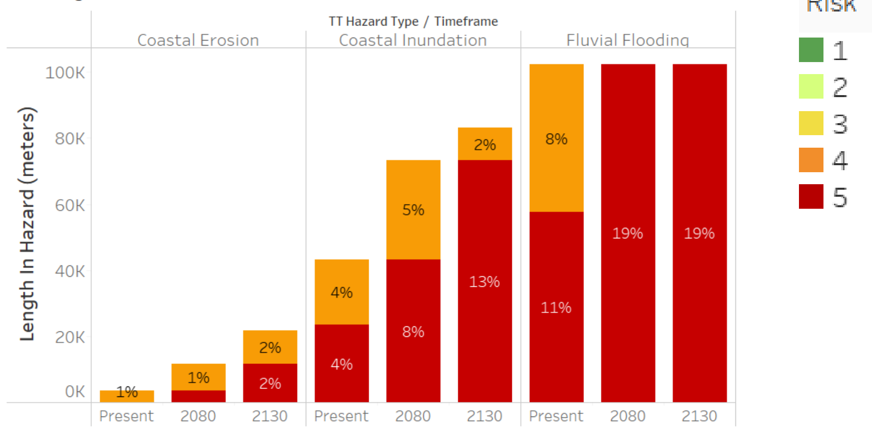
APPENDICES

APPENDIX A - TRANSPORT RESULTS

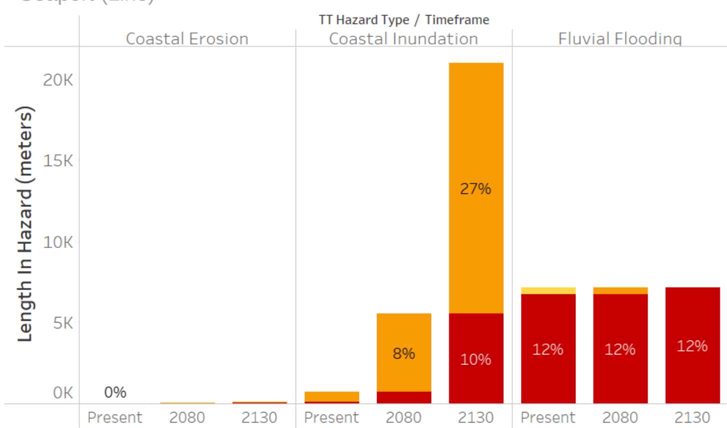
Pipes



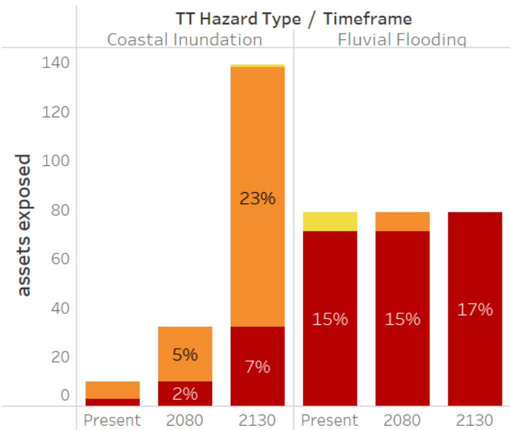
Drainage



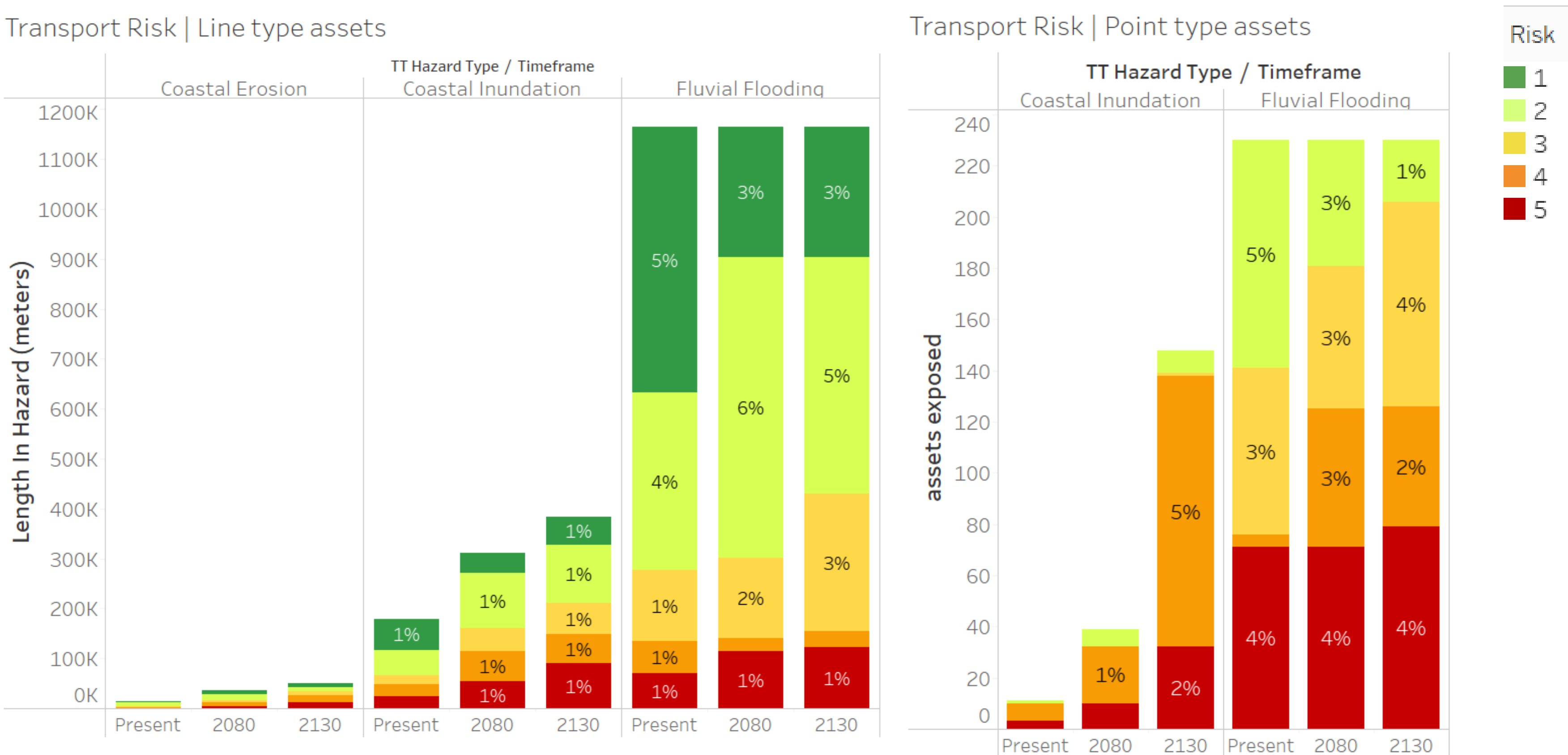
Seaport (Line)



Seaport (Point)

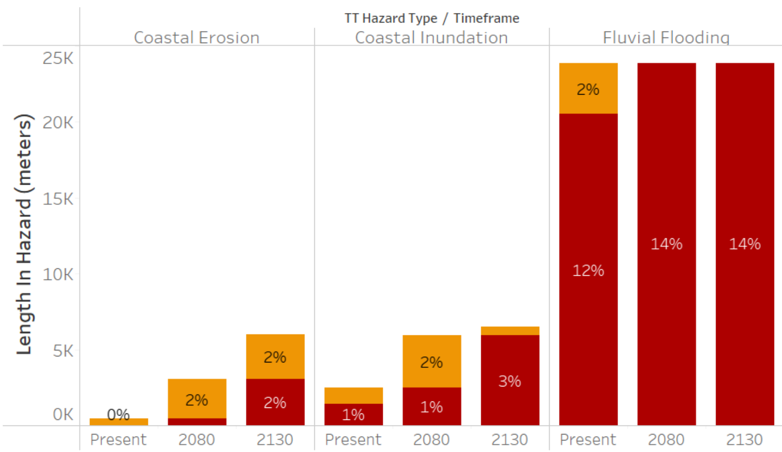


TRANSPORT RISK ASSESSMENT RESULTS DISPLAYED BY LINE AND POINT TYPE ASSETS

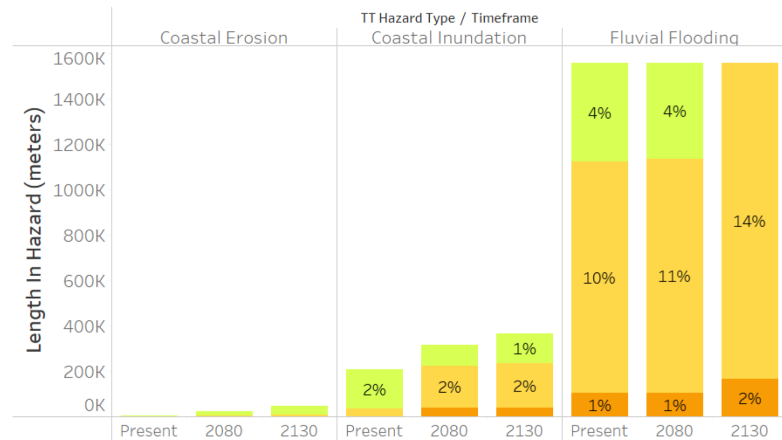


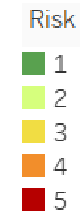
APPENDIX B - ENERGY RESULTS

Energy Pipes



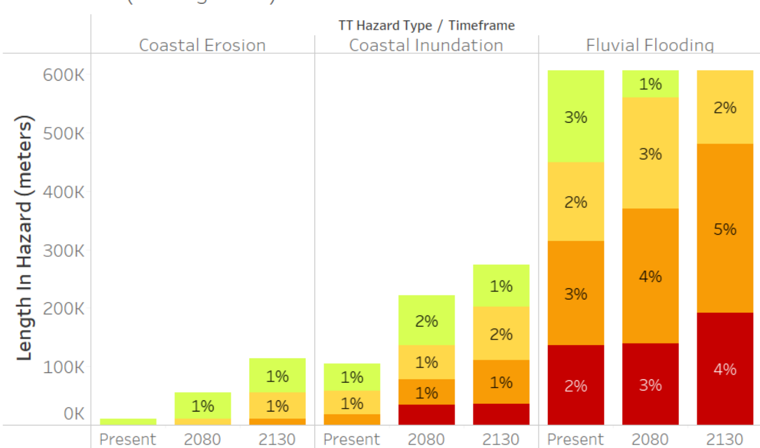
Conductors (Overhead)



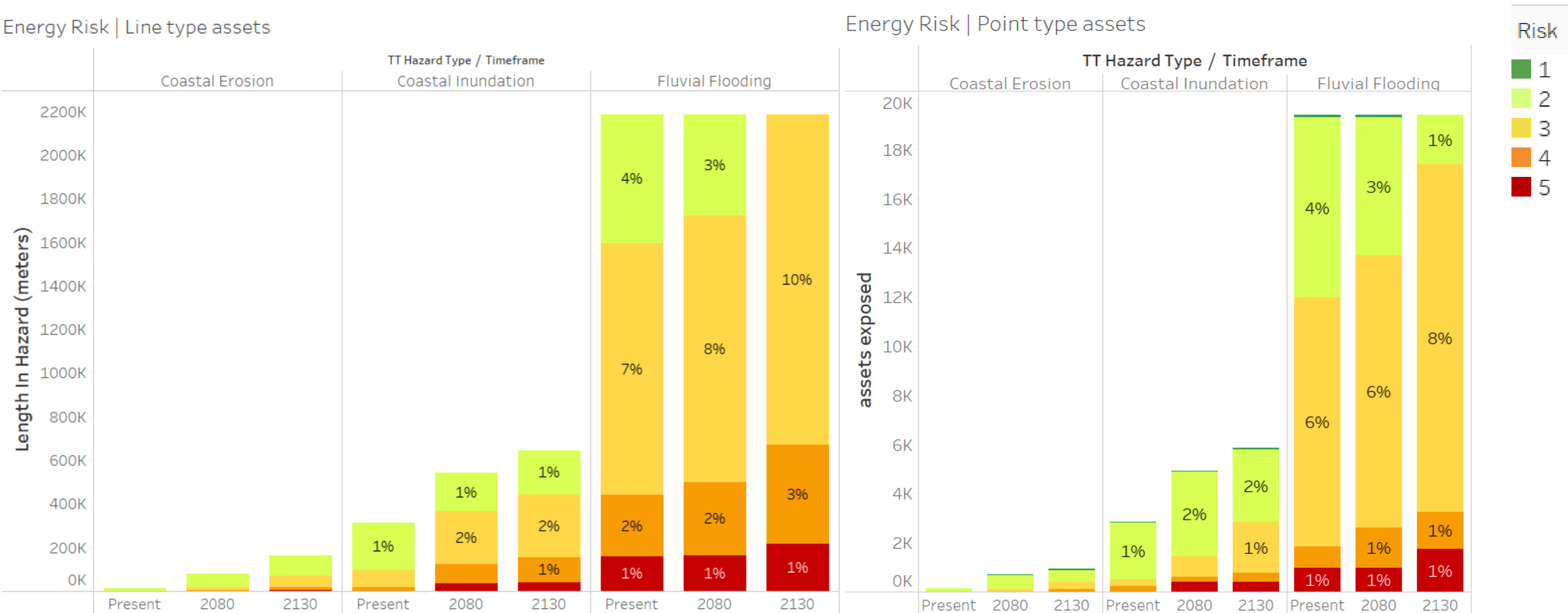


Note risk relates to access rather than damage

Conductors (Underground)

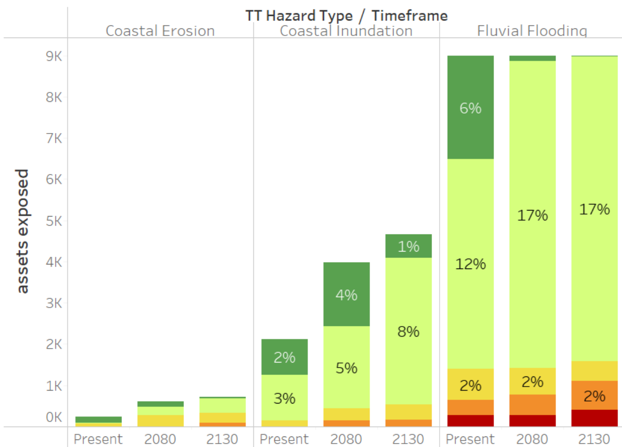


ENERGY RISK ASSESSMENT RESULTS DISPLAYED BY LINE AND POINT TYPE ASSETS

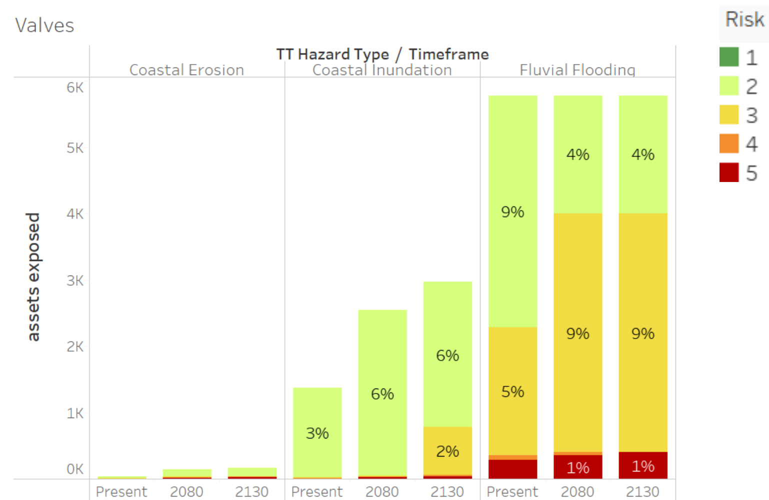


APPENDIX C - WATER RESULTS

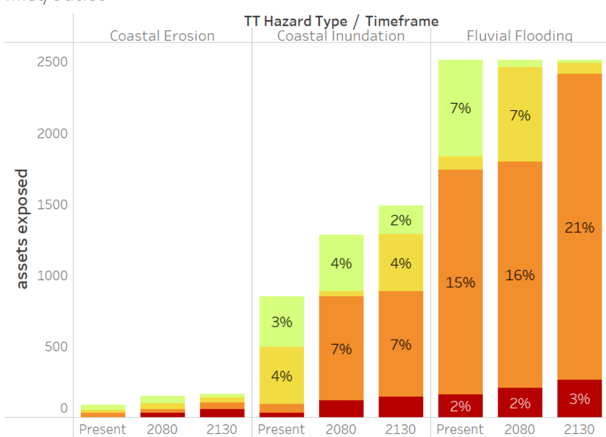
Manholes



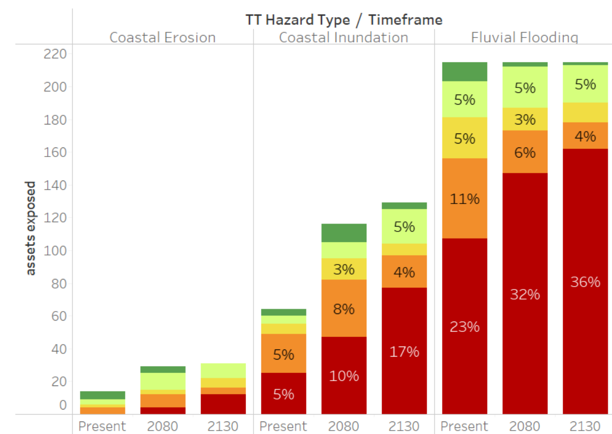
Valves



Inlet/Outlet

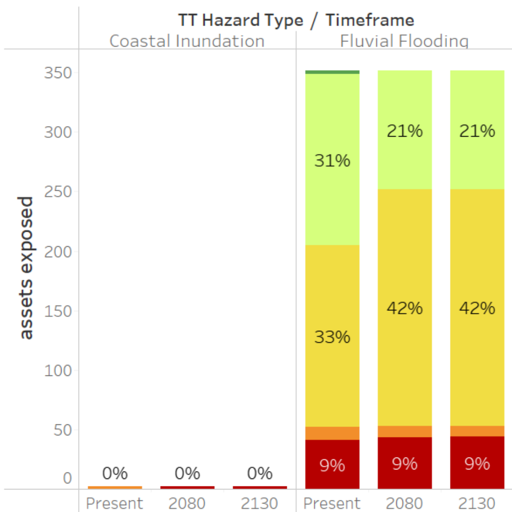


Pumps

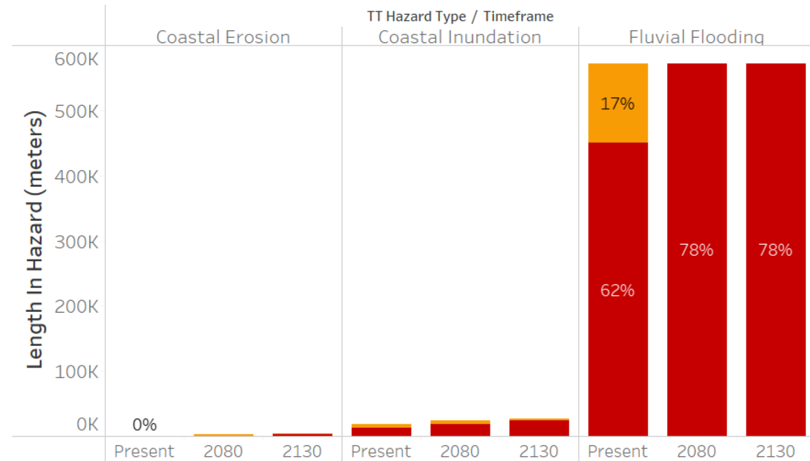


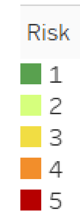
Structures include floodgates, spillways, detention dams, floodwalls, and dams. The division of point and line type assets is based on the data received from Northland Lifeline Utilities.

Structure (Point type)

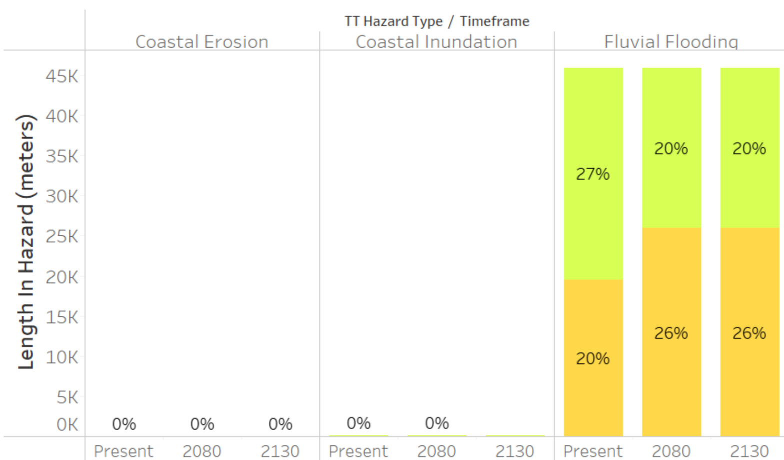


Open Channels

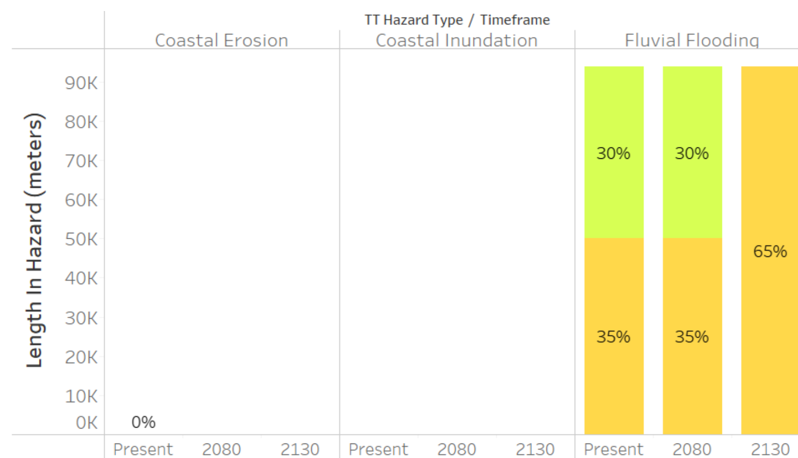




Structure (Line type)

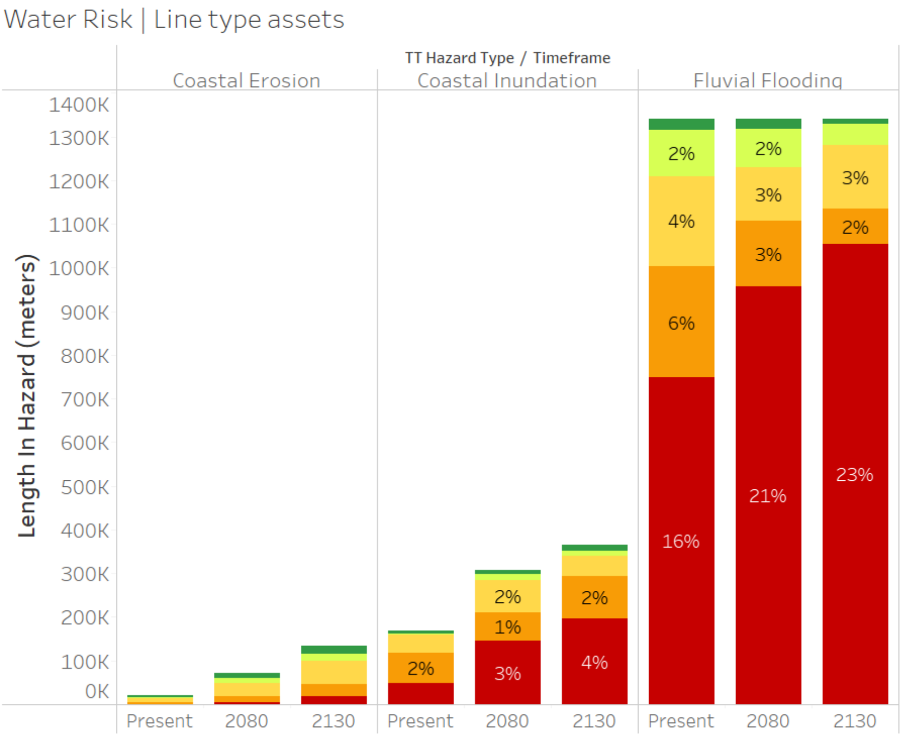


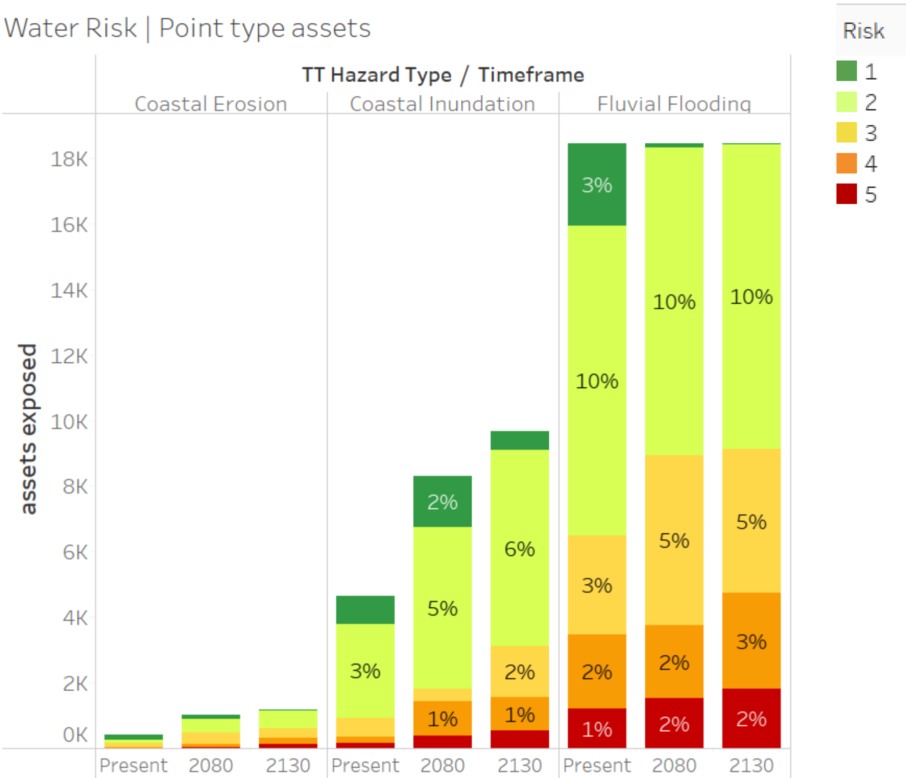
Stopbanks



WATER RISK ASSESSMENT RESULTS DISPLAYED BY LINE AND POINT TYPE ASSETS

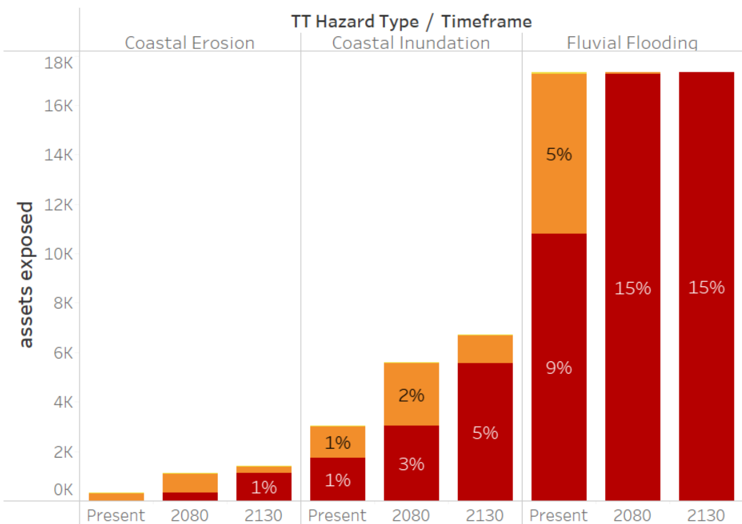
The line assets graph below includes pipes, stopbanks, open channels and line structures. The point assets graph below includes manholes, valves, inlet/outlets, pumps, structures (points), buildings/facilities, and treatment facilities.



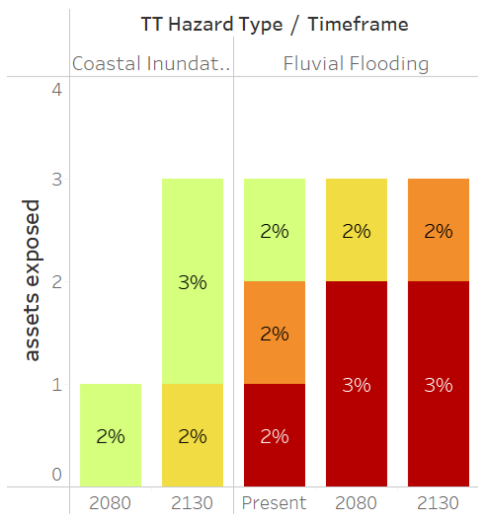


APPENDIX D – TELECOMMUNICATIONS RESULTS

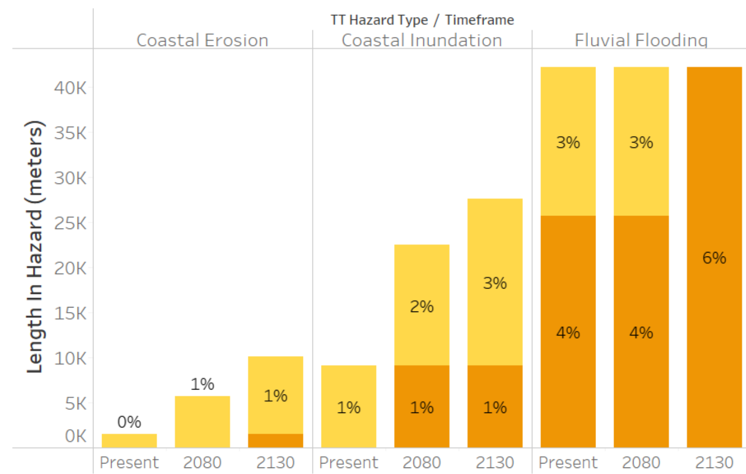
Cabinets, Pits & Pedestals



Exchange Buildings



Conductors



Risk
- 1
- 2
- 3
- 4
- 5

TELECOMMUNICATIONS RISK ASSESSMENT RESULTS DISPLAYED BY LINE AND POINT TYPE ASSETS