Eastern Cape Disaster Risk Assessment Report

Report Prepared for

Eastern Cape Department of Cooperative Governance and Traditional Affairs

Report Number 576193

Province of the
EASTERN CAPE
COOPERATIVE GOVERNANCE
& TRADITIONAL AFFAIRS

Report Prepared by

srk consulting

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Eastern Cape Disaster Risk Assessment Report

Eastern Cape Department of Cooperative Governance and Traditional Affairs

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Executive Summary

The prioritised risk profile for the Eastern Cape Province is based on the data received from the workshop consultations, as well as the base data collected during the study. The stakeholder perception data and local resilience data were also compared with the desktop hazard assessment results, and the prioritised risk profile was developed. The numbers indicated is a combination of the hazard, vulnerability capacity and manageability of various hazards categories.

The Risk Prioritization for the Eastern Cape Province is shown in the tables below.

Table 1-1: Prioritized risks for Alfred Nzo District Municipality

Hazard Category	Alfred Nzo District Municipality
Fire Hazards - Formal & Informal Settlements / Urban Area	10.43
Fire Hazards - Veld/Forest Fires	9.83
Hazardous Material - Fire/Explosion (Storage & Transportation)	9.03
Hydro-meteorological - Drought	9.02
Hazardous Material - Spill/Release (Storage & Transportation)	8.93
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	8.93
Pollution - Water Pollution (Fresh and Sea)	7.83
Pollution - Land Pollution	7.83
Transport Hazards - Road Transportation	7.63
Disease / Health - Disease: Human	6.93
Pollution - Air Pollution	6.93
Infestations - Plant Infestations (Intruder Plants)	6.73
Civil Unrest - Demonstrations / Riots	6.43
Major Event Hazards - Political	6.13
Major Event Hazards - Cultural / Religious	6.13
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	6.03
Structural Failure - Dam failure	5.93
Infrastructure Failure / Service Delivery Failure - Electrical	5.93
Infrastructure Failure / Service Delivery Failure - Water	5.93
Civil Unrest - Armed Conflict (Civil/Political War)	5.93
Infrastructure Failure / Service Delivery Failure - Transport	5.93
Infrastructure Failure / Service Delivery Failure - Sanitation	5.93
Environmental Degradation - Land Degradation	5.83
Environmental Degradation - Loss of Biodiversity	5.83
Transport Hazards - Air Transportation	5.73

Major Event Hazards - Recreational / Commercial	5.63
Structural Failure - Bridge Failure	5.63
Major Event Hazards - Sport	5.53
Environmental Degradation - Erosion	5.43
Civil Unrest - Crime	5.33
Geological Hazards - Earthquake	5.23
Disease / Health - Disease: Animal	5.13
Geological Hazards - Landslides/Mud flows	5.13
Environmental Degradation - Deforestation	5.13
Disease / Health - Disease: Plants	5.03
Hydro-meteorological Hazards - Extreme Temperatures	4.93
Infestations - Insect Infestation	4.93
Hydro-meteorological Hazards - Desertification	4.93
Geological Hazards - Rock-fall	4.63
Structural Failure - Building Failure	4.43
Oceanographic - Tsunami	4.43
Oceanographic - Storm Surge	4.33
Transport Hazards - Water Transportation (Incl Marine Accident)	4.23
Infestations - Animal Infestation / Over Population	4.13
Oceanographic - Sea Level Rise (Climate Change)	3.93
Infrastructure Failure / Service Delivery Failure - Information Technology	3.83
Civil Unrest - Refugees / Displaced People	2.93
Geological Hazards - Subsidence	2.43
Civil Unrest - Xenophobic Violence	1.93
Civil Unrest - Terrorism	0.93

Table 1-2: Prioritized risks for Amathole District Municipality

Hazard Category	Amathole District Municipality
Hydro-meteorological - Drought	9.92
Fire Hazards - Veld/Forest Fires	9.52
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	9.52
Fire Hazards - Formal & Informal Settlements / Urban Area	9.42
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	8.92
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.52
Transport Hazards - Road Transportation	8.22
Civil Unrest - Demonstrations / Riots	8.12

Civil Unrest - Crime	8.12
Hazardous Material - Spill/Release (Storage & Transportation)	8.02
Infestations - Insect Infestation	7.92
Infestations - Plant Infestations (Intruder Plants)	7.72
Pollution - Water Pollution (Fresh and Sea)	7.62
Pollution - Land Pollution	7.62
Infrastructure Failure / Service Delivery Failure - Transport	7.42
Structural Failure - Bridge Failure	7.42
Oceanographic - Storm Surge	7.42
Major Event Hazards - Recreational / Commercial	7.32
Civil Unrest - Armed Conflict (Civil/Political War)	7.12
Pollution - Air Pollution	6.92
Infrastructure Failure / Service Delivery Failure - Electrical	6.92
Disease / Health - Disease: Plants	6.82
Transport Hazards - Air Transportation	6.72
Hydro-meteorological Hazards - Desertification	6.62
Environmental Degradation - Deforestation	6.42
Hydro-meteorological Hazards - Extreme Temperatures	6.42
Major Event Hazards - Political	6.32
Major Event Hazards - Cultural / Religious	6.32
Major Event Hazards - Sport	6.32
Disease / Health - Disease: Human	6.12
Environmental Degradation - Land Degradation	6.02
Geological Hazards - Landslides/Mud flows	6.02
Geological Hazards - Rock-fall	6.02
Infrastructure Failure / Service Delivery Failure - Water	5.92
Oceanographic - Tsunami	5.92
Oceanographic - Sea Level Rise (Climate Change)	5.92
Infrastructure Failure / Service Delivery Failure - Sanitation	5.72
Structural Failure - Building Failure	5.72
Transport Hazards - Water Transportation (Incl Marine Accident)	5.72
Environmental Degradation - Loss of Biodiversity	5.62
Infestations - Animal Infestation / Over Population	5.62
Infrastructure Failure / Service Delivery Failure - Information Technology	5.42
Structural Failure - Dam failure	5.22
Environmental Degradation - Erosion	4.92
Disease / Health - Disease: Animal	4.92
Civil Unrest - Refugees / Displaced People	3.92
Geological Hazards - Earthquake	2.92
Civil Unrest - Xenophobic Violence	2.92
Civil Unrest - Terrorism	2.92
Transport Hazards - Rail Transportation	2.92
Geological Hazards - Subsidence	0.92

Table 1-3: Prioritized risks for Buffalo City Metropolitan

Hazard Category	Buffalo City Metropolitan
Fire Hazards - Formal & Informal Settlements / Urban Area	9.49
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	8.99
Hydro-meteorological - Drought	8.59
Transport Hazards - Road Transportation	8.29
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.09
Hazardous Material - Spill/Release (Storage & Transportation)	8.09
Fire Hazards - Veld/Forest Fires	7.99
Transport Hazards - Air Transportation	7.99
Disease / Health - Disease: Human	7.89
Pollution - Water Pollution (Fresh and Sea)	7.59
Civil Unrest - Demonstrations / Riots	7.49
Transport Hazards - Water Transportation (Incl Marine Accident)	7.29
Pollution - Air Pollution	7.04
Civil Unrest - Crime	6.99
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	6.69
Pollution - Land Pollution	6.59
Major Event Hazards - Recreational / Commercial	6.49
Major Event Hazards - Sport	6.49
Structural Failure - Building Failure	6.49
Structural Failure - Bridge Failure	6.29
Major Event Hazards - Political	5.99
Major Event Hazards - Cultural / Religious	5.89
Oceanographic - Storm Surge	5.79
Infestations - Plant Infestations (Intruder Plants)	5.69
Oceanographic - Sea Level Rise (Climate Change)	5.59
Hydro-meteorological Hazards - Extreme Temperatures	5.49
Infestations - Animal Infestation / Over Population	5.39
Structural Failure - Dam failure	5.19
Disease / Health - Disease: Animal	5.09
Civil Unrest - Armed Conflict (Civil/Political War)	4.99
Infrastructure Failure / Service Delivery Failure - Electrical	4.99
Infrastructure Failure / Service Delivery Failure - Water	4.99
Geological Hazards - Rock-fall	4.79
Oceanographic - Tsunami	4.79

Environmental Degradation - Land Degradation	4.69
Geological Hazards - Landslides/Mud flows	4.69
Infrastructure Failure / Service Delivery Failure - Transport	4.49
Infrastructure Failure / Service Delivery Failure - Sanitation	4.49
Infestations - Insect Infestation	4.39
Hydro-meteorological Hazards - Desertification	4.29
Environmental Degradation - Deforestation	4.09
Environmental Degradation - Erosion	3.99
Disease / Health - Disease: Plants	3.89
Environmental Degradation - Loss of Biodiversity	3.69
Infrastructure Failure / Service Delivery Failure - Information Technology	3.59
Civil Unrest - Xenophobic Violence	3.29
Transport Hazards - Rail Transportation	2.99
Geological Hazards - Earthquake	2.59
Civil Unrest - Refugees / Displaced People	2.49
Civil Unrest - Terrorism	2.49
Geological Hazards - Subsidence	2.49
Infestations - Algal Bloom (Red Tide)	2.49

Table 1-4: Prioritized risks for Chris Hani District Municipality

Hazard Category	Chris Hani District Municipality
Hydro-meteorological - Drought	9.51
Fire Hazards - Veld/Forest Fires	9.31
Fire Hazards - Formal & Informal Settlements / Urban Area	9.21
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	9.11
Infestations - Insect Infestation	9.01
Pollution - Water Pollution (Fresh and Sea)	8.11
Disease / Health - Disease: Human	8.01
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	8.01
Civil Unrest - Demonstrations / Riots	7.21
Hazardous Material - Spill/Release (Storage & Transportation)	7.11
Pollution - Land Pollution	7.11
Transport Hazards - Road Transportation	7.01
Infrastructure Failure / Service Delivery Failure - Transport	7.01
Hydro-meteorological Hazards - Desertification	6.91
Hazardous Material - Fire/Explosion (Storage & Transportation)	6.71

Civil Unrest - Crime	6.71
Infestations - Animal Infestation / Over Population	6.71
Disease / Health - Disease: Animal	6.71
Infestations - Plant Infestations (Intruder Plants)	6.61
Pollution - Air Pollution	6.51
Hydro-meteorological Hazards - Extreme Temperatures	6.51
Infrastructure Failure / Service Delivery Failure - Electrical	6.51
Infrastructure Failure / Service Delivery Failure - Water	6.51
Infrastructure Failure / Service Delivery Failure - Sanitation	6.51
Disease / Health - Disease: Plants	6.51
Structural Failure - Bridge Failure	6.31
Geological Hazards - Rock-fall	6.21
Geological Hazards - Landslides/Mud flows	6.21
Major Event Hazards - Recreational / Commercial	6.01
Major Event Hazards - Political	6.01
Major Event Hazards - Cultural / Religious	6.01
Transport Hazards - Air Transportation	5.81
Environmental Degradation - Land Degradation	5.71
Environmental Degradation - Loss of Biodiversity	5.61
Transport Hazards - Rail Transportation	5.51
Structural Failure - Dam failure	5.31
Environmental Degradation - Erosion	5.31
Environmental Degradation - Deforestation	5.21
Major Event Hazards - Sport	5.01
Infrastructure Failure / Service Delivery Failure - Information Technology	5.01
Structural Failure - Building Failure	4.41
Civil Unrest - Armed Conflict (Civil/Political War)	4.01
Civil Unrest - Xenophobic Violence	4.01
Geological Hazards - Earthquake	4.01
Civil Unrest - Refugees / Displaced People	4.01
Civil Unrest - Terrorism	4.01
Geological Hazards - Subsidence	4.01

Table 1-5: Prioritized risks for Joe Gqabi District Municipality

Hazard Category	Joe Gqabi District Municipality
Hydro-meteorological - Drought	9.96

Fire Hazards - Veld/Forest Fires	9.96
Fire Hazards - Formal & Informal Settlements / Urban Area	8.66
Hazardous Material - Spill/Release (Storage & Transportation)	8.26
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.26
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	7.66
Transport Hazards - Road Transportation	5.76
Pollution - Water Pollution (Fresh and Sea)	5.56
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	5.46
Disease / Health - Disease: Human	5.16
Environmental Degradation - Erosion	5.06
Structural Failure - Bridge Failure	4.96
Pollution - Land Pollution	4.86
Structural Failure - Dam failure	4.86
Pollution - Air Pollution	4.66
Hydro-meteorological Hazards - Desertification	4.56
Civil Unrest - Demonstrations / Riots	4.46
Civil Unrest - Crime	4.46
Infestations - Animal Infestation / Over Population	4.26
Disease / Health - Disease: Animal	4.26
Infestations - Plant Infestations (Intruder Plants)	4.26
Infestations - Insect Infestation	4.16
Hydro-meteorological Hazards - Extreme Temperatures	4.16
Major Event Hazards - Recreational / Commercial	4.16
Environmental Degradation - Deforestation	3.96
Infrastructure Failure / Service Delivery Failure - Water	3.86
Geological Hazards - Rock-fall	3.86
Environmental Degradation - Land Degradation	3.76
Environmental Degradation - Loss of Biodiversity	3.76
Infrastructure Failure / Service Delivery Failure - Electrical	3.66
Infrastructure Failure / Service Delivery Failure - Sanitation	3.66
Disease / Health - Disease: Plants	3.66
Geological Hazards - Landslides/Mud flows	3.66
Major Event Hazards - Political	3.66
Major Event Hazards - Cultural / Religious	3.66
Major Event Hazards - Sport	3.66
Transport Hazards - Air Transportation	3.46
Civil Unrest - Armed Conflict (Civil/Political War)	3.46
Structural Failure - Building Failure	3.06
Geological Hazards - Subsidence	2.86
Infrastructure Failure / Service Delivery Failure - Information Technology	2.66
Transport Hazards - Water Transportation (Incl Marine Accident)	1.76
Infrastructure Failure / Service Delivery Failure - Transport	1.66
Civil Unrest - Xenophobic Violence	1.66
Geological Hazards - Earthquake	1.66
Civil Unrest - Refugees / Displaced People	1.66
Civil Unrest - Terrorism	1.66
Transport Hazards - Rail Transportation	0.66

Table 1-6: Prioritized risks for Nelson Mandela Bay Metropolitan

Hazard Category	Nelson Mandela Bay Metropolitan
Hydro-meteorological - Drought	10.35
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	10.05
Fire Hazards - Formal & Informal Settlements / Urban Area	9.85
Fire Hazards - Veld/Forest Fires	9.15
Hazardous Material - Spill/Release (Storage & Transportation)	8.85
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.75
Transport Hazards - Road Transportation	8.25
Civil Unrest - Crime	8.15
Civil Unrest - Demonstrations / Riots	8.05
Disease / Health - Disease: Human	7.95
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	7.75
Transport Hazards - Air Transportation	7.65
Pollution - Air Pollution	7.05
Oceanographic - Storm Surge	6.75
Major Event Hazards - Sport	6.45
Infrastructure Failure / Service Delivery Failure - Electrical	6.25
Infrastructure Failure / Service Delivery Failure - Sanitation	6.25
Transport Hazards - Water Transportation (Incl Marine Accident)	6.05
Major Event Hazards - Recreational / Commercial	5.85
Hydro-meteorological Hazards - Extreme Temperatures	5.75
Major Event Hazards - Political	5.75
Pollution - Water Pollution (Fresh and Sea)	5.65
Pollution - Land Pollution	5.65
Major Event Hazards - Cultural / Religious	5.25
Infrastructure Failure / Service Delivery Failure - Information Technology	5.25
Infrastructure Failure / Service Delivery Failure - Transport	5.25
Disease / Health - Disease: Animal	5.05
Infrastructure Failure / Service Delivery Failure - Water	4.75
Oceanographic - Sea Level Rise (Climate Change)	4.75
Oceanographic - Tsunami	4.75
Disease / Health - Disease: Plants	4.65
Geological Hazards - Landslides/Mud flows	4.55
Environmental Degradation - Loss of Biodiversity	4.45
Structural Failure - Building Failure	4.45

Structural Failure - Bridge Failure	4.25
Hydro-meteorological Hazards - Desertification	4.25
Geological Hazards - Rock-fall	4.25
Environmental Degradation - Land Degradation	4.25
Transport Hazards - Rail Transportation	4.25
Infestations - Plant Infestations (Intruder Plants)	4.15
Environmental Degradation - Erosion	3.95
Infestations - Animal Infestation / Over Population	3.85
Environmental Degradation - Deforestation	3.45
Civil Unrest - Xenophobic Violence	3.25
Structural Failure - Dam failure	2.95
Infestations - Insect Infestation	2.75
Infrastructure Failure / Service Delivery Failure - Gas	2.35
Civil Unrest - Armed Conflict (Civil/Political War)	2.25
Geological Hazards - Subsidence	2.25
Geological Hazards - Earthquake	2.25
Civil Unrest - Refugees / Displaced People	2.25
Civil Unrest - Terrorism	2.25
Infestations - Algal Bloom (Red Tide)	0.25

Table 1-7: Prioritized risks for OR Tambo District Municipality

Hazard Category	OR Tambo District Municipality
Fire Hazards - Formal & Informal Settlements / Urban Area	10.44
Hazardous Material - Spill/Release (Storage & Transportation)	10.34
Hydro-meteorological - Drought	9.84
Hazardous Material - Fire/Explosion (Storage & Transportation)	9.84
Fire Hazards - Veld/Forest Fires	9.74
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	9.54
Transport Hazards - Road Transportation	9.24
Pollution - Land Pollution	8.94
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	8.54
Structural Failure - Bridge Failure	7.94
Structural Failure - Dam failure	7.94
Infestations - Plant Infestations (Intruder Plants)	7.84
Pollution - Water Pollution (Fresh and Sea)	7.74
Infrastructure Failure / Service Delivery Failure - Transport	7.74

Infrastructure Failure / Service Delivery Failure - Electrical	7.24
Infrastructure Failure / Service Delivery Failure - Water	7.24
Major Event Hazards - Recreational / Commercial	7.14
Major Event Hazards - Political	7.14
Major Event Hazards - Cultural / Religious	7.14
Disease / Health - Disease: Plants	7.04
Pollution - Air Pollution	7.01
Civil Unrest - Demonstrations / Riots	6.94
Disease / Health - Disease: Human	6.94
Infrastructure Failure / Service Delivery Failure - Sanitation	6.94
Civil Unrest - Crime	6.84
Transport Hazards - Air Transportation	6.74
Disease / Health - Disease: Animal	6.74
Infestations - Animal Infestation / Over Population	6.74
Civil Unrest - Armed Conflict (Civil/Political War)	6.74
Major Event Hazards - Sport	6.64
Hydro-meteorological Hazards - Desertification	6.64
Environmental Degradation - Land Degradation	6.64
Oceanographic - Storm Surge	6.54
Transport Hazards - Water Transportation (Incl Marine Accident)	6.54
Oceanographic - Tsunami	6.54
Structural Failure - Building Failure	6.54
Geological Hazards - Landslides/Mud flows	6.44
Environmental Degradation - Erosion	6.44
Geological Hazards - Rock-fall	6.34
Geological Hazards - Earthquake	6.34
Hydro-meteorological Hazards - Extreme Temperatures	6.24
Environmental Degradation - Deforestation	6.24
Infestations - Insect Infestation	6.24
Environmental Degradation - Loss of Biodiversity	6.14
Oceanographic - Sea Level Rise (Climate Change)	5.84
Infrastructure Failure / Service Delivery Failure - Information Technology	5.74
Geological Hazards - Subsidence	5.74
Civil Unrest - Xenophobic Violence	4.74
Civil Unrest - Refugees / Displaced People	4.74
Civil Unrest - Terrorism	1.74
Transport Hazards - Rail Transportation	0.74

Table 1-8: Prioritized risks for Sarah Baartman District Municipality

Hazard Category	Sarah Baartman District Municipality
Hydro-meteorological - Drought	10.27
Fire Hazards - Veld/Forest Fires	9.67
Hazardous Material - Spill/Release (Storage & Transportation)	9.07
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.77
Fire Hazards - Formal & Informal Settlements / Urban Area	8.37
Pollution - Water Pollution (Fresh and Sea)	7.97
Disease / Health - Disease: Human	7.17
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	6.77
Transport Hazards - Road Transportation	6.67
Infestations - Insect Infestation	6.17
Civil Unrest - Demonstrations / Riots	5.97
Disease / Health - Disease: Animal	5.97
Pollution - Land Pollution	5.87
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	5.77
Structural Failure - Bridge Failure	5.47
Infestations - Plant Infestations (Intruder Plants)	5.47
Environmental Degradation - Erosion	5.37
Pollution - Air Pollution	5.17
Hydro-meteorological Hazards - Extreme Temperatures	5.17
Structural Failure - Dam failure	5.07
Major Event Hazards - Recreational / Commercial	4.87
Major Event Hazards - Cultural / Religious	4.87
Environmental Degradation - Deforestation	4.87
Infrastructure Failure / Service Delivery Failure - Transport	4.67
Infrastructure Failure / Service Delivery Failure - Water	4.67
Oceanographic - Sea Level Rise (Climate Change)	4.67
Disease / Health - Disease: Plants	4.47
Civil Unrest - Crime	4.47
Major Event Hazards - Political	4.37
Infestations - Animal Infestation / Over Population	4.37
Major Event Hazards - Sport	4.37
Geological Hazards - Landslides/Mud flows	4.37
Geological Hazards - Rock-fall	4.37
Hydro-meteorological Hazards - Desertification	4.27

Environmental Degradation - Land Degradation	4.27
Infrastructure Failure / Service Delivery Failure - Electrical	4.17
Infrastructure Failure / Service Delivery Failure - Sanitation	4.17
Oceanographic - Storm Surge	4.17
Transport Hazards - Water Transportation (Incl Marine Accident)	4.17
Environmental Degradation - Loss of Biodiversity	4.07
Structural Failure - Building Failure	3.97
Transport Hazards - Air Transportation	3.67
Oceanographic - Tsunami	3.67
Infrastructure Failure / Service Delivery Failure - Information Technology	3.17
Geological Hazards - Subsidence	2.27
Civil Unrest - Armed Conflict (Civil/Political War)	2.17
Civil Unrest - Refugees / Displaced People	2.17
Geological Hazards - Earthquake	1.17
Civil Unrest - Terrorism	1.17
Civil Unrest - Xenophobic Violence	0.67

Table 1-9: Prioritized risk for Eastern Cape Combined

Hazard Category	Eastern Cape Combined
Hydro-meteorological - Drought	77.45
Fire Hazards - Formal & Informal Settlements / Urban Area	75.86
Fire Hazards - Veld/Forest Fires	75.16
Hazardous Material - Spill/Release (Storage & Transportation)	68.66
Hazardous Material - Fire/Explosion (Storage & Transportation)	67.96
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	66.66
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	61.06
Transport Hazards - Road Transportation	61.06
Pollution - Water Pollution (Fresh and Sea)	58.06
Disease / Health - Disease: Human	56.16
Civil Unrest - Demonstrations / Riots	54.66
Pollution - Land Pollution	54.46
Pollution - Air Pollution	51.28
Civil Unrest - Crime	51.06
Infestations - Plant Infestations (Intruder Plants)	48.46
Structural Failure - Bridge Failure	48.26
Transport Hazards - Air Transportation	47.76

Major Event Hazards - Recreational / Commercial	47.46
Infrastructure Failure / Service Delivery Failure - Electrical	45.66
Infestations - Insect Infestation	45.56
Major Event Hazards - Political	45.36
Major Event Hazards - Cultural / Religious	45.26
Hydro-meteorological Hazards - Extreme Temperatures	44.66
Major Event Hazards - Sport	44.46
Infrastructure Failure / Service Delivery Failure - Transport	44.16
Disease / Health - Disease: Animal	43.86
Infrastructure Failure / Service Delivery Failure - Water	43.86
Infrastructure Failure / Service Delivery Failure - Sanitation	43.66
Structural Failure - Dam failure	42.46
Hydro-meteorological Hazards - Desertification	42.46
Disease / Health - Disease: Plants	42.06
Environmental Degradation - Land Degradation	41.16
Infestations - Animal Infestation / Over Population	41.06
Geological Hazards - Landslides/Mud flows	41.06
Environmental Degradation - Erosion	40.46
Geological Hazards - Rock-fall	40.46
Environmental Degradation - Deforestation	39.36
Environmental Degradation - Loss of Biodiversity	39.16
Structural Failure - Building Failure	39.06
Civil Unrest - Armed Conflict (Civil/Political War)	36.66
Transport Hazards - Water Transportation (Incl Marine Accident)	35.75
Oceanographic - Storm Surge	35.00
Infrastructure Failure / Service Delivery Failure - Information Technology	34.66
Oceanographic - Sea Level Rise (Climate Change)	30.70
Oceanographic - Tsunami	30.10
Geological Hazards - Earthquake	26.16
Civil Unrest - Refugees / Displaced People	24.16
Geological Hazards - Subsidence	22.96
Civil Unrest - Xenophobic Violence	22.46
Civil Unrest - Terrorism	17.16
Transport Hazards - Rail Transportation	17.06
Infestations - Algal Bloom (Red Tide)	2.74
Infrastructure Failure / Service Delivery Failure - Gas	2.35

For more details, please see Section 10 and 11 of this document.

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Glossary

Abbreviation	Meaning
ACSA	Airports Company South Africa
AFIS	Advanced Fire Information System
AIDS	Acquired Immune Deficiency/Immunodeficiency Syndrome
ASF	African Swine Fever
B & B	Bed and Breakfast
C	Capacity
CBD	Central Business District
CSIR	South Africa's Council for Scientific and Industrial Research
DALRRD	Department of Agriculture, Land Reform and Rural Development
DEA	Department of Environment Affairs
DEM	Digital Elevation Models
DM:	Disaster Management
DFFE	Department of Forestry, Fisheries and Environment (Formerly DEA)
DMAF	District Management Advisory Forum
DMC	Disaster Management Centre
DMIIS	Disaster Management Information System
DRA	Disaster Risk Assessment
DWS	Department of Water and Sanitation
EC CoGTA	Eastern Cape Department of Corporate Governance and Traditional Affairs
ECD	Early Childhood Development
EC SECC	Eastern Cape Socio Economic Consultative Council
ENSO	El Niño–Southern Oscillation
FPA	Fire Protection Association of South Africa
GBH	Grievous Bodily Harm
GIS	Geographical Information Systems
GPODM	Green Paper on Disaster Management
GVA	Gross Value Added
H	Hazard
Ha	Hectare
HAND	Height Above Nearest Drainage
HAZMAT	Hazardous Materials
HIV	Human Immunodeficiency Virus
HVR	Hazard, Vulnerability & Resilience
ICSU	International Council for Science
IDP	Integrated Development Plan
IPTN	Integrated Public Transport Network
JHU	Johns Hopkins University
KZN	KwaZulu Natal Province
LM	Local Mun7icipality
LPG	Liquefied Petroleum Gas
MIG	Municipal Infrastructure Grant
MHI:	Major Hazardous Installations
MVA(s)	Motor Vehicle Accident(s)
NBR	National Building Regulations

NCCR	National Climate Change Response
NDMC	National Disaster Management Centre
NDMF	National Disaster Management Framework
NGI	National Geo-spatial Information
NGO	Non-Governmental Organisation
PDMC	Provincial Disaster Management Centre
PDP	Provincial Development Plan
PSHB	Polyphagous Shot Hole Borer
RDP	Reconstruction and Development Programme
RHVMC	Risk, Hazard, Vulnerability, Manageability, Capacity
RID	Risk Informed Development
SANBI	South African National Biodiversity Institute
SANDF	South African National Defence Force
SAPS	South African Police Service
SAWS	South African Weather Services
SDF	Spatial Development Framework
SDI Act	Spatial Data Infrastructure Act no. 54 of 2000 (SDI Act)
SPI	Standardise Precipitation Index
SPLUMA	Spatial Planning and Land Use Management Act
SRK	SRK Consulting (Pty) Ltd
TB	Tuberculosis
UNHCR	United Nations High Commissioner for Refugees
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USDA	U. S. Department of Agriculture
WASH	Water, sanitation and hygiene
WMO	World Meteorological Organisation
WOAH	World Organisation for Animal Health
WOF	Working On Fire
WWF	World Wildlife Fund

1 Introduction

The Eastern Cape Department of Co-operative Governance and Traditional Affairs (EC CoGTA) appointed SRK Consulting (Pty) Ltd (SRK) to perform a Disaster Risk Assessment (DRA) and for the Eastern Cape Province.

This report presents a description of the DRA process undertaken for the Eastern Cape Province, as well as the associated results, conclusions and recommendations of the assessment.

2 Background and Brief

2.1 Background and objectives

The Disaster Management Act (Act 57 of 2002), Disaster Management Amendment Act (Act 16 of 2015) as well as the National Disaster Management Framework (2005), requires that Provinces in South Africa conduct DRAs for their area of jurisdiction (Republic of South Africa, 2005).

The main objective of the DRA is to provide the Eastern Cape department of Cooperative Governance and Traditional Affairs with relevant information to enable and support the disaster risk reduction planning and activities undertaken by the province. The supporting information includes the levels of disaster risks, hazards, vulnerabilities, manageability, and capacities (RHVMC) within the area of jurisdiction of the Eastern Cape Province. The deliverables also include suitable ratings, mapping and prioritization of the RHVMC levels for the Eastern Cape Province.

2.2 Requirements for Disaster Risk Assessments

A DRA is a requirement as directed in the guiding documents with regards to Disaster Management in South Africa, including the Disaster Management Act (as amended), the National Disaster Management Framework (NDMF) and National Disaster Management Centre Guidelines. These guidelines and legislation give direction with regards to DRAs. Below is a summary of the requirements relating to DRAs, as well as how the implemented DRA methodology ensure that these requirements are met by the approach followed in this assessment.

Table 2-1: Requirements related to DRAs

Requirement	Response
NDMF: 2.3 Monitoring, updating and disseminating disaster risk information	• Available statistics are included in the assessment. • Where appropriate, recommendations for improvement of risk information are made.

Requirement	Response
Act (As amended): 33 – (1) A provincial disaster management centre, to the extent that it has the capacity, must give guidance to the organs of state, the private sector, nongovernmental organisations, communities and individuals in the province to assess and prevent or reduce the risk of disasters, including- (a) ways and means of- (i) determining levels of risk; (ii) assessing the vulnerability of communities and households to disasters that may occur; (iii) increasing the capacity of communities and households to minimise the risk and impact of disasters that may occur and (iv) monitoring the likelihood of, and the state of alertness to, disasters that may occur; (b) the development and implementation of appropriate prevention and mitigation methodologies; (c) the integration of prevention and mitigation methodologies with development plans, programmes and initiatives; and (d) the management of high-risk developments (2) A provincial disaster management centre must promote formal and informal initiatives that encourage risk avoidance behaviour by organs of state, the private sector, non-governmental organisations, communities and individuals in the province.	These aspects are considered in this report.
NDMF: Integration of Disaster Management Plan with IDP	The main recommendations of the DRA should be included in the IDP.
Act Section 39: Disaster management plans for provinces. 1) Each province must— (a) conduct a disaster risk assessment for its provincial area; (b) identify and map risks, areas, ecosystems, communities and households that are exposed or vulnerable to physical and human induced threats; (c) prepare a disaster management plan for the province as a whole setting out— (i) the way in which the concept and principles of disaster management are to be applied in its provincial	Reduction measures are included in the recommendations. The methodology allows for the identification of communities and households at risk.

Requirement	Response
area, including expected climate change impacts and risks for the province; (ii) its role and responsibilities in terms of the national and provincial disaster management framework; (iii) its role and responsibilities regarding emergency response and post-disaster recovery and rehabilitation; (iv) its capacity to fulfil its role and responsibilities; (vi) contingency strategies and emergency procedures in the event of a disaster, including measures to finance these strategies; and (vii) specific measures taken to address the needs of women, children, the elderly and persons with disabilities during the disaster management process; (d) co-ordinate and align the implementation of its plan with those of other organs of state and institutional role-players; (e) provide measures and indicate how it will invest in disaster risk reduction and climate change adaptation, including ecosystem and community-based adaptation approaches; (f) develop early warning mechanisms and procedures for risks identified in the provincial area; (g) regularly review and update its plan.;	
NDMF: Key performance area 2, section 2.1: identification of stakeholders.	List of stakeholders invited to workshops and consultations are in line with requirements of members of the District Management Advisory Forum (DMAF).
NDMF: Section 2.1.1.1: The framework specifically refers to events of frequency/seasonality, and scale/magnitude, speed of onset, affected area and duration	These characteristics of the hazards were considered in the DRA.
NDMF: The risk assessment must include setting priorities for action to be taken	Priorities for action are included in the recommendations.
NDMF: Section 2.1.2: Identify if the risk is becoming more serious.	This aspect is included in the hazard rating and assessment.

Requirement	Response
NDMF: Section 2.1.3.5: link the risk assessment with the disaster risk management planning	Reduction measures and risk management planning are included in the recommendations.
NDMF: Section 2.1.4: Community-based disaster risk assessment	Representatives of communities were invited to stakeholder consultations. Stakeholder consultations and collection of indigenous knowledge were included in this assessment.

3 Work Program

The principal stages of the project were as follows:

Table 3-1: DRA Work Program

1	Project initiation
1.1	**Preparation for initiation meeting**
1.1.1	Scheduling Delivery Dates
1.1.2	Compile Payment Schedule
1.1.3	Workshop and refine Methodology
1.2	Project initiation meeting
1.3	Prepare and finalise project plan
1.4	Milestone: Project Initiation Complete
2	**Status quo assessment**
2.1	**Preparation for Status Quo Workshop**
2.1.1	Confirm attendance list
2.1.2	SRK host workshop and COGTA send invitations
2.1.3	Prepare data collection forms
2.1.4	Conduct 1 Training Workshop on project methodology and obtain status quo data
2.1.5	Identify custodians and sources
2.1.6	Milestone: Status quo complete
3	Data Gathering
3.1	Prepare required data list (Spatial and non-spatial data)
3.2	Meeting to finalise data list, and custodians
3.3	**Data gathering process**
3.3.1	Data gathering process
3.3.2	Assess existing District and Local DRAs
3.4	One on one interviews with identified key persons
3.5	Assessment of received data and identification of gaps
3.6	Document received data
3.7	Milestone: Data Gathering complete
4	**Literature Review of Similar Assessments (Neighbouring Provinces)**
4.1	Data gathering
4.2	Assessment and analysis of literature

4.3	Literature Review Report
4.4	Milestone: Literature Review complete
5	**Stakeholder Engagement / DRA Training Workshop**
5.1	Workshop preparation
5.2	Workshop 1: Alfred Nzo District Municipality
5.3	Workshop 2: Amathole District & Buffalo City Metro
5.4	Workshop 3: Sarah Baartman District & Nelson Mandela Bay Metro
5.5	Workshop 4: Chris Hani District
5.6	Workshop 5: Joe Qgabi District
5.7	Workshop 6: OR Tambo District
5.8	Milestone: Stakeholder Engagement Complete
6	**DRA**
6.1	**Preparation of Spatial Model**
6.1.1	Spatial data evaluation
6.1.2	Capturing of Collected Information in GIS
6.1.3	Combining and Preparing Data Layers to enable Spatial Modelling
6.2	**Quantification of Hazards, Vulnerabilities and Manageability**
6.2.1	Social vulnerability profiling and gender analysis
6.3	**Spatial (GIS) Disaster Risk Modelling**
6.3.1	Identification of Communities at Risk
6.3.2	Prioritising of identified hazards and risks
6.4	Creation of Hazard, Vulnerability and Resilience Maps
6.5	Identification of Risk Reduction Measures based on Risk Assessment results
6.6	**Compilation of Draft DRA Report**
6.6.1	**Present draft DRA and distribute for comment (Provincial Workshop)**
6.6.2	Present draft DRA report at provincial workshop
6.6.3	Circulate for comments
6.6.4	Incorporate comments from Draft Report and
6.6.5	Milestone: DRA complete
7	Transfer Data to DMIIS
7.1	Package all spatial Data
7.2	Publish on Provincial DMIIS
7.3	District level training on DMIIS
7.4	Milestone: Transfer to DMIIS completed
8	Project Management
8.1	**Progress Reports and Project Management Meetings) Virtual Meetings)**
8.2	Project Management
8.3	Milestone: Project completed

4 DRA Methodology

For a DRA to provide credible results, the process that is followed needs to be based on scientific principles and accurate information. The methodology followed during the DRA process is discussed below:

4.1 Spatial and non-spatial data collection

The entire DRA specific data and information. This data and information include both spatial and non-spatial data as well as electronic and hard copy data. Examples of typical spatial and non-spatial data are shown below:

Table 4-1: Typical Spatial and Non-Spatial Data used in DRA's

Types of Data	Spatial Data	Non-Spatial Data
Description of Data	Spatial data is data that can be represented spatially. This includes GIS Data as well as maps and drawings.	Non-Spatial data relates to data which is not represented spatially. This includes reports and statistics in tabular format.
Typical examples of data to be used in DRAs	• **Infrastructure:** Roads, rail, water and waste water pipelines, water and wastewater treatment works, reservoirs, power lines and electricity sub stations, gas or petrol pipelines, airports, etc.; • **Land use and Land cover data:** Classification of the environment based on its use or physical characteristics. • **Government Buildings and Critical Facilities:** Key Ministerial and government buildings, government offices, police stations, fire tations, hospitals, clinics, schools, Location of all council properties, Government warehouses and storage areas, • **Other Buildings and Land-use data:** Stadiums, sport fields, waste and landfill sites, surveyed land-parcels with land-use labels, etc. • **Administrative boundaries:** Boundaries for the District, Municipalities and Wards • **Cadastral data:** Erven, farms, servitudes • **Topographic data:** Rivers, streams, contours, dolomitic Areas and undermined areas, flood lines, etc. • **Remote Sensing data:** Aerial photography or satellite Images. • **Statistical data:** Demography, socio economical and health related.	• Integrated Development Plans and Spatial Development Frameworks; • Census Statistics; • **General statistics**, including Health, Crime, Rainfall, Floods, Fire, etc.; • Information on disaster management capacity; and • **Specific reports**, including reports of floods, drought, geological problems, accidents, illegal immigrants and refugees, major hazardous installations and health.

4.2 Eastern Cape Provincial Disaster Management Centre arranged consultation workshop

The PDMC arranged a data gathering workshop. The aim of this workshop was to collect indigenous knowledge as well as disaster management related information from various stakeholders and representatives in the Eastern Cape Province.

Typical key stakeholders that were invited to the workshop included:

- The PDMC staff;
- Ward and Portfolio Councillors;
- All Departmental Managers / Senior Representatives from each department;
- Organized Business;
- Organized Labour;
- Mining and Large Industry;
- Representatives from Agricultural Sector;
- Medical, Paramedical and Hospitals;
- Institutions of Education, including Schools and University;
- South African Police Service;
- South African National Defence Force;
- Representatives from the Provincial and National;
- Representatives from Utilities (Electricity, Water, etc.);
- Fire Protection Associations and similar entities/organizations such as Working for Water and Roads Agencies;
- Transportation organizations (Spoornet, etc.);
- Non-governmental organizations, Community based development workers and disaster management volunteers;
- Traditional councils;
- Religious and Welfare organizations; and
- Representatives from all the National Key Points in the Municipal area.

4.3 Creation of maps and data collection sheets for workshops

Specific data collection base maps and sheets were created to facilitate the stakeholder consultation process to enable the collection and capturing of indigenous information in a suitable format..

Table 4-2: Information collected during consultation workshops

Category	Type of Information
General Information	• Area of occurrence

Category	Type of Information

Hazard Specific Information	• Name of hazard event
	• Description of event
	• Classification of Event: Ordinary, Rare or Extreme.
	• Actual vs. Potential event
	• Location of Hazard Event
	  o Map grid code
	  o Suburb, road, etc.
	• History of event (frequency)
	• Perception regarding increasing occurrence
	• Seasonal occurrence
	• Effects on:
	  o People
	  o Buildings
	  o Other infrastructure
	  o Environment
	  o Economic Activities
	• Cause of event
	• Secondary hazards
	• Responsibility of Department / Line-functions
	• Current plans, policies or programmes to address this hazard
	• Specific reasons people are vulnerable to this hazard
	• Priority to reduce hazard
	• Comments

Resilience Information	• Self-evaluation of Facility's Resources on a scale from 1 – 3.
	  o Staff & human resources
	  o Expertise, experience & specialist knowledge
	  o Vehicles
	  o Equipment
	  o Funding/budget
	  o Prevention, mitigation & risk reduction plans
	  o Response & Recovery Plans
	• Identification of challenges experienced by role players / departments in terms of safety, security and disaster management
	• Greatest needs in terms of safety, security and disaster management

Category	Type of Information
Other Information	• Additional comments, remarks or recommendations

The information collected during and after these consultations and workshop are incorporated into the Risk Profiling process and are discussed in Section 5 of this document.

4.4 Capturing of data in GIS and risk modelling

After the consultations, all the relevant information was captured into the appropriate electronic formats and prepared for the risk modelling. Base data from various collected documents and reports were also captured and included in the Risk Profiling.

More detail regarding the Risk Profiling is provided in Section 5 of this document. Requirements from the Spatial Data Infrastructure Act no. 54 of 2000 (SDI Act) such as metadata and standards are considered when working with spatial data.

Data quality analysis and data cleaning focussed on location and attribute accuracy while keeping in mind that the analysis is on provincial level. Where possible, spatial data were verified as to the the correct location, place name changes were incorporated, and spelling mistakes were rectified.

4.5 Creation of Hazard, Vulnerability, Manageability, Capacity & Risk maps and Disaster Risk Profiles

The results from the Disaster Risk Model were used to compile the various Hazard, Vulnerability, Resilience and Risk (HVR) maps, while information collected from workshop consultations as well as information abstracted from base data sources were used to compile disaster risk profiles for the Eastern Cape. These results are shown in Section 10.

4.6 Compilation of draft report and workshop

A draft DRA report that contains the draft findings of the DRA was presented to stakeholders in order to collect comments and any additional input to add value to this report. The draft document was circulated to obtain written inputs and comments. These comments and inputs were used to update and refine the final DRA report..

5 Risk Model and Variables

The DRA approach was conducted in terms of an overall theoretical frame work which provides the guiding principles for setting up and running the disaster risk model during the DRA.

The model is a representation of a set of components, a process, a system, or subject area, generally developed for understanding, analysis, improvement, and/or replacement of the subject under investigation. The model therefore provides the opportunity to represent certain aspects of reality to illustrate or determine relationships, impacts or influences that normally might be difficult to identify. Because disaster risk management takes place in complex and dynamic environments, modelling is ideally suited to determine relative disaster risk levels.

The disaster risk model was used to represent relevant aspects and characteristics of the Eastern Cape Province to illustrate the effects of interaction between various HVR's-levels and to calculate relative levels of disaster risk. It was therefore important to ensure that the results achieved from this modelling process are accurate, by making use of accurate and adequate data as a basis for the risk model.

It should be mentioned that it is not possible to model an exact and detailed replica of the Eastern Cape Province geographical study area in a spatial model. Therefore, to present the complex and intricate Eastern Cape area in a manageable and cost-effective spatial model, specific assumptions were made to present a simplified, but useful model, of the Eastern Cape. Furthermore, specific limitations and challenges with regards to the base data, information and modelling approach were identified during the assessment process. Some of these assumptions and limitations are presented in Section 5.8.

The guiding theoretical framework as well as technical aspects of the risk modelling and assessment process is discussed below.

5.1 The Disaster Risk formula

The Disaster Risk Model is based on a mathematical formula considering the various factors that constitute the level of risk, based on specific hazards, in a specific area. The mathematical formula can be illustrated as follows:

$$Risk = \frac{Hazard\ x\ Vulnerability}{Manageability + Capacity}$$

where:

Risk The probability of harmful consequences or expected losses resulting from the interactions of hazards and vulnerable conditions. Conventionally risk is expressed as follows: Risk (R) = Hazard x Vulnerability. However, the concepts of Manageability and Capacity (combined as Resilience) are also included in the formula.

Hazard A potentially damaging physical event, phenomenon and/or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Vulnerability The degree to which an individual, a household, a community, an area or a development may be adversely affected by the impact of a hazard. Conditions of vulnerability and susceptibility to the impact of hazards are determined by political, physical, social, economic and environmental factors or processes. *The political aspect of vulnerability is not included in this assessment since it entails a long process of investigating the political climate and culture of different areas within the study area, which is a complete long-term study on its own.*

Manageability For the purpose of this assessment Manageability will be defined as the combination of all the strengths and resources available within the government departments and line-functions (such as Fire Services, South African Police Service, Department of Health, etc.) that can reduce the level of risk or mitigate the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personnel or collective attributes such as leadership and management.

Capacity For the purpose of this assessment Capacity will be defined as the combination of all the strengths and resources available within the community or society (including NGOs, CBOs, Faith Based Organizations, etc.) that can reduce the level of risk or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personnel or collective attributes such as leadership and management.

Resilience The combined value between the Manageability and Capacity values are referred to as the Resilience value.

5.2 Concepts and model variables

To accurately interpret the results from the risk assessment, it is essential to understand the effects of different HVR's levels on the calculated Risk levels. The underlying principle of the Disaster Risk formula is that an increased Hazard and Vulnerability level associated with decreased Resilience levels will lead to an increased Risk level. Whereas, a reduced Hazard and Vulnerability level associated with an increased Resilience level, will lead to a decreased Risk level. A change in any one of the individual HVR's values will have an impact on the resulting Risk level. This relationship is provided in Figure 5-1.

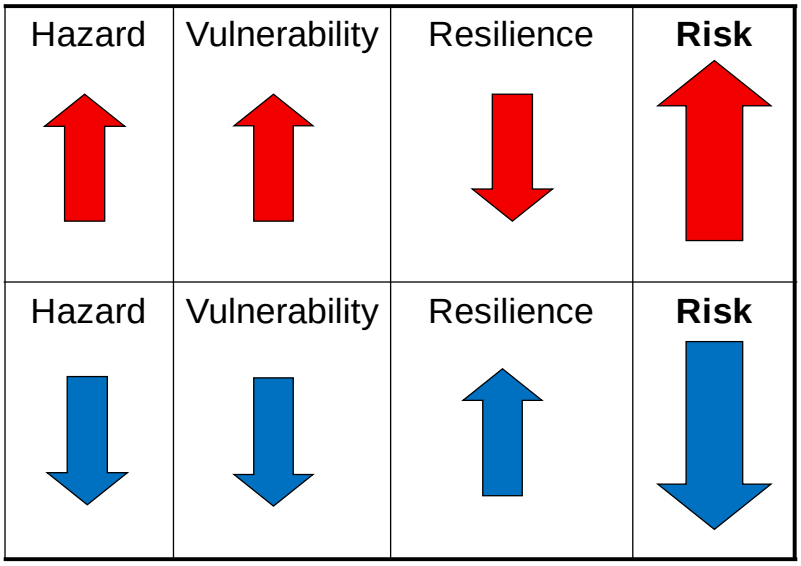

Figure 5-1: Relationship of Hazard, Vulnerability, Resilience and Risk levels

An example of a flood hazard event can be used to illustrate this relationship:

Example 1 – High disaster risk

A severe flood event, with high water levels and velocities (high hazard value) occurs in an informal settlement, where the community has low-income levels, are exposed to poor environmental conditions, have limited access to health services and are sheltered in informal structures (high vulnerability value). It is also indicated that the local authorities and line functions (fire services, police, health facilities) or the community-based NGOs do not have adequate resources (such as vehicles, equipment or human resources) to respond to an event (low resilience value). These circumstances contribute to a high Disaster Risk value.

Example 2 – Low disaster risk

A low severity flood event, with low water levels and a low velocity (low hazard value) occurs in a formal and established community. The community has a high-income level, high level of general health and the infrastructure in the community is designed and constructed to a suitable standard with required storm water management infrastructure and easy access for support vehicles. It is also indicated that both the local authorities and community-based NGOs have adequate levels of resources to respond to this type of event. This community will be classified as having a low disaster risk level regarding this flood event.

One should bear in mind that areas with a high vulnerability do not necessary have a low resilience value, and that any combination of different hazard, vulnerability and resilience values can be identified in an area or community. The interaction between these levels is important to understand and interpret the results (and limitations) of the DRA.

5.3 The use of Geographic Information System (GIS)

Extensive use is made of a Geographical Information System (GIS) during the DRA process. This section provides an overview of the GIS approach for the risk assessment for the Eastern Cape.

5.3.1 What is a Geographic Information System (GIS)?

A Geographical Information Systems (GIS) is an information system which hosted on a computer whereby colected data is stored, managed, analysed and displayed spatially whilst also being geographically referenced.. It consists of various components, including data, people, hardware, software and processes. Data related to the hazard, vulnerability, and resilience levels of a specific area or feature is also mostly related to a specific geographical location which is then presented in a GIS.

The level of disaster risk in a specific area depends on a range of interrelated factors. Amongst these factors are the spatial extent and distribution of the HVR's related features. A GIS is therefore ideally suited to undertake the DRA modelling and presentation of results.

To present the various HVR's-levels spatially, various individual GIS data layers will be created. These data layers are used to calculate and spatially represent the risk levels in this study area. This process is represented below:

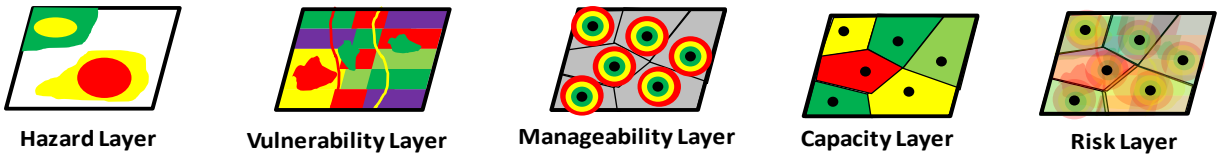

Figure 5-2: Data Layers to be used in the Disaster Risk Modelling

Even though the Spatial Modelling component of the Risk Assessment process involves a more complex process of inputs and outputs, the basic process is related to the principle described in the previous section. In the simplest form, the Risk Assessment Process involves the following steps:

- Input;
- Processing; and
- Output.

Input used in the Risk Assessment process relates to the collected spatial and non-spatial data, and information. These are further supplemented and refined by using inputs received from participants and stakeholders through the workshops and consultation sessions.

Processing involves the capturing, transforming/projecting, format changing, quality control/checking and calculation in both the spatial (GIS) and non-spatial environments. It also includes re-visiting aspects that may have been collected during the input stage which may need clarification, i.e., data based on certain stakeholder perceptions or spatial data that may need to be adjusted or edited.

Output is mostly in the form of descriptions, values or ratings and is presented in the report in the form of qualitative descriptions, quantitative tables and figures. Maps will be presented as an integral part of the output since it will clearly identify areas and communities at risk.

5.3.2 Software

The risk assessment includes a spatial disaster risk modelling process. This modelling process was conducted by making use of ESRI's ArcGIS10.6.1™ software and its Spatial Analyst Extension.

5.3.3 Data distribution

All hazard, vulnerability and resilience data generated during the execution of this project will be made available to EC GoGTA as an ArcGIS Map Package. The map package will enable EC CoGTA to view edit and redistribute all spatial data generated for this project.

5.4 Hazard severity indices and mapping

This section describes the technical aspects and approach used to conduct the hazard assessment and profiling for the Eastern Cape Province.

5.4.1 Hazards description and categories

The National Disaster Management Framework provides a list of hazards to be considered during a DRA.

The hazards considered during a DRA is shown in Table 5-1:

Table 5-1: Classification of hazards according to the National Disaster Management Framework

Natural hazards	Examples
Geological	Landslides, rockslides, liquefaction, subsidence
Biological	Epidemic diseases affecting people or livestock, veld fires, plant infestations
Hydro meteorological	Floods, debris flows, tropical cyclones, storm surges, severe storms, drought, desertification
Technological hazards	Examples
	Industrial pollution, nuclear activities, toxic waste, dam failure, transport accidents
Environmental hazards	Examples
Environmental degradation	Land degradation, deforestation, loss of biodiversity

For the purpose of the DRA for the Eastern Cape Province, Table 5-1 was further refined and expanded, and the hazard categorization provided in Figure 5-3 was used.

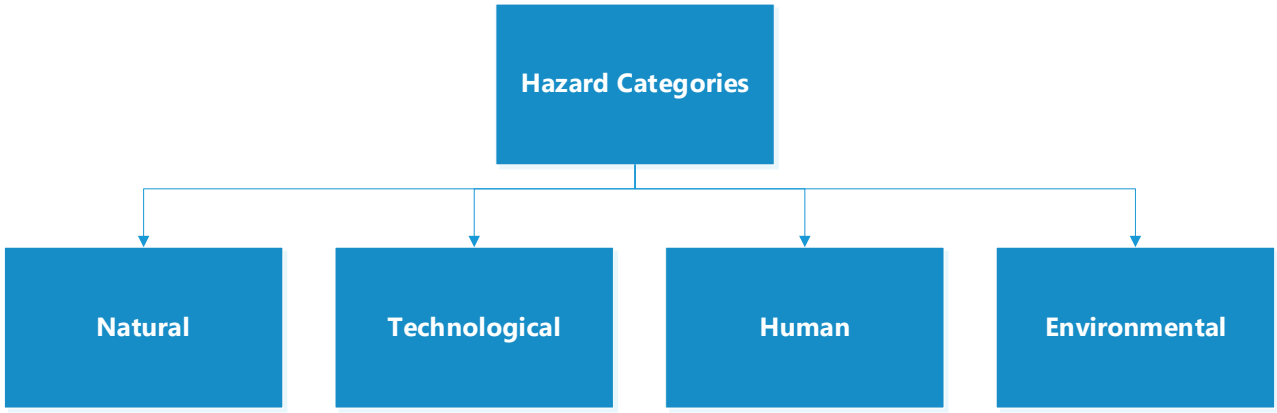

Figure 5-3: Hazard Categories

Each of these main hazard categories comprise of several individual hazards. To facilitate reporting as well as the creation of maps, these individual hazards were grouped into 'Combined Hazard Categories'. These categories are shown in Table 5-2:

Table 5-2: Hazards considered during the DRA

No	Hazard category
1	Civil Unrest - Armed Conflict (Civil/Political War)
2	Civil Unrest - Crime
3	Civil Unrest - Demonstrations / Riots
4	Civil Unrest - Refugees / Displaced People
5	Civil Unrest - Terrorism

No	Hazard category
6	Civil Unrest - Xenophobic Violence
7	Disease / Health - Disease: Animal
8	Disease / Health - Disease: Human
9	Disease / Health - Disease: Plants
10	Environmental Degradation - Deforestation
11	Environmental Degradation - Erosion
12	Environmental Degradation - Land Degradation
13	Environmental Degradation - Loss of Biodiversity
14	Fire Hazards - Formal & Informal Settlements / Urban Area
15	Fire Hazards - Veld/Forest Fires
16	Geological Hazards - Earthquake
17	Geological Hazards - Landslides/Mud flows
18	Geological Hazards - Rock-fall
19	Geological Hazards - Subsidence
20	Hazardous Material - Fire/Explosion (Storage & Transportation)
21	Hazardous Material - Spill/Release (Storage & Transportation)
22	Hydro-meteorological - Drought
23	Hydro-meteorological Hazards - Desertification
24	Hydro-meteorological Hazards - Extreme Temperatures
25	Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)
26	Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)
27	Infestations - Algal Bloom (Red Tide)
28	Infestations - Animal Infestation / Over Population
29	Infestations - Insect Infestation
30	Infestations - Plant Infestations (Intruder Plants)
31	Infrastructure Failure / Service Delivery Failure - Electrical
32	Infrastructure Failure / Service Delivery Failure - Gas
33	Infrastructure Failure / Service Delivery Failure - Information Technology
34	Infrastructure Failure / Service Delivery Failure - Sanitation
35	Infrastructure Failure / Service Delivery Failure - Transport
36	Infrastructure Failure / Service Delivery Failure - Water
37	Major Event Hazards - Cultural / Religious
38	Major Event Hazards - Political
39	Major Event Hazards - Recreational / Commercial
40	Major Event Hazards - Sport
41	Oceanographic - Sea Level Rise (Climate Change)
42	Oceanographic - Storm Surge
43	Oceanographic - Tsunami
44	Other - Space Objects

No	Hazard category
45	Pollution - Air Pollution
46	Pollution - Land Pollution
47	Pollution - Water Pollution (Fresh and Sea)
48	Structural Failure - Bridge Failure
49	Structural Failure - Building Failure
50	Structural Failure - Dam failure
51	Transport Hazards - Air Transportation
52	Transport Hazards - Rail Transportation
53	Transport Hazards - Road Transportation
54	Transport Hazards - Water Transportation (Incl Marine Accident)

5.4.2 Approach to hazard profiling

It is important that indigenous knowledge relating to disaster management should be included in Disaster Management Planning, as well as in DRA. However, indigenous knowledge, especially when related to the occurrences of hazard events and disasters, might sometimes be based on a particular individual's perception and memory, and might therefore not always be entirely accurate. It is therefore often valuable to verify indigenous knowledge in a group set-up, where information can be discussed and verified by more than one member of a specific community. Alternative sources of information such as incident reports and statistics can provide a formal record of events. However, formal records might not always be available, or statistics might be captured incorrectly and not always illustrate or consider all factors related to specific events (Adams 2001).

For this assessment and related hazard profiling, three approaches were used to compile the hazard profile of the Eastern Cape Province. These approaches were:

- Hazard profiling through individual and workshop consultations and group discussions to collect specialist and indigenous knowledge with regards to hazards in the Eastern Cape Province;
- Desk-top hazard profiling using statistics, reports and base data (where available); and
- GIS Based hazard profiling using GIS base data to identify hazards based on local conditions in the Eastern Cape Province (where available).

The results of these three approaches were compared and are presented in the relevant sections of this report.

5.4.3 Hazard profiling through individual and workshop consultation sessions

All hazard data was collected during individual and workshop consultations sessions. The information collected during these workshops and consultations was captured in an electronic format and used to calculate indicative hazard ratings for the various identified hazards. This was done by assigning specific ratings and weights to the various hazard characteristics. The Hazard Assessment Tool (HAT) from the NDMC were studied and the principles were incorporated into the methodology used.

The hazard characteristics used in the calculation of the indicative hazard ratings, based on stakeholder perceptions, were:

- Probability factor:
  - Frequency
  - Perception of Increase in Hazard Events
  - Seasonal / Monthly Occurrence of Hazard

- Severity factor
  - Perceived impact of Hazard on
    - People
    - Infrastructure
    - Environment
    - Economy

The results from this assessment are discussed in the relevant section of this report.

5.4.4 Desk-top hazard profiling

The desktop risk assessment was conducted based on information abstracted from various data sources and statistics. The desktop risk assessment calculated the relative risk levels associated with each of the identified hazards, for each of the metro and district municipalities. To calculate relative risk levels, the risk assessment model made use of the following components:

- **Vulnerability:** Vulnerability levels for each of the local municipalities were based on:
- Level of access to water;
- Level of access to sanitation;
- Level and access to refuse removal services;
- Dwelling types;
- Sources of energy;
- Age profile of the community; and
- Income levels of the community.
- **Impact:** The impact of each typical hazard event was estimated, based on:
- Impact on people;
- Impact on buildings;
- Impact on infrastructure;
- Impact on the environment;
- Size of area generally affected by hazard event; and
- The general period over which the impact is caused.
- **Frequency:** The estimated frequency of the hazard event;
- **Possibility:** The possibility of the event occurring; and
- **Exposure:** The level to which the metro and district municipalities is exposed to the specific hazard.

The results received from the desktop assessment were compared with the results from the GIS modelling, previous assessments and stakeholder perception value, and all this information was used to compile the final risk ratings for the Eastern Cape Province.

5.4.5 GIS based hazard profiling

Hazard profiles were also presented spatially by making use of a GIS. This was done by considering the land-use/land-cover data of the Eastern Cape Province, and then mapping specific hazards associated with the different land-use/land-cover categories as well as features in the Eastern Cape. The hazard mapping and buffering guidelines (explained in the text throughout the document) Information received from stakeholders, as well as conclusions made from base data were included in the GIS hazard mapping.

5.4.6 Finalizing the hazard profile

Figure 5-4 provides a summary of the process followed during the hazard assessment as part of DRA.

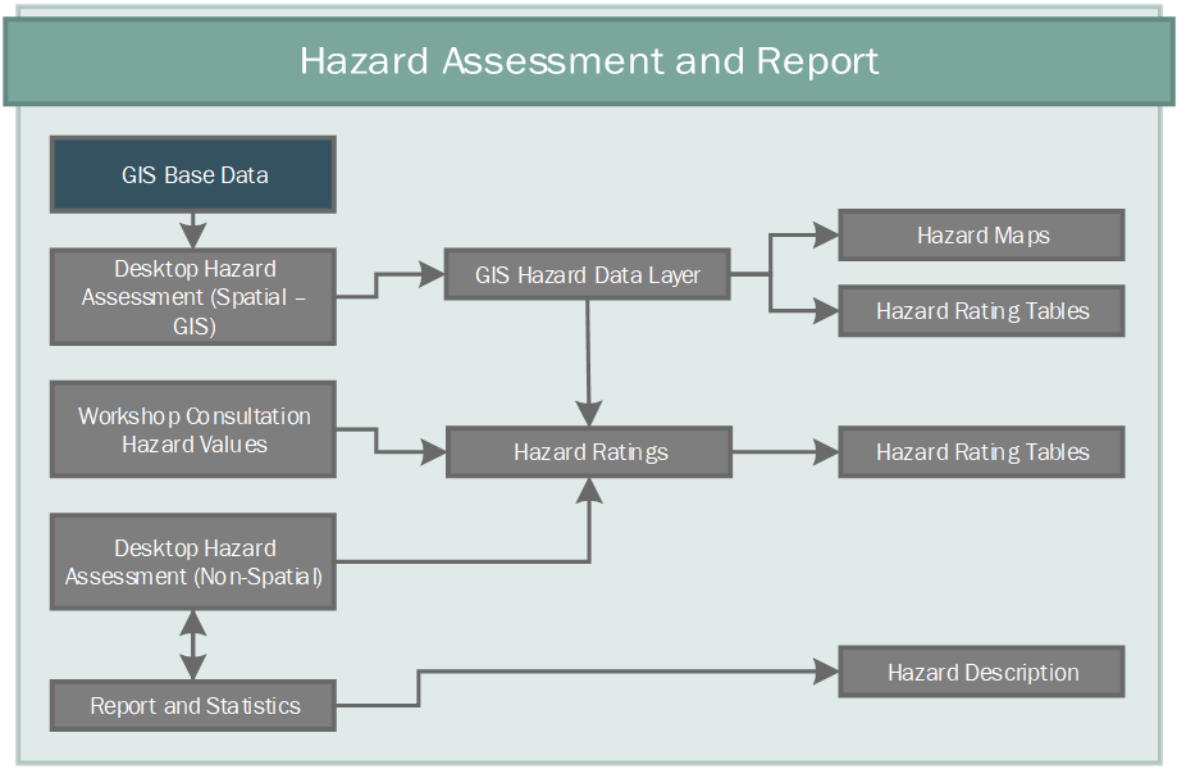

Figure 5-4: Hazard assessment and reporting approach

5.5 Vulnerability indices and mapping

Vulnerability assessments and reporting form part of the DRA process. The vulnerability profiling for the Eastern Cape Province consists of three processes. These processes are discussed in the following sections.

5.5.1 General vulnerability description

The initial step was to describe the general vulnerability indicators identified for the Eastern Cape Province. This mainly includes census 2011 information. Following this assessment, the vulnerability of the Eastern Cape Province as described is compared to key indicators of neighbouring municipalities and areas.

5.5.2 Vulnerability rating

The second approach to vulnerability mapping in the Eastern Cape Province involves the classification of land-use/land-cover data, environmental status and social statistics to create a single vulnerability rating. Land-use data was used to classify the vulnerability of various land-uses within the study area to the effects of different types of hazards. The vulnerability of the various areas in the Eastern Cape Province was classified in terms of social, structural, environmental and economic vulnerability. The results of this vulnerability profiling are discussed in Section 8.

5.5.3 Finalizing the vulnerability profile

Figure 5-5 presents an overview of the process generally followed to conduct the vulnerability assessment as part of a DRA.

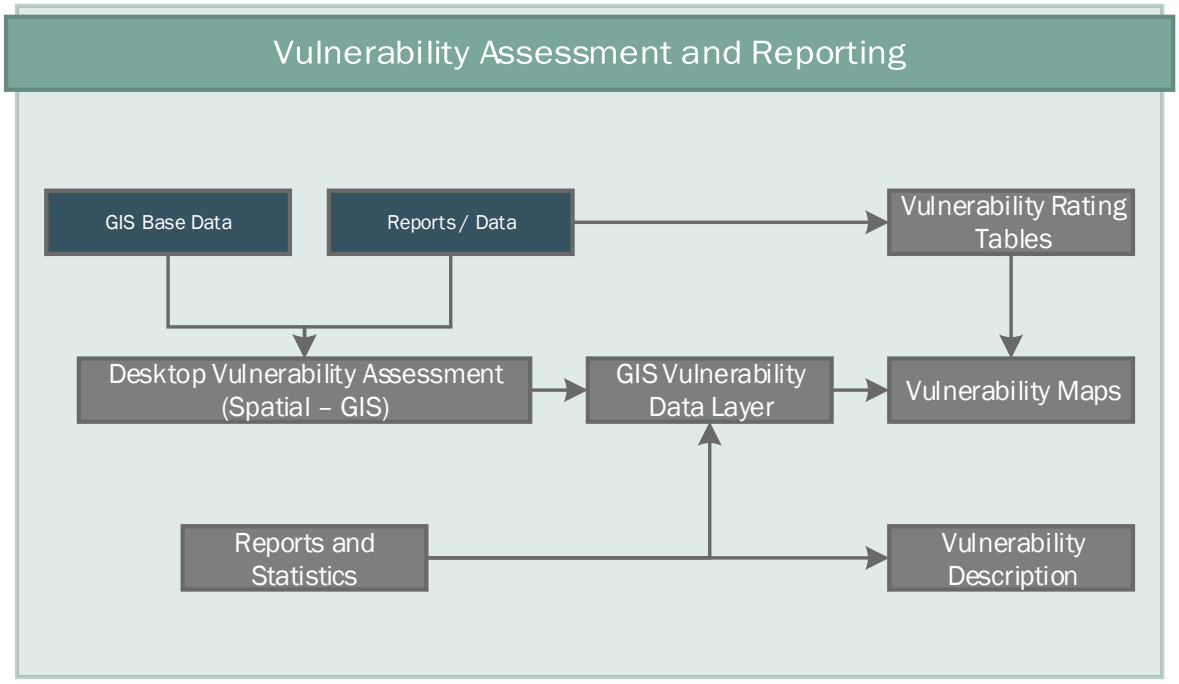

Figure 5-5: Overview of the process followed to conduct the vulnerability assessment as part of a DRA

The results from this vulnerability assessment are discussed in Section 8.

5.6 Resilience indices and mapping

Resilience mapping was required as part of this assessment. Resilience mapping refers to the mapping of a combination of the Manageability and Capacity levels within the study area. The resilience assessment consisted of two main activities. The first activity relates to the resilience profiling based on input received from stakeholders. The second activity was GIS based resilience mapping, based on the location of resilience-related facilities in the Eastern Cape.

5.6.1 Resilience profiling through stakeholder consultation

During the stakeholder consultation workshops and interviews, representatives from the relevant Districts, Metros and departments were provided with the opportunity to give inputs regarding hazards and their own organization's capacity to fulfil their responsibility in terms of disaster management activities. The representatives were provided with a questionnaire, whereby they were requested to rate the capacity of their own line function/department in terms of the capacity to conduct the required day-to-day, disaster risk reduction as well as disaster response activities.

Representatives were asked to rate their capacity in terms of the following aspects:

- Staff/Human Resources;
- Expertise, Experience & Specialist Knowledge;
- Vehicles;
- Equipment;
- Funding/Budget;
- Facilities/Buildings;
- Risk Reduction Plans, Policies & Programmes; and
- Response Plans, Policies & Programmes.

Representatives were further requested to rate the above-mentioned categories in terms of one of the following ratings:

"1" I**nsufficient** level of resources, equipment, or plans to fulfil disaster management related responsibilities;

"2" **Sometimes incapable of coping** level of resources, equipment, or plans to fulfil the disaster management related responsibilities;

"4" **Just sufficient** level of resources, equipment, or plans to fulfil the disaster management related responsibilities; and

"5" **More than sufficient** level of resources, equipment, or plans to fulfil the disaster management related responsibilities.

Representatives were given the opportunity to identify and describe specific prerequisites their organization has to reduce disaster risk or to ensure a more effective response to disasters. It should, however, be noted that the results achieved during the capacity self-evaluation was based only on the feedback received from the representatives and was not subjected to additional confirmation and verification.

The result of this assessment was used to calculate average resilience values for each of the role players and the results are discussed in Section 9.1.

5.6.2 GIS based resilience profiling

To model the disaster risk in the Eastern Cape Province spatially, it was required to present the resilience values spatially. This was done by making use of the location of key line-functions, and to present approximate service areas spatially. The basis of this approach relates to the assumption that communities that are in proximity of facilities such as hospitals, police stations and fire stations, might have relatively more access to services than communities located remotely from facilities. Based on this, it was therefore assumed that communities closer to facilities will have a comparatively higher resilience value, than communities that were located further away from facilities. An example of resilience mapping based on the location of key facilities (SAPS) is shown in Figure 5-6.

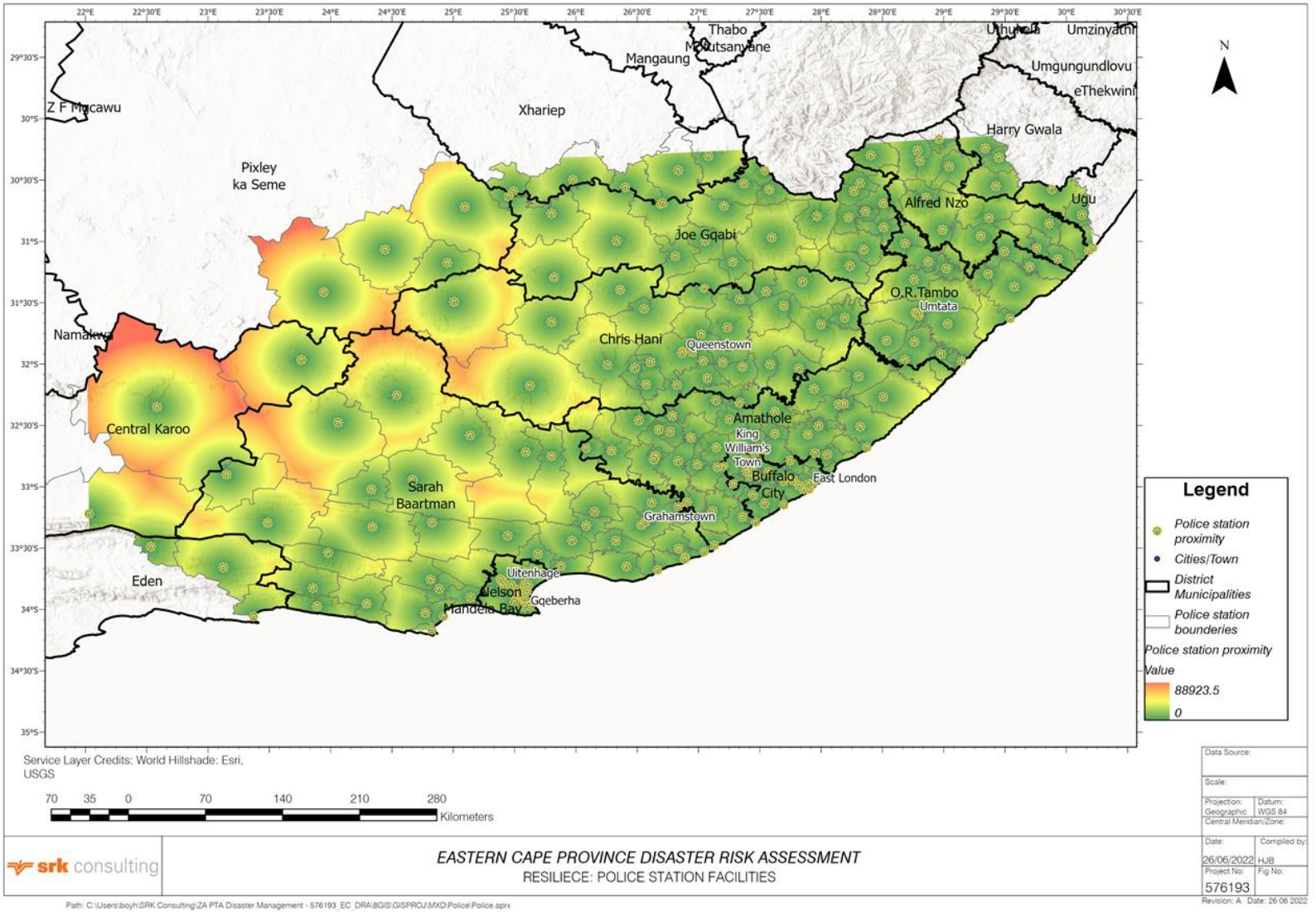

Figure 5-6: Example resilience profile of SAPS in the Eastern Cape

5.6.3 Finalizing the resilience profile

The resilience profile (consisting of Capacity & Manageability data) for the Eastern Cape Province consisted of two deliverables:

- The first deliverable is the description of the various resilience role players as contained in Section 9; and
- The second deliverable is the Combined Resilience map as shown in Section 9.2.

These components must not be considered as stand-alone resilience profiles of the Eastern Cape Province but should be considered together to analyse and understand the holistic resilience profile of the Eastern Cape Province. An overview of the process followed to compile the resilience profile is shown in Figure 5-7.

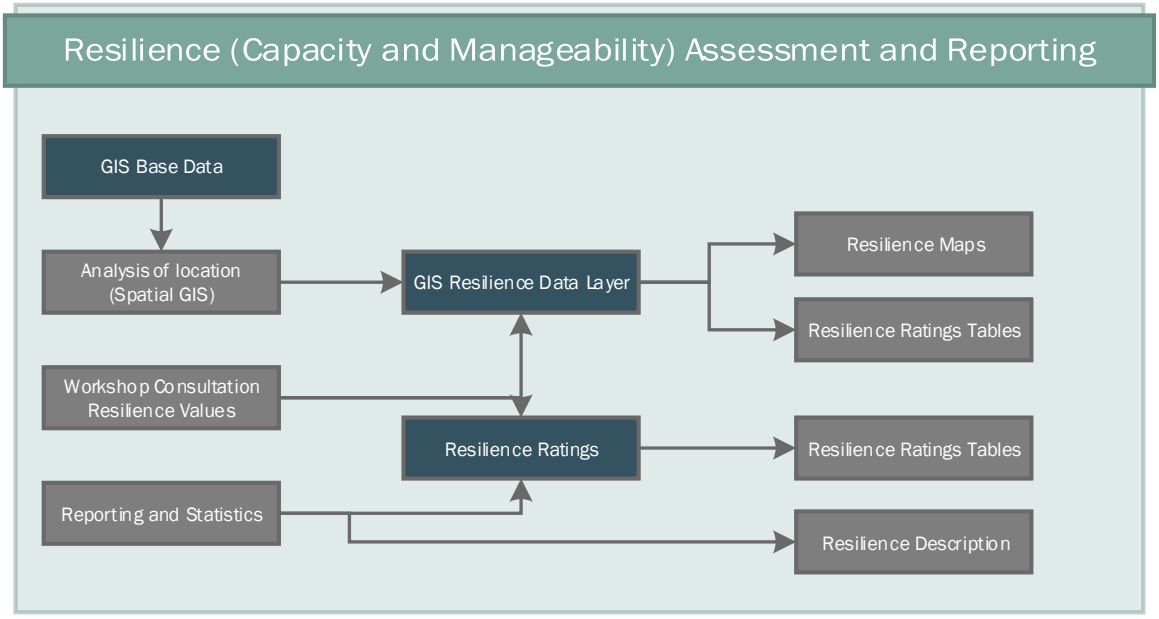

Figure 5-7: Resilience assessment and reporting approach for the Eastern Cape

The results from this resilience assessment are discussed in Section 0.

5.7 Risk profiling and rating

The final risk values were calculated by making use of the defined risk formula and combining the appropriate HVR's values and data layers. The result of this process is the prioritized risk profile contained in Section 11

5.7.1 Interpreting the results

The deliverables from the Risk Assessment include, amongst other items, various maps and tables. In addition to ratings, colour coding is also used to represent various hazard, vulnerability, resilience or risk levels.

In interpreting the maps and tables, it is important to consider the following:

Tables – The tables represent the quantitative results of the various calculations and provide a tool for comparing different levels of the hazard, vulnerability or resilience values. In most cases, the tables are also colour coded, with Red indicating a negative value (High Hazard, Vulnerability or Risk), with Green indication a positive value (Low Hazard, Vulnerability or Risk).

Maps – The results contained in the maps provides a spatial representation of the various Hazard, Vulnerability, Resilience and Risk levels. For example, Road Transport Hazards may be high on major routes. It should however be stated that maps represent only a spatial representation of the component under investigation, and different maps should generally not be compared with one another. For example, a Red Hazard Rating on a Fire Hazard map should not be compared with a Red Hazard Rating for Transportation

Hazards. The rating only relates to the relative intensity and spatial occurrence of the hazard. All comparison should be done based on the provided prioritization table which was compiled for the Eastern Cape Province.

Table 5-3: Rating classifications in reporting tables and maps

Colour	Hazard	Vulnerability	Resilience	Risk	Priority
Red	A high hazard rating, causing an increased risk	A high vulnerability rating, causing an increased risk rating	A low resilience rating, causing an increased risk	A high-risk rating	Higher Priority, mitigation or treatment options should be implemented over a shorter term
Yellow	A medium hazard rating	A medium vulnerability rating	A medium resilience rating	A medium risk rating	Medium Priority, mitigation or treatment measures should be implemented over the medium term
Green	A low hazard rating, causing a decreased risk	A low vulnerability rating, causing a decreased risk rating	A high resilience rating, causing a decreased risk rating	A low-risk rating	Lower Priority, mitigation or treatment measures should be implemented over a longer term

It is important to consider that the highest risk rating will be achieved in an area where the Hazard and Vulnerability levels are high, while the Resilience levels are low. This interaction between the three components should be considered to determine the risk level within any area under investigation.

5.8 Assumptions and limitations

5.8.1 Data limitations and challenges

It should be noted that SRK are not custodians of any of the project data and therefore cannot guarantee the accuracy of data received from the data custodians consulted during this project or any of the stakeholders involved.

Where multiple sets of the same data were collected, the data was evaluated, and the most accurate or most recently updated data was used.

It should also be considered that most spatial objects are dynamic, and changes occur over time. Changes in land use for instance can have major implications on the modelling results as both a large amount of hazard information and vulnerability information is based on land cover and land use data.

It must therefore also be considered that the modelling of disaster risk is a dynamic process that needs to be updated regularly to reflect any changes in the physical environment and human settlement and activities.

5.8.2 Limitations and challenges to the methodology

Specific other limitations and challenges identified during the assessment include:

- The manageability and capacity assessment is dependent on information received from project stakeholders.
- The project scope did not allow for independent and in-depth assessment of the resilience levels of departments, line-functions or community role-players. The results from the self-evaluation were used as a basic indication of the resilience levels (capacity and manageability) and needs within the Eastern Cape. It is proposed that a more detailed and in-depth assessment of resilience be conducted.
- Resilience values are not hazard specific, but average multi-hazard resilience values for role players in the Eastern Cape were used.

It is proposed that, should additional funds be available, a more detailed hazard-specific resilience assessment be conducted in the Eastern Cape Province.

6 Status quo assessment of the Eastern Cape Province

The current characteristics of the Eastern Cape Province were considered during the Risk Assessment process. This section focuses on the characteristics of the Eastern Cape and investigates how the current situation impacts on disaster risks in the Eastern Cape.

6.1 Geographical setting

The Eastern Cape is the second largest province in South Africa. It is located on the south-eastern tip of South Africa. The province borders provinces KwaZulu Natal to the North-eastern side, Free State to the North and the Western Cape) to the West. Eastern Cape also borders Lesotho. This province of diverse landscapes is divided into six district municipalities and two metropolitan municipalities The Eastern Cape is mostly rural and is among the country's poorest provinces (Statistics South Africa, 2017) Approximately 93% of the population resides in dispersed homesteads and small villages (Eastern Cape Provincal Government, 2021). This thus indicates an increased need and potential for development within the province. Development is usually associated with risks of various hazards and needs to be carried out using the Risk Informed Development (RID) approach. This way, development contributes towards risk reduction, avoids creation of new risks and building resilience (UNDP, 2019) (GNDR, 2022)

There are 6 District and 2 Metropolitan Municipalities that fall under the Eastern Cape province. Table 6-1 provides a summary of the area and population estimates (Community Survey 2016) in Eastern Cape (Statistics South Africa, 2017)

Table 6-1: Summary of the Eastern Cape Province

Municipality	Population Estimate 2016	Area in km^2
BUF: Buffalo City	834997	2750.281
DC10: Sarah Baartman	479923	58245.229
DC12: Amathole	880791	21117.164
DC13: Chris Hani	840055	36406.939
DC14: Joe Gqabi	372911	25616.946
DC15: O.R. Tambo	1457384	12141.235
DC44: Alfred Nzo	867864	10731.218
NMA: Nelson Mandela Bay	1263051	1956.957
Total	6996976	168965.969

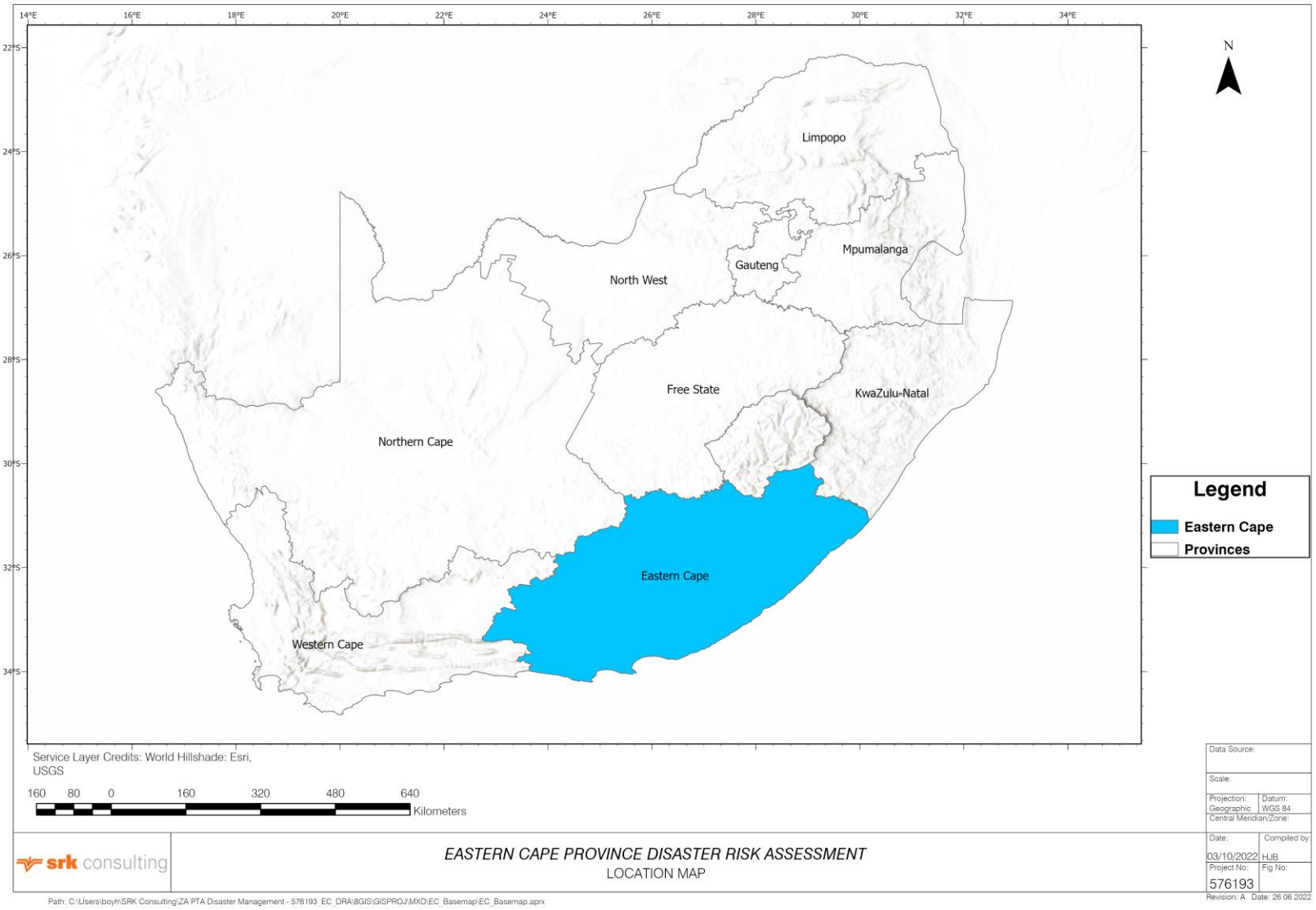

Figure 6-1: Eastern Cape locality map

6.2 Population and socio-economic characteristics

The population and socio-economic characteristics of the Eastern Cape Province provides insight into the vulnerability of communities within the province. Information related to the Eastern Cape is provided in this section.

6.2.1 Demographic characteristics

The population age groups for Eastern Cape and the District and Metropolitan Municipalities in the Eastern Cape Province based on Census 2011 results, are shown below (Statistics South Africa, 2012).

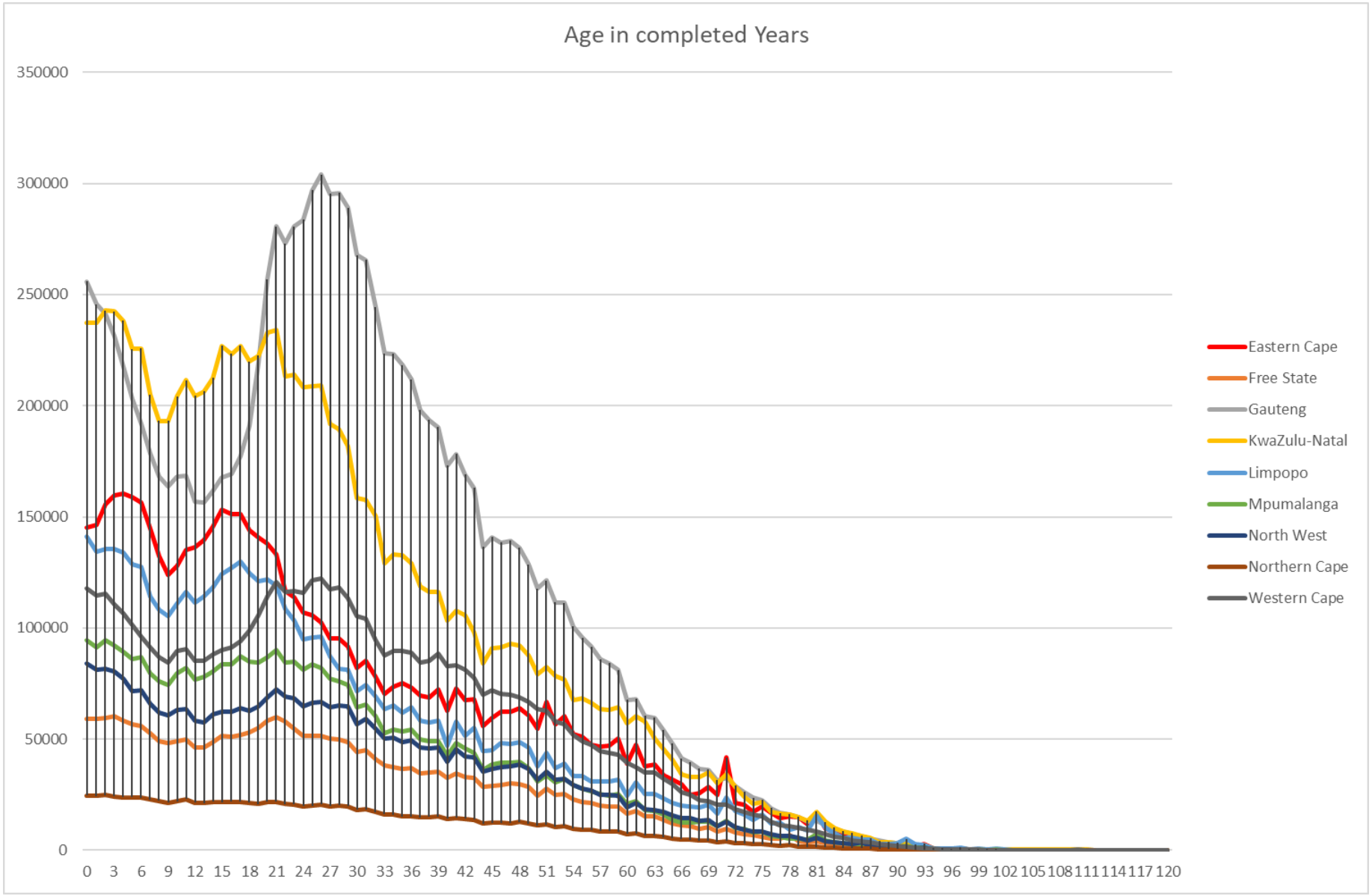

Figure 6-2: Age in completed years Eastern Cape vs Other Provinces

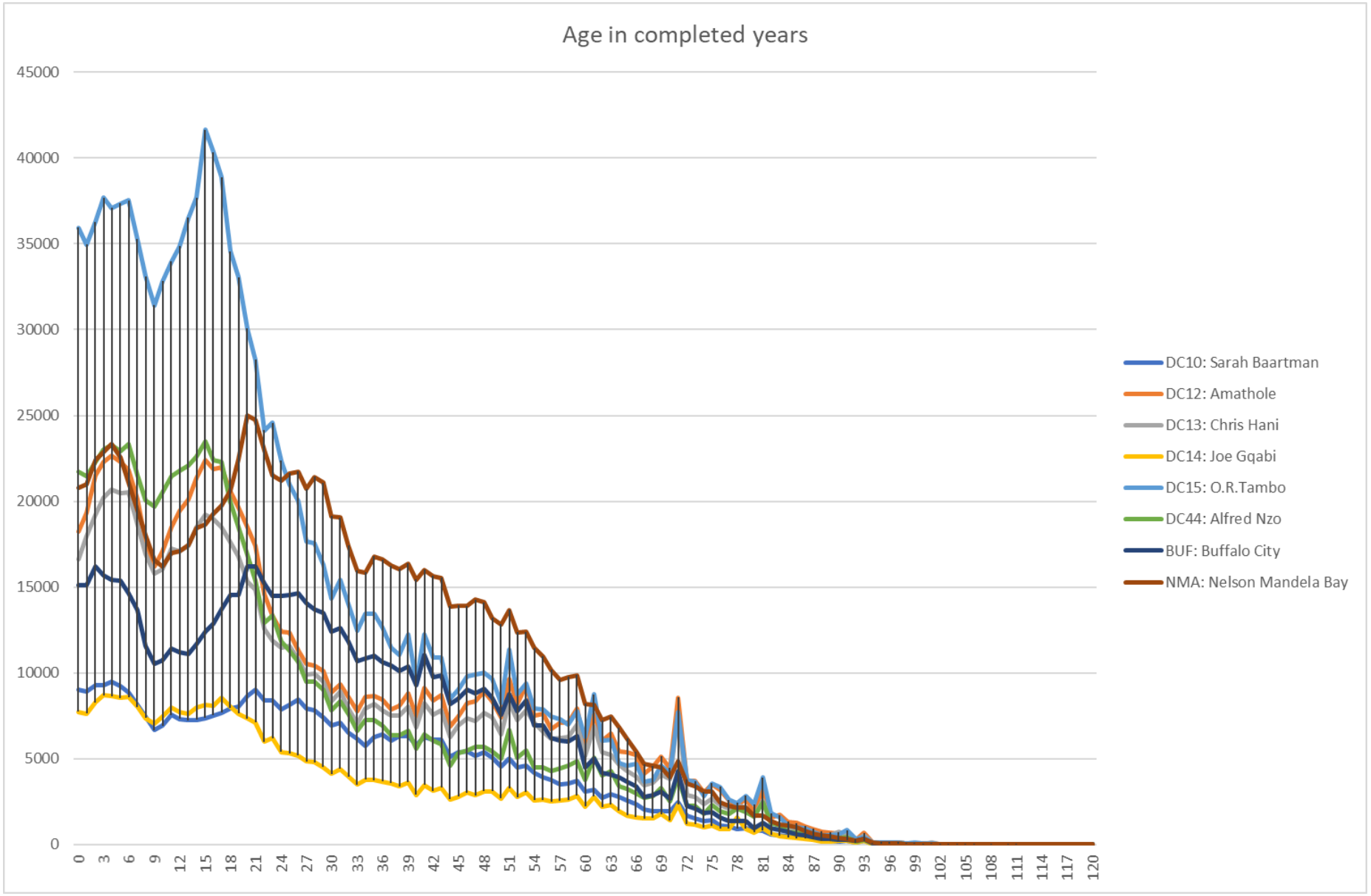

Figure 6-3: Age groups – Eastern Cape District and Metro Municipalities

The age curve shows that Eastern Cape shares a similar trend with other provinces. The comparison between Eastern Cape Districts and Metros indicates a trend where there is a high number of young people in OR Tambo District, it also seems that large numbers of youths are leaving the district in their early twenties (20's). At this point in it seems that there is an increase in Nelson Mandela Bay. This may be due to people seeking economic opportunities in the Metro.

6.2.2 Households and population

The total population of Eastern Cape is indicated to have grown from 6 562 053 in 2011 (Statistics South Africa, 2012) to an estimated 6 996 976 (Statistics South Africa, 2017) in 2016. This equates to a population growth of 6.6% over five (5) years.

The total number of households for the Eastern Cape also shown a growth from 1 687 343 to 1 773 395 (Statistics South Africa, 2012). The 2016 Community Survey Data of Statistics SA indicates a 5.1% percent increase in households in the Eastern Cape Province (Statistics South Africa, 2012).

Table 6-2: Comparison Census 2011 and Community Survey 2016 for Eastern Cape

Municipality	Census 2011			Community Survey 2016		
	Male	Female	Grand Total	Male	Female	Grand Total
Alfred Nzo District Municipality	366 488	434 857	801 344	397 206	470 658	867 864
Amathole District Municipality	401 735	454 058	855 793	416 355	464 46	880 790
Buffalo City Metropolitan Municipality	370 857	410 170	781 027	404 155	430 842	834 997
Chris Hani District Municipality	381 850	424 628	806 478	398 806	441 249	840 055
Joe Gqabi District Municipality	164 918	183 748	348 667	1764 44	196 467	3 729 12
Nelson Mandela Bay Metropolitan Municipality	5 529 94	599 121	1 152 115	618 528	644 523	1 263 051
OR Tambo District Municipality	630 612	735 433	1 366 045	679 882	777 502	1 457 384
Sarah Baartman District Municipality	220 246	230 338	450 584	236 120	243 803	479 923
Grand Total	**3 089 701**	**3 472 353**	**6 562 053**	**3 327 495**	**3 669 481**	**6 996 976**

The community survey data suggests a growth of population of 434923 or 6.6%

6.2.3 Education

It is a well-documented fact that children from low-income households are significantly less likely to be successful than their middle and upper-class counterparts. Studies have repeatedly shown that family income is one of the strongest predictors available for measuring success, both in the classroom and later in life.

Poor households are characterized by a lack of wage income; either because of unemployment or of low-paying employment due to lack of education, and typically rely on multiple sources of income, which help reduce risk of suffering income poverty. The provision of educational services and proper schooling is therefore a very effective method of reducing poverty and thereby reducing vulnerability and disaster risk. The educational profile of Municipalities in the Eastern Cape Province, based on the Stats SA Census 2011 is shown in Figure 6-5..

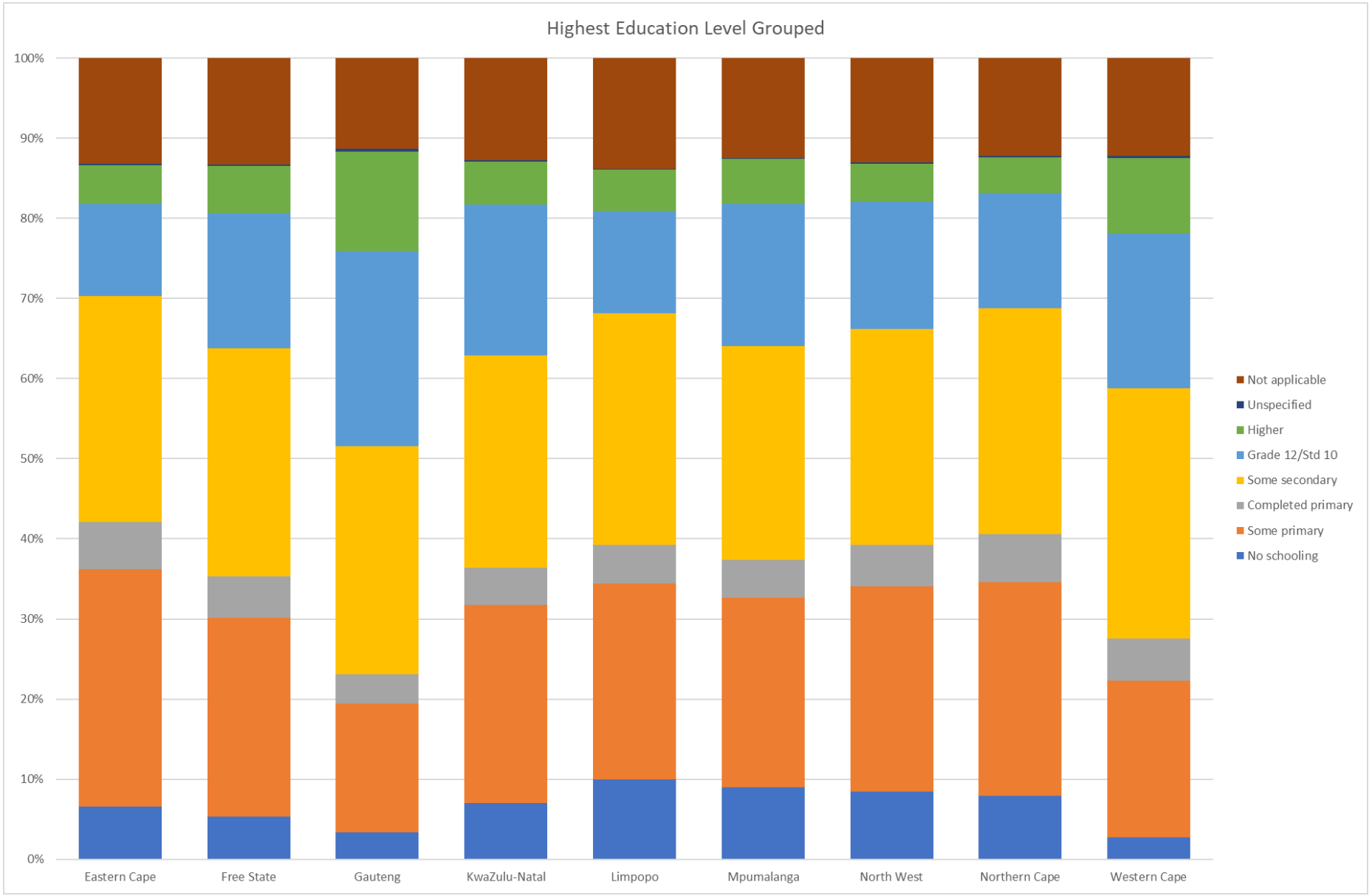

Figure 6-4: Eastern Cape compared with other provinces Highest level of education

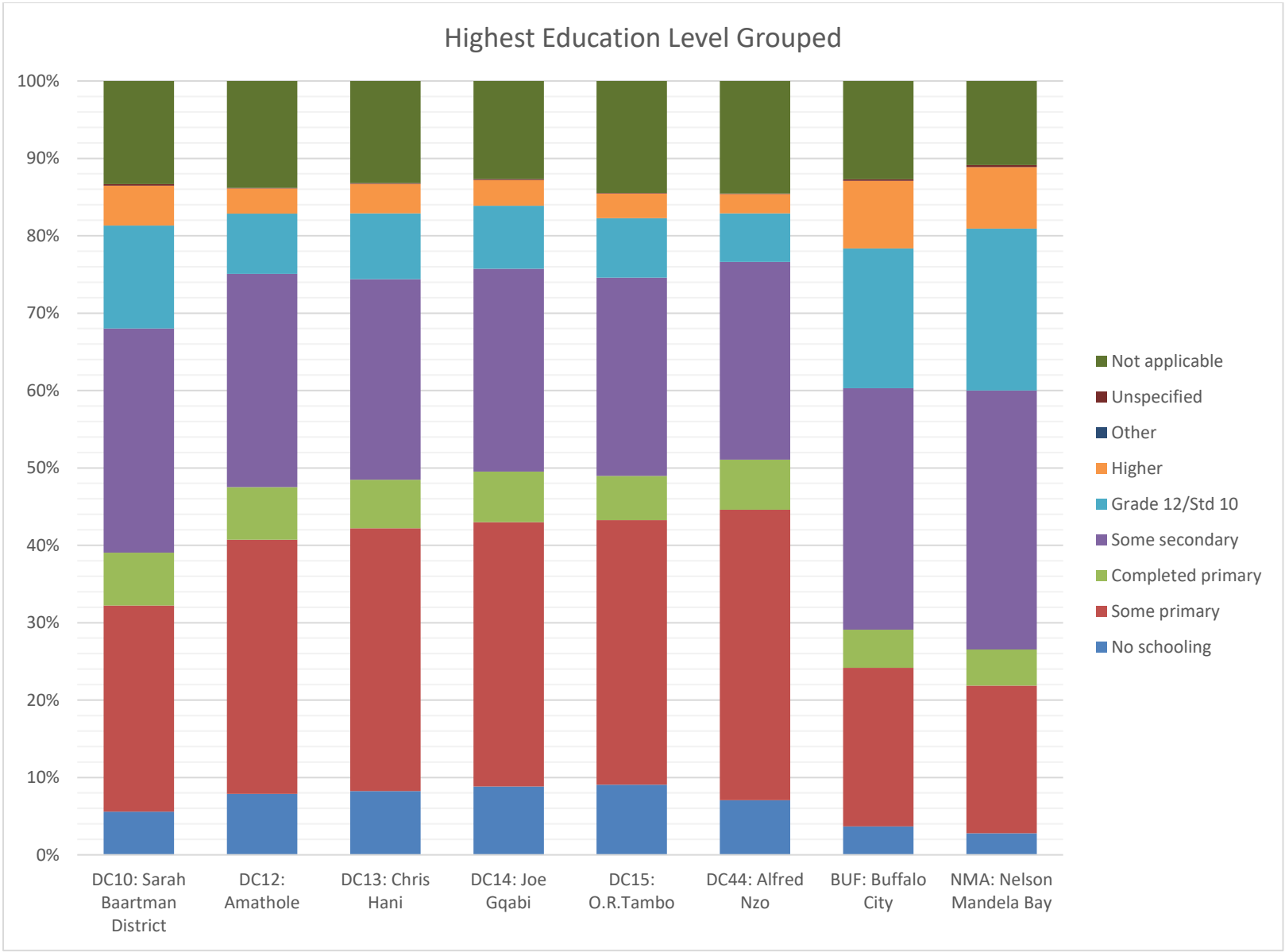

Figure 6-5: Education profile grouped for the Eastern Cape Province Municipalities

The Eastern Cape compared with other provinces has higher levels of no schooling than Gauteng and Western Cape but does show lower levels of no schooling compared to Limpopo, Mpumalanga and Northern Cape. Buffalo City and Nelson Mandela Bay does stand out among the district with noticeable higher levels of education.

6.2.3.1 Early Childhood Development

The Government of the Republic of South Africa has prioritised early childhood development (ECD) since 1994. ECD has been recognised as one of the most powerful tools for breaking the intergenerational cycle of poverty in South Africa. Overwhelming scientific evidence confirms the tremendous importance of the early years for human development and the need for investing resources to support and promote optimal child development from conception. Lack of opportunities and interventions, or poor-quality interventions, during early childhood can significantly disadvantage young children and diminish their potential for success (National Development Agency, 2017). There is a direct correlation between lacking Early Childhood Development and poverty.

6.2.4 Employment

The employment level within the province can play a significant role regarding the vulnerability of communities. Because employment is linked to the income of an individual and low income increases vulnerability, it can therefore be stated that high unemployment levels is an indicator of high vulnerability levels. According to the Eastern Cape Socio Economic Consultative Council (ECSECC) report, unemployment rate dropped to 45% with the number of employment people increasing to 1.2 Million. Unemployment in the Eastern Cape remains the highest in South Africa (ECSECC, 2021) Below is an overview of the employment levels within Municipalities in Eastern Cape Province.

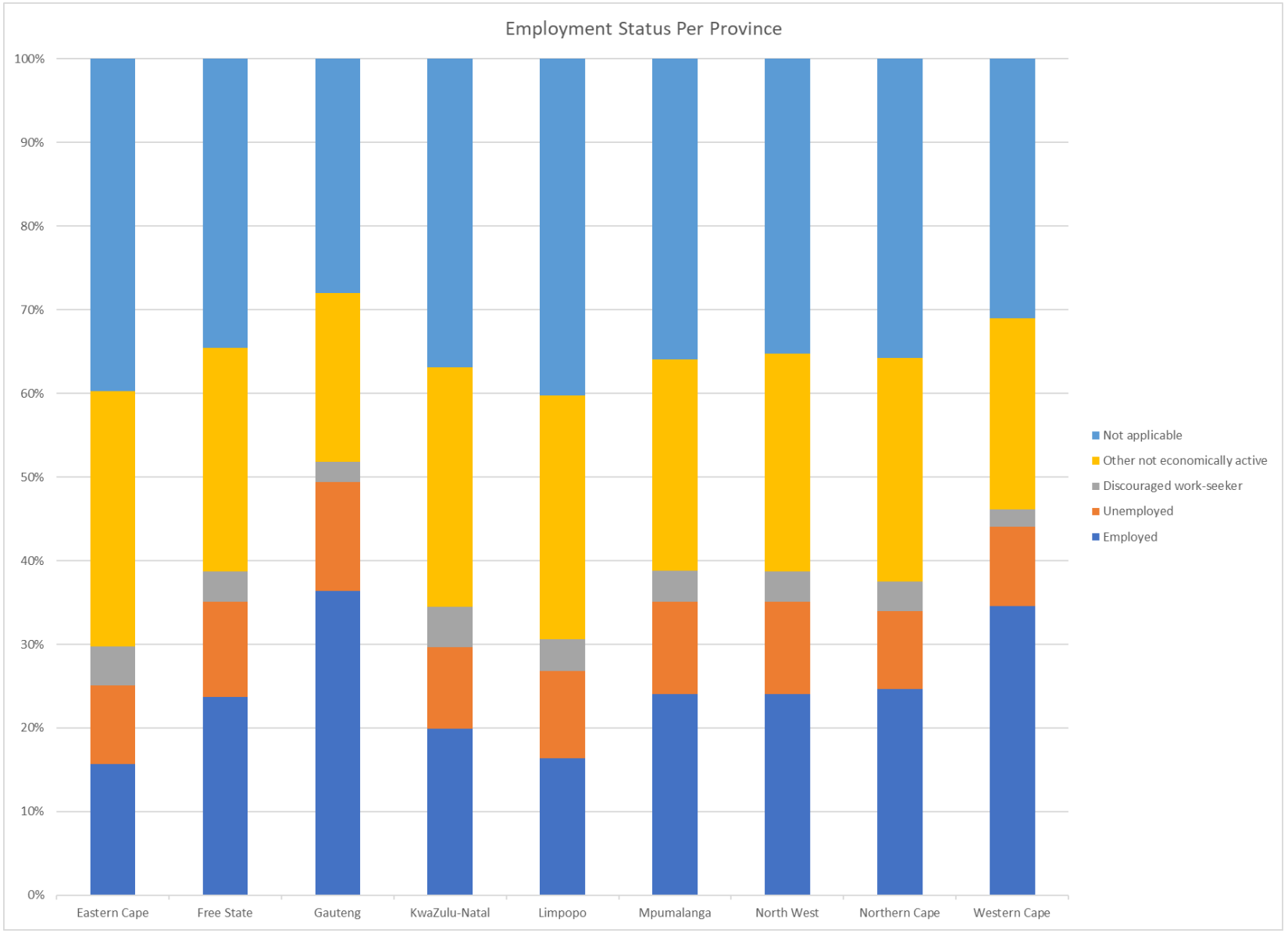

Figure 6-6: Employment profile of Provinces

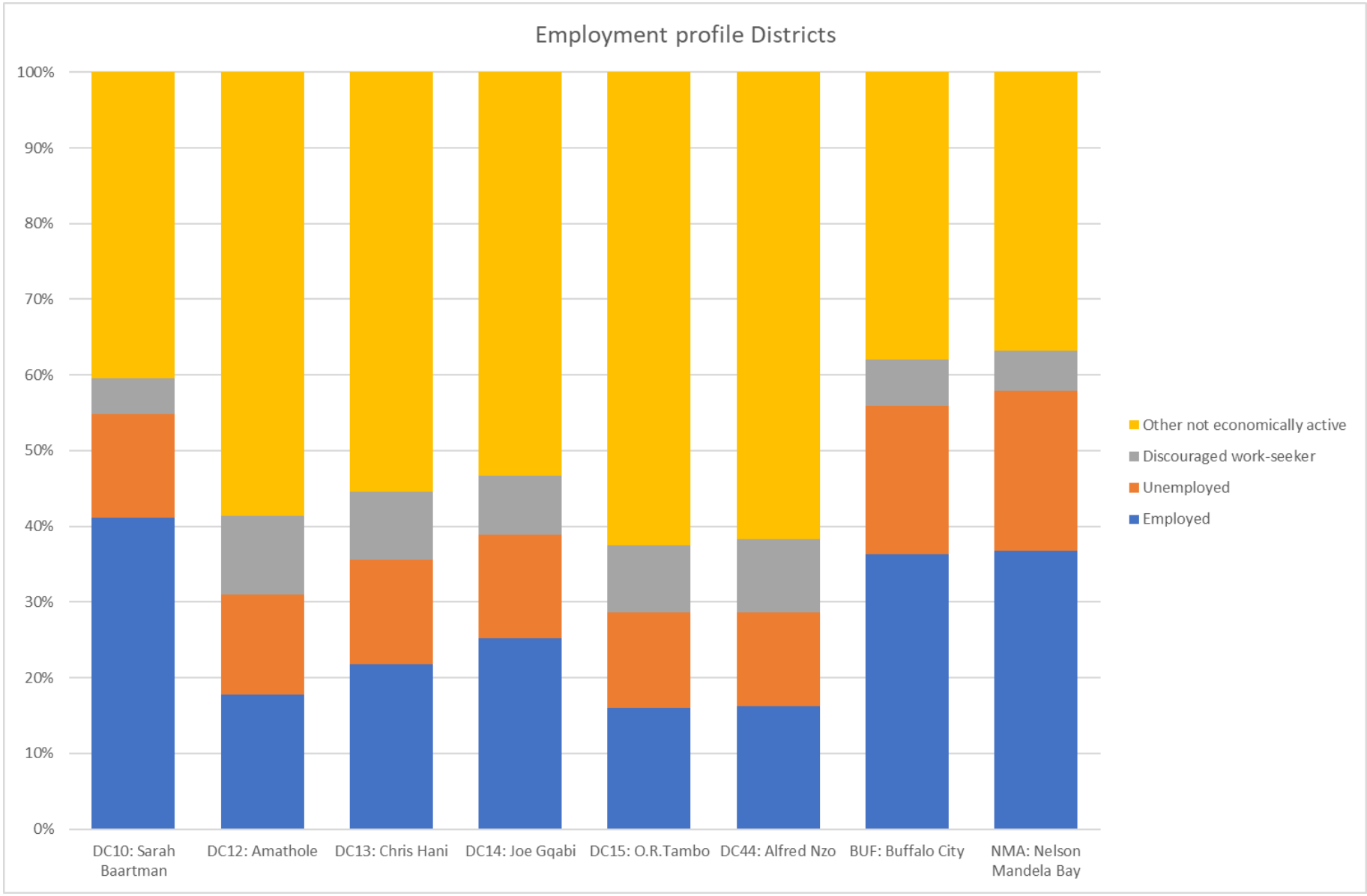

Figure 6-7: Employment profile municipalities Eastern Cape

The Eastern Cape and Limpopo Province has the lowest rates of employment of the provinces in South Africa. This can possibly be attributed to the rural nature of Eastern Cape as well as subsistence farming that is common practice in the Eastern Cape. Approximately 78% generate their income and livelihoods from subsistence farming (South African Journal of Agricultural Extension , 2020)

The percentage of "Not economically active" is relatively high throughout the districts and metro municipalities of the Easter Cape. According to Stats SA (Statistics South Africa, 2022), the term 'not economically active' is used for *'a person aged 15-64 years who are neither employed nor unemployed in the reference week. This group includes full time students, housewives, the disabled who cannot work, retired people and others who cannot work. …the term is only officially applied to those of working age, 15 to 65."*

Only 20% of the Eastern Cape population is formally employed, which indicates a highly vulnerable population from an income perspective. The Eastern Cape Provincial Development Plan further highlighted that "*too few people work*" with unemployment worsening in the economically depressed rural regions (Eastern Cape Planning Commission, 2014).

An international source gave the following comparative figures for employment rate in percentage of total population.

Table 6-3: Percentage employment for African Countries (Trading Economics, .2022)

Country	Last	Previous	Reference	Unit
Mauritius	91.3	91.9	Mar/22	%
Nigeria	66.7	72.9	Dec/20	%
Angola	61.2	60.5	Dec/21	%
Rwanda	45.5	46.5	Feb/22	%
Cape Verde	45.3	50.9	Dec/20	%
Morocco	40.2	39.1	Jun/22	%
South Africa	38.7	37.26	Jun/22	%

South Africa has one of the lowest employment rates in world and the lowest rate of the African Countries in Table 6-3 (Trading Economics, .2022)

6.2.5 Income levels

Income levels can have a substantial influence on the vulnerability and resilience of individuals in a community. The income level profile of Districts and Metro Municipalities in the Eastern Cape Province is based on the Stats SA Census 2011 (Statistics South Africa, 2012), is shown in Figure 6-9 below.

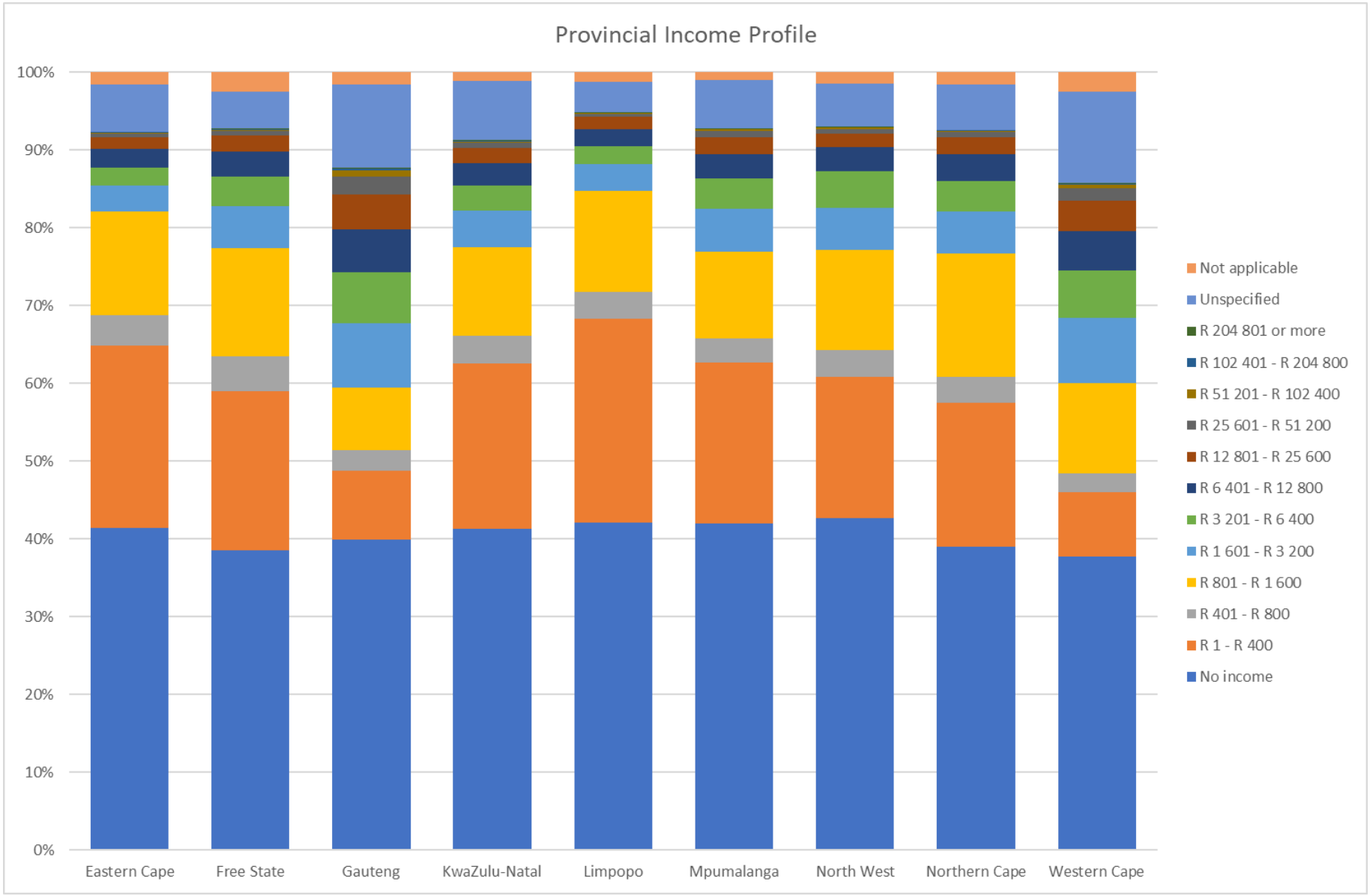

Figure 6-8: Provincial Income Profile

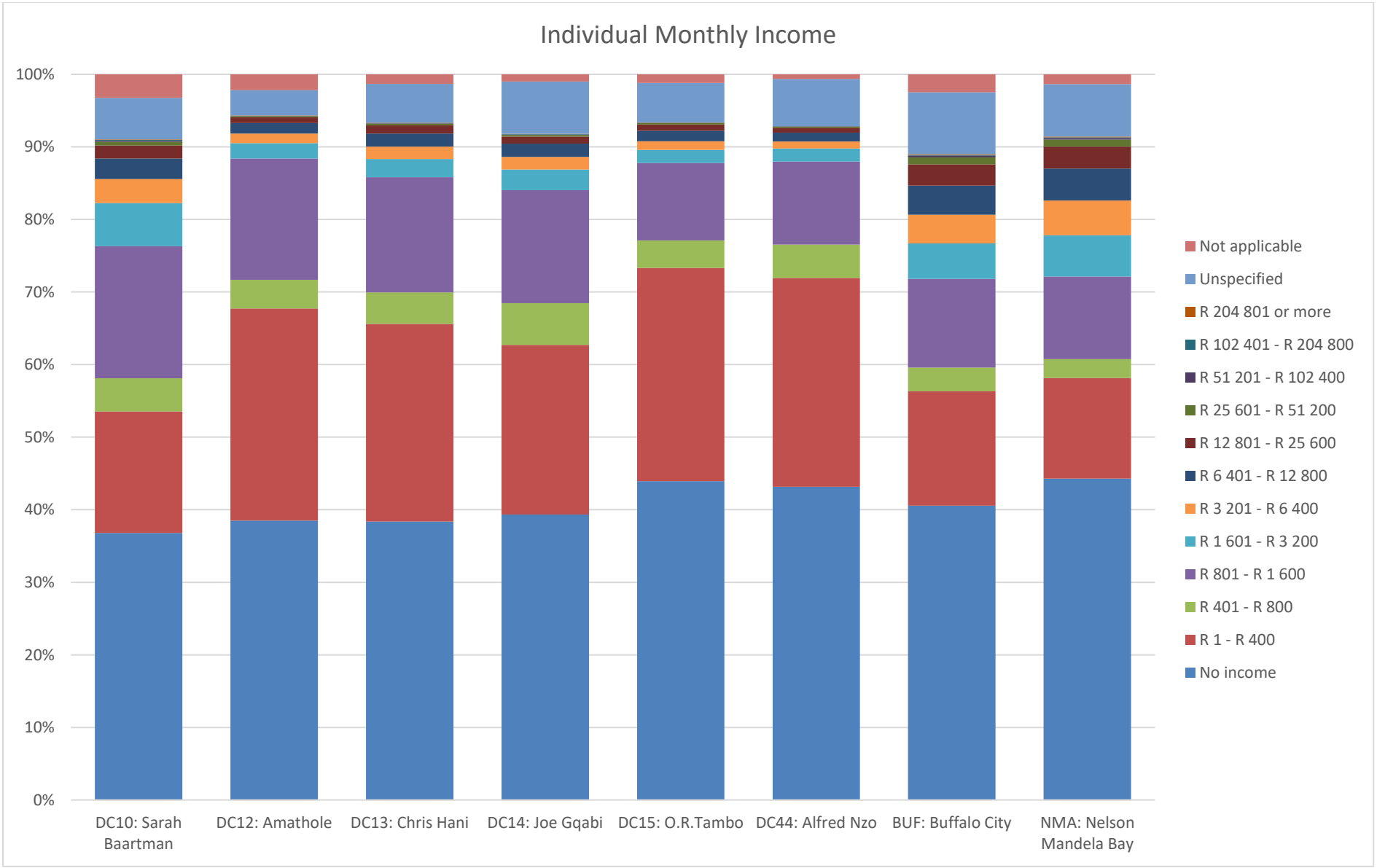

Figure 6-9: Eastern Cape Municipal Income Profile

Gauteng has higher-than-average top income sections. Eastern Cape and other provinces have a consistent no income percentage of around 40%

There is a consistent trend of at least 35% with no income, with the OR Tambo District having the highest percentage within the no income bracket (approximately 45%) followed by Nelson Mandela and Alfred Nzo in the top three.

6.3 Housing, service delivery and infrastructure

6.3.1 Housing

The availability of safe and well-constructed houses with sufficient levels of infrastructure services not only add to living quality but also reduces vulnerability levels in communities. The type and supply of housing could therefore have a big influence on vulnerability levels in a community.

Most households are in formal dwellings. However, formal dwellings in the Eastern Cape are about 14% lower than the national average according to the 2016 Community Survey. The percentage of traditional dwellings in the Eastern Cape is almost four times higher than the national average (Statistics South Africa, 2017). The housing profile of the Eastern Cape and Municipalities in the Eastern Cape Province is shown in Figure 6-11.

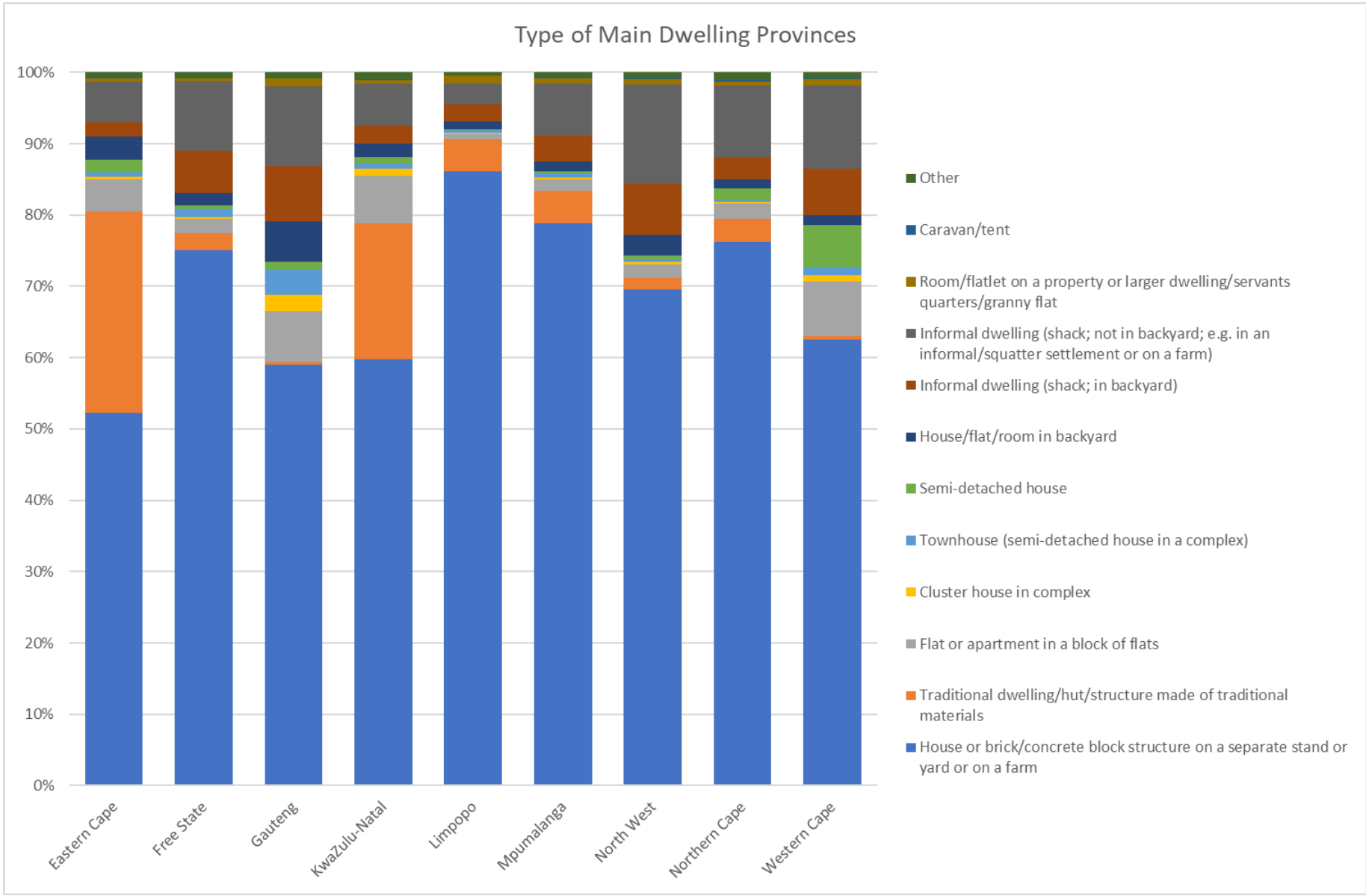

Figure 6-10: Type of Main Dwelling Provinces

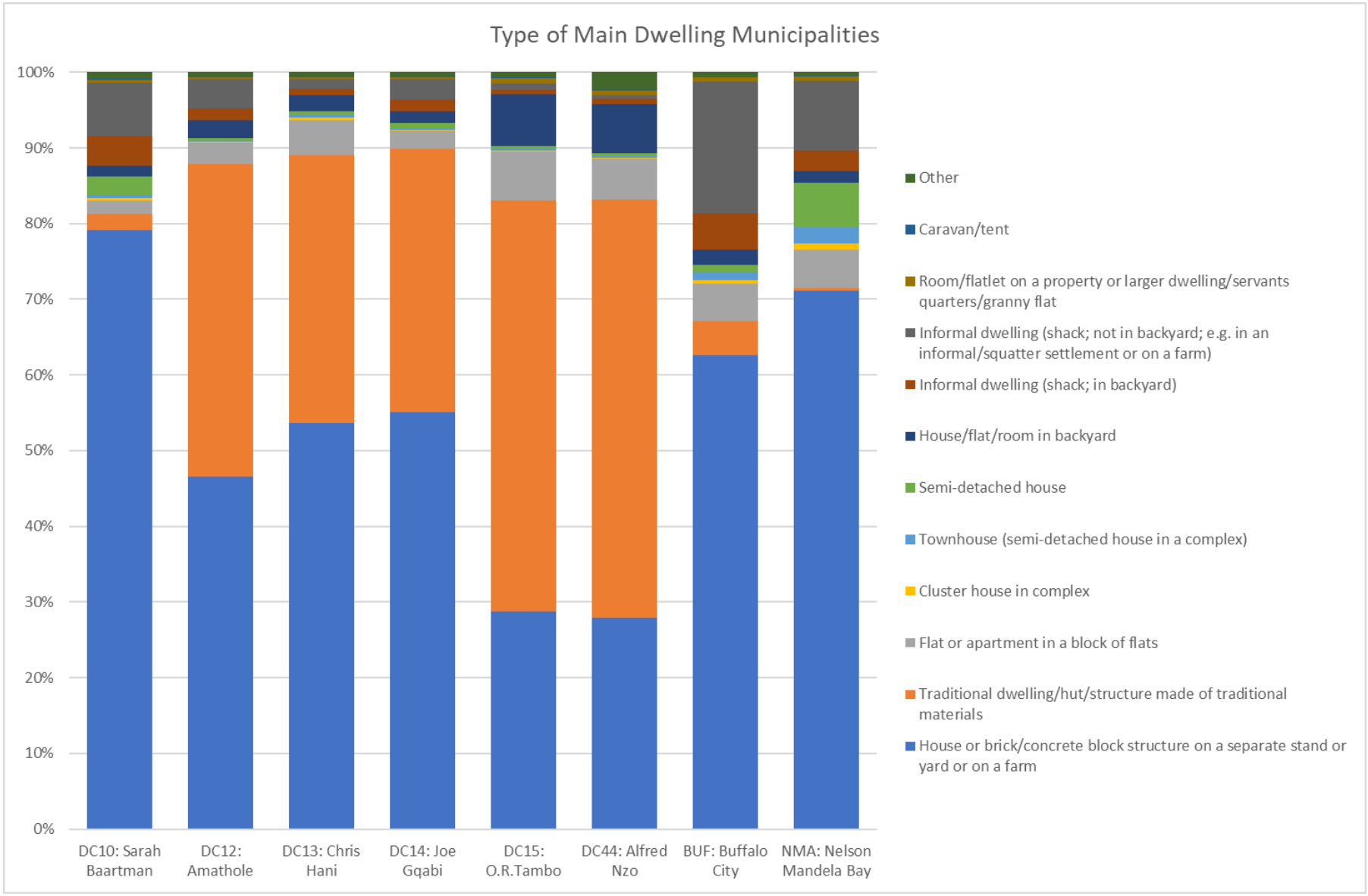

Figure 6-11: Type of Main Dwelling Municipalities

The Eastern Cape Province has a large percentage of traditional dwellings with OR Tambo and Alfred Nzo Districts leading with percentage of traditional structures. OR Tambo and Alfred Nzo have few informal dwellings compared to other Districts, especially the Metros.

The traditional architecture was found to be the most adequate and suitable answer to the requirements of environmental and energy consumption need compared to the low-cost modern houses. The dark thick walls with highly insulative grass roofs, long overhangs and all-round gap between the wall top and the roof in traditional hut construction assures a minimum temperature swing. Traditional huts were observed to suffer minimal outdoor noise disturbances; this is due to the high sound damping property of the grass roof and the wall materials used (Makaka & Meyer, 2005)

6.3.2 Water

The principals of WAter, Sanitation and Hygiene (WASH) indicates that safe drinking-water, sanitation and hygiene are crucial to human health and well-being (World Health Organization, 2019).

Evidence suggests that improving service levels towards the safely managing of drinking-water or sanitation such as regulated piped water or connections to sewers with wastewater treatment can dramatically improve health by reducing diarrhoeal disease deaths (World Health Organization, 2019).

The access of communities to water can also influence the vulnerability profile of communities. In areas where communities need to make use of rivers or streams, they are more vulnerable to the effects of water pollution, waterborne diseases or low water quality levels. Households without access to safe drinking water were mostly found in the OR Tambo and Alfred Nzo District Municipality. On the other hand, Nelson Mandela Bay, Buffalo City and Sarah Baartman District recorded the highest percentage of households with access to piped drinking water inside the dwellings (Statistics South Africa, 2017).

The data shows that in the Eastern Cape, the highest percentage of households are dependent of River/Streams as their source of water. The profile associated with communities' access to water in the various municipalities in the Eastern Cape Province, is shown in Figure 6-13 below.

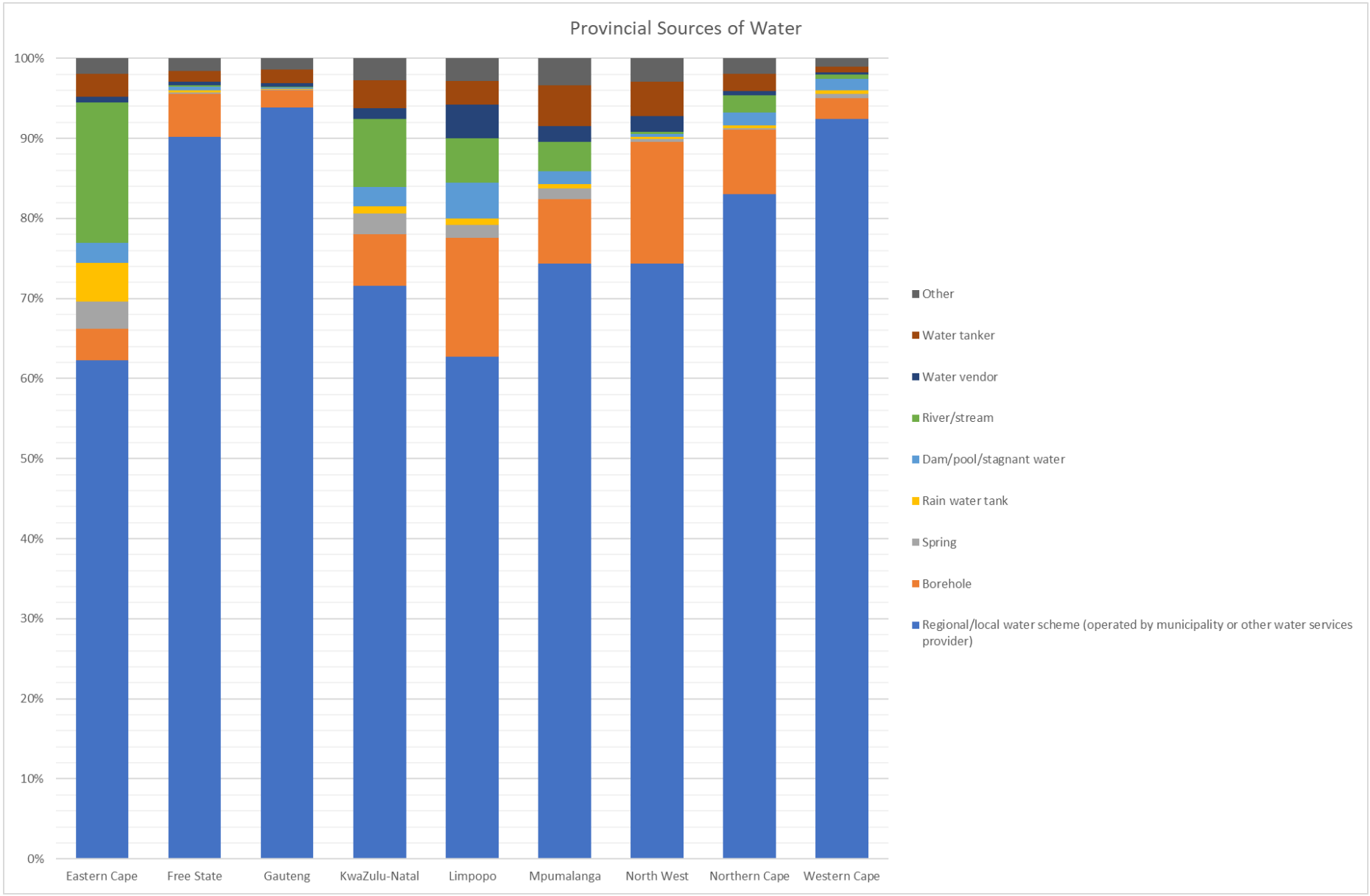

Figure 6-12: Provincial sources of water

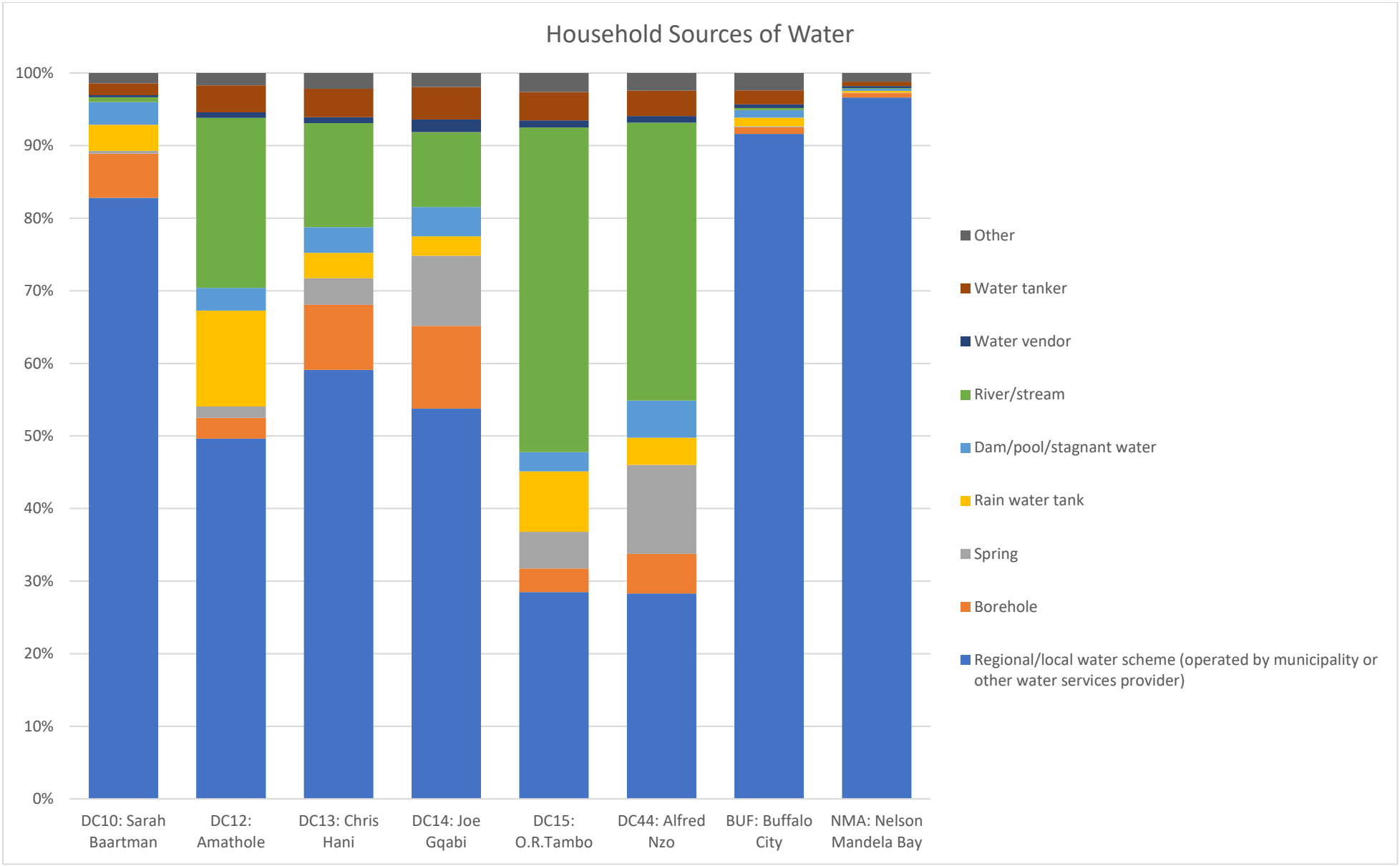

Figure 6-13: Comparison of access to water in the Eastern Cape Municipalities

OR Tambo and Alfred Nzo stand out with the highest dependency on river or stream for their sources of water. The Nelson Mandela Bay, Buffalo City and Sarah Baartman District show large percentage of regional or local water schemes.

6.3.3 Sanitation

Sanitation is also a key consideration as part of the DRA, influencing both the vulnerability and hazard profile of communities. The Sanitation Profile of Provinces and Municipalities are shown in the figures below.

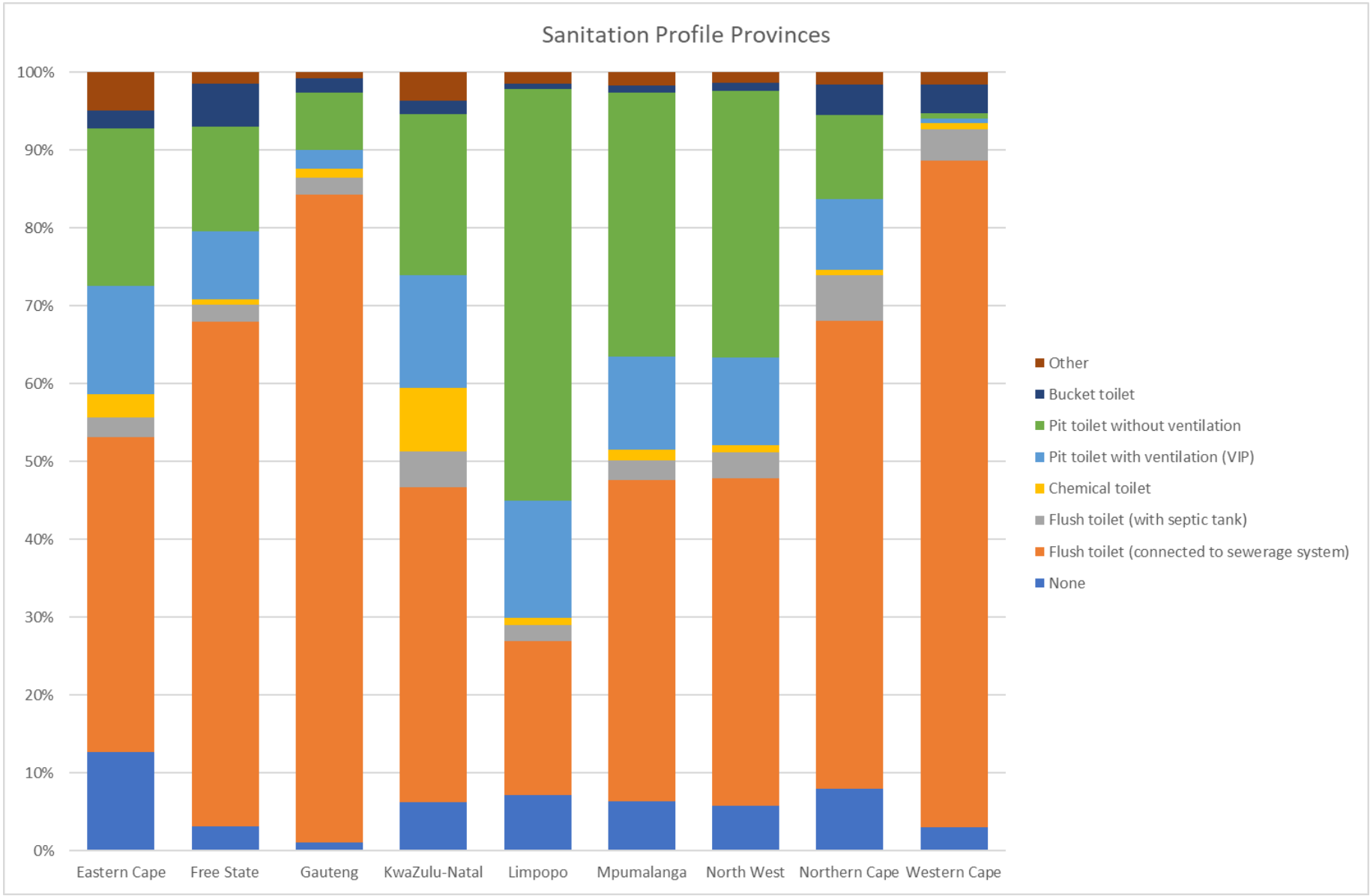

Figure 6-14: Sanitation Profile Provinces

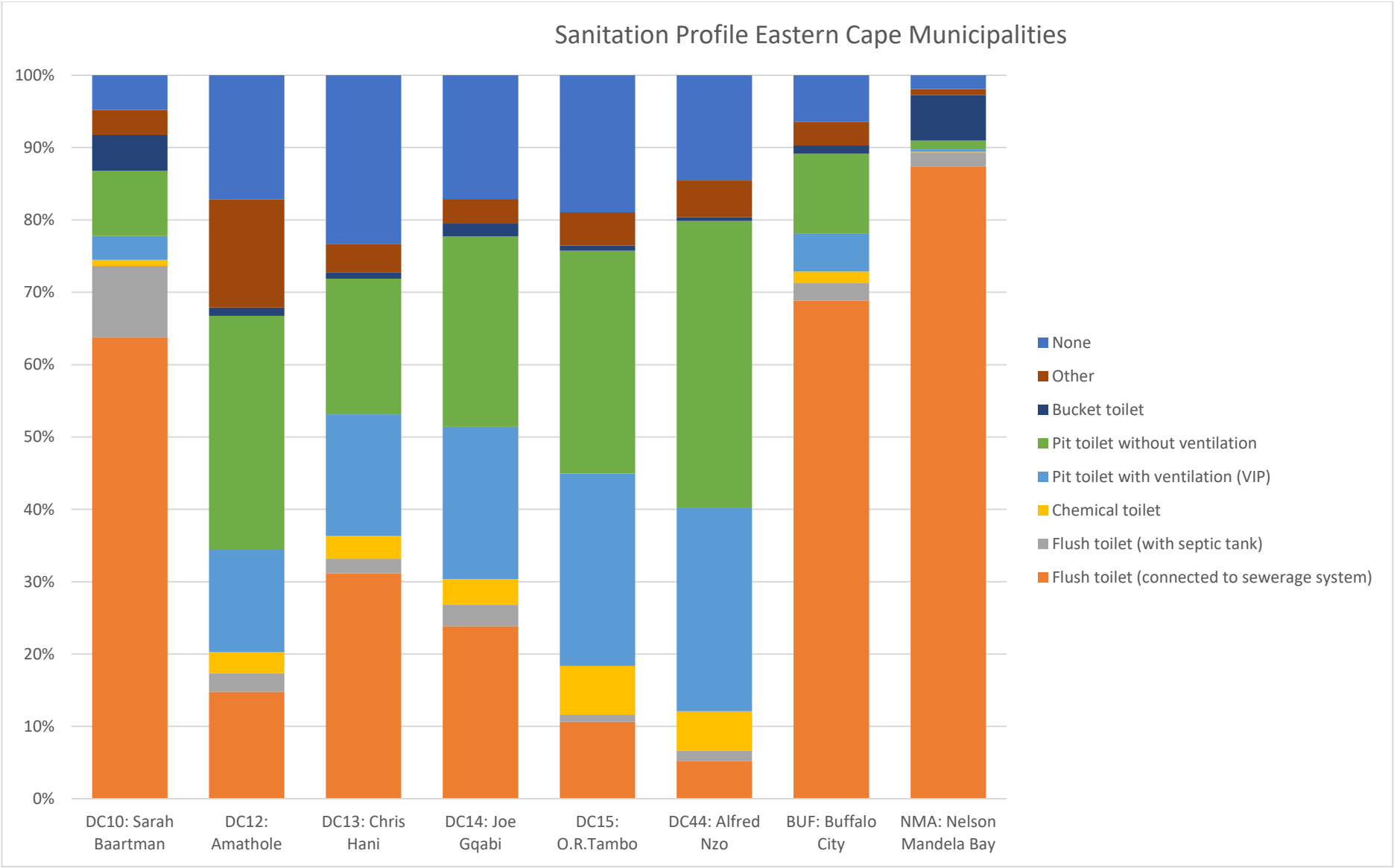

Figure 6-15: Comparison of type of sanitation system in the Eastern Cape Province

Mpumalanga and North West shows the largest number of pit toilets while the Eastern Cape shows the largest percentage of people with no sanitation facilities.

There is a large contrast between the facilities available in the different municipalities. Sarah Baartman District have a much larger percentage of “flush toilets (connected to the sewage system)” than any of the other District Municipalities in Eastern Cape Province. The high usage of pit toilets in the province also has potential to influence land pollution.

6.3.4 Energy

Access and sources of energy not only influence the hazard profile of an area, but also have an impact on the health and vulnerability of communities.

The Provincial and Municipal Profiles associated with usage of energy for cooking is shown in Figures below.

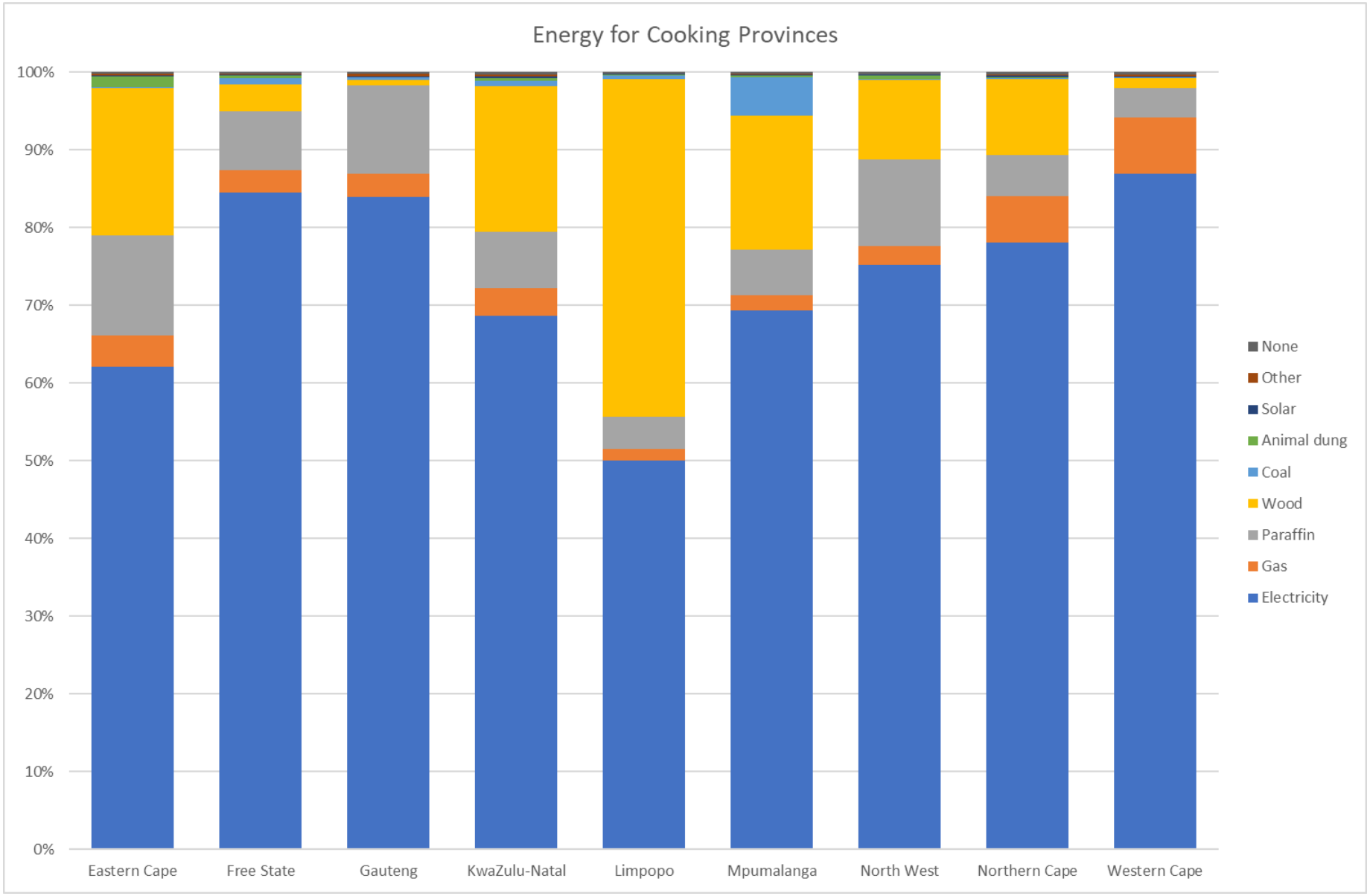

Figure 6-16: Energy for Cooking Provinces

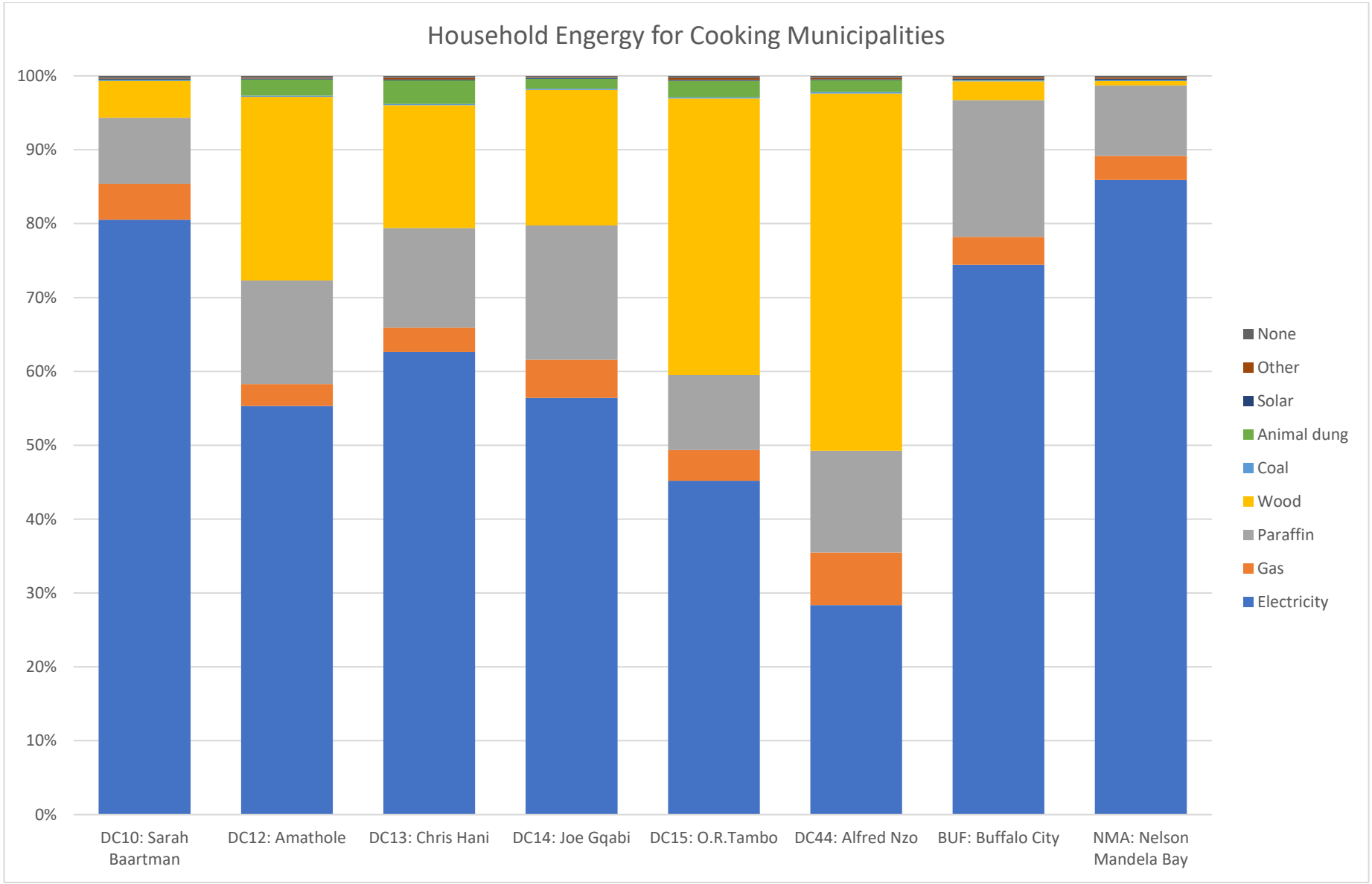

Figure 6-17: Energy for Cooking Municipalities

Limpopo is most reliant on wood and paraffin, followed by the Eastern Cape. Alfred Nzo and OR Tambo has a very high rate of dependence on wood for cooking.

The high use of wood has large environmental impact and contribute factors such as environmental degradation.

6.3.5 Waste management

Waste management not only influences the vulnerability and hazard profile of human populations but can also have an impact on the wider environment in the Eastern Cape

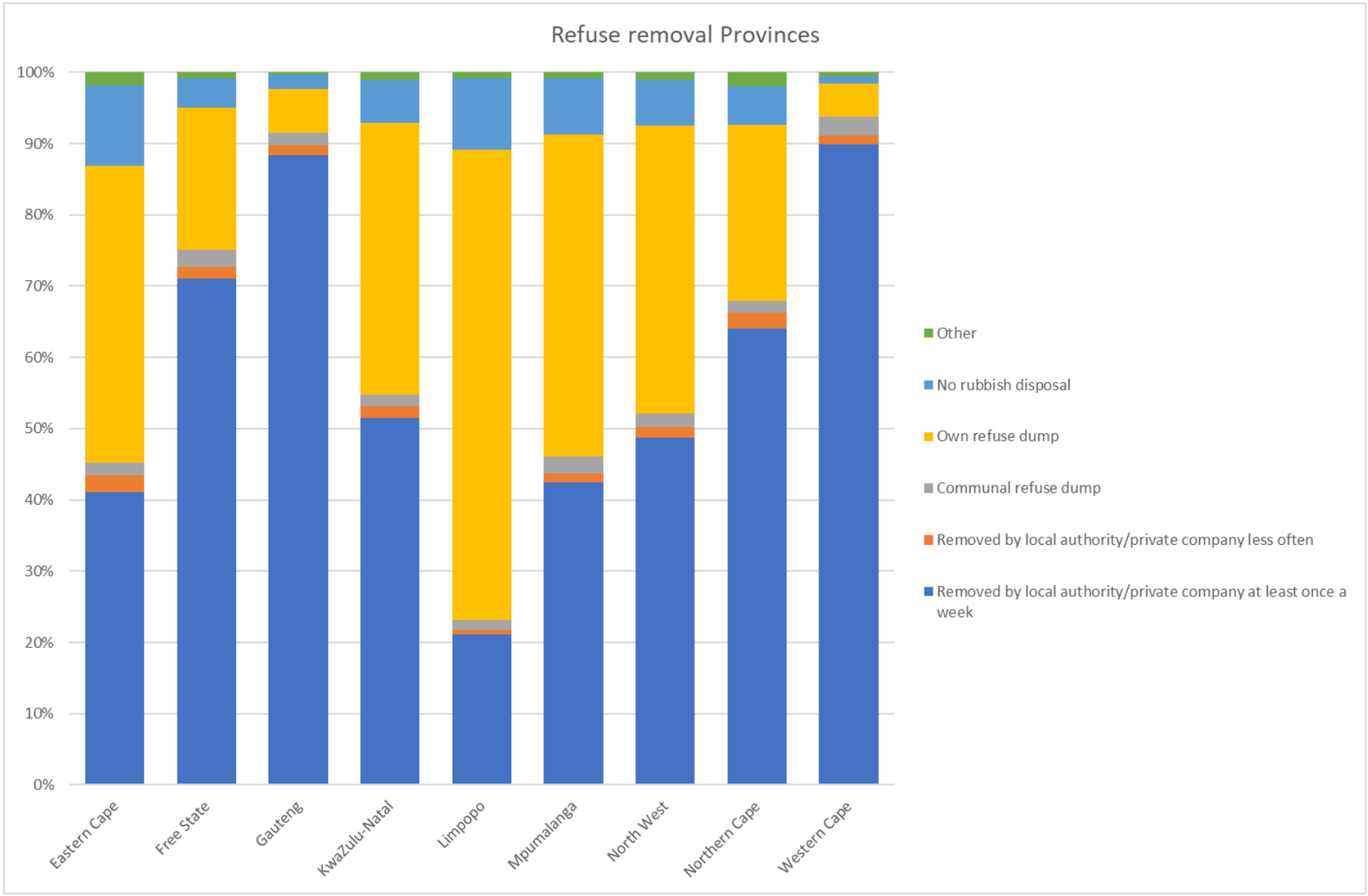

Figure 6-18: Refuse Removal Provinces

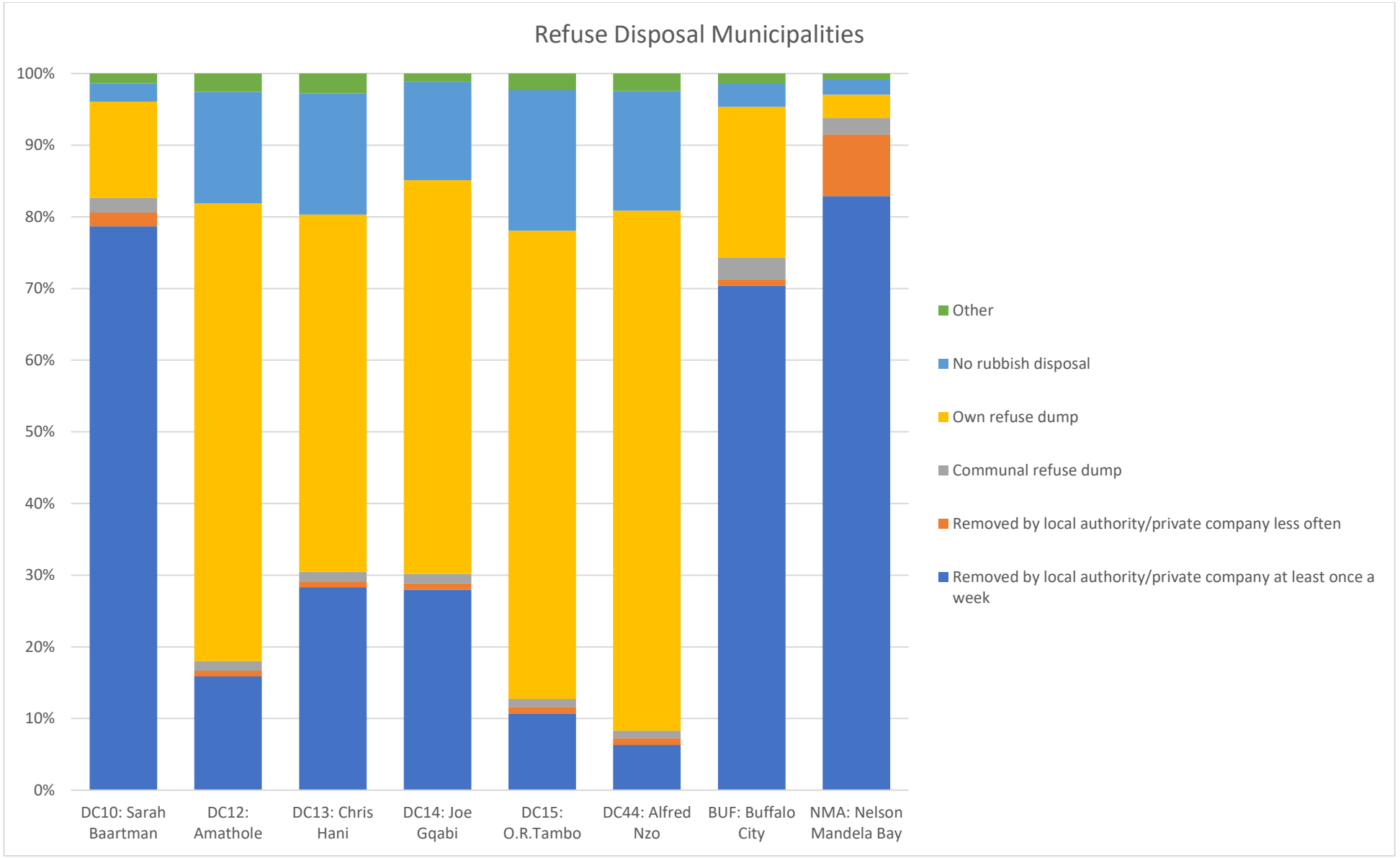

Figure 6-19: Refuse Removal Municipalities

Limpopo Province has the highest percentage of own refuse dump followed by North West and Eastern Cape. The large percentage of own refuse dump can contribute to pollution, health, human and animal disease related problems and large environmental impacts

6.4 Transport infrastructure

The Eastern Cape has a number of airports including Mthatha Airport is located within the OR Tambo, Chief Dawid Stuurman International Airport, formerly known as Port Elizabeth International Airport and King Phalo airport, formerly known as East London Airport. There are also smaller airfields spread throughout the province

According to the Eastern Cape Provincial Development Plan (PDP) (Eastern Cape Planning Commission, 2014), the province has roads as one of developmental opportunities and upgrading of roads as one of the priorities. Deteriorated roads can negatively impact socio-economic growth, hamper response to incidents as access to the major routes may be affected.

About 14% of the Eastern Cape provincial roads are surfaced, which is relatively low in comparison with the 26% of the entire country. Thus, placing the Eastern Cape at a backlog of over 3000 km of provincial surfaced roads to be aligned with the average of the other provinces.

The Eastern Cape department of Transport has partnered with Sanral in order to address the backlog of some hundreds of the major culverts and bridges where several road infrastructure projects were completed on the following roads: (Eastern Cape Department of Transport, 2022)

According to the Eastern Cape Annual performance plan, over 309.52km of gravel roads carry high traffic volumes. This could be as many as 500 vehicles a day. An additional 1300.78km of gravel roads carry medium to high traffic volumes. Several hundred undersized bridges, culverts and drifts are cut off during heavy rains. Roughly 9000km of provincial gravel roads have poor drainage which often result from roads being eroded down to below natural ground level requiring extensive rehabilitation or reconstruction as a gravel road (Eastern Cape Department of Transport, 2022).

6.4.1 Water Transport

The South African Maritime Safety Authority (SAMSA) was established in April 1998 under the SAMSA Act 5 of 1998.

The objectives of the Authority are-

- To ensure safety of life and property at sea;
- To prevent and combat pollution from ships in the marine environment; and
- To promote the Republic's maritime interests.

SAMSA has also been charged with the responsibility of executing the following:

- Administration of the Merchant shipping (National Small Vessel Safety) Regulation, 2007, as amended (the Regulations).
- The Regulations extends SAMSA's Core mandate to include inland waterways (only waterways accessible to the public) within the Republic. That is to ensure boating safety on our waters.
- Implementing and executing the Long-Range Identification and Tracking (LRIT) of vessels along the South African coastline.
- The Long-Range vessels monitoring system assist in securing South Africa's coastal waters amid the rising lawlessness at sea, with reference to the worrying scourge of pirate attacks along the east coast of Africa.

Transnet Ports Authority (Port of Ngqura, Port Gqeberha and Port of East London) vessel traffic Services are responsible for:

- Containers;
- International Maritime Dangerous Goods (IMDG);

- Automotive exports;
- Manganese;
- Multi-Purpose terminal (wind turbines);
- Tanker Berth (petroleum and LPG gas);
- Bunkering (fuelling of ships);
- Ship to Ship / land to ship;

Figure 6-20 shows ship traffic along the South African coastline which indicates high volume throughout the year.

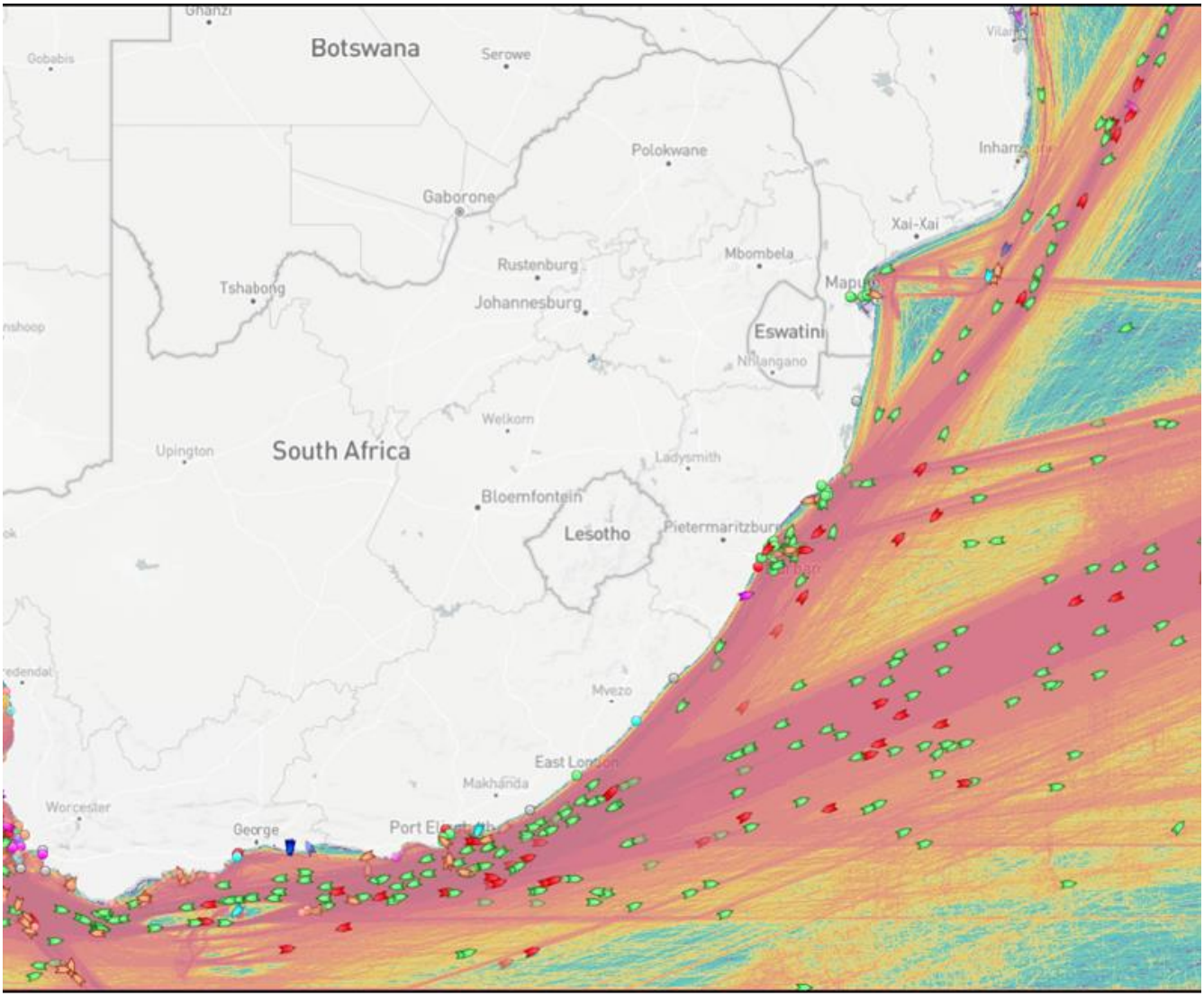

Figure 6-20: Ship traffic along the South African coastline (Source: (Marine Traffic, 2022)

This indicates t a high volume of marine traffic present along the coastline of the Eastern Cape Province, especially between East London and Gqeberha. The volume of marine traffic makes a significant contribution to vulnerability to pollution and possible maritime disasters.

6.5 Facilities

Facilities in the Eastern Cape not only serve the normal functions of providing services, education or recreation, but can also support disaster risk reduction or disaster response activities in the Eastern Cape.

6.5.1 Education Facilities

The Figure 6-21 shows the education facilities in Eastern Cape spatially.

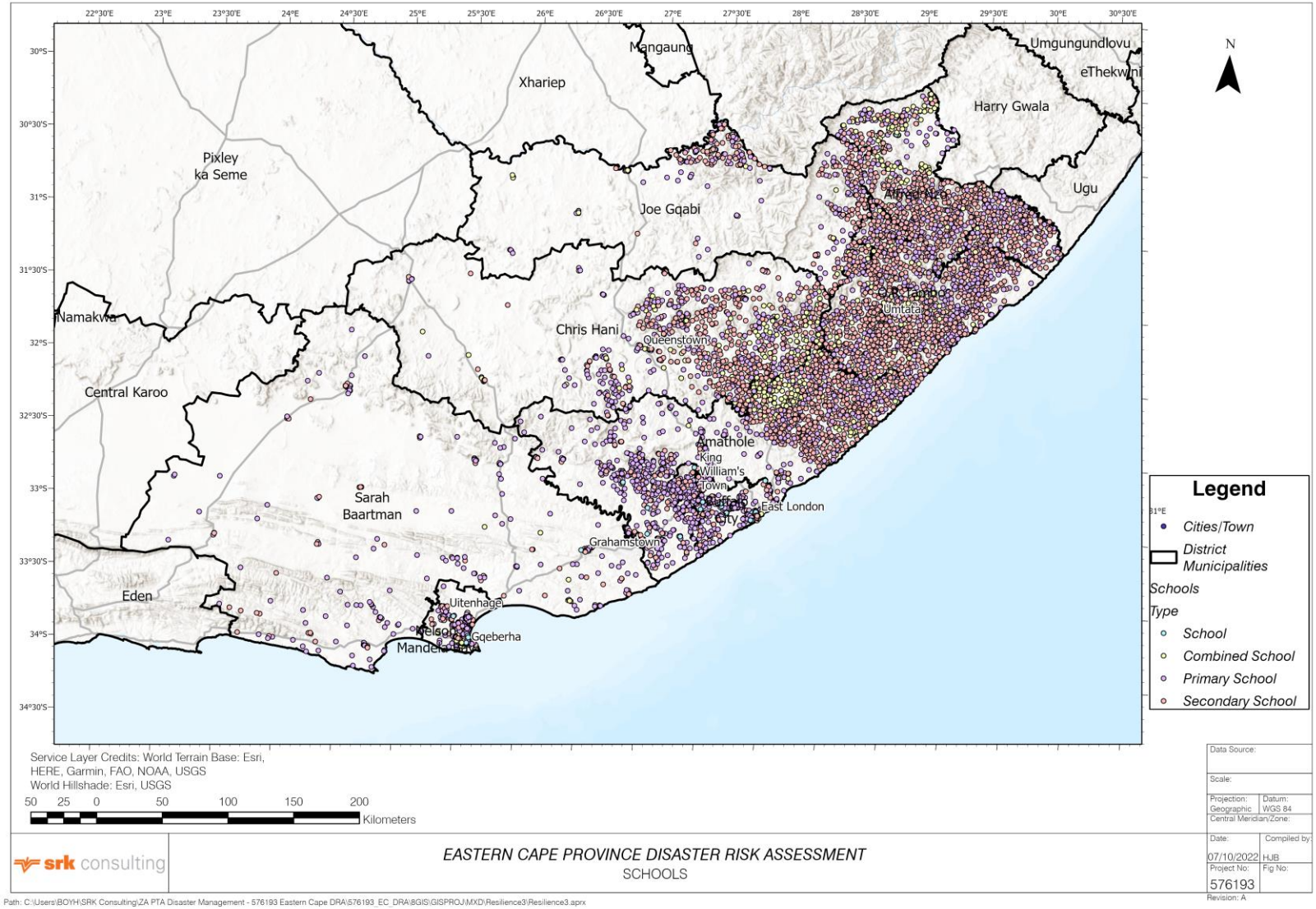

Figure 6-21: Places of education in the Eastern Cape

6.5.2 Healthcare facilities

Health care facilities play a pivotal role during any emergency. Health care facilities can also have high vulnerability due to the vulnerability of the patients but also due to the consequences if a health care facility is affected and can not deliver the required services during an emergency.

The Eastern Cape Department of Health gives the following strategic overview of their functioning (Eastern Cape Department of Health, n.d.):

“The mission of the Eastern Cape Department of Health is to provide and ensure accessible, comprehensive, integrated services in the Eastern Cape, emphasising the primary health care approach, optimally utilising all resources to enable all its present and future generations to enjoy health and quality of life.

The primary business of the Department and health care service delivery is based on the following five strategic goals:

1. Facilitate a functional, quality-driven public health system that provides an integrated and seamless package of health services and is responsive to customer needs;
2. Combat and reduce the impact of TB and HIV/AIDS, with a special focus on preventing the emergence of drug-resistant strains;
3. Improve and strengthen the mother and child health services;
4. Combat and reduce diseases of lifestyle and mental conditions; and
5. Enhance institutional capacity through effective leadership, governance, accountability, and efficient and effective utilisation of resources.”

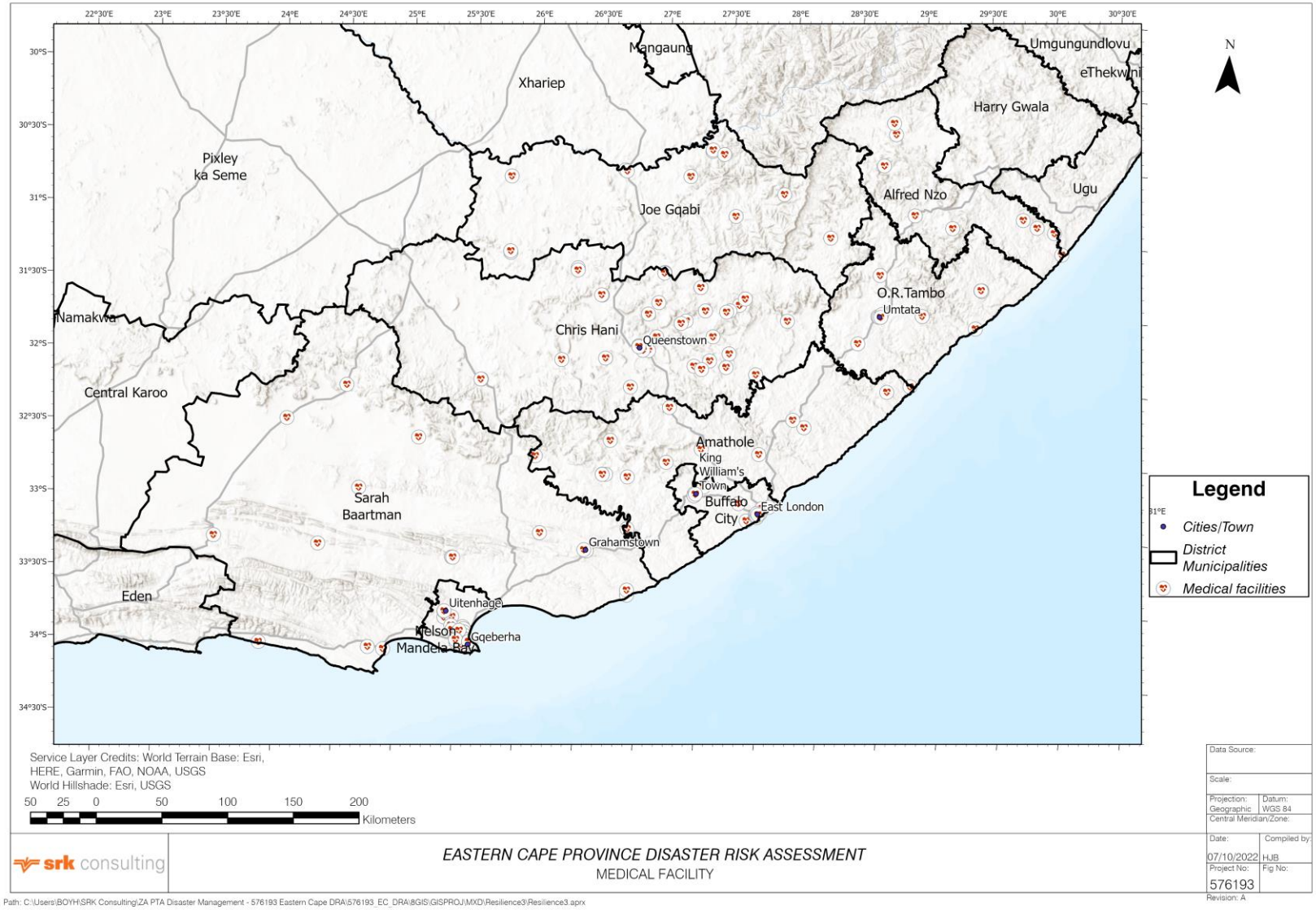

Figure 6-22: Health Care Facilities in the Eastern Cape

6.5.3 Police Stations

The Eastern Cape is committed to creating a safe and secure environment for all residents and has identified crime prevention as one of the province wide priorities. **Error! Reference source not found.** indicates the s patial distribution of all police stations in the Eastern Cape.

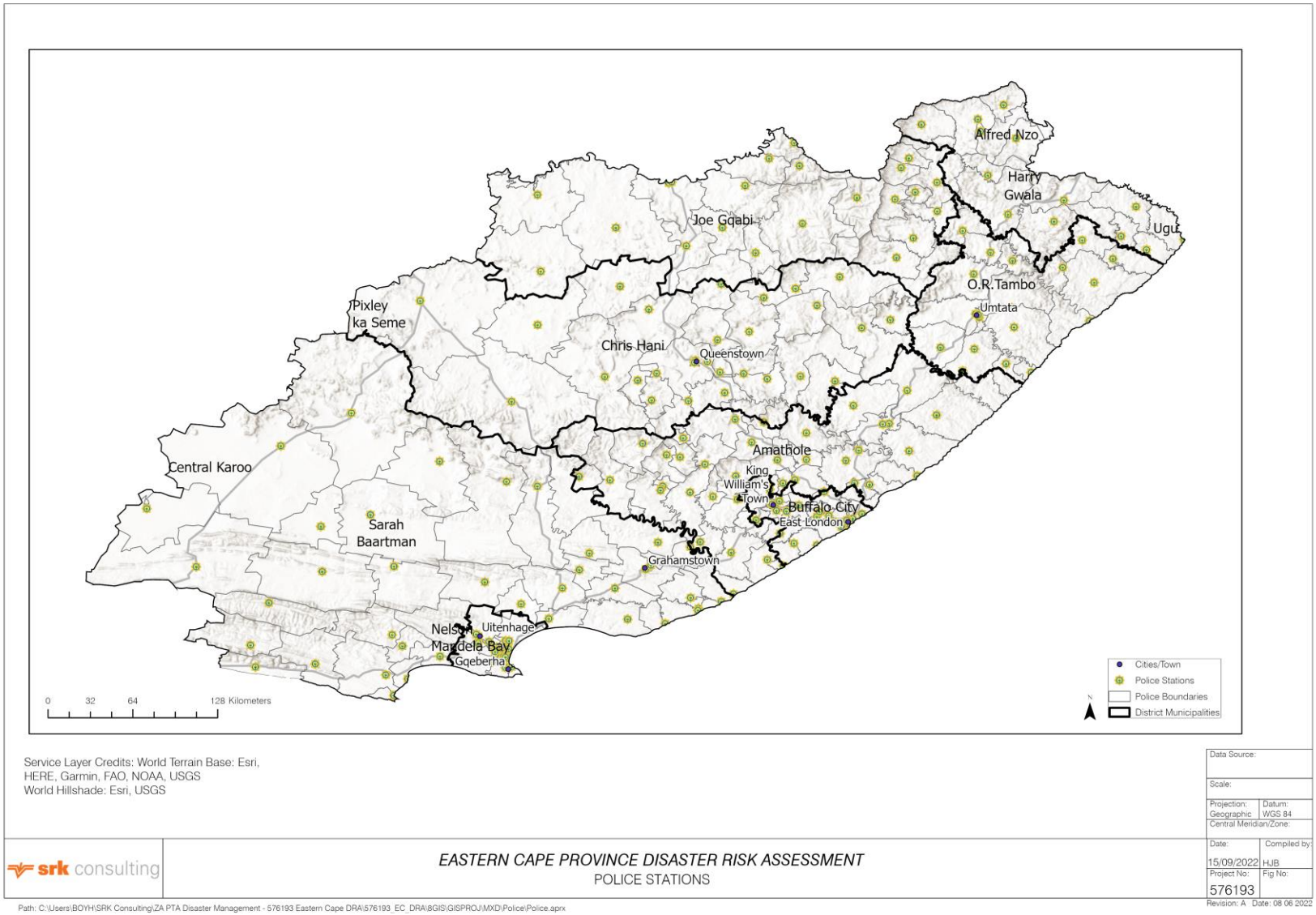

Figure 6-23: Police Stations Eastern Cape

7 Hazard Profile

This section provides a description of the hazards assessed during the risk assessment, as well as a description of the characteristics of the Eastern Cape Province in relation to each of the hazards.

This section contains a description on various hazards within the Eastern Cape. The hazard description includes an overview of the information gathered during the consultations workshops as well as information collected from other sources.

7.1 Meso data

Meso zone data was used to assess disaster risk for the Eastern Cape. The Meso zone set consists of the demarcation of South Africa into an absolute grid of 25 000 spatial units. These meso zones' shapes are not uniform however they are all approximately the same size (~50km2). These meso zones were created in such a way that they fit completely within the current municipalities and other significant geo-economic and historic area demarcations. The zone boundaries correspond with major travel barriers (such as rivers) as well as 'break lines' between sparsely populated areas (such as mountains) and areas with medium to high levels of human activity (such as fertile valleys or built-up areas) (StepSA, n.d.).

7.2 Transport hazards

Transportation hazard events, such as motor vehicle accidents, are considered a regular event in most urban and rural areas in South Africa. This is because these events are often considered high frequency, low severity hazard events. However, low frequency, high severity events do occur, and these are the events that are in the ambit of disaster management. For the purpose of this assessment, transport disasters were divided into the following three categories:

- Air transportation;
- Rail transportation;
- Road transportation; and
- Water transportation.

7.2.1 Air transportation

Even though major casualty incidents related to air transportation hazards are rare, the potential risk presented by air transportation remains present. This risk can also increase with an increase in air traffic due to economic and urban developments or special events, leading to an increase in air travel to and from the Eastern Cape.

Most of the accidents over the last 20 years occurred during approach and landing phases. Approach and landing are highly complex flight phases, which place significant demands on the crew in terms of navigation, aircraft configuration changes, communication with Air Traffic Control, congested airspace, and degraded weather conditions. This combination of high workload and the increased potential for unanticipated events can create a complex interplay of contributing factors, which may lead to an accident (Airbus, 2021).

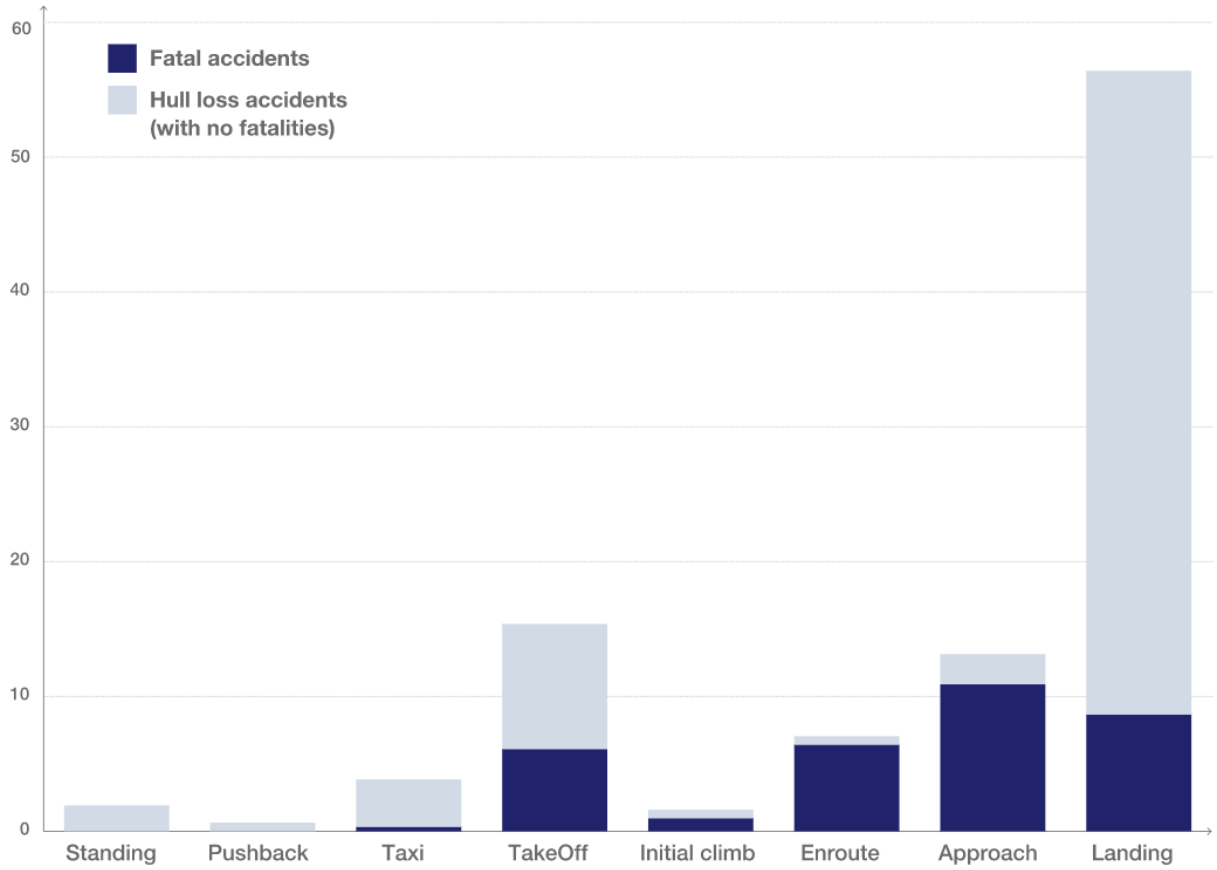

Figure 7-1: Accident distribution per flight phase 2002-2021 (Airbus, 2021)

Mthatha Airport is located within the OR Tambo. The airport was handed over to the South African National Defence Force for border security operations in 2012 but has since been taken over by ACSA. Mthatha Airport has been received several upgrades in recent years, some of which include a state-of-the-art terminal and expanded runway. Mthatha Airport serves domestic departures and arrivals within South Africa. It also offers connecting flights to the major airports for international departures.

Chief Dawid Stuurman International Airport, formerly known as Port Elizabeth International Airport, is in Gqeberha. The airport currently handles more than 1,2 million passengers per year, over 60 000 scheduled flights and over 800 tons of cargo. The cargo includes flowers, frozen lobster, meat, ostrich skins and mushrooms. The airport has also undergone several improvements including a terminal expansion. This facility provides a central retail area as well as a fully compliant international arrivals and departures terminal to complement upgraded amenities for domestic traffic (Airports Company South Africa (ACSA), 2022) .

King Phalo airport, formerly known as East London Airport, has between 20 and 30 flights that land each day, and the airport welcomes 620,000 people each year. The airport is also a crucial link in the cargo chain, playing an important role in the growing economy of the Eastern Cape. Planes carrying a variety of cargo head for domestic and international destinations, including France and Holland (Airports Company South Africa (ACSA), 2022)

To represent the hazard spatially, information regarding the location of airfields/airports in the Eastern Cape as well as flight paths were used. This flight path as well as buffer areas around the airports and local airfields are deemed to be high hazard areas for potential aircraft accidents. The result of the hazard mapping is provided in Figure 7-3.:

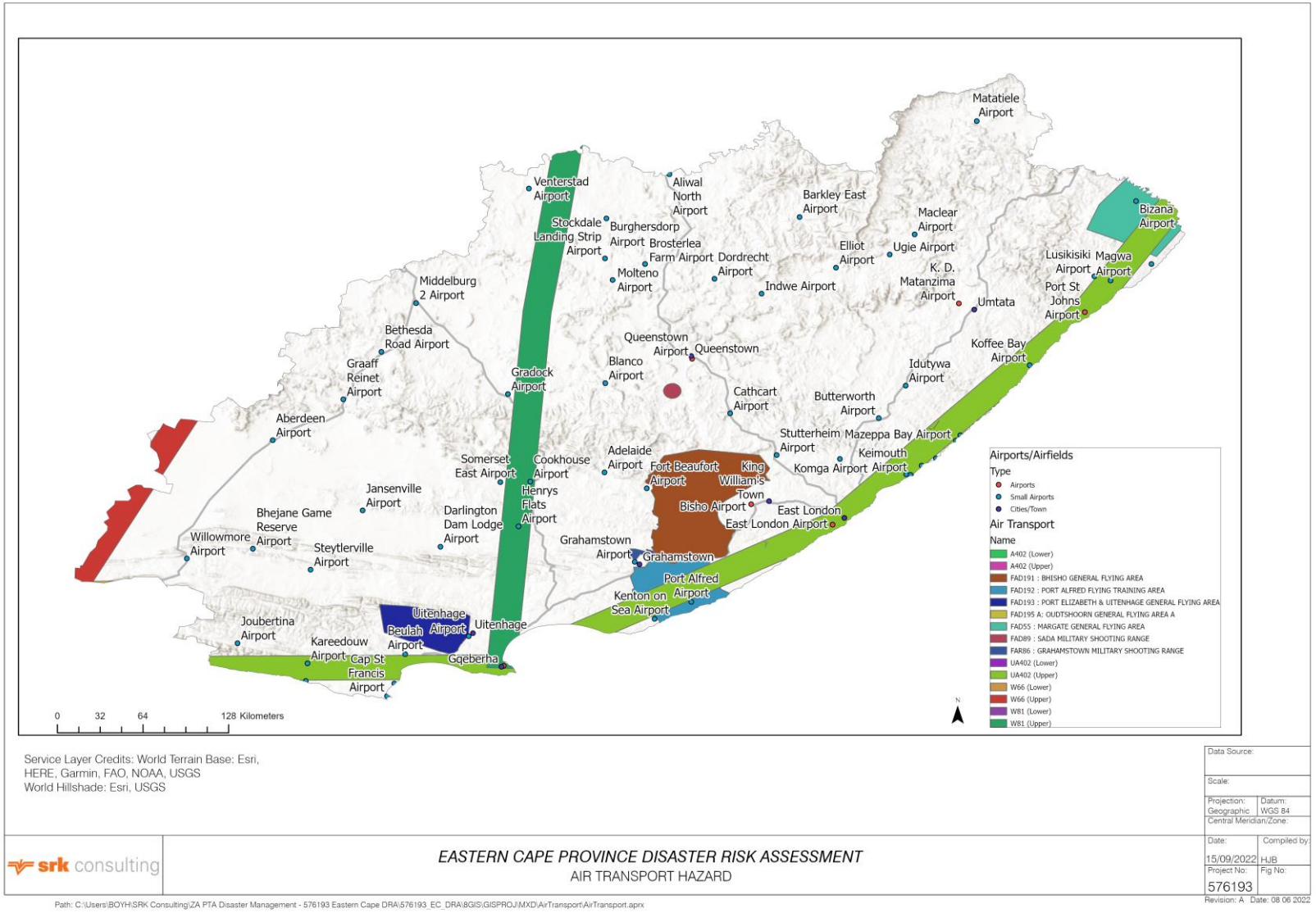

Figure 7-2: Airport / Airfields and air transport flying areas

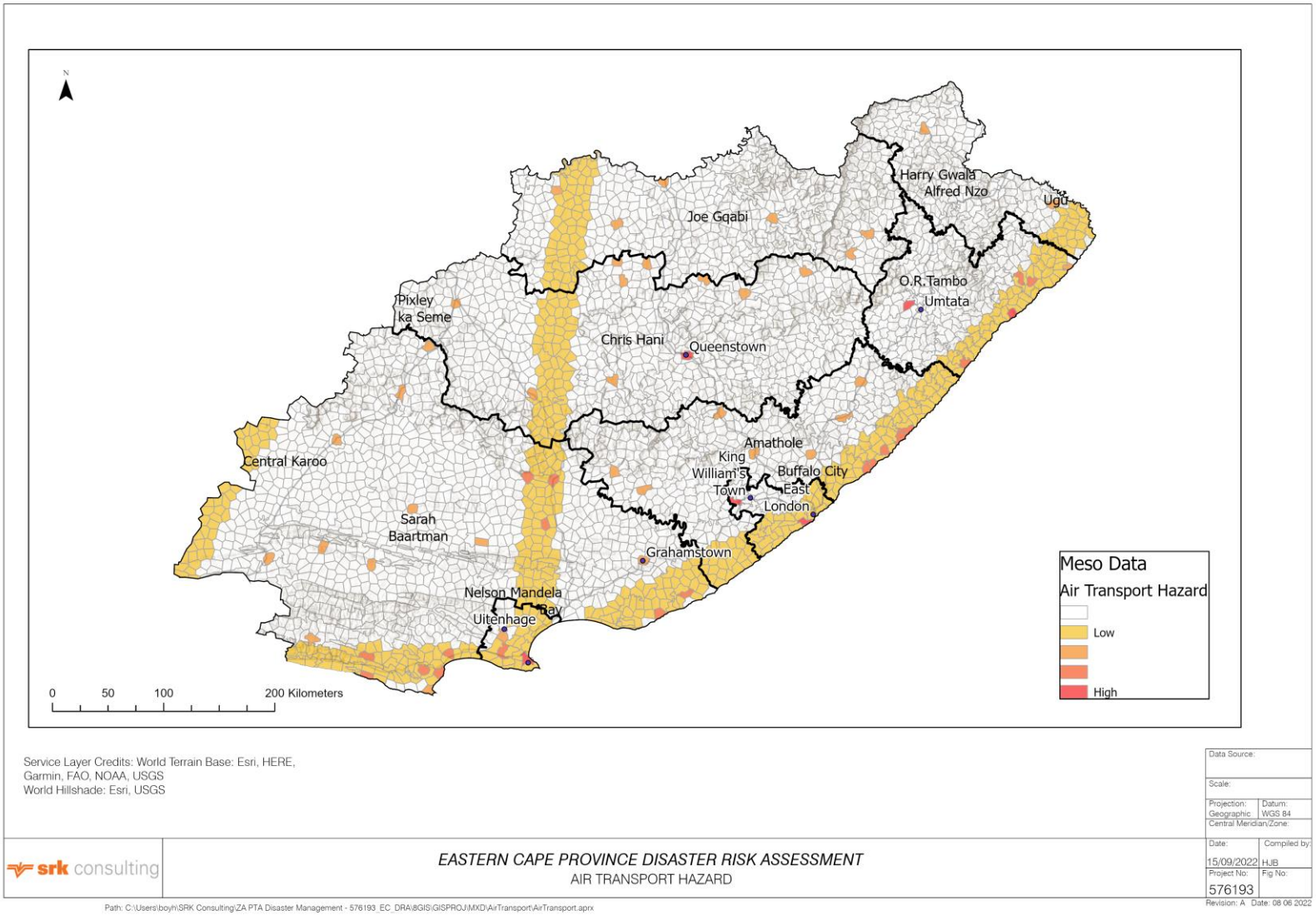

Figure 7-3: Airfields and flight paths for the Eastern Cape (meso data)

7.2.1.1 Consultation inputs

7.2.1.1.1 Amathole

There are some dysfunctional airports in Amathole. A big airport in Buffalo City is surrounded by informal settlements. Smaller runways are present in the area.

7.2.2 Rail transportation

Rail transportation hazards can present a disaster risk especially if a large number of passengers and/or hazardous material is involved. Incidents involving trains and road vehicles, or hazard events such as structural failure can also lead to a mass casualty or high fatality events.

The Eastern Cape have a substantial rail infrastructure, but to a large extent is unfortunately not currently functional.

To map rail transport hazard, the length of railway network in a meso zone was calculated. Figure 7-4 shows in the red the zones with the highest sum of railway length.

During consultations it was mentioned that structures are being constructed that encroach on the rail tracks and that it may be problem should the tracts be rehabilitated. Specific mention was made of the railway line between Mbhashe and Mthatha.

The rail infrastructure is added and shown on Figure 7-4 but is currently largely not functional.

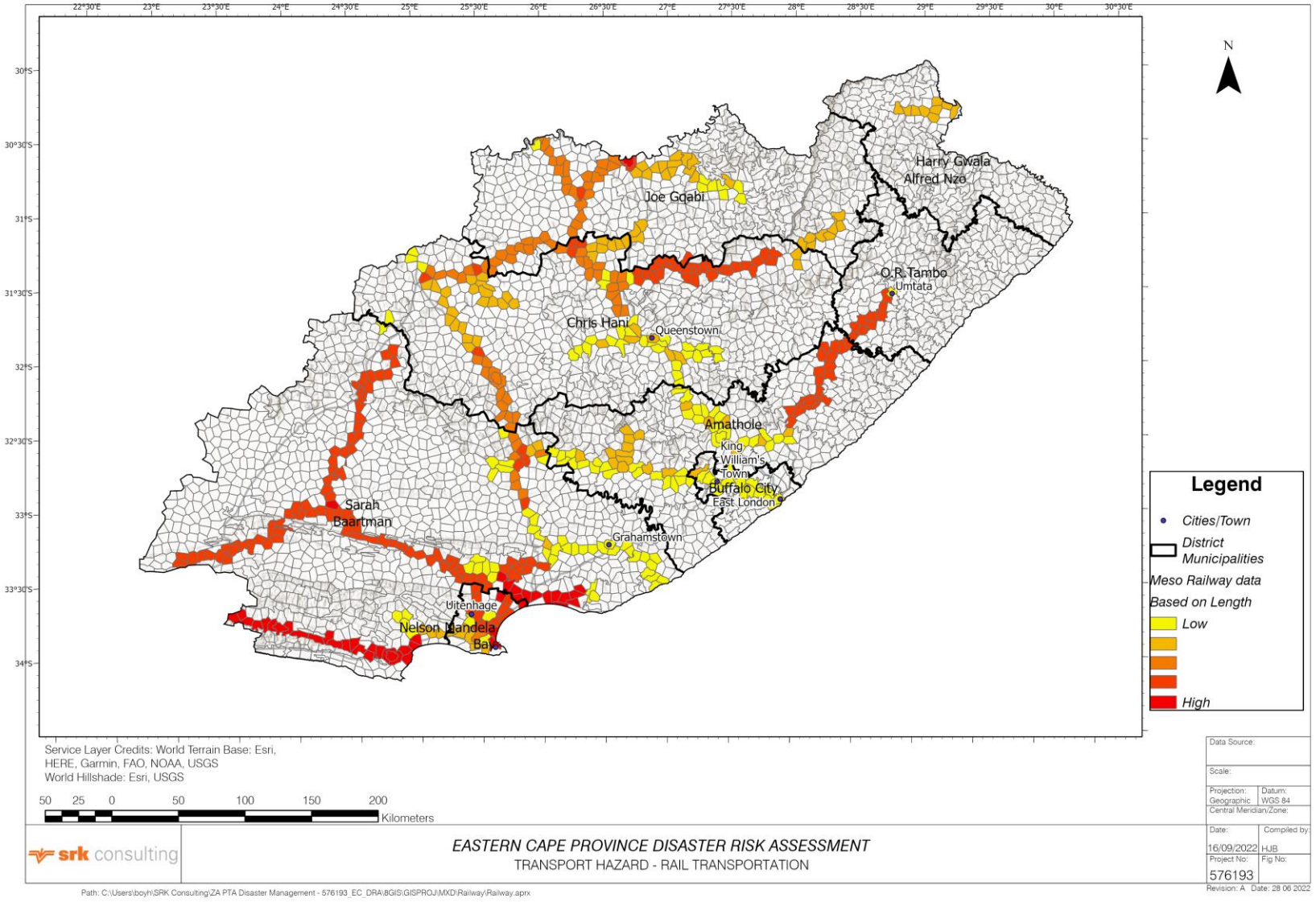

Figure 7-4: Rail transport hazard (meso data)

7.2.2.1 Consultation inputs

7.2.2.1.1 Amathole

During the engagement with the project stakeholders, an ongoing problem of theft of railway infrastructure was indicated, which may further cause communication problems and derailment.

7.2.2.1.2 Chris Hani

It was highlighted that Queenstown had rail transport which may have been suspended. There is a main line that is routed from East London to the interior where cable theft is also a continuous problem. Cable thieves are said to operate specifically during late evening through to the early morning

The Covid 19 lockdown caused a dramatic reduction in rail activities and a lot of these activities have not resumed after Covid 19 restrictions have been lifted (Williams, 2021).

7.2.3 Road transportation

According to the Global Status Report on Road Safety 2018 (World Health Organization, 2018) the African regions have the highest road traffic fatality rate. Africa has a 26.6 per 100000 rate, while Europe has a 9.3 per 100000 rate.

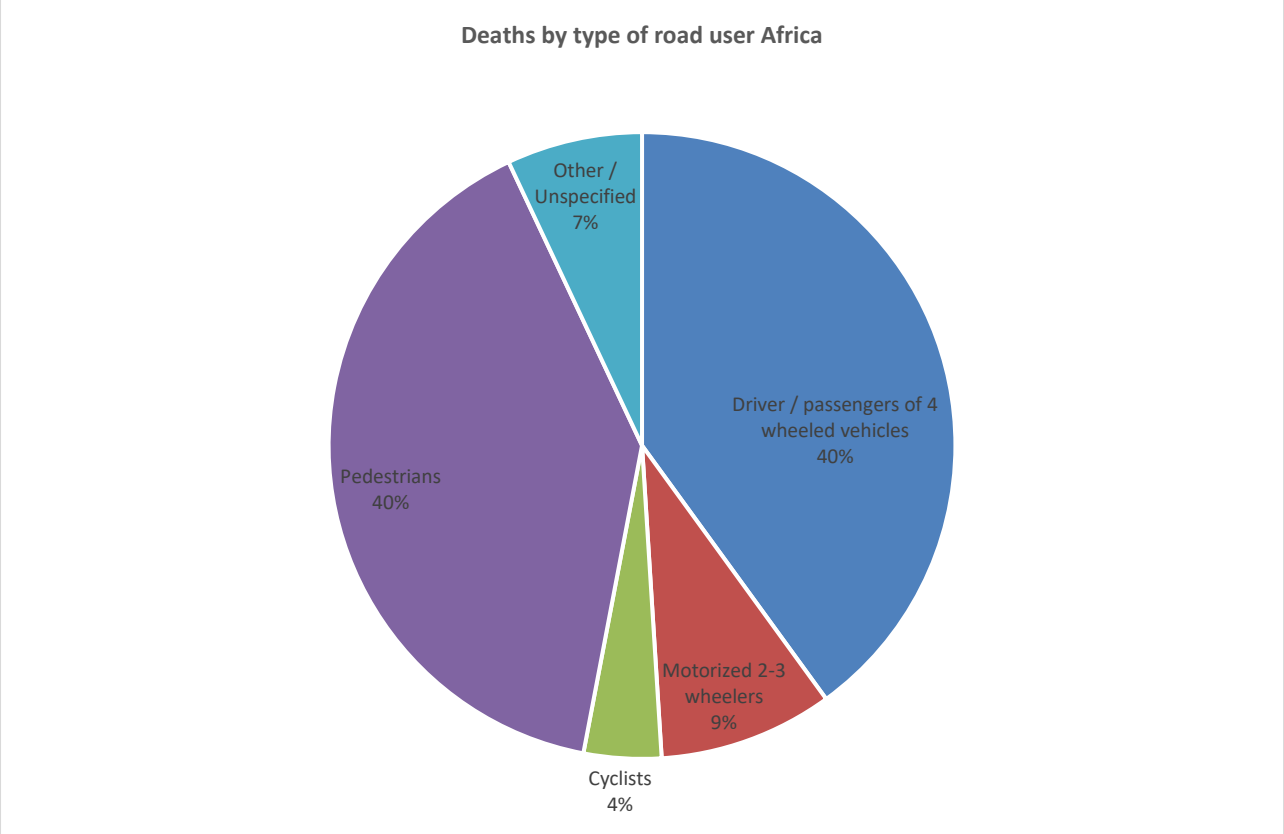

Figure 7-5: Road related incident Deaths by type of road user (World Health Organization, 2018)

The severity or the impact of a single incident is usually low, it can however in extreme circumstances cause a disastrous event that can exceed the capacity to deal with the relevant incident. One should however take cognisance of the accumulative effect of incidents to exhaust resources and thereby diminishing the capacity to deal with any further or secondary incidents.

The road hazard is based on type of road, estimated number of passengers, estimated weight of freight carried, villages nearby, rainfall and slope. The assumption is that type of road has an impact on speed, passengers and freight increase the frequency of road use and possible impact. The other indicators can increase the

likelihood of an accident. Figure 7-6 shows the hotspots when the abovementioned indicators are combined. The results are transferred to the meso layer with Figure 7-7 the result.

Table 7-1 provides a breakdown of the road classes and associated hazard level.

Table 7-1: Road hazard classification

Indicator	Indicator Weight	Indicator class	Indicator Class Weight	Indicator Layer Weight
Slope >10 degrees	0,05	1		0,05
People near road	0,15	1		0,15
Speed	0,3	3	0,4	0,12
		5	0,3	0,09
		6	0,2	0,06
		2	0,1	0,03
Traffic/People per road	0,2	1	0,2	0,04
		3	0,3	0,06
		5	0,5	0,1
Freight	0,2	1	0,05	0,01
		2	0,05	0,01
		3	0,05	0,01
		4	0,15	0,03
		5	0,2	0,04
		6	0,2	0,04
		7	0,3	0,06
Rainfall	0,1	1	0,1	0,01
		2	0,15	0,015
		3	0,15	0,015
		4	0,25	0,025
		5	0,35	0,035

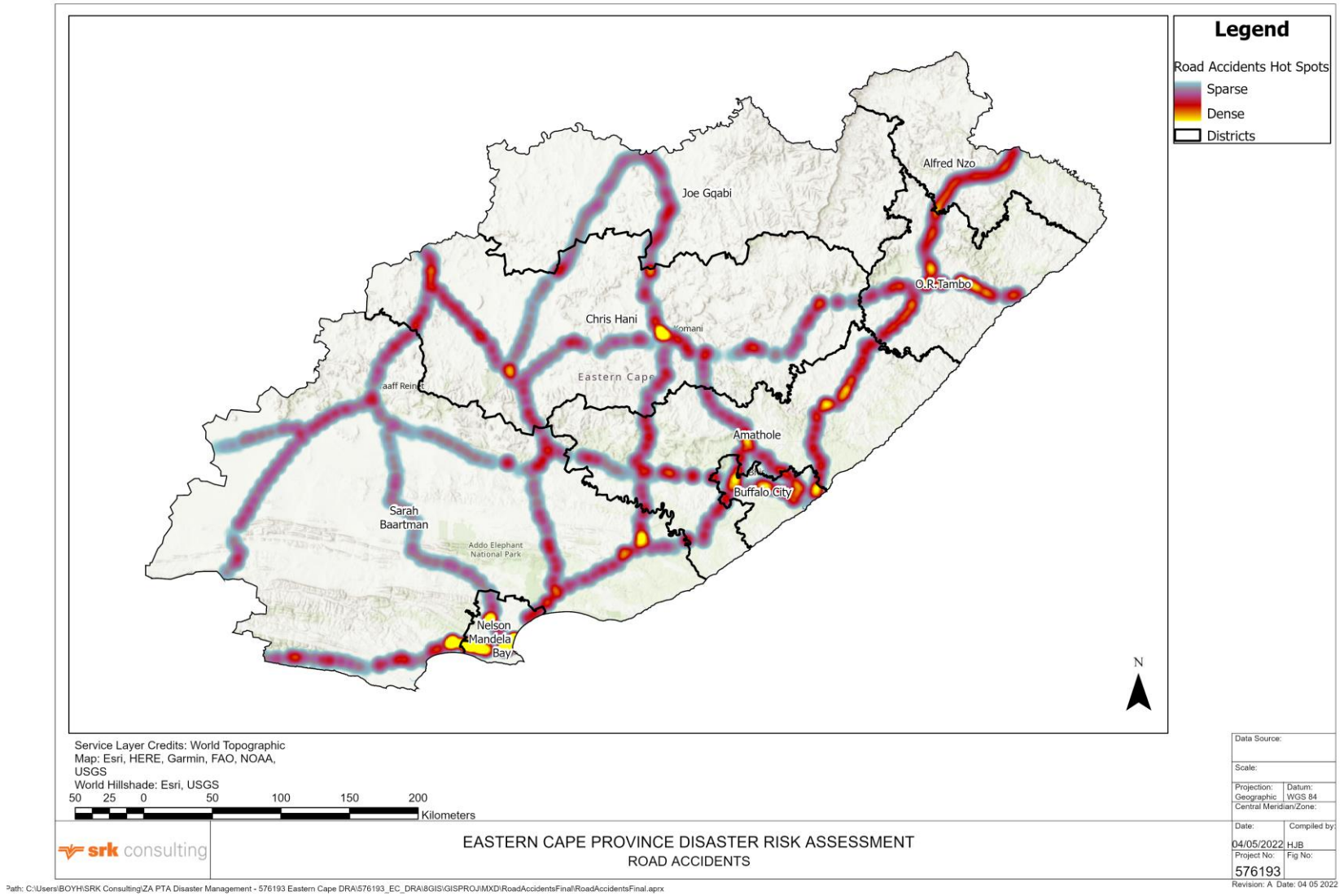

Figure 7-6: Road transport hazard

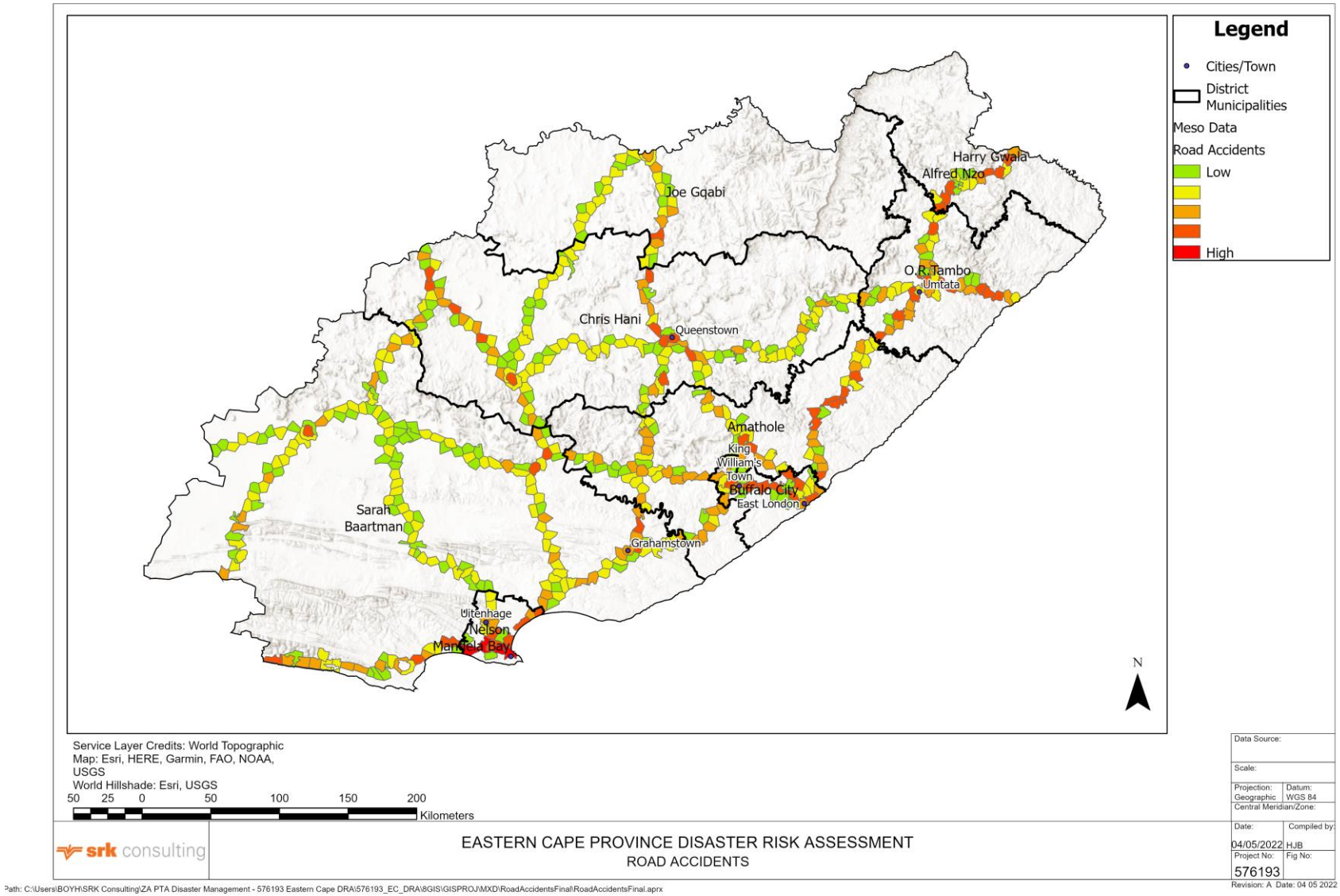

Figure 7-7: Road Accident Hazard (meso data)

7.2.3.1 Consultation inputs

7.2.3.1.1 Alfred Nzo

Poor state of roads and service delivery protests were mentioned to contribute to accidents Motor Vehicle Accident (MVA) is one of the priority risks. Curves and no signages on the roads while some drivers disregard the rules of the road. Heavy trucks are big contributors to accident as products would fall off trucks or spill making traveling impossible. Taxis and "vans" that are also used to transport people in other areas, thus contributing to accidents on the roads that are in bad state. Snow fall in the district sometimes does contribute to road blockages and accidents. Possible widening of roads may help reduce the risks.

7.2.3.1.2 Amathole

Roads in Amathole are damaged by rain and floods. The expansion in the area poses a risk as the .road carrying capacity between N6 to Queenstown is way over its design. Integrated Public Transport Network (IPTN) will identify busy routes/roads. The route of the N2 through the district often have incidents associated with fuel trucks. The N6 between East London and Queenstown is also busy due to industrial activities and general expansion in Queenstown. N6 from Stutterheim is also dangerous. Kei cuttings experiences incidents especially when it is raining and rockfalls. Passes in the area has a high incidence of trucks carrying goods being targeted by looters since they drive slowly.

7.2.3.1.3 Buffalo City

Ziphunzana bypass extending between Thandabantu through to Mdantsane access is busy. Traffic engineers are currently monitoring the traffic. Passenger transportation during holiday season/peak periods result in increased volumes. Many busses commute between the Western Cape and former Transkei. Hazchem incidents occur, ranging from minor to serious. Fuel tankers overturn on the roads in and around Buffalo City often resulting in flames. This has an impact on surrounding community, Hemmingway's and Beacon Bay. Mdantsane and Berlin has incidents involving animals/livestock due to the absence of property fences in the rural areas. Breidbach intersection. R363. Traffic Safety Plan.

7.2.3.1.4 Nelson Mandela Bay

Fuel and other hazardous liquids are transported daily, including the transportation to and from the harbour. An estimation of 3000 trucks transports manganese only daily, within Nelson Mandela Bay.

7.2.3.1.5 OR Tambo

It was reported that road incidents are frequent.

7.2.3.1.6 Sarah Baartman

The N10, N2 and N9 are national roads with numerous high motor vehicle hazardous zones e.g Olifantskop Pass,Thorn Hill Gamtoos.

7.2.4 Water Transportation

Eastern Cape has several harbours i.e.: in Buffalo City and Nelson Mandela Bay. There are a few fuel storage facilities that are in or very close to the harbours.

While the importance of marine transportation both in terms of the economy and recreational activities within the Eastern Cape must not be underestimated, the related hazards can pose a serious risk in Eastern Cape. The risk associated with marine transportation hazards poses a risk not only to human health or safety, but also to the environment.

The high traffic marine shipping routes, between East London and Gqeberha contributes to potential for pollution not only within the marine but especially within harbours. The pollution hazard was accounted for under the associated land and water pollution hazards. Please refer to Figure 6-20 shipping traffic on the Eastern Cape shoreline.

7.3 Civil unrest

Civil unrest and mass disturbances can occur at any time, and normally lead to destruction of property and concerns about public safety and security. For the purpose of this assessment civil unrest hazards were divided into six categories, namely

- Demonstrations and riots;
- Refugees and Internally displaced persons;
- Terrorism;
- Armed Conflict; and
- Crime.

The hazard map associated with civil unrest is shown in the Figure 7-8

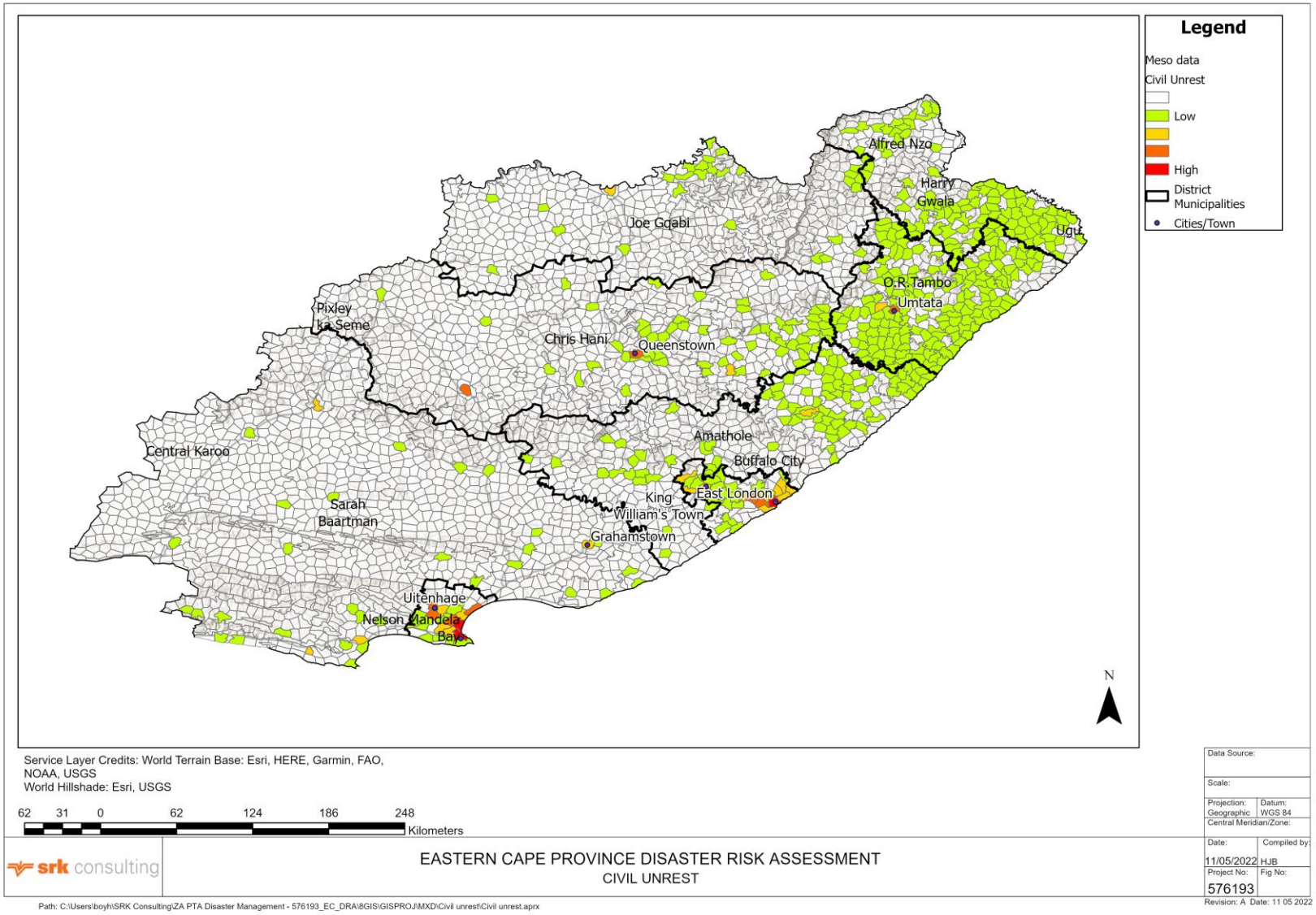

Figure 7-8: Civil unrest hazard (meso data)

Figure 7-8 presents the results of the civil unrest hazard mapping for the Eastern Cape. Areas identified as high civil unrest hazard areas include industrial areas, government buildings and major transport routes in and around informal areas, young people, as well as areas identified by representatives from the Eastern Cape during stakeholder consultations. The assumption is that unemployed and younger people are more likely to participate in civil unrest.

The information was transferred to the meso zones and mapped and areas with higher values can be more prone for civil unrest based on mentioned indicators.

7.3.1 Armed Conflict

Armed conflict refers to conflicts occur when there is conflict between a state and one or more non-state armed groups or among other groups such as taxi associations or other armed groups.

7.3.1.1 Consultation inputs

7.3.1.1.1 Alfred Nzo

The following was recorded:

- Conflicts between villages on cattle/livestock invasion;
- Taxi conflicts in Bizana over taxi routes;.
- Livestock theft which might be due to the provincial borders as well as borders with Lesotho.

7.3.1.1.2 Amathole

- Conflicts between taxi associations.

7.3.1.1.3 Buffalo City

- Councillors' houses being targeted with petrol bombs in isolated incidents.

7.3.1.1.4 OR Tambo

- Land disputes between villages took place in 2019.
- Port St Johns experience livestock theft, however the incidents are decreasing.
- Pondoland region experience livestock theft

7.3.2 Xenophobic violence

As discussed in the previous section, South Africa has experienced an influx of immigrants from neighbouring countries. This has increased the potential risk of xenophobic violence. According to the UNHCR refugees, immigrants and asylum-seekers generally tend to settle in the main urban centres. However, unemployment in such centres is often already a concern for residents, and an influx of immigrants might aggravate the situation. In many areas of South Africa, the competition for employment and resources has led to frustration and boiled over into violence affecting many communities. During consultations it was however indicated that xenophobic violence in the Eastern Cape is not common.

There has lately been a lot of illegal mining in South Africa. The Illegal Miners are also known as "zama zamas". According to various news articles many of the miners are migrants from other African countries, and the violence has raised concerns over xenophobia. No concerns about this were raised during the consultations.

7.3.2.1 Consultation inputs

7.3.2.1.1 Buffalo City

- Large number of foreign nationals within Buffalo City with isolated incidents. However, plans are in place to manage.

7.3.2.1.2 Nelson Mandela Bay

- There have been incidents related to xenophobia.

7.3.2.1.3 Sarah Baartman

- Makana had incidents of xenophobic attacks in the past.

7.3.3 Demonstrations and riots

Demonstrations and riots are a common occurrence in South Africa and incidents where these events escalate to physical violence, injuries and damage to property are becoming more frequent. Areas that are considered likely to be affected by demonstrations and rioting are public buildings, the Central Business District (CBD), industrial areas, informal settlements and main transportation routes.

Service Delivery Protests are frequently seen, South Africa has even been accredited of being “the protest capital of the world” (Wikipedia, 2019).

7.3.3.1 Consultation inputs

7.3.3.1.1 Alfred Nzo

- Service delivery protests in Bizana are mainly on electricity and road-related issues where communities are not satisfied with the conditions of the roads,

7.3.3.1.2 Amathole

- In Great Kei and Amahlathi, the municipal offices were burned down, and the major’s cars got burned down during demonstrations.

7.3.3.1.3 Buffalo City

- Demonstrations in Buffalo City are mainly on student protest, service delivery as well as taxi-related protests where major routes are blocked.

7.3.3.1.4 Chris Hani

- Service delivery protest occur throughout Chris Hani. Demonstrations are because of infrastructure. On the other hand, the national load shedding is creating more challenges. Areas that are overgrown also contribute to problems.

7.3.3.1.5 Joe Gqabi

- Service delivery protests. Demonstrations also occur close to the election.

7.3.3.1.6 Nelson Mandela Bay

- Riots by community accompanied by burning of tyres. Demonstrations are mainly aimed at the local authorities for lack of service delivery, SMMEs on awarding of contracts (tenders), as well as taxi strikes that occur between the government and the taxi industry.

7.3.3.1.7 OR Tambo

- Service delivery protests are increasing.

7.3.3.1.8 Sarah Baartman

- Unions in Kouga have taken to the streets in case of labour disputes. Municipal officials burned down municipal buildings in the Sundays River Valley in 2013/14 School children protested for more teachers. Services delivery protests are prevalent towards elections in Makana.

- In Ndlambe, roads are blocked, houses and municipal buildings burned. Entrances into the township also get blocked. It was also highlighted that the role of Disaster Management is unclear in the face of unrest.

7.3.4 Crime

Figure 7-9gives a visual presentation of the reported crime profile in Eastern Cape.

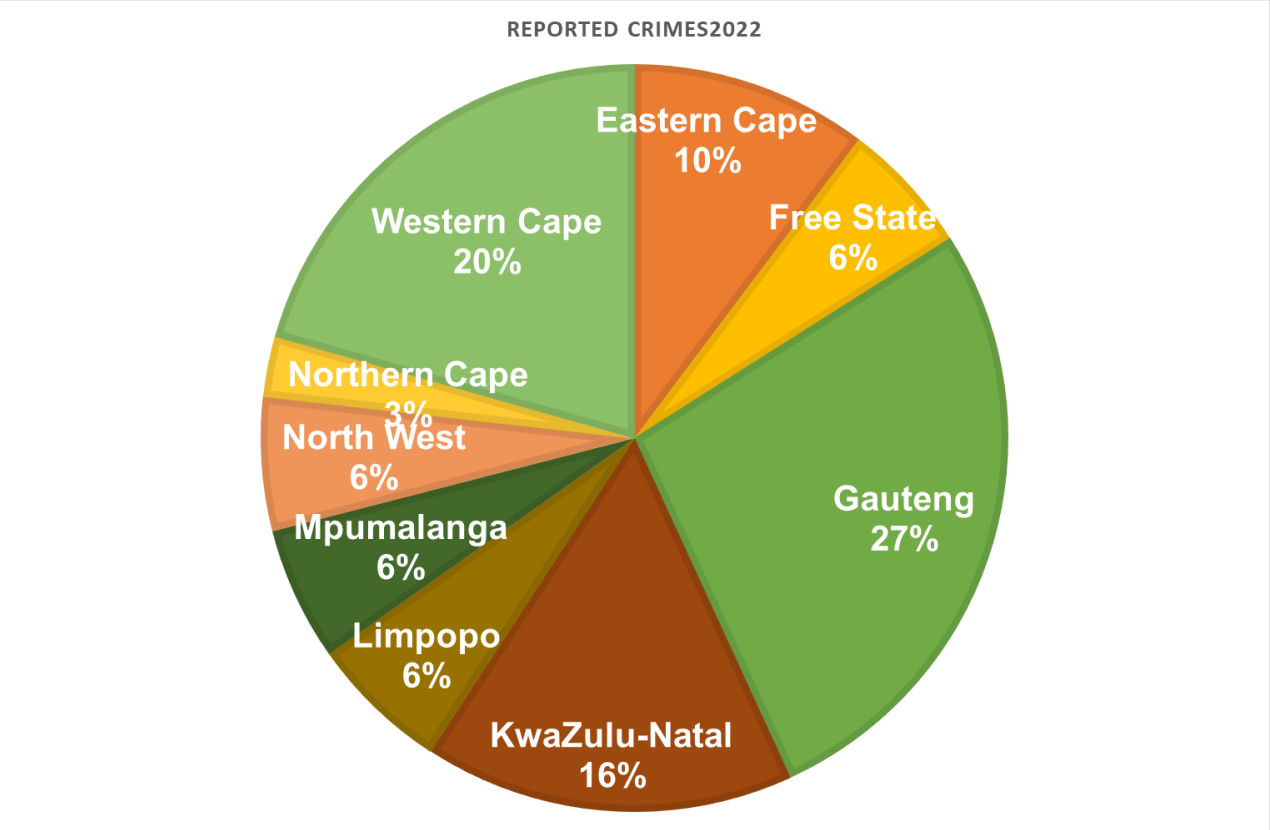

Figure 7-9: Reported Crime all Provinces (2015-2022 Crime Stats SA (based on SAPS Crime Statistics), 2022 Crime Stats SA)

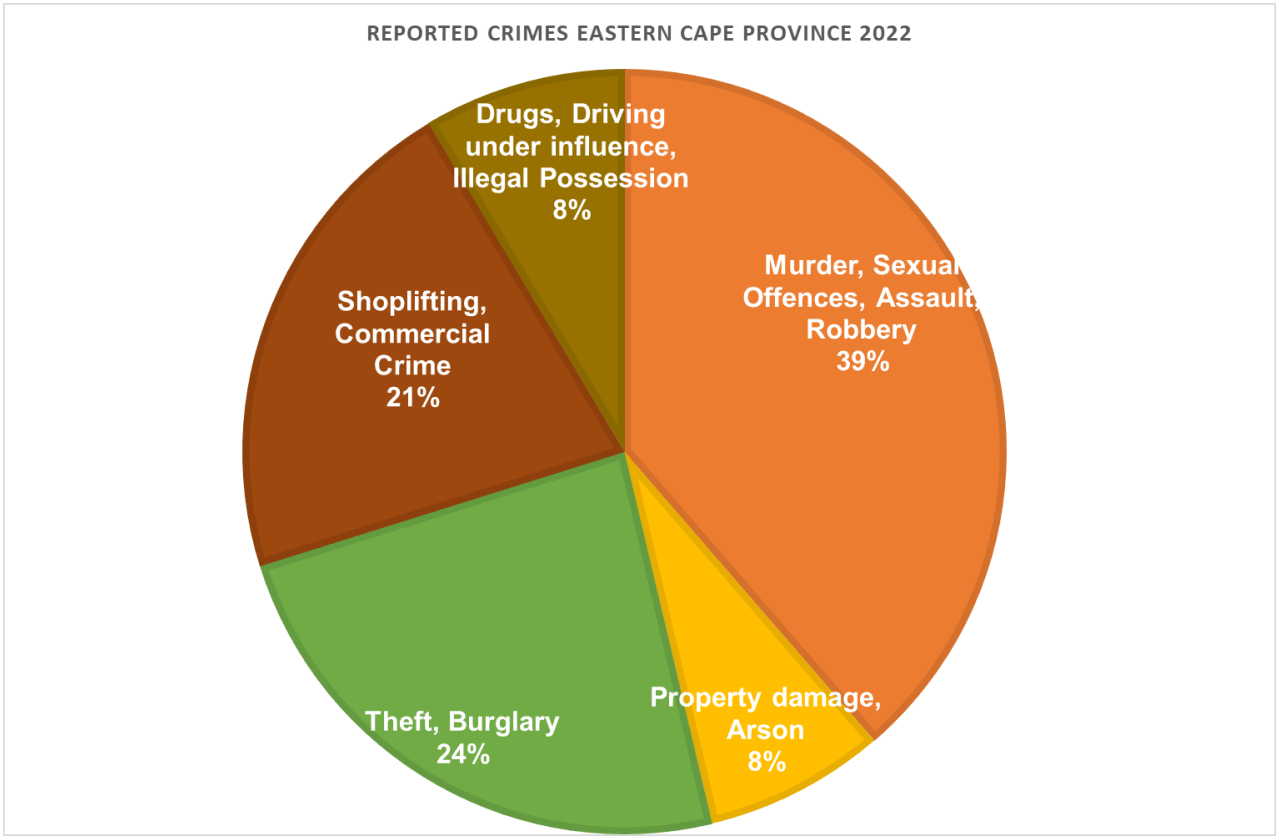

Figure 7-10: Distribution of reported crime profile of Eastern Cape (2015-2022 Crime Stats SA (based on SAPS Crime Statistics), 2022 Crime Stats SA)

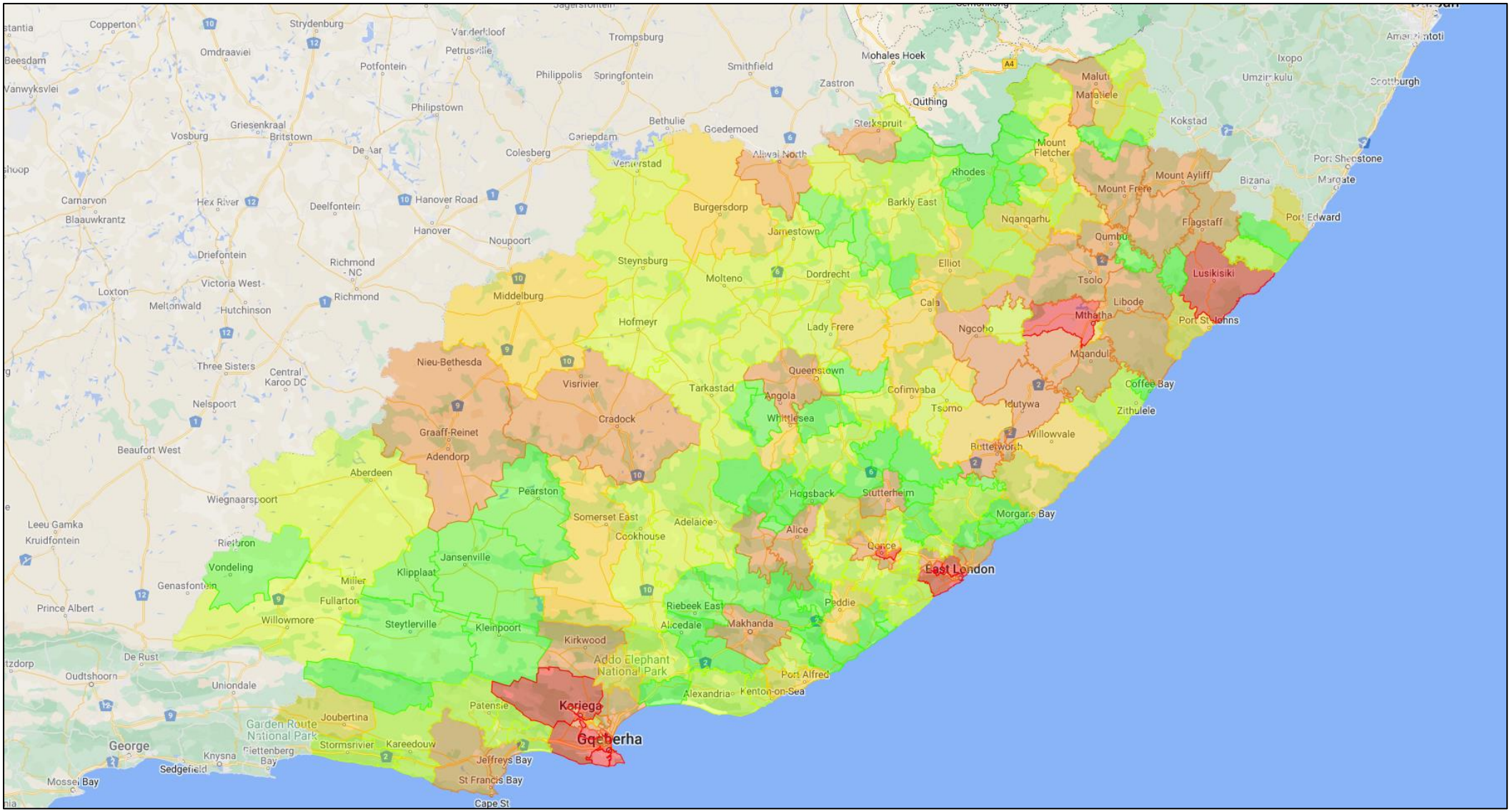

Figure 7-11: Eastern Cape reported crime heatmap (2015-2022 Crime Stats SA (based on SAPS Crime Statistics), 2022 Crime Stats SA)

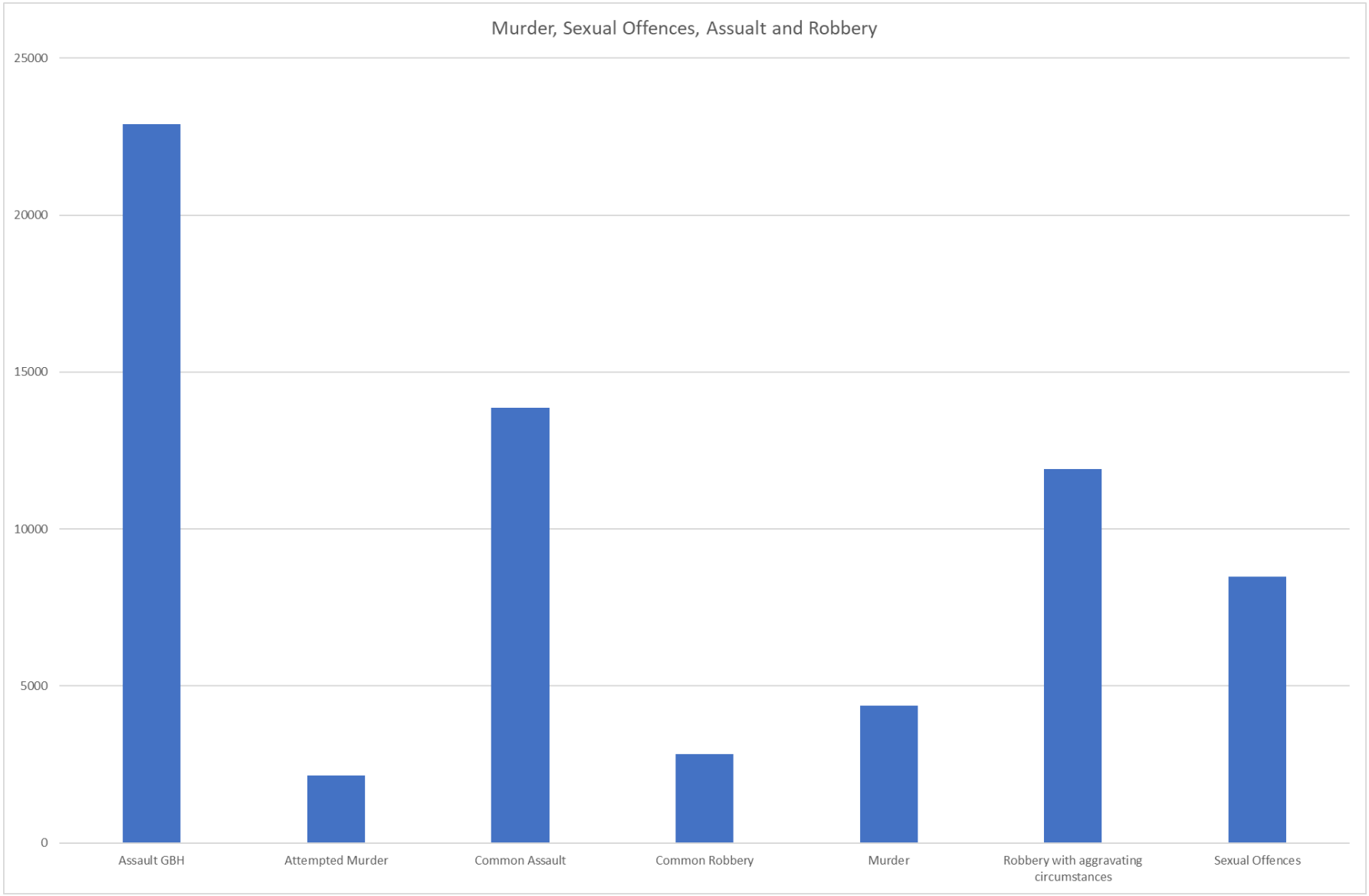

Figure 7-12: Further analysation of clustered category (Figure 7-10): Murder, Sexual Offences, Assault, Robbery (2015-2022 Crime Stats SA (based on SAPS Crime Statistics), 2022 Crime Stats SA)

The analysis of the SAPS data revealed that there are 196 police stations within the Eastern Cape. The Eastern Cape crime constitutes 10% of the total reported crime for South Africa. Murder, Sexual Offences, Assault and Robbery is the highest combined category making up 39% of total reported crime in the Eastern Cape. A further analysis of the combined category (Murder, Sexual Offences, Assault, Robbery) reveals a very high number of "Assault with the intent to cause grievous bodily harm (GBH)" followed by "Common Assault" and "Robbery with aggravating circumstances

The heatmap of reported crime for the Eastern Cape indicates that Gqeberha, East London, Mthatha and areas around Lusikisiki have the highest reported crime.

The South African Police Service (SAPS) crime stats for the first quarter of 2022, show that 6 police stations in the Eastern Cape were in the top 30 stations in the country where murder cases were reported. The police stations include Mthatha, Kwazakele, Lusikisiki, Willowvale, New Brighton and Libode. There is also a high reports of stock theft, which was also highlighted during the stakeholder consultations (South African Police Services, 2022)

7.3.4.1 Consultation inputs

7.3.4.1.1 Alfred Nzo

Stock theft due to the district sharing borders with KwaZulu Natal Province (KZN) and Lesotho.

7.3.4.1.2 Amathole

Crime has large impacts that come up frequently. Mainly associated with poverty. There should be plans on poverty alleviation.

7.3.4.1.3 Chris Hani

- Unemployment in the area contributes to crime. Crime is increasing. Restructuring of stations is taking place to better manage crime.

7.4 Environmental degradation

For this assessment, environmental degradation was divided into four sub-categories. They included:

- Desertification;
- Deforestation;
- Erosion:
- Land degradation; and
- Loss of biodiversity.

Environmental degradation may result from a variety of factors, including overpopulation and the resulting overuse of land and other resources. Intensive farming, for instance, depletes soil fertility, thus decreasing crop yields. Pollution is also a well-known cause of environmental degradation. Sources of pollution include mines, power generating facilities (especially those burning fossil fuels), industry and agriculture.

In many parts of the world, environmental degradation is an important cause of poverty. Environmental problems have led to shortages of food, clean water, materials for shelter, and other essential resources. As natural resources are degraded, people who live directly off the environment suffer most from the effects. Environmental degradation is often not considered a disaster risk, but environmental degradation hazards can contribute to slow-onset disasters, with less dramatic results than other rapid-onset disasters such as fires or floods. Various environmental degradation hazards are discussed in more detail below:

7.4.1 Desertification

Desertification is defined by the U.N. Convention to Combat Desertification as "land degradation in arid, semiarid and dry subhumid areas resulting from various factors, including climatic variations and human activities." Land degradation is in turn defined as the reduction or loss of the biological or economic productivity of drylands. Desertification occurs because dryland ecosystems are extremely vulnerable to over-exploitation

and inappropriate land use. Poverty, political instability, deforestation, overgrazing, and bad irrigation practices can all undermine the land's fertility (Natural Resources Conservation Service, 2003).

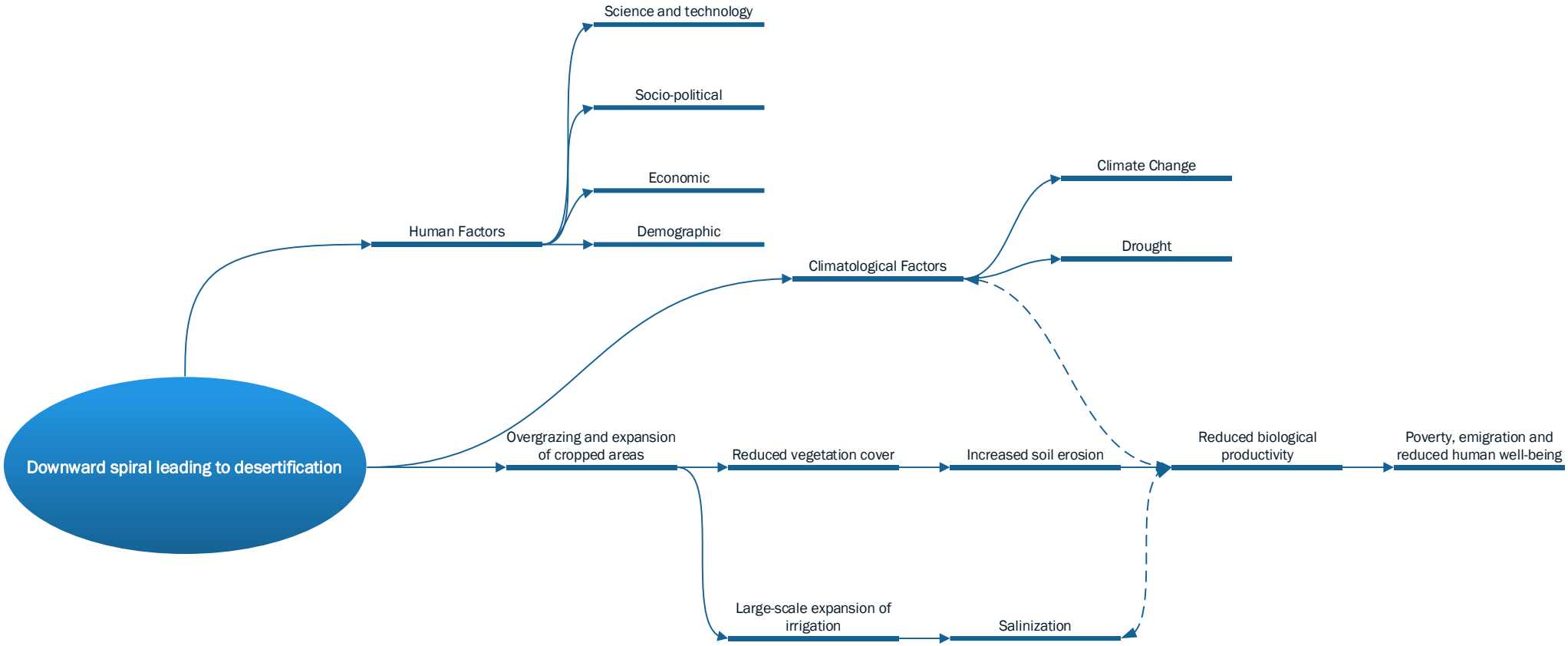

Figure 7-13: Downward[1] spiral leading to desertification

[1] Salinization is the process by which water-soluble salts accumulate in the soil. Salinization is a resource concern because excess salts hinder the growth of crops by limiting their ability to take up water.

To map desertification in the Eastern Cape, data and information from U. S. Department of Agriculture (USDA), Natural Resources Conservation Service, Soil Survey Division, World Soil Resources. More specifically their study on desertification vulnerability of Africa[2] were used to map desertification.

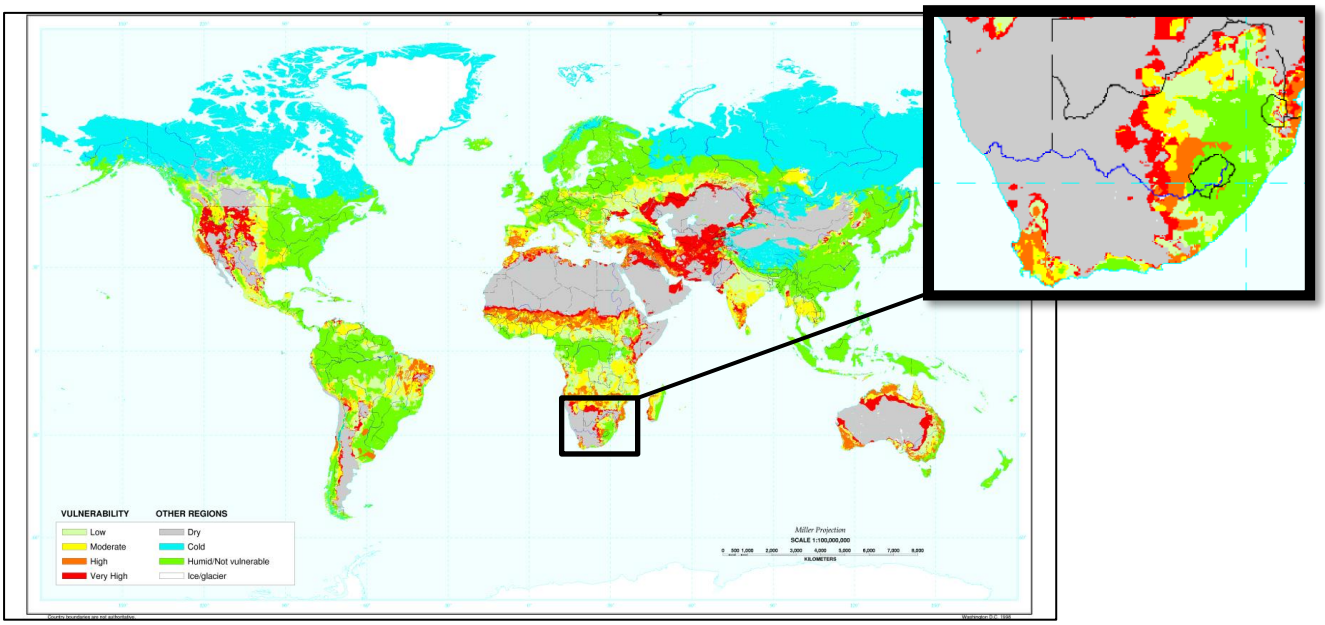

Figure 7-14: Global desertification vulnerability map3

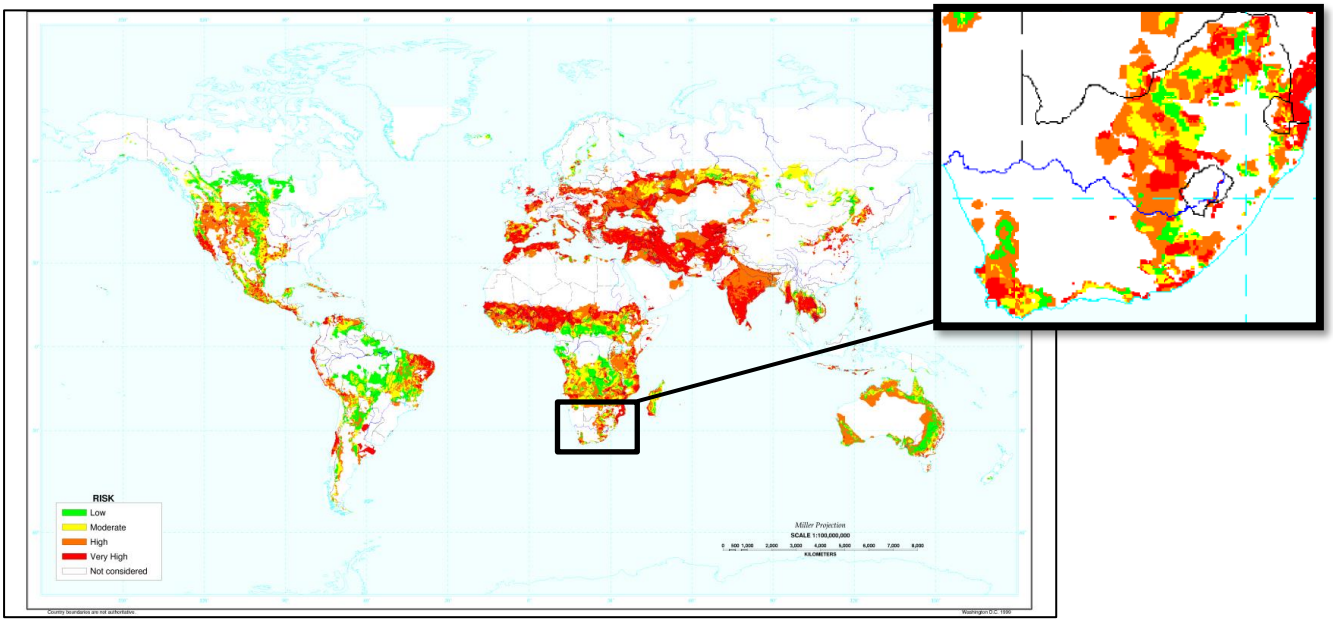

Figure 7-15: Risk of human induced desertification map4

[2] Soil Use | NRCS Soils (usda.gov)

[3] Soil map and soil climate map, USDA-NRCS, Soil Survey Division, World Soil Resources, Washington D.C. Retrieved from: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/maps/?cid=nrcs142p2_054003

[4] Desertification map, USDA-NRCS, Soil Survey Division, World Soil Resources, Washington D.C. Population density map, Tobler, W., V. Deichmann, J. Gottsegen, and K. Maloy. 1995. The global demography project. Technical Report TR-95-6. National Center for Geographic Information analysis. Univ. Santa Barbara, CA. 75 pp. Retrieved from: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/worldsoils/?cid=nrcs142p2_054004]

Figure 7-16 shows the results after information from USDA was transferred to the meso data of the Eastern Cape. The red areas represent very high risk for desertification, orange high and yellow is low.

The graph (Figure 7-17) shows that the very high zone (5) can have the biggest impact on Sarah Baartman's agricultural sector.

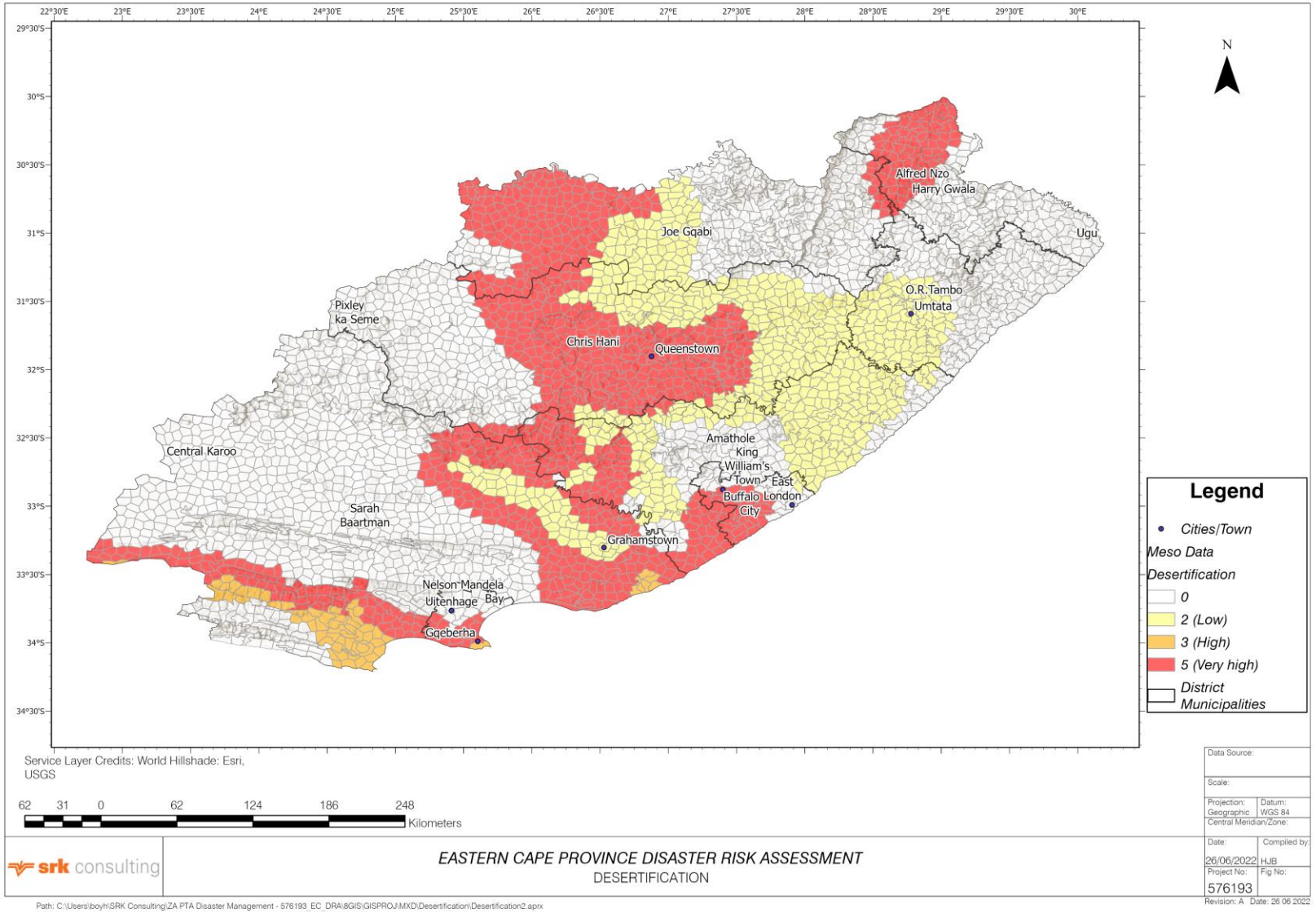

Figure 7-16: Eastern Cape Desertification and possible impact (meso data)

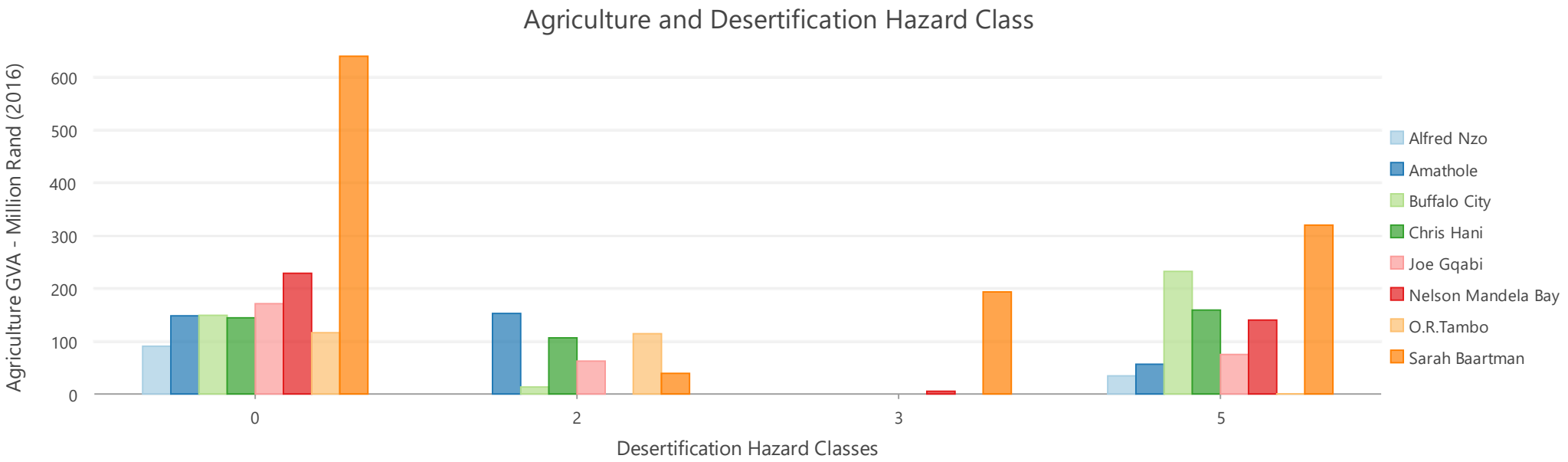

Figure 7-17: Agriculture and Desertification

7.4.2 Deforestation

Deforestation is the term used to describe the removal of a forest or trees. In some areas it is very apparent such as the cutting down of a rain forest. In other areas it is not as apparent such as the continued cutting of trees in a broader area for firewood (Wikipedia, 2019).

The use of wood as an energy source for cooking will contribute to a substantial loss of trees within the province.

Forest land cover data from 1990 (indigenous forest) was compared with forest data of 2020 (contiguous (indigenous) forest, contiguous low forest & thicket and dense forest & woodland) and a heat map was created of areas where there was forest in 1990 but no forest in 2020 (Figure 7-18). Data from the heat map was transferred to the meso data layer and Figure 7-19 shows in red the areas that are the hardest hit with deforestation the las 30 years.

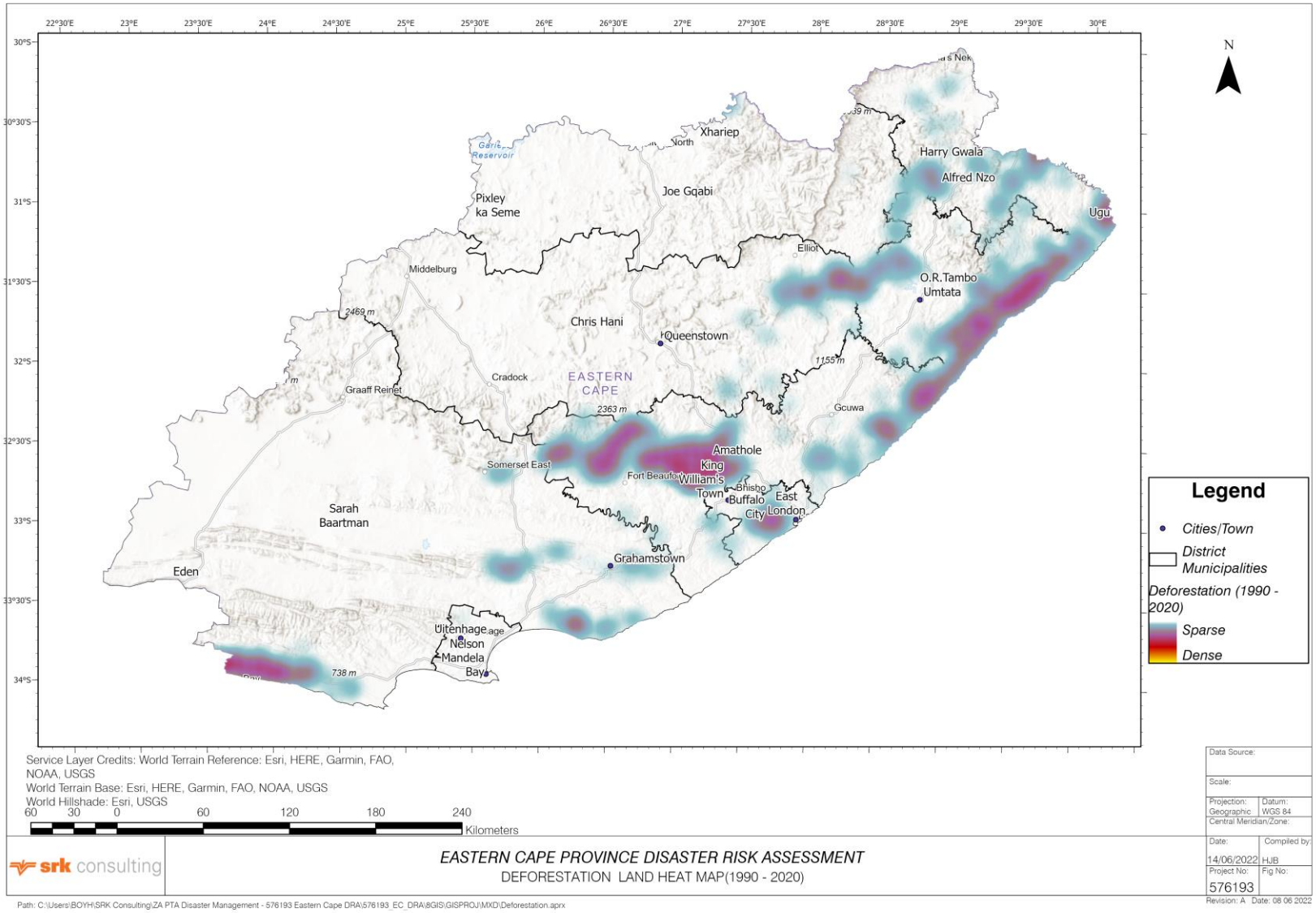

Figure 7-18: Deforestation (1990 – 2020) heat map

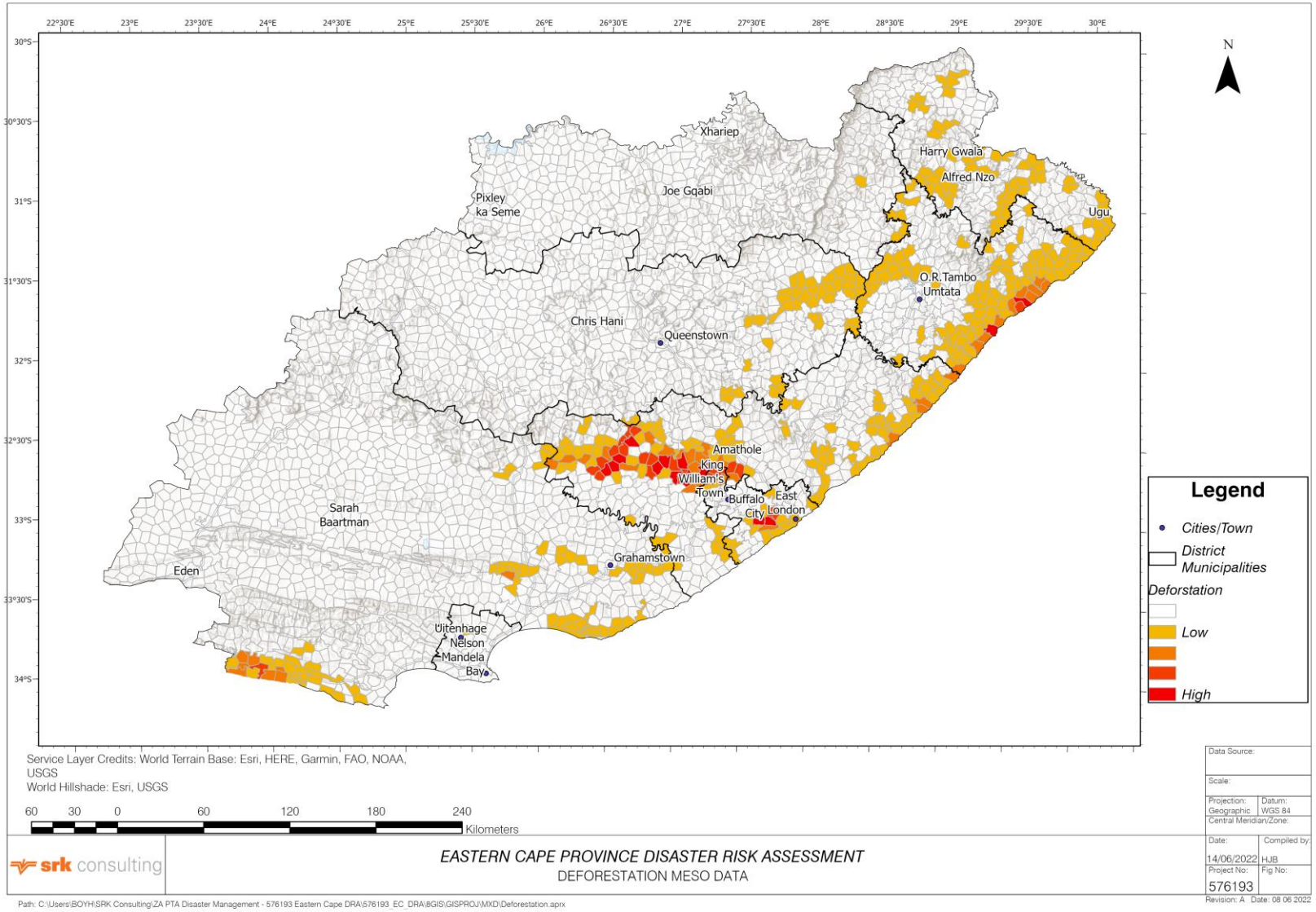

Figure 7-19: Deforestation possible impact on Agriculture and forestry (meso data)

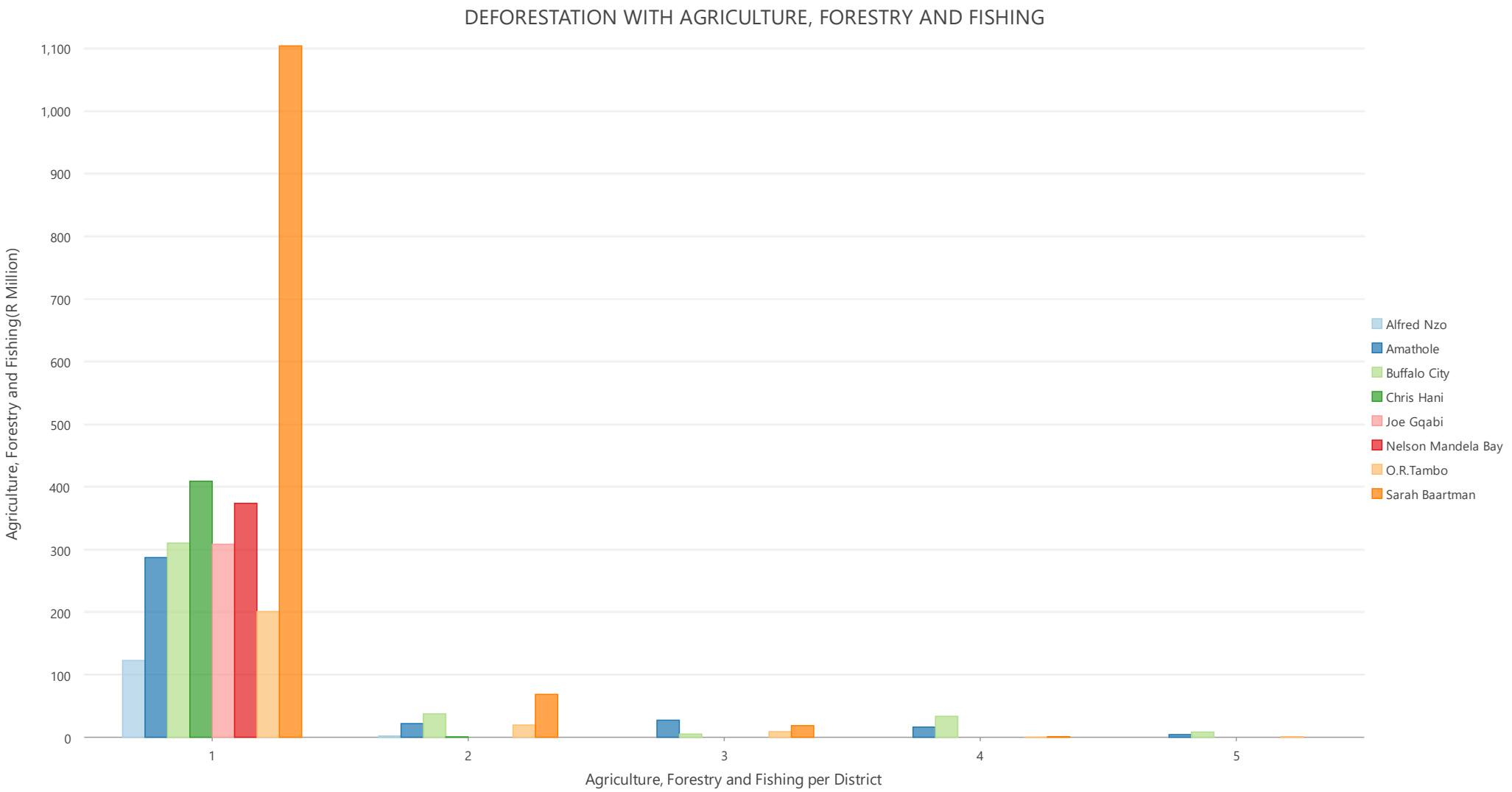

Figure 7-20: Deforestation and Agriculture Forestry and Fishing

7.4.2.1 Negative impact of deforestation

The following impacts from deforestation are evident.

7.4.2.1.1 Increased greenhouse Gas Emissions

Forests are carbon sinks and, therefore, help to mitigate the emission of carbon dioxide and other greenhouse gases. Tropical forests alone hold more than 228 to 247 gigatons of carbon, which is more than seven times the amount emitted each year by human activities (World Wildlife Fund (WWF), 2022).

When forests are cut, burned or otherwise removed they emit carbon instead of absorb carbon. Deforestation and forest degradation are responsible for around 15% of all greenhouse gas emissions. These greenhouse gas emissions contribute to rising temperatures, changes in patterns of weather and water, and an increased frequency of extreme weather events.

7.4.2.1.2 Disruption of water cycle

Trees play a key role in the local water cycle by helping to keep a balance between the water on land and water in the atmosphere. When deforestation occurs, that balance can be disturbed, resulting in changes in precipitation and river flow (World Wildlife Fund (WWF), 2022).

7.4.2.1.3 Increased soil erosion

Without trees to anchor fertile soil, erosion can occur and sweep the land into rivers. The agricultural plants that often replace the trees cannot hold onto the soil. Many of these plants can exacerbate soil erosion. Scientists have estimated that a third of the world's arable land has been lost through soil erosion and other types of degradation since 1960. Erosion remains a challenge mainly in developing countries, in comparison with developed countries. Coastal erosion can also have an impact on settlements, livelihood and the infrastructure along the coastline (World Wildlife Fund (WWF), 2022) (Gupta & Nair, 2012).

7.4.2.2 Consultation inputs

7.4.2.2.1 Amathole

- Deforestation is more from commercial side;
- Burning of trees has a large impact on the immediate micro environment as this is how indigenous forests are lost due the presence of highly flammable plants. Consequently, deforestation is more commercial. Research projects are looking at Environmental deficiencies. Poverty alleviation programs can assist to curb degradation. Community programs to plant trees for example can assist in this regard.
- Commercial plantations are located close the indigenous forests.

7.4.2.2.2 Joe Gqabi

- Invasive plant species infestation generally results in environmental degradation. The wattle is present.

7.4.3 Erosion

Erosion, including soil, wind and water erosion, is often not considered as a major disaster hazard, but as is the case with several environmental degradation hazards, uncontrolled erosion can cause severe damage to the environment, and lead to a general reduction in environmental quality. Erosion in the vicinity of infrastructure, such as roads, pipelines and electricity infrastructure, can also lead to damage and the eventual destruction of the infrastructure.

Soil erosion can result from several causes, including overstocking and overgrazing as well as inappropriate farming techniques. The effect of erosion can include an on-site loss of agricultural potential and localized environmental damage. Water erosion, on the other hand, can cause problems in watercourses. This is due to the downstream movement of sediment, causing the silting up of reservoirs and flooding.

Eroded Land classification from 2020 Land Cover data was used to map erosion areas in the Eastern Cape Province. Figure 7-21 shows a heat map of effected areas. This data was transferred to the meso data layer Figure 7-22.

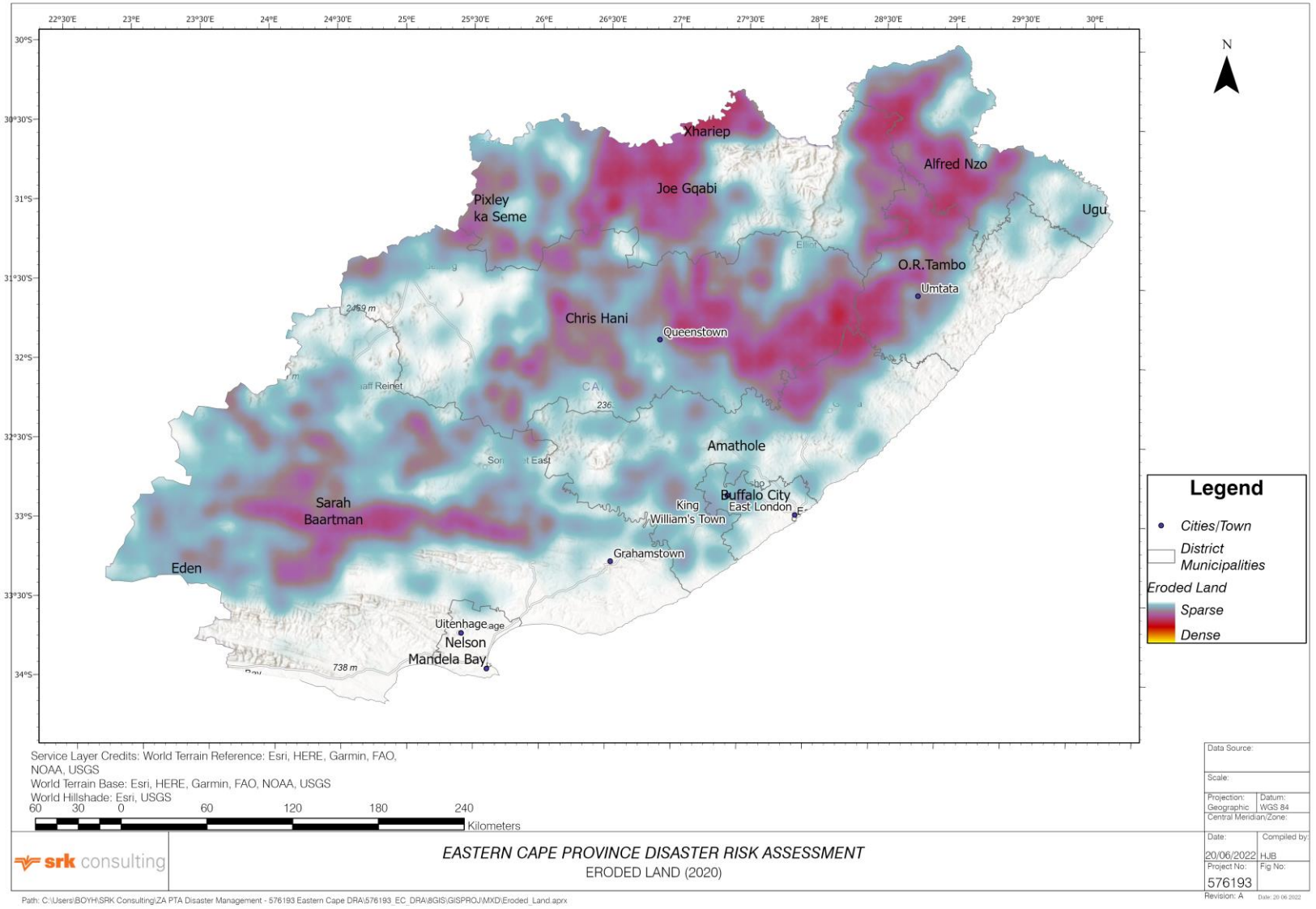

Figure 7-21: Eroded land heatmap

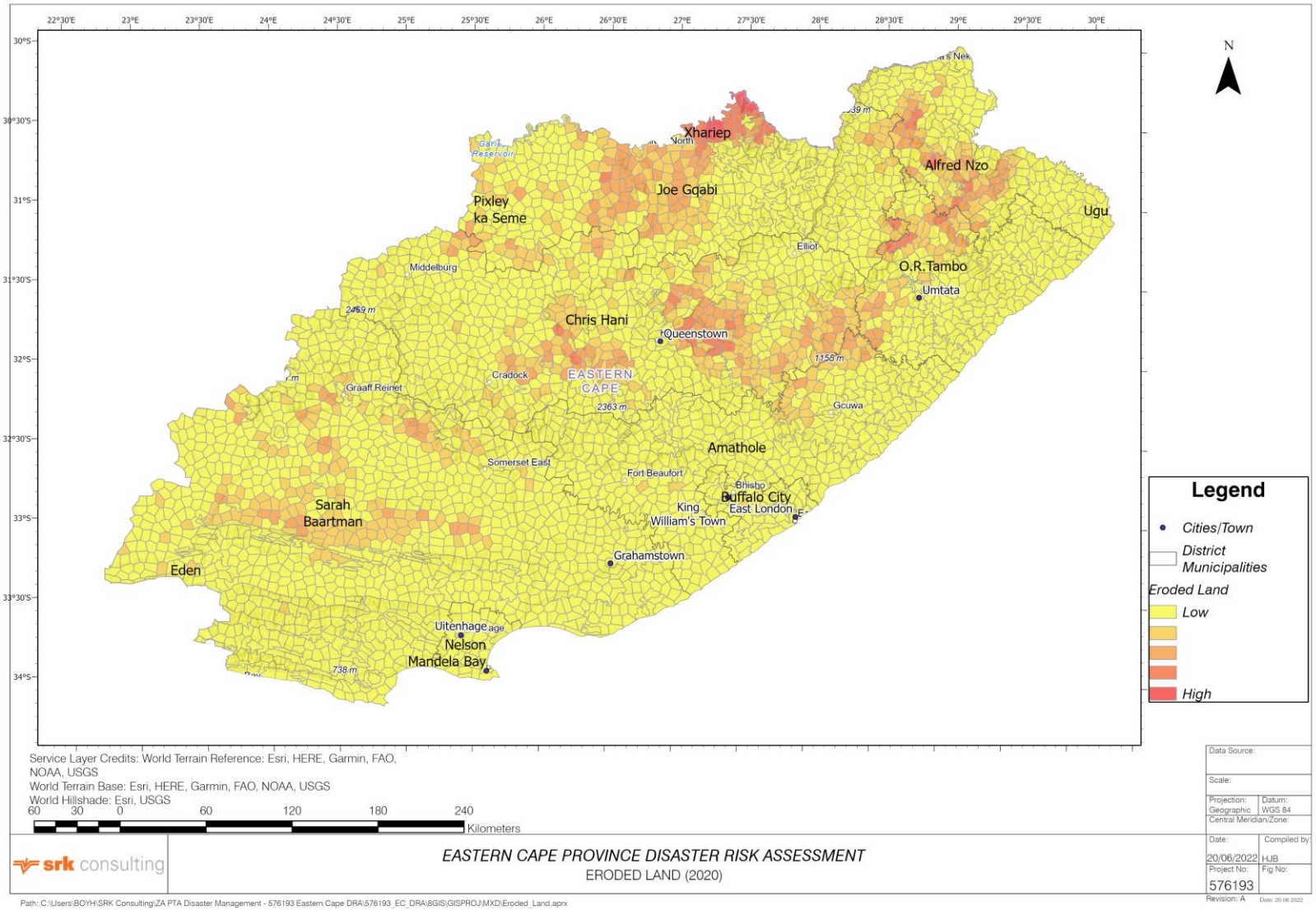

Figure 7-22: Eroded land 2020 (meso data)

7.4.4 Consultation inputs

7.4.4.1 Alfred Nzo

Erosion may be exacerbated by veld fires and invasion of alien species, particularly in Mount Ayliff, Bizana and Matatiele. Popular invasive species is the black wattle. There is an Environmental Management Plan in place. The district has capacity problems. A detailed study on the subject is required. There is also an increase in the number of veld fires.

7.4.4.2 Amathole

Erosion within Amathole is exacerbated by overgrazing, alien invasive plant species and fire. Land use should be controlled to allow growth after fire. Erosion is also prevalent along riparian zones. Settlements seem to coincide with erosion. For example, settlements on slopes can increase impact, and settlements where grass is completely dug out instead of being cut and / or maintained. Town planning committees are not inclusive of other stakeholders such as Agriculture, Disaster Management and Environmental Specialists in the planning process. Regulations on burning and grazing should be implemented in the Local Municipalities and Disaster Management Act must be implemented.

7.4.4.3 Buffalo City

Rural areas where eroded soil ends in dams. Natural dune forest along coastal areas are removed, erosion of dunes.

7.4.4.4 Joe Gqabi

Overgrazing, especially in the communal camps leads to erosion and further degradation. Geological and mountainous nature of the area make the Elundini and Senqu vulnerable to erosion with Senqu being more prone to erosion due to its topography. Other factors include destruction of wetlands, Climate Change also generally contributes.

7.4.5 Land degradation

Land degradation is caused by multiple elements, including extreme weather conditions, particularly drought. It is also caused by human activities that pollute or degrade the quality of soils and land use. It negatively affects food production, livelihoods, and the production and provision of other ecosystem goods and services. Desertification is a form of land degradation by which fertile land becomes desert (World Health Organization, 2020).

The current pressures on land are huge and expected to continue growing there is rapidly escalating competition between the demand for land functions that provide food, water, and energy, and those services that support and regulate all life cycles on Earth (United Nations Covention to Combat Desertification, 2018). It has been estimated by The United Nations Environment Programme (UNEP) that more than a quarter of the African continent is rapidly degrading and the land for cultivation is becoming scarce commodity. One of the causes of degradation is population pressure, which forces farmers to cultivate marginal land (ICSU, 2018).

According to International Council for Science (ICSU) “The rural poor, the overwhelming majority of Africa’s population, destroy their own environment, not out of ignorance but simply for survival. Rural dwellers strip trees and shrubs for wood because they need fuel. In the context of the short-term basic needs of an individual, each decision is rational; in the long run, the effects are disastrous.” (International Council for Science, 2007)

Areas of severe degradation (that is, degradation of both soil and vegetation) and desertification in South Africa are perceived to correspond closely with the distribution of communal rangelands, specifically in the steeply sloping environments adjacent to the escarpment in Limpopo, KwaZulu-Natal, and the Eastern Cape. From the report, the Eastern Cape Province is in an area classified as having a medium to high degradation index. Figure 7-23 show areas that were identified for degradation or possible land degradation based on urbanisation and eroded land. In Figure 7-24 values from identified areas for land degradation were transferred to meso data to calculate possible impact on the economy or communities.

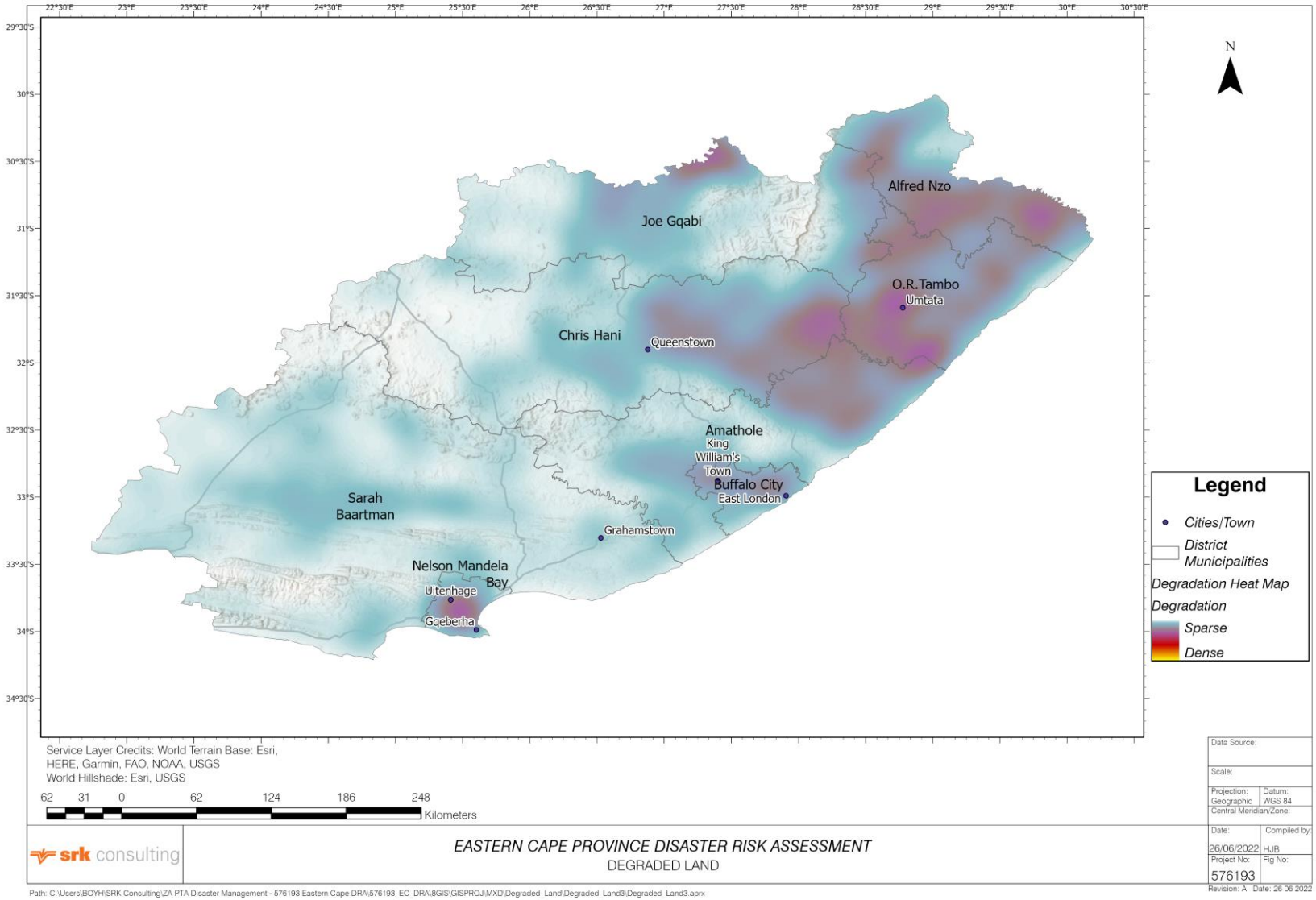

Figure 7-23: Heat Map of land degradation

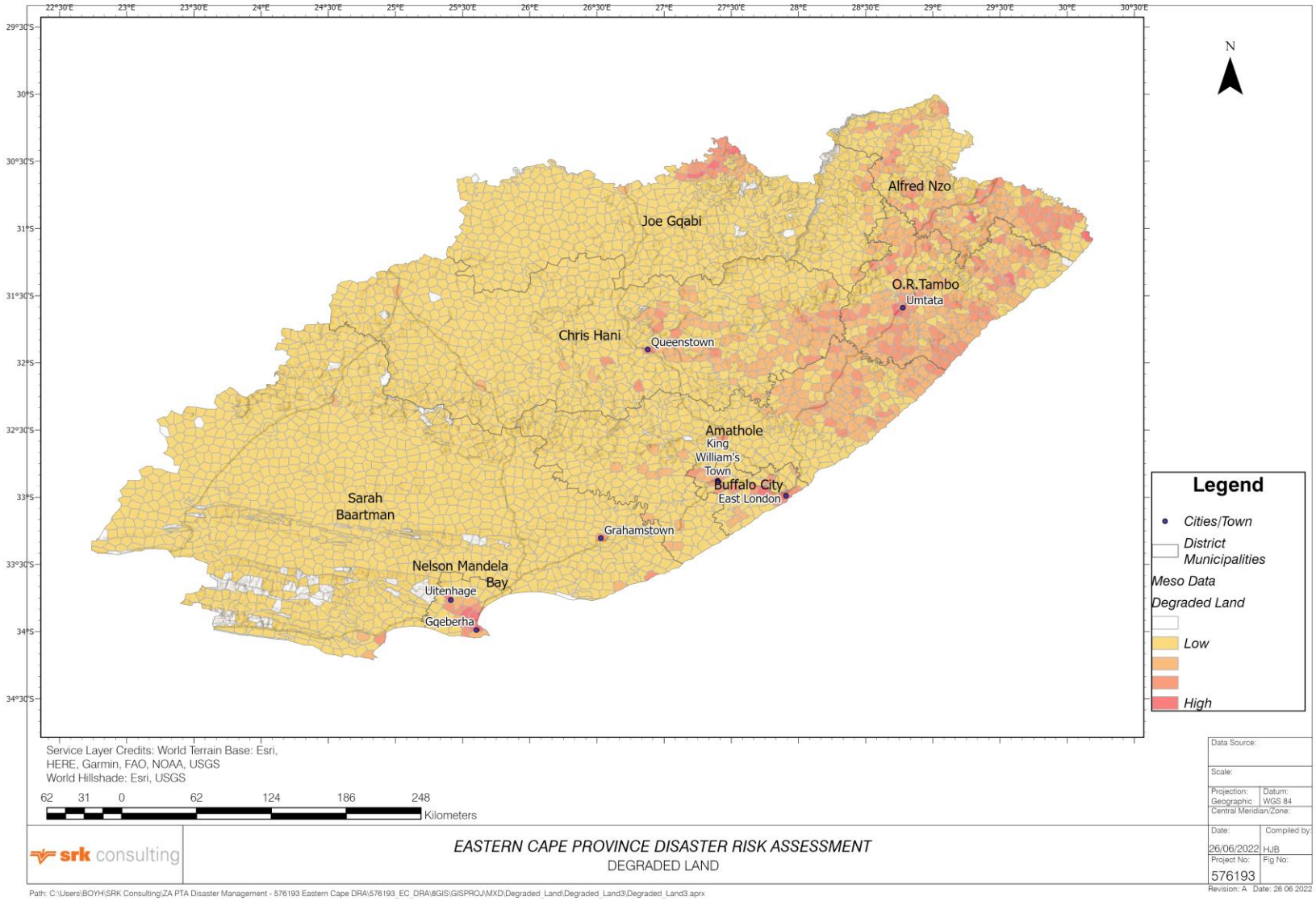

Figure 7-24: Distribution of land degradation (meso data)

Figure 7-24 presents the environmental degradation hazard for Eastern Cape Province. Areas with a high hazard rating were identified using the 2020 Land Cover map of Eastern Cape Province. Areas where degradation is already present including built-up areas were rated as highly degraded, while the medium hazard is a 100m buffer zone of the existing degraded areas.

7.4.5.1 Consultation inputs

7.4.5.1.1 Alfred Nzo

Development of houses and in areas that are within flood zones is becoming a problem and influencing the land degradation.

7.4.5.1.2 Buffalo City

Land use changes that cause hardening of surfaces. Increases runoff and impact rain.

7.4.5.1.3 Joe Gqabi

Overgrazing. Destruction of wetlands. Climate Change effects. There are programs aimed at slowing or stopping the degradation. Senqu Local Municipality and some of Walter Sisulu Municipality. Venterstaad and Steinberg form a transitional zone to karoo. Senqu has a different topography from the rest of Joe Gqabi.

7.4.6 Loss of biodiversity

The Eastern Cape Biodiversity Plan describe a biodiversity vulnerability study of the Eastern Cape in 2017. A multi-criteria analysis approach was used, within a GIS environment, to map and integrated thirteen socio-economic and biodiversity indicators believed to be spatial representatives of the major drivers of biodiversity loss across the Eastern Cape Province (Desmet & Hawley, 2020).

Table 7-2 shows the four criteria and 13 indicators used in the study. The Mean and Mean Weight columns present the mean of three experts in the field of biodiversity. The mean shows the average score, or weight of relevance or importance given by the experts assigned to each criterion and indicator. The sum is of the weights are 1. The Net Weight of the indicators were used to develop the biodiversity vulnerability of the Eastern Cape.

Table 7-2: Expert derived cost weightings used for criteria and indicators

Criteria	Mean	Indicator	Mean Weight	Net Weight
Human footprint	0.22	Population density	0.367	0.079
		Pop density neighbour	0.283	0.061
		Distance to settlement	0.183	0.040
		Road access footprint	0.167	0.036
Resource dependency index	0.18	Poverty index	0.450	0.083
		Wood as main energy for cooking	0.550	0.101
Alternative land use opportunity costs	0.35	Agricultural potential	0.361	0.126
		Afforesting potential	0.328	0.115
		Specific infrastructure projects	0.310	0.109
Ecological Integrity	0.25	Alien invasive plants	0.250	0.063
		Bush encroachment/pu	0.150	0.038
		Not natural pixel/pu	0.383	0.096
		Not natural of Neighbourhood	0.217	0.054
Sum				1

Figure 7-25 is the result from the above-mentioned analysis. Red colour indicates a higher biodiversity vulnerability for the specific area. The values from the assessment were transferred to the meso data layer with

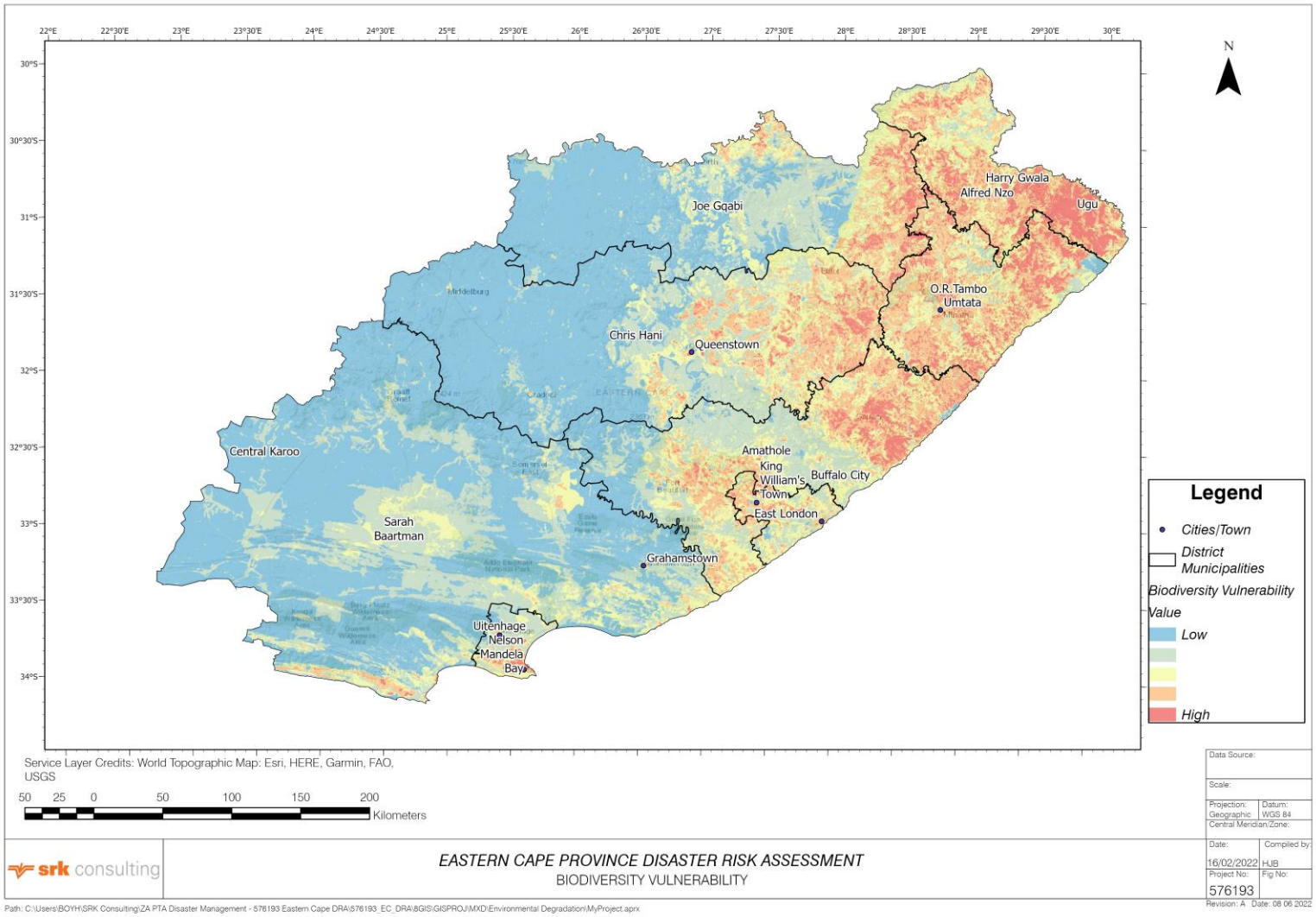

Figure 7-25: Biodiversity vulnerability (Desmet & Hawley, 2020)

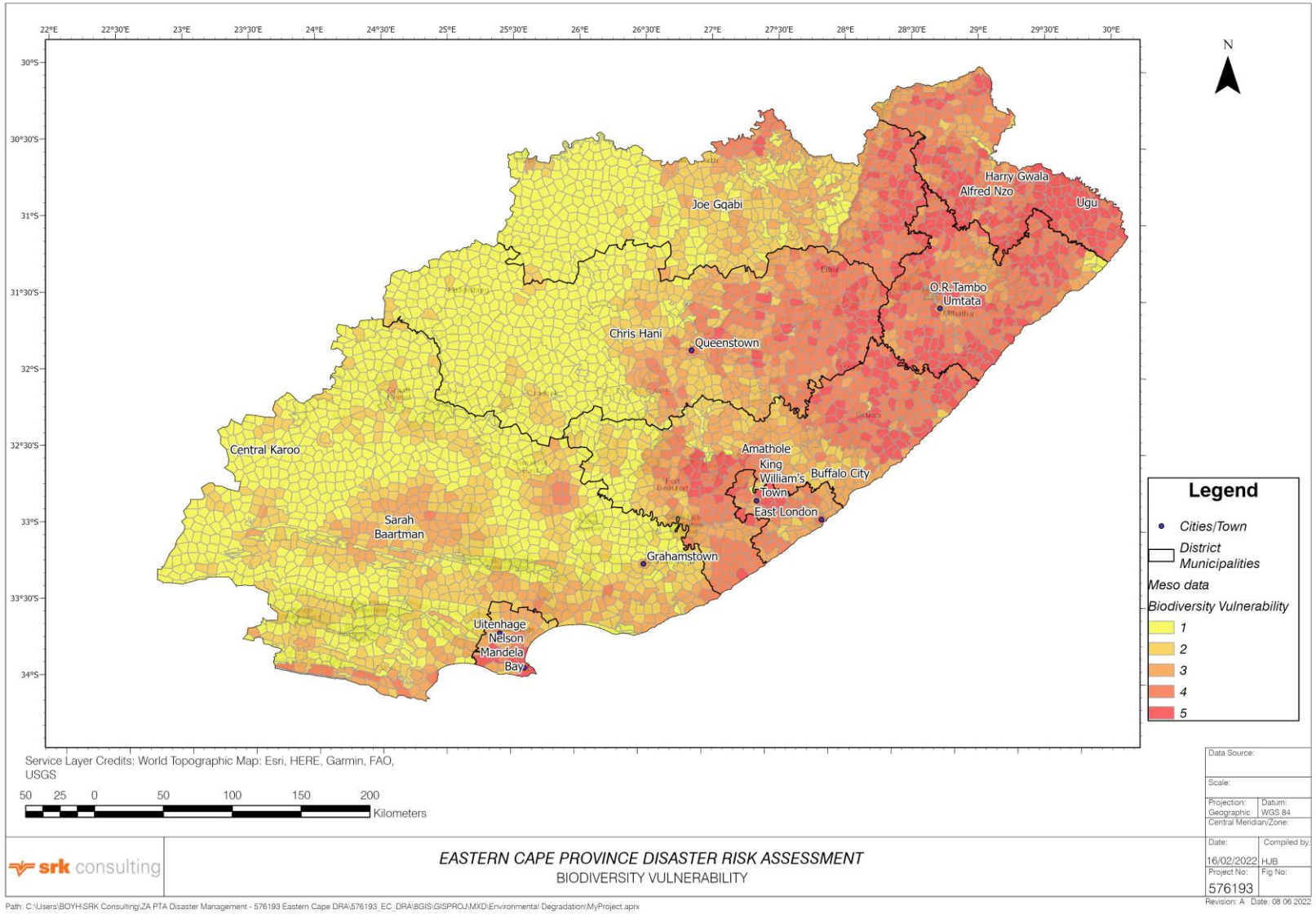

Figure 7-26: Distribution of biodiversity vulnerability (meso data)

7.4.6.1 Consultation inputs

7.4.6.1.1 Joe Gqabi

Drakensberg mountain range runs into Joe Gqabi. Afro Montana Grassland is dominant in the area. Projections indicate that the grassland in this area will be impacted by climate change. Loss of flora and change thereof will affect Fauna particularly the Beaded Vulture colony. This will further affect ecological balance. Serious increase of alien and invasive species such as *Seriphium plumosum* "Slang Bos" in Chris Hani & Joe Gqabi.

7.4.7 Comprehensive Environmental Degradation Profile

Desertification, Land Degradation, Deforestation and Eroded Land were combined to compile a comprehensive Environmental Degradation Profile for the Eastern Cape. Figure 7-27 is the result.

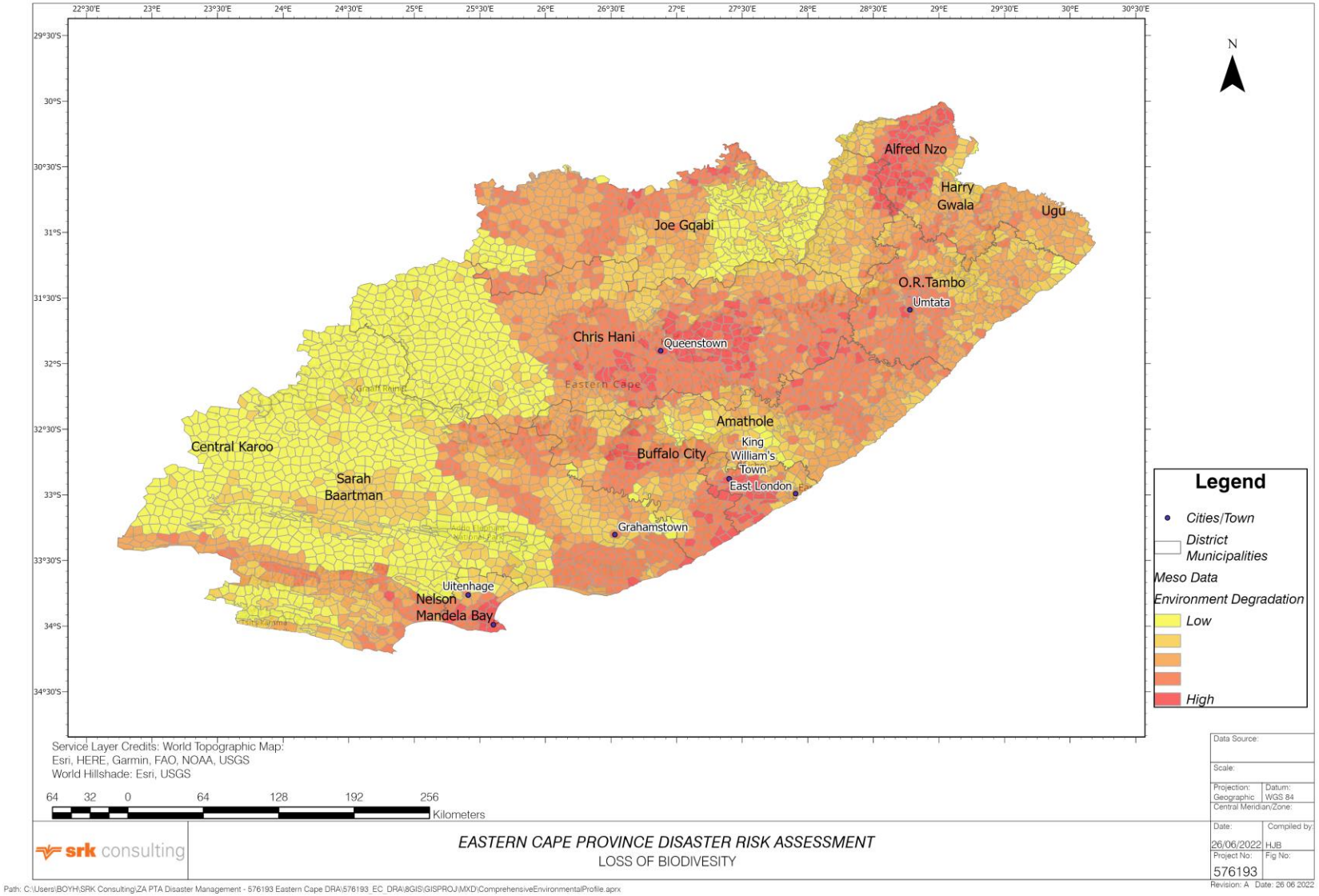

Figure 7-27: Comprehensive Environmental Degradation Profile (meso data)

7.5 Disease / health - disease: animal

Informal and rural areas are associated with a higher risk of animal infections due to sometimes large quantities of animals that are often not well managed and lack of animal care facilities. Rabies is an example of an animal disease that is more common in rural and informal areas due to lack of resources to vaccinate animals. Most of the settlements in Eastern Cape Province are classified as rural, where the keeping of livestock for subsistence farming is common.

Intensive commercial agricultural activities involving high densities of animals such as chicken broilers, piggeries and feed lots could pose a risk for animal disease due to the density and high number of animals. No information on the location of such activity was found for Eastern Cape Province.

7.5.1 Foot-and-mouth disease

Foot-and-mouth disease or hoof-and-mouth disease is an infectious and sometimes fatal viral disease that affects cloven-hoofed animals, including domestic and wild game. The virus causes a high fever for two or three days, followed by blisters inside the mouth and on the feet that may rupture and cause lameness (Wikipedia, 2019).

The foot-and-mouth disease virus can be transmitted in several ways, including close-contact animal-to-animal spread, long-distance aerosol spread and fomites, or inanimate objects, typically fodder and motor vehicles. Control measures include quarantine and destruction of infected livestock, and export bans for meat and other animal products to countries not infected with the disease (Wikipedia, 2019).

7.5.2 Classical swine fever

Classical swine fever is a highly contagious disease of pigs and wild boar. Swine fever causes fever, skin lesions, convulsions and usually (particularly in young animals) death within 15 days (Wikipedia, 2019).

7.5.3 African swine fever

African Swine Fever (ASF) is a highly contagious viral disease of domestic and wild pigs, whose mortality rate can reach 100%.

ASF does not pose any threat to human health, but it has devastating effects on pig populations and the farming economy as there is currently no effective vaccine against ASF. The virus can be transmitted from one pig to another by direct contact with bodily fluids from an infected pig (WOAH, 2022) (US Food and Drug Administration (FDA), 2022)

The virus is highly resistant in the environment, it can survive on surfaces such as clothes, boots, wheels, and other materials. It can also survive in various pork products, such as ham, sausages or bacon. Thus, human behaviours can play a significant role in spreading the disease across borders if adequate measures are not taken (WOAH, 2022).

African Swine Fever (ASF) first outbreak in the Eastern Cape was in 2020 in Mnquma Municipality with Great Kei and closely followed by Buffalo City. In 2021, King Sabata Dalindyebo Municipality, Engcobo Municipality and Nelson Mandela Bay. The outbreak affected free-roaming, communal, and smallholder pig sectors. Further outbreaks occurred in Ngqushwa municipality, Port Elizabeth as well as Mnquma local municipality (DALRRD, 2022)

7.5.4 Rift valley fever

Rift Valley fever is a virus primarily affecting domestic livestock, but it can be passed to humans. It is spread by bite of infected mosquitoes. About 1% of the human sufferers of this disease die (Wikipedia, 2019). There is a preventative vaccination for Rift Valley Fever.

7.5.5 Avian influenza

Avian influenza, known informally as avian flu or bird flu refers to "influenza caused by viruses adapted to birds. Most human contractions of the avian flu are a result of either handling dead infected birds or from contact with infected fluids. While most wild birds mainly have only a mild form of the H5N1 strain, once domesticated birds such as chickens or turkeys are infected, it could become much deadlier because the birds are often within close contact of one another (Wikipedia, 2019).

7.5.6 Rabies

Rabies is a viral disease that causes inflammation of the brain in humans and other mammals. Rabies is caused by lyssaviruses, including the rabies virus and Australian bat lyssavirus. It is spread when an infected animal scratches or bites a human or other animal. Saliva from an infected animal can also transmit rabies if the saliva comes into contact with the eyes, mouth, or nose. Globally, dogs are the most common animal involved. In countries where dogs commonly have the disease, more than 99% of rabies cases are the direct result of dog bites. (Wikipedia, 2019).

After a rabies exposure, the rabies virus must travel to the brain before it can cause symptoms. This time between exposure and appearance of symptoms is the incubation period. It may last for weeks to months. The incubation period may vary based on

- the location of the exposure site (how far away it is from the brain),
- the type of rabies virus, and
- any existing immunity.

The first symptoms of rabies may be similar to the flu, including weakness or discomfort, fever, or headache. There also may be discomfort, prickling, or an itching sensation at the site of the bite. These symptoms may last for days (Centers for Disease Control and Prevention, 2021).

Symptoms then progress to cerebral dysfunction, anxiety, confusion, and agitation. As the disease progresses, the person may experience delirium, abnormal behaviour, hallucinations, hydrophobia (fear of water), and insomnia. The acute period of disease typically ends after 2 to 10 days. Once clinical signs of rabies appear, the disease is nearly always fatal, and treatment is typically supportive. Less than 20 cases of human survival from clinical rabies have been documented (Centers for Disease Control and Prevention, 2021)

News reports also indicate that Rabies outbreak has been ongoing in the Eastern Cape, particularly in Nelson Mandela Bay, Amathole and OR Tambo. Annual awareness and vaccination campaigns are run between June and September (News24, 2022).

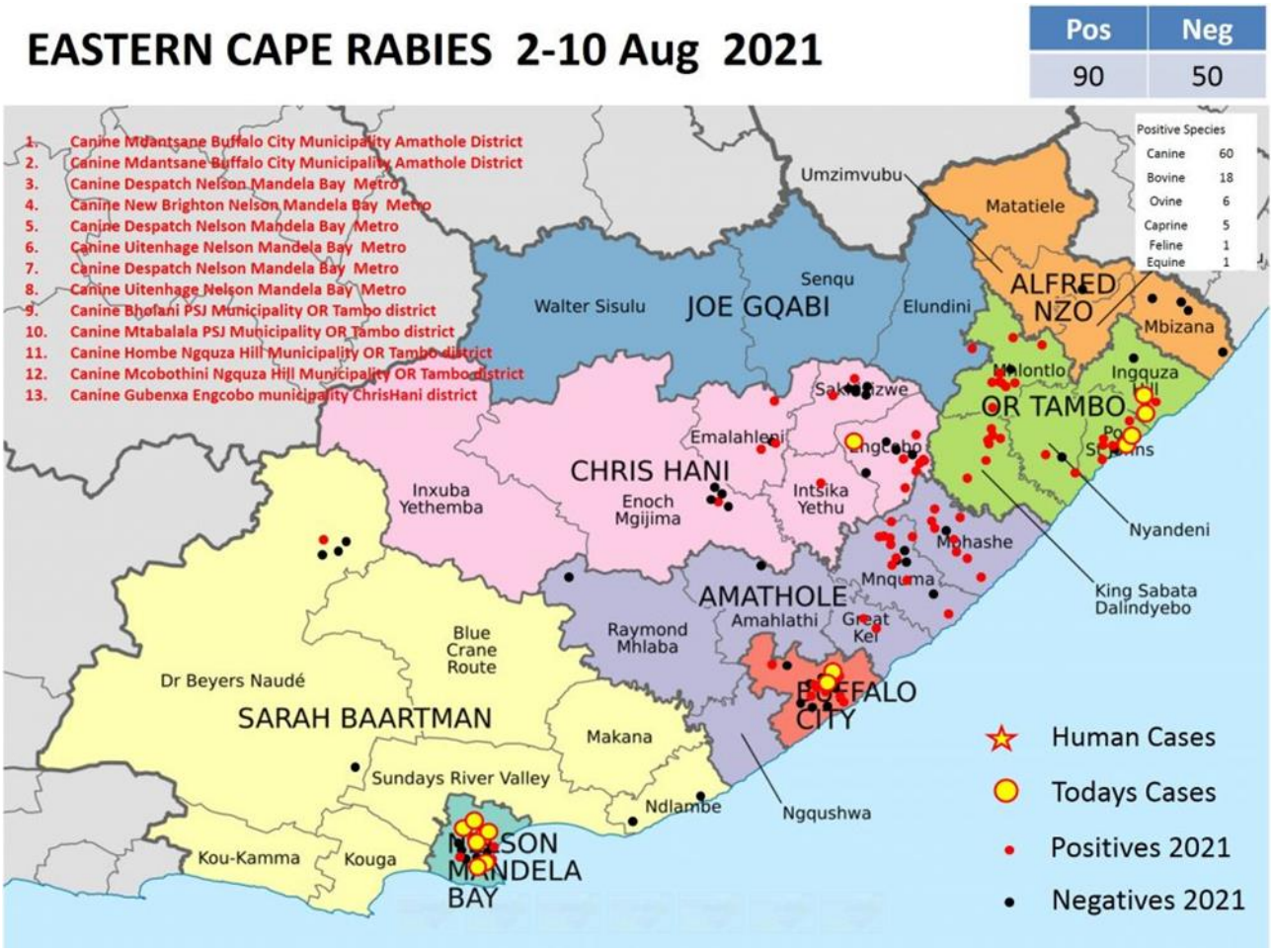

Figure 7-28: Reported Rabies Eastern Cape August 2021 (Ruminant Veterinary Association of South Africa, 2021)

Data of the outbreaks of highly pathogenic avian influenza and Rift Valley fever in the past, were mapped and interpolation was done to estimate the possible spread of the diseases. The result is shown in Figure 7-29 below. Data was transferred to the meso data layer. The green areas show the areas where animal disease can have the biggest impact based on agricultural activities.

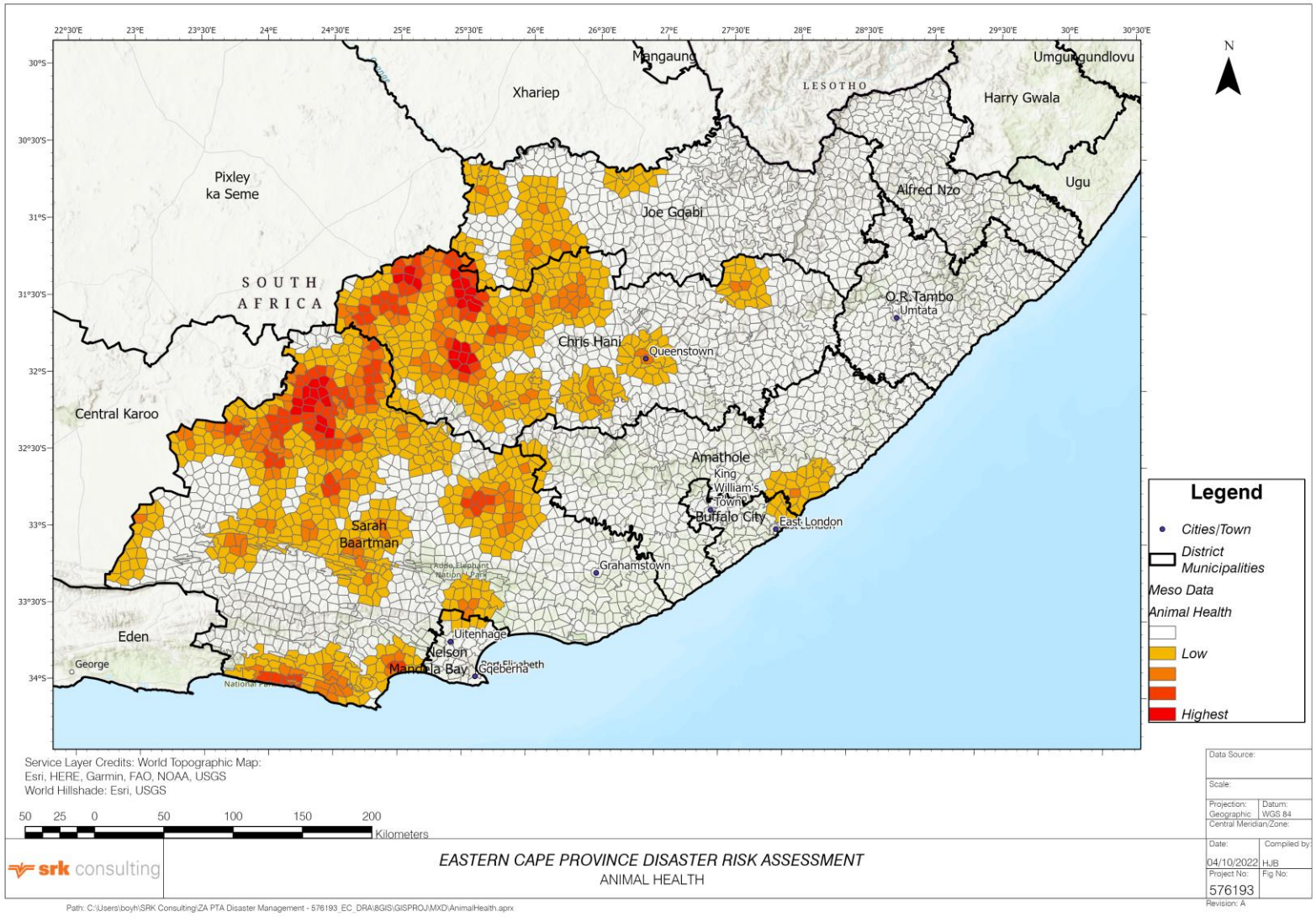

Figure 7-29: Animal disease hazard (meso data)

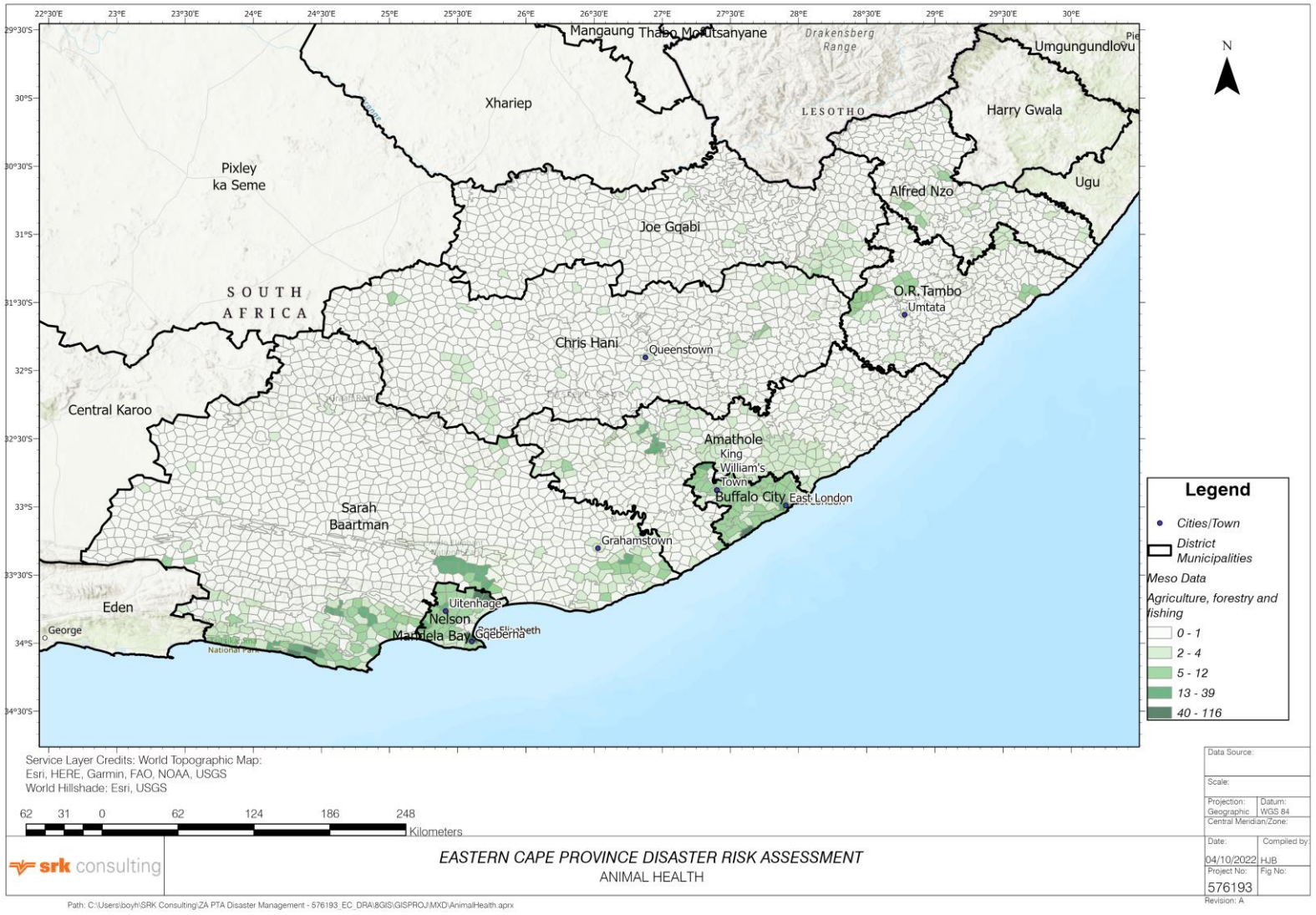

Figure 7-30: Agriculture, forestry and fishing and Animal Health (meso data)

7.5.7 Consultation inputs

7.5.7.1 Alfred Nzo

- Cases of Rabies,
- Foot and mouth disease.

Department of Agriculture, Land Reform and Rural Development is running various programmes to manage. Foot and Mouth disease was also managed in collaboration with KZN. Classical swine fever is also a challenge. Municipal Department of Health was also involved. Brucellosis also well-managed. Classical swine fever. Early Warning System in place on weather-related occurrences.

7.5.7.2 Amathole

- There was outbreak of swine flu in Nxuma.
- Rabies has also occurred within Amathole. National institute should be contacted. Eastern Cape is major producer of red meat. Roaming animals pose threats of spreading diseases.
- Swine flu outbreak in Ngqushwa.
- Rabies cases were also reported in Amathole. Animal control is crucial.

7.5.7.3 Buffalo City

- Cases of Classical swine, New Castle Disease and Rabies have been reported.

7.5.7.4 Chris Hani

- Rabies is a problem within Chris Hani. Positive cases in Ezibeleni (Enoch Mgijima LM) area with regards to rabies.
- Cryptosporidiosis in livestock, which has also been found in game and is due to poor management of sewerage systems.

7.5.7.5 Joe Gqabi

- In 2010/11 Foot and Mouth disease affected mainly Elundini.

7.5.7.6 Nelson Mandela Bay

- Swine flu and Rabies cases.
- Campaign for vaccination of dogs against rabies. Was controlled. State Vet.

7.5.7.7 OR Tambo

- Animals died due to fodder shortage which was caused by draught.

7.5.7.8 Sarah Baartman

- Kouga has had a couple of Rabies cases. 10 to 15 dogs infected.
- Number of years back Avian influenza.
- Blue Crane and Makana.
- Swine flu Sundays River Valley.
- Foot and Mouth disease, Alexandria side.

7.6 Disease / health - disease: human

The estimated overall HIV prevalence rate for Eastern Cape is 13.04% (Spotlight, 2019). This translates to a total number 859 329 people living with HIV.

Several notable diseases in Southern Africa have strong environmental links. Hepatitis and cholera are most often transmitted through contaminated water, whereas typhoid fever is often associated with a lack of clean water supply and sanitation facilities, unplanned urbanization, and increased movement of migrant workers

(World Health Organization, 2018) The large dependency on water sources such as rivers and streams notably influence the vulnerability to water-borne diseases.

The poor experience above normal rates of infectious disease. Malnutrition lowers the body's resistance to illness and illness aggravates malnutrition. Inadequate services and shelter or housing also create conditions that promote disease. Without decent protection, many of the poor are exposed to severe and dangerous weather as well as to bacteria and viruses carried by other people and animals.

Diseases also have major economic implications through the costs of caring for the ill, ill people not being able to go to work, and the loss of breadwinners in many families. A family's well-being is strongly linked with the physical health of its members so when an economically active family member becomes ill or disabled, the entire family faces an economic as well as a physical burden.

7.6.1 SARS-Cov-2 (Covid 19)

A total of 610,490,907 worldwide cases was reported when this section of the document was drafted (16 September 2022). There was 6,520,681 Deaths and 12,222,371,255 vaccinations (Johns Hopkins University (JHU), 2022).

Looking at South Africa (South African Department of Health, 2022) 4 012 860 positive cases have been reported, 3 905 937 recoveries and 102 129 deaths.

The following table and graph give a summary of the positive cases and deaths in South Africa.

Table 7-3: Covid - 19 Positive Cases and Covid related Deaths

No	Province	Positive Cases	Deaths
1	Western Cape	703604	22337
2	Eastern Cape	364658	16897
3	Northern Cape	115441	3249
4	KwaZulu-Natal	718461	16260
5	Mpumalanga	202686	4770
6	Limpopo	160009	4676
7	North West	202506	5024
8	Free State	216420	7893
9	Gauteng	1329072	21023

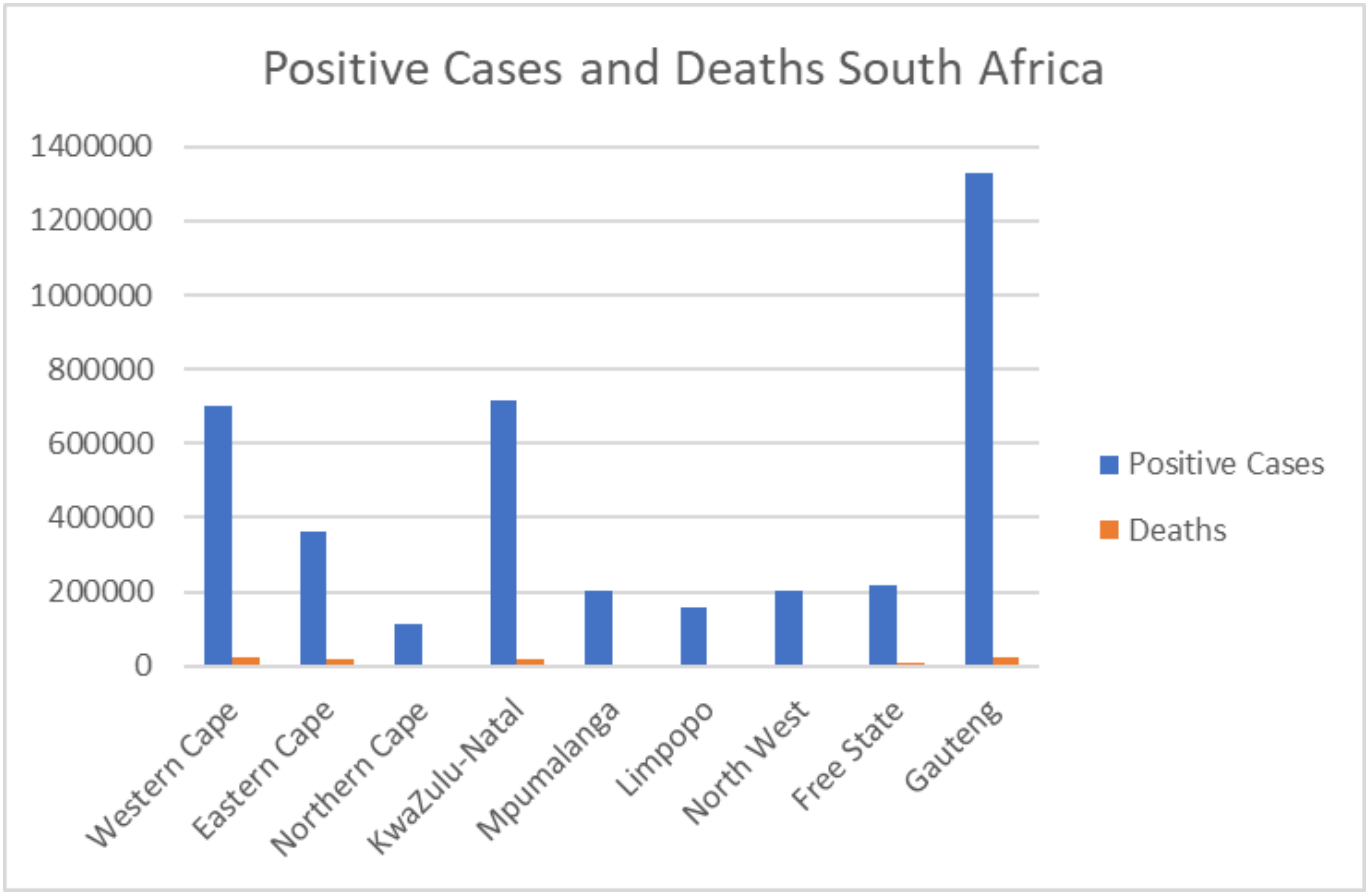

Figure 7-31: Covid - 19 Positive Cases and Deaths

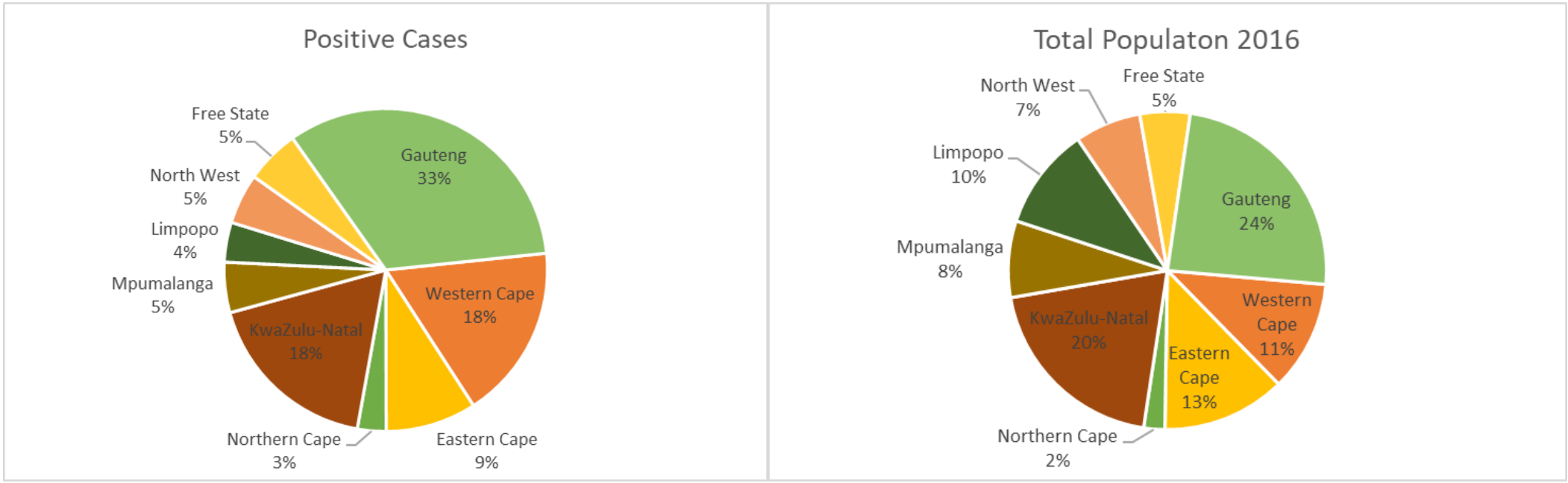

Figure 7-32: Percentage Positive Cases vs Total Population per Province

The Western and Northern Cape Provinces have a higher Covid positive percentage (%) in relation to 2016 population estimates. This put into perspective would mean that resource planning in these provinces may have required to be increased during Covid Pandemic to cope with the higher figures.

It was apparent from several of the reports (Eastern Cape Department of Health, 2022) that comorbidities attributed to morbidity due to Covid -19. These morbidities included hypertension, heart conditions, HIV Infections, compromised immune systems, obesity, pregnancy, smoking (current or former) and diabetes (amongst a lot of other morbidities). From Eastern Cape Department of Health reports and statistics is seems that the co-morbidities that that the worst effect was Diabetes Mellitus and Hypertension (Eastern Cape Department of Health, 2022)

A lot of emphasis was placed on effective turnaround times for test results from laboratories and on capacity building of all required resource (Eastern Cape Department of Health, 2022)

The effects of secondary factors or hazards impact such as extreme weather and drought on human diseases should not be underestimated (Eastern Cape Department of Health, 2022)

The following figures give a visual presentation of positive cases in the Eastern Cape compared with population estimates of 2016 (Statistics South Africa, 2017)

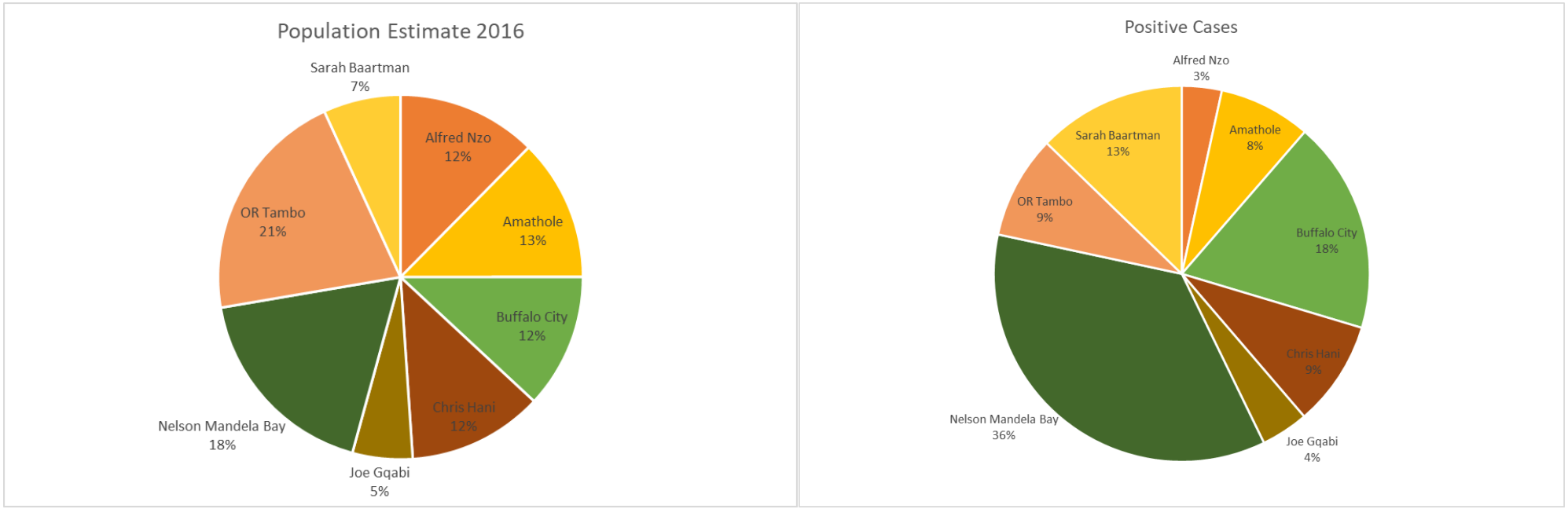

Figure 7-33: Positive Cases vs total Population Eastern Cape

Nelson Mandela Bay, Buffalo City and Sarah Baartman have a larger percentage positive case than their share of the percentage of the total Eastern Cape population.

7.6.2 Mapping human health hazard for the Eastern Cape

Land cover data of 2020 was used to calculate and identify possible areas for potential diseases which are transmitted between humans . The weights are based on population density, movement and vulnerability of people

Table 7-4: Land cover indicator for human health hazard profile

Type	Health hazard indicator weight
Formal Residential	0.5
Industrial / Commercial	0.3
Informal	1.0
Villages	1.0
Border post	1.0
Bus & train Stations	1.0
International Airport	1.0

The weights were assigned to the corresponding land cover and summed to the applicable meso zone polygon or area. Figure 7-34 shows the spatial distribution of possible human health hazard areas in the Eastern Cape Province. High hazard areas are linked to urban areas and the graph also indicate this for Nelson Mandela and Buffalo City.

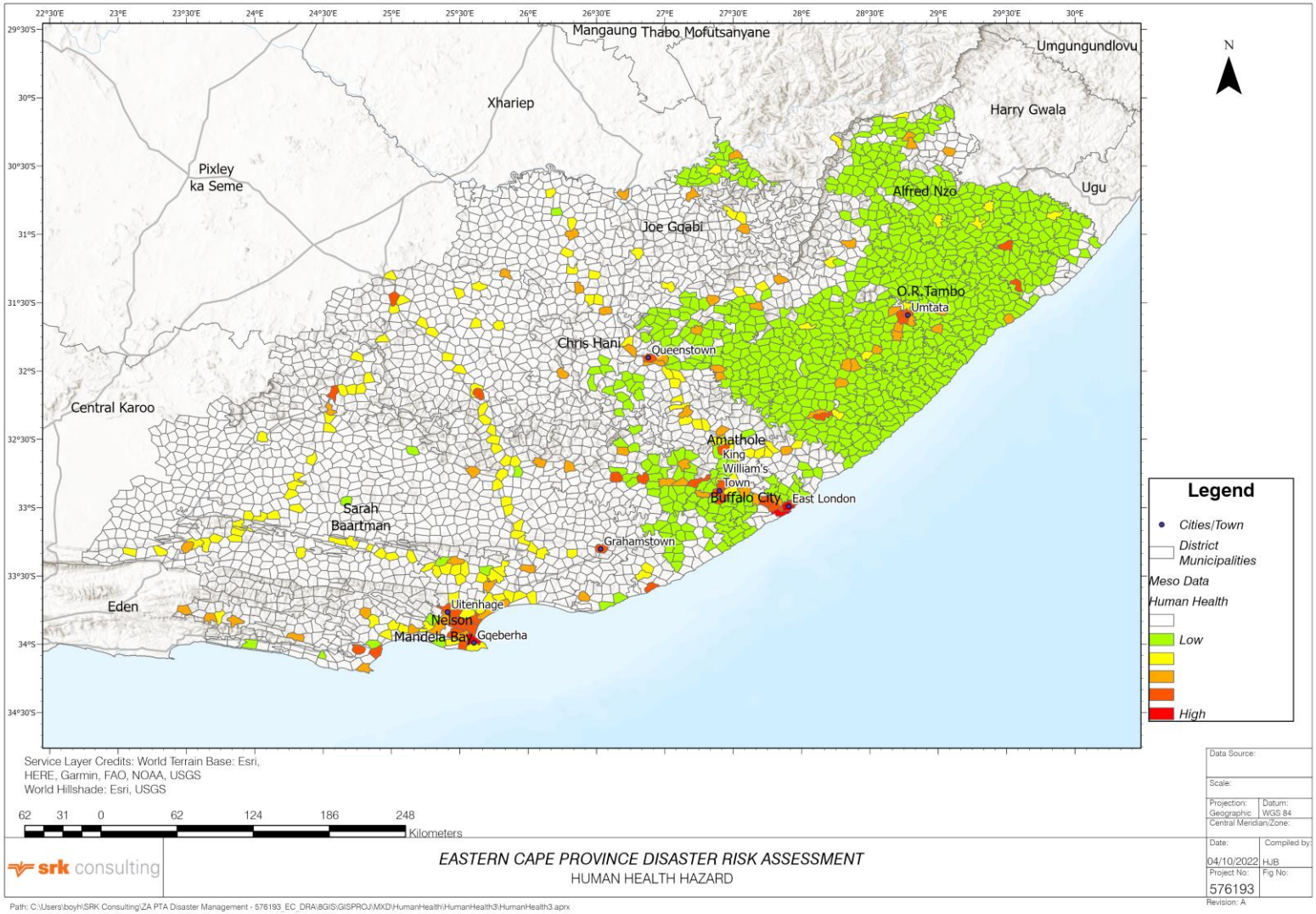

Figure 7-34: Human disease hazard (meso data)

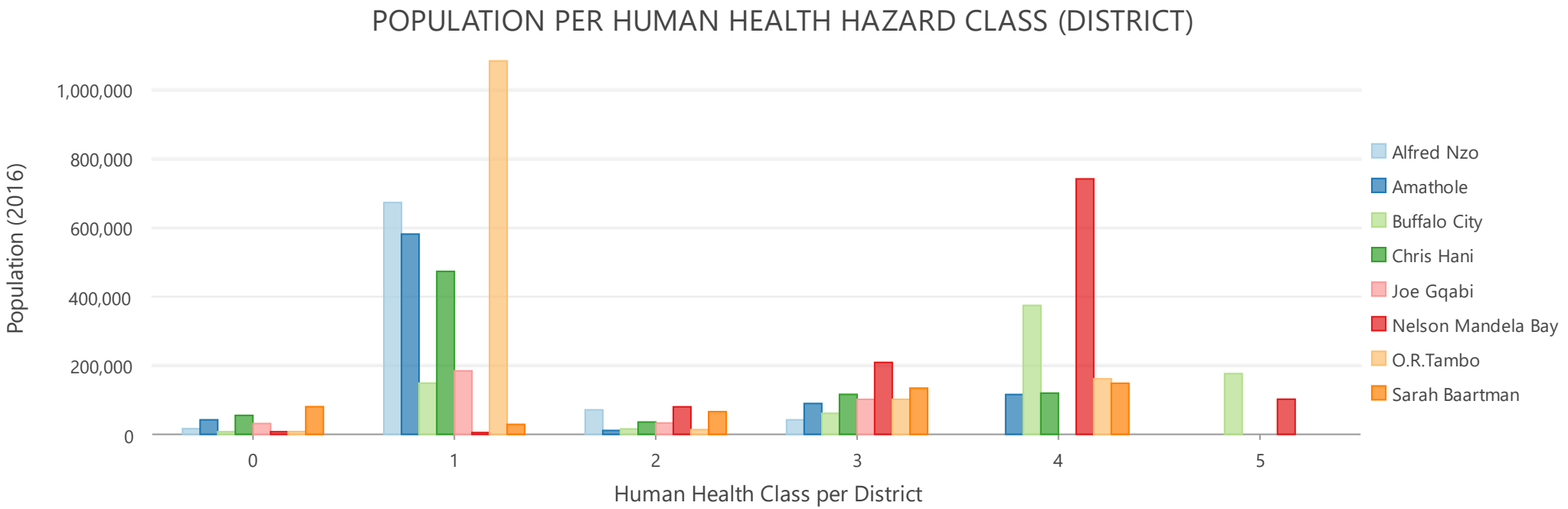

Figure 7-35: Human Health Hazard per District Population

The above mapping (Figure 7-34) identifies areas where a high concentration of people can be found due to associated land use such as churches, night clubs and shopping centres, as a relatively higher hazard associated with human disease is associated with these areas where there is close contact between many people as in areas where fewer people are located.

7.6.3 Consultation inputs

7.6.3.1 Alfred Nzo

- Water borne diseases are very frequent. Measles cases.

7.6.3.2 Buffalo City

- Covid pandemic.
- Tuberculosis,
- Typhoid Fever,
- Meningitis cases have been reported.
- Three cases of Malaria.
- Public Health Care facilities.
- Not major outbreaks. .

7.6.3.3 Chris Hani

- Listeriosis.
- Food poisoning at schools.

7.6.3.4 Joe Gqabi

- Joe Gqabi managed Covid19 pandemic well and received commendation for this. Provincial assistance with backlogs was done to promote the washing of hands.
- Various stakeholders from all spheres of the government collaborated. Health services were able to cope.
- Water project/distribution by the Department of Water and Sanitation (DWS).
- The Municipal Infrastructure Grant (MIG) fund were redirected to COVID19 projects. HIV & TB initiatives were not interrupted

7.6.3.5 Nelson Mandela Bay

- The Covid numbers are dropping.
- Nelson Mandela Bay is generally prepared to manage communicable diseases outbreaks.

7.6.3.6 OR Tambo

- The district has done well in coping with the Covid Pandemic.
- Dependent on province to cope with some of the hazards.
- Health facilities in the district has improved.

7.6.3.7 Sarah Baartman

- Incidents of food poisoning has been reported in schools in Ndlambe, food safety awareness for people handling food.
- There has been a decline in the quality of water, there is a possibility of the outbreak of diseases.

7.7 Fire hazards

Fire hazards are considered a risk for both urban, developed areas and rural and undeveloped areas. Fire can be considered both a naturally occurring hazard, caused by lighting or other natural processes, or man-made hazard. For this DRA, fire hazards were divided into the following two categories:

- Formal & informal settlement and urban fires; and
- Veld and forest fires.

7.7.1 Veld, forest fires and wild fires

Much of Sub-Saharan Africa is susceptible to fires, which destroy pastures, crops, buildings, and infrastructure. Even though natural fires can be ignited by lightning, human beings are mostly responsible for veld fires (ICSU, 2018).

The large area affected by fires has implications for short-term productivity and long-term land degradation processes, which eventually contribute to famine during drought periods. Combined with intense drought, these fires destroy biodiversity and reduce the regeneration capacity of the vegetation. Although fires cause few deaths, valuable resources are lost, thereby contributing to poverty. Pasture is destroyed, and animals must be moved, or funds allocated to purchase their feed. Fires also affect air quality and generate greenhouse gases. In addition, they can affect hydrological processes such as run-off and may lead to soil erosion (Earth Observatory, 2018).

The risk associated with veld fires in South Africa is substantial, and veld fires cause severe losses to life, property and the environment in most areas of the country. However, this risk has two parts: first, that arising from wildfires (i.e., unwanted veld fires) that cause damage to assets, and second, the risk arising from ecologically inappropriate fire regimes in environments where fire plays an ecological role. As in most countries with wildfires, the risk can be managed to acceptable levels at an acceptable cost, provided a comprehensive approach, based on integrated natural resource management within a proper development planning and management framework, is adopted and applied consistently (CSIR, 2010).

Risk classification was compiled to classify vegetation types and categorize each metropolitan and local municipality in South Africa according to classes of wildfire risk. It also deals with the environmental risk associated with inappropriate fire regimes. These two dimensions of risk need to be examined together, since experience in South Africa and elsewhere have shown that managing the two dimensions separately leads inevitably to long-term environmental and resource degradation, rising costs of wildfire suppression and intractable problems in maintaining a safe environment (CSIR, 2010).

The term ‘wildfire risk’ was used as the standard sense, i.e., it is the chance of a fire igniting, spreading and causing damage to one or more assets, measured in terms of likelihood and consequence to the assets.

The risk classification was based in the first place on the information on the prevailing natural vegetation in any part of the country. For each vegetation type, the likelihood of wildfires occurring in that vegetation was established, and the consequences that arise in modern times when such wildfires occur. This combination of likelihood and consequence allows the risk to be rated. Then, using the spatial distribution of vegetation types, a risk class was assigned to each metropolitan and local municipality.

The following figure contains the Advanced Fire Information System (AFIS) data that indicates the number of days those areas have burned from January 2002 to October 2019.

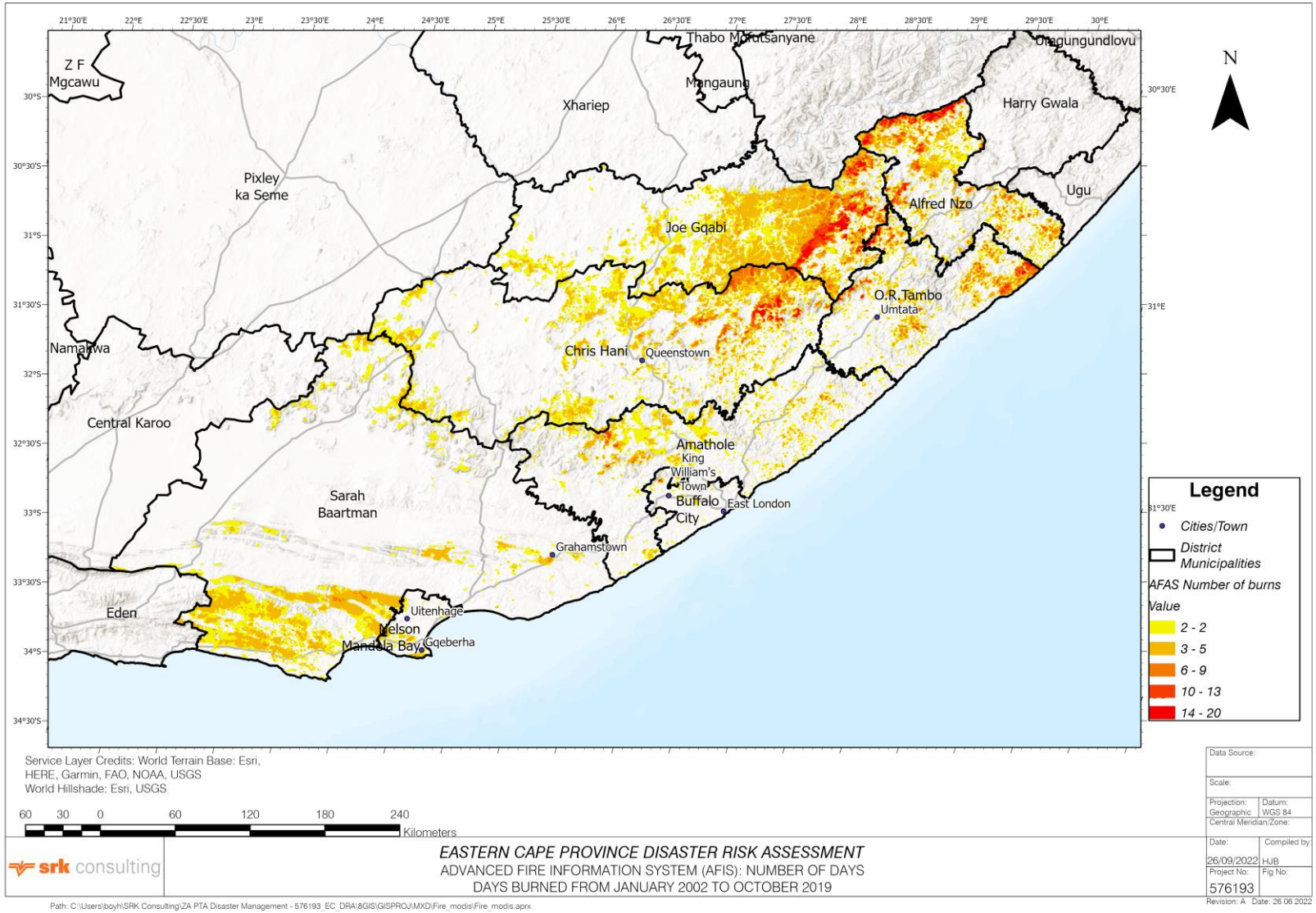

Figure 7-36: AFIS Fire Data: Number of days burned from January 2002 to October 2019 (Advanced Fire Information System (AFIS), 2019)

The province can be divided into four clear fire regions (O.R. Tambo District, Master Fire Plan, 2020).

- Predominant Grassland area with summer rainfall in the Northern part of the province. This area has a clear winter fire season. A fire prohibition period is normally in place from August until the end of October or until the first substantial Spring rains has occurred.
- Fynbos belt in the South Western portion of the province (portion of Sarah Baartman district) with an all-year fire season.
- The arid inland areas with predominant Karoo types of vegetation tend to have a lower fire risk. These areas are susceptible to dry thunderstorms during the summer months that lead to fires in the inaccessible mountainous areas.
- The thicket areas rarely burn and is to a large extent a natural barrier between the Fynbos and Grassland vegetations.

The vastly different vegetation types and fire regimes make fire management even more challenging. This, associated with the fact that the Eastern Cape is the second largest province, necessitates the need for good fire management strategies by all the District Municipalities who are responsible for dealing with wildfires.

Vegetation was used as indicator for fuel load and thus indicated in red. The fire hazard profile of Figure 7-37 was combined with slope and Figure 7-38 was created. Slope was included because of the assumption that fire is more intense at higher slope.

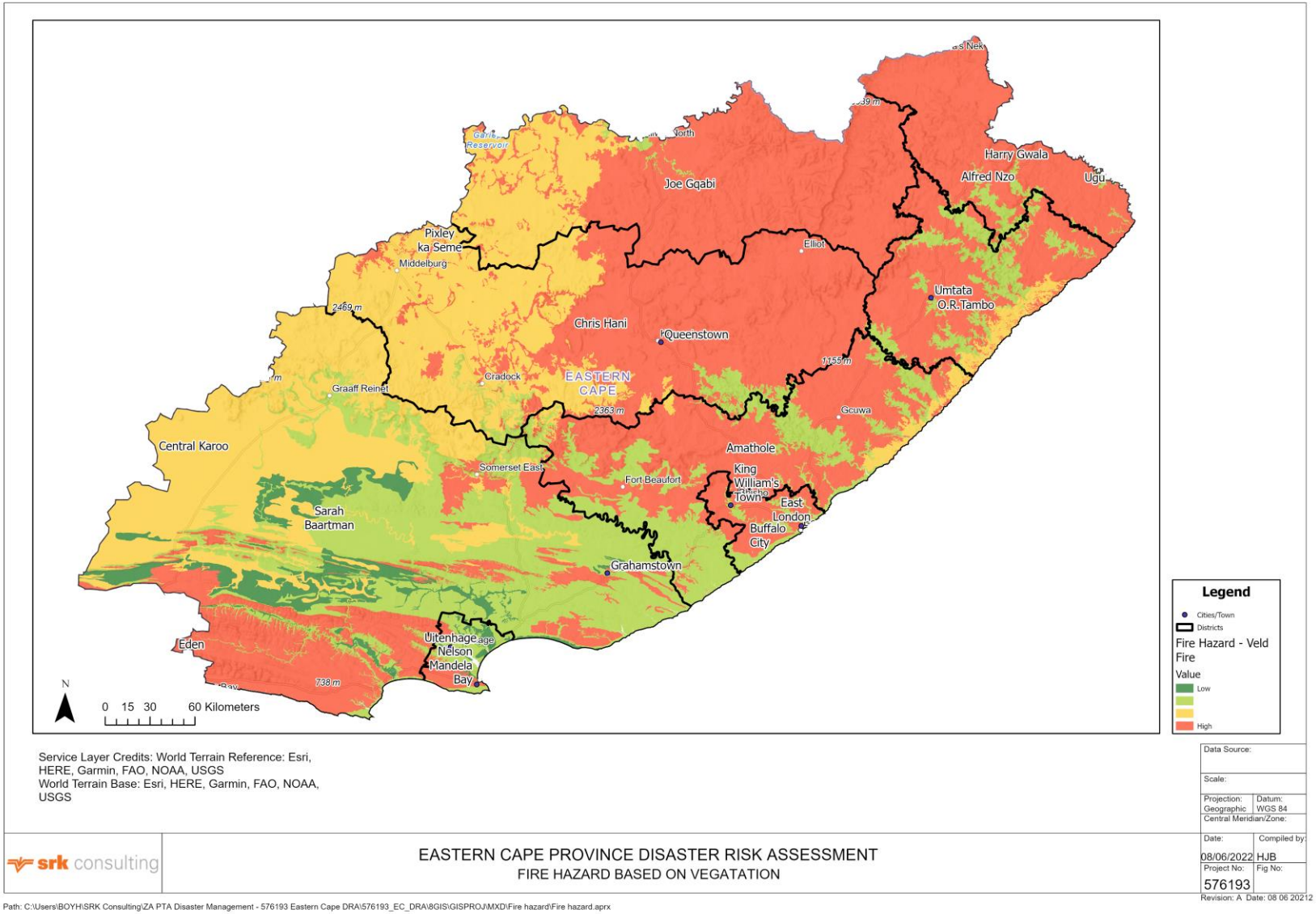

Figure 7-37: Fire hazard profile for Eastern Cape based on vegetation (O.R. Tambo District, Master Fire Plan, 2020)

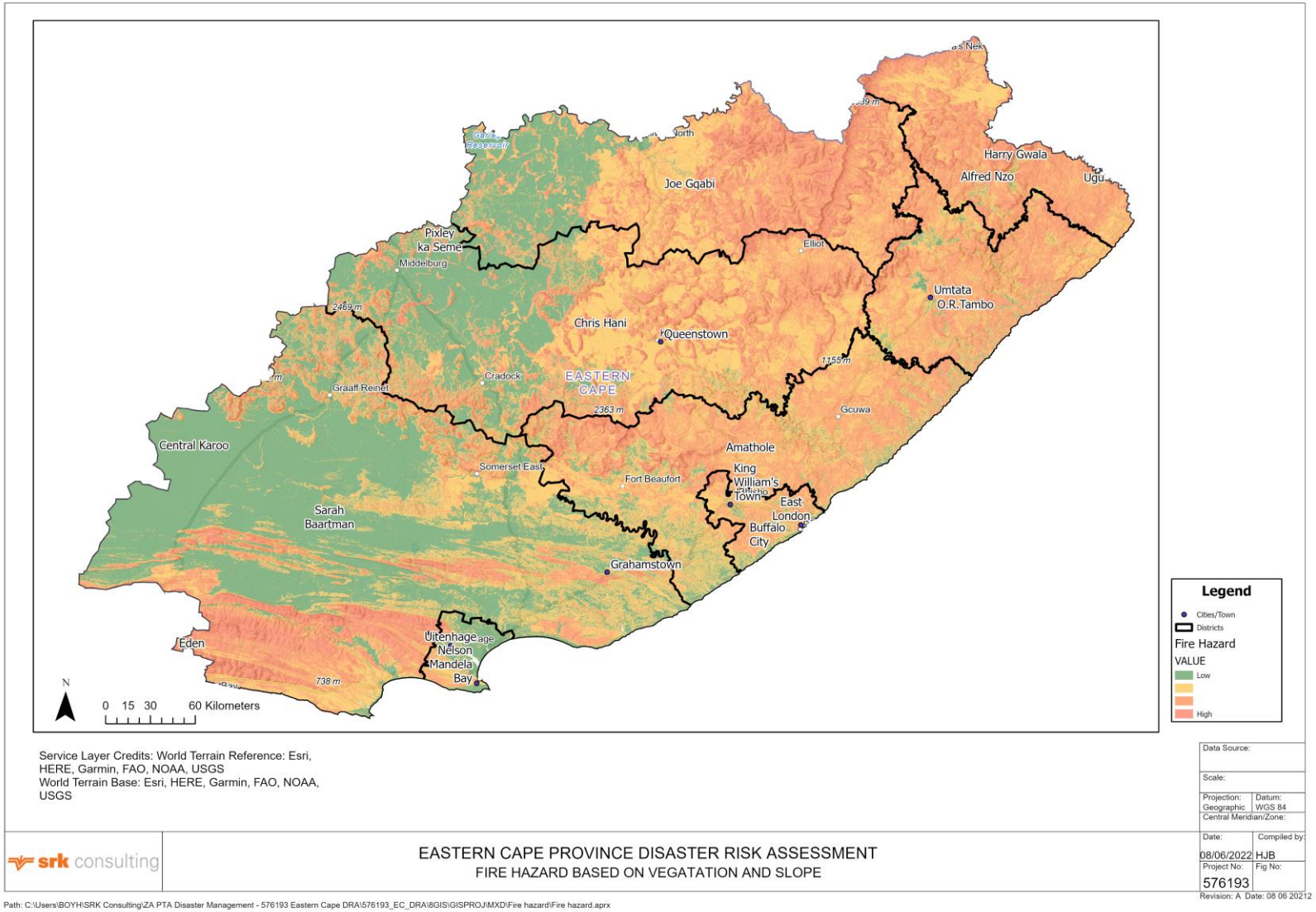

Figure 7-38: Fire hazard profile for Eastern Cape based on vegetation and slope

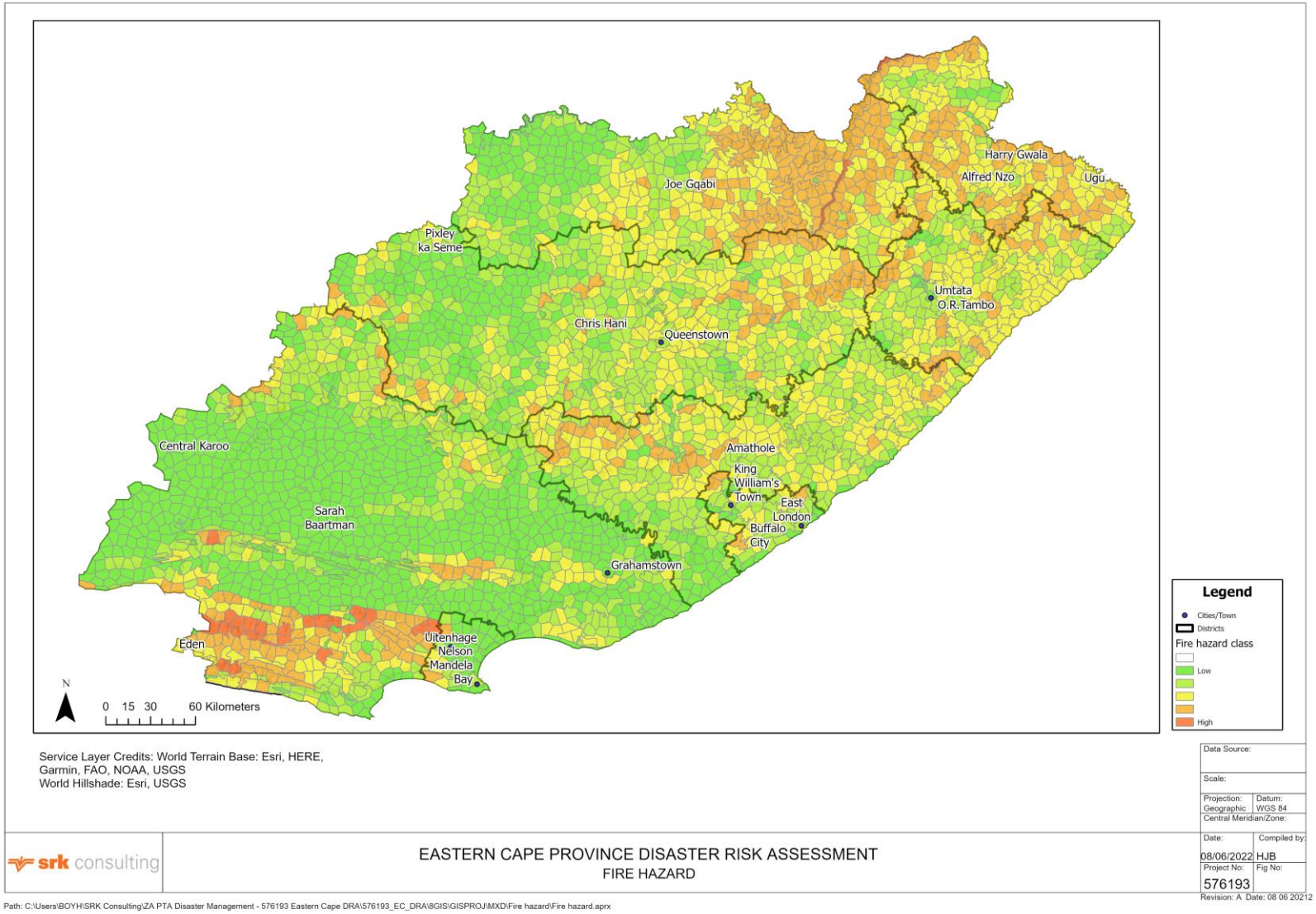

Figure 7-39: Spatial Distribution of Veld Fire Hazard (meso data)

7.7.1.1 Consultation inputs

7.7.1.1.1 Alfred Nzo

- Climate change is contributing to increase of fires in the area. The last couple of years there has been a lot of fires in the area.
- Four Local Municipalities with their own fire station.
- The distance from the fire stations is often very far and increases vulnerability as the response is delayed. Satellite station have been suggested to reduce the impact of distance.
- Formal structures are burning, sometimes it can be attributed to poor housekeeping practices. Fire Management plan is being updated. Working On Fire (WOF) resources can also be of great assistance.

7.7.1.1.2 Amathole

- Mbashe and Nxuma areas have lot of grass fires, small farmers grazing lands once destroyed by veld fires.
- Free roaming domestic animals bring in alien invasive plant species, thus, contributes to fire risk
- Shortage of water impacted on the ability to extinguish the fires.
- Long distances to get water. N2 fuel trucks MVA fires.
- First responders could assist with rural fires until Fire services can take over. Bad road conditions and remote areas contribute to vulnerability.

7.7.1.1.3 Buffalo City

- Berg winds that come from high elevation during the months of May – August dries vegetation and increases fire risk. Fire season is June - August. Open ground in large areas.
- Dumping increase fire load.
- There are 7 Fire Stations.
- A ,B and C Regions.

7.7.1.1.4 Chris Hani

- Grassland dominant throughout the district.
- Some of the fires are caused by people, some natural. Fires more intense during winter.
- Months of July and August are extreme months regarding the occurrence of veld fires as these are the windy months and as stated these challenges compound these problems.

7.7.1.1.5 Joe Gqabi

- Sheep had to be culled due to Veld Fire between September and December 2020.
- Fire at PG Bison Forest in Elundini resulted in 2 fatalities in 2021. More than 700 ha was affected including the maize field and grazing lands of about 7 farms.
- Senqu is also prone to fires.
- About 900 Ha burned in Barkly East & Elliot (Khowa).
- The fires are also exacerbated by drought. Fire breaks are made to mitigate the impacts.
- The area had lot of cattle and sheep that was lost.
- In 2020, fires occurred on the mountains in Senqu 10000 Ha within Joe Gqabi had been affected.
- Fire Protection Association of South Africa (FPA) made fire belts and fire breaks to minimise risk.

7.7.1.1.6 Nelson Mandela Bay

- High risk. Major veld fires,
- Drought increases risk.
- Alien vegetation increased risk: high fuel load.
- Woodridge school was burned down.
- Longmore forest.
- Pine.

7.7.1.1.7 OR Tambo

- The risk for fires has increased due to resources that have decreased.
- Hydrological drought also contributes.
- High rainfall can also result in the increased veld fires due to increased fuel load.

7.7.1.1.8 Sarah Baartman

- Kouga and Kou Kamma has huge species of Fynbos resulting in huge fires.
- Tsitsi Kama, Blue Crane. It took two weeks, to extinguish some of the fires. Province helped extinguish. Longer time frame noted.
- Cross border agreement for Garden Route.
- The entire Sarah Baartman District is prone to fires. Makana has had some major veld fires due to high rains (July - October intense veld fires) 2 years ago which was 10km long.
- Ndlambe has problems relating to vehicles and personnel, however, there is a collaboration with farmers to improve on response.
- Isolated incidents but manageable fires.
- Are however taking proactive steps to reduce risk.
- Sundays River Valley equipment and staffing problems. Blue Crane Route. Boschberg mountains have frequent fires.
- St Francis, coastal belt, west and east has thatched room houses. Ndlambe: Riots sometimes influence fire events; intel can help avoid some incidents. Working with fire teams- staffing

7.7.2 Formal & informal settlements / urban fires

Eastern Cape Province does not have a lot of informal settlements, with the municipal demarcation board estimating the number of people based in informal settlements to be approximately 1.3% of the population (Municipal Dermacation Board, 2018). However traditional and informal areas often do not comply with local requirements for conventional (formal) townships and are consequently areas of increasingly high risk of fire. This is also due to the following general characteristics of these settlements:

- Inadequate infrastructure;
- The surrounding environment is often considered unsuitable;
- Informal settlements are often characterised by population densities that are uncontrolled and dangerously high;
- There is often poor access to health and educational facilities as well as employment opportunities;
- Lack of effective governance and management; and
- Individual dwellings within informal settlements are often considered inadequate.

The structural fire hazard modelling for the Eastern Cape Province was based on the land-use/land-cover map of 2020. The various land-use categories were classified in terms of fire-related factors, such as the perceived burn load, ignition factors and control measures. Higher loads and ease of ignition would increase fire hazards while control or manageability measures would decrease the hazard rating.

Table 7-5 indicates the scores used to calculate the fire hazard ratings. The Hazard (Fuel x Ignition / Manageability) values for each area were calculated and transferred to the meso zone layer. Figure 7-40

shows from green to read the areas that are at risk of structural fires. Values of areas in O.R. Tambo are based on rural settlements as well. Distances from fire stations will have an impact on capacity to cope in these areas.

Table 7-5: Fire hazard rating

Land Cover	Fuel Load	Manageability	Probability of Ignition	Hazard (Fuel x Ignition / Manageability)
	0 = low, 1= high			0 = low, 1.8= high
Mines water permanent	0	0	0	0.00
Urban sports and golf (bare)	0.3	0.6	0.4	0.20
Mines 1 bare	0.2	0.7	0.8	0.23
Urban residential (bare)	0.3	0.6	0.6	0.30
Urban built-up (bare)	0.3	0.6	0.8	0.40
Urban township (bare)	0.3	0.6	0.8	0.40
Urban village (bare)	0.3	0.6	0.8	0.40
Urban smallholding (bare)	0.3	0.5	0.7	0.42
Urban school and sports ground	0.5	0.7	0.6	0.43
Urban sports and golf (low veg / grass)	0.5	0.6	0.7	0.58
Urban commercial	0.7	0.8	0.7	0.61
Urban informal (bare)	0.3	0.4	0.9	0.68
Urban residential (low veg / grass)	0.6	0.6	0.7	0.70
Urban residential (open trees / bush)	0.7	0.6	0.6	0.70
Urban sports and golf (open tree / bush)	0.7	0.6	0.6	0.70
Urban built-up (low veg / grass)	0.5	0.6	0.9	0.75
Urban township (low veg / grass)	0.5	0.6	0.9	0.75
Urban village (low veg / grass)	0.5	0.6	0.9	0.75
Urban residential (dense trees / bush)	0.8	0.6	0.6	0.80
Urban sports and golf (dense tree / bush)	0.8	0.6	0.6	0.80
Urban township (open trees / bush)	0.7	0.6	0.8	0.93
Urban village (open trees / bush)	0.7	0.6	0.8	0.93
Urban township (dense trees / bush)	0.8	0.6	0.8	1.07
Urban village (dense trees / bush)	0.8	0.6	0.8	1.07
Urban smallholding (low veg / grass)	0.6	0.5	0.9	1.08
Urban smallholding (open trees / bush)	0.7	0.5	0.8	1.12
Urban industrial	0.9	0.7	0.9	1.16
Urban built-up (dense trees / bush)	0.9	0.6	0.8	1.20
Urban smallholding (dense trees / bush)	0.8	0.5	0.8	1.28
Urban informal (low veg / grass)	0.6	0.4	0.9	1.35
Urban informal (open trees / bush)	0.7	0.4	0.9	1.58
Urban informal (dense trees / bush)	0.8	0.4	0.9	1.80

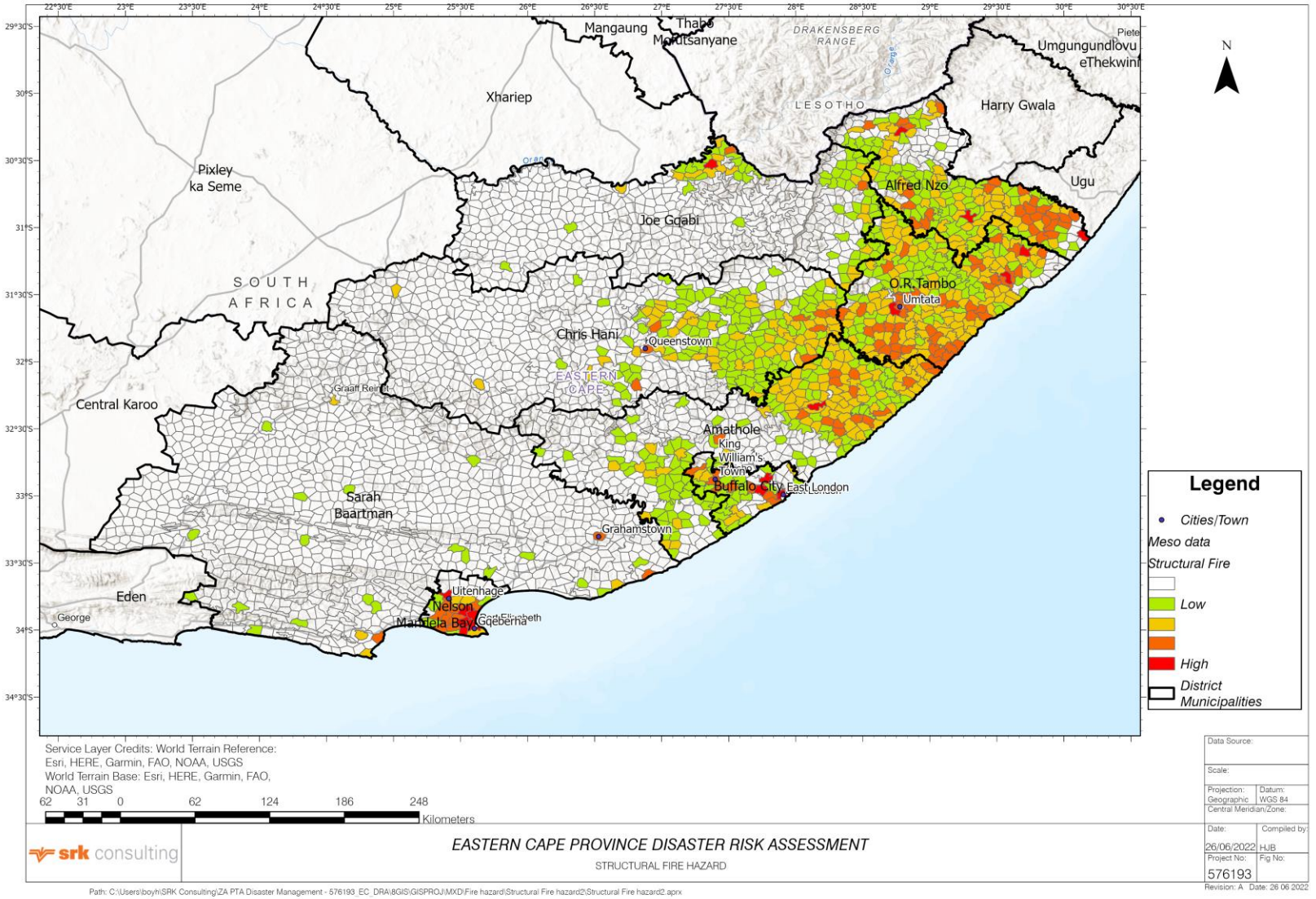

Figure 7-40: Fire hazard profile for Urban Areas (meso data)

7.7.2.1 Consultation inputs

7.7.2.1.1 Alfred Nzo

Urban Fires are increasing. Fires affecting business/ settlements in town can also be exacerbated by the multifunctional buildings (household/business) as some foreign nationals live inside the shops. Local Municipalities are enforcing more rules in this regard. Alfred Nzo has number of borders that are affecting this.

4 Local municipalities. Fire stations far from some areas. Proposed stations to deal with the distance issue. Housekeeping and non-compliance increase the fire risk. Plan being developed to deal with fire-related issues.

7.7.2.1.2 Amathole

Shacks and structural fires occur. Safety zones should be created, even for informal settlements, guided by fuel load and subsequently fire heights. Some shacks built on the foot of a mountain where berg winds increase the risk of fire

Funding for Fire services. Kill zone for fire spread. Three times the hight of combustible material.

7.7.2.1.3 Buffalo City

Orange Grove and Duncan Village fire incidents are frequent. About 10 to 30 Shacks damaged in one incident. Fire safety looks at building level plans. Strong winds affect fires in informal settlements. About 70 fire incidents during August 2020 (24-hour period) affected informal, formal settlements as well as the grass.

7.7.2.1.4 Chris Hani

Informal Settlements throughout district have challenges with shack fires. Also, in Enoch Mgijima Municipal buildings. Lack of resources is a contributing factor where several wards are served by one fire fighter. The equipment is used is not suitable for structural fires.

7.7.2.1.5 Joe Gqabi

Formal housing or domestic fires in the Walter Sisulu Municipality and cases of shack fires in the Senqu municipality. In 2021, a school was also affected. Businesses and homes. As district vulnerable.

7.7.2.1.6 Nelson Mandela Bay

Informal settlements are mostly affected by fire, with arson being prevalent. Some incidents in the formal settlement also occur.

7.7.2.1.7 OR Tambo

Few informal settlements fires occur. Lost about 4 public sector buildings and 3- 5 retail buildings. Business fires. Old Transkei Hotel was damaged, and Clarington Hotel burnt down. The risk for fires has increased due to resources that have decreased. In Mthatha, Lusikisiki, Flagstaff multi-functional buildings which are used as both residence and business are also prone to fires.

7.8 Floods (river, urban & dam failure)

Also see Section 7.9.3 for more information on the Hydro-meteorological hazards in the Eastern Cape Province. This section contains information on flooding in the Eastern Cape Province.

Floods are among the most devastating natural hazards in Africa, whereas flash floods are among the greatest hazards arising from tropical cyclones and severe storms. Floods and flash floods cause loss of life, damage to property, and promote the spread of diseases such as cholera. Floods in Africa are yearly responsible for many deaths and huge economic losses. While the primary cause of flooding is abnormally high rainfall, there are many human-induced contributory causes such as:

- land degradation;
- deforestation of catchment areas;
- increased population density along riverbanks;
- poor land use planning, zoning, and control of flood plain development;

- inadequate drainage, particularly in cities; and
- poor management of river and dam levels.

Flooding can also be caused by the failure of constructed dams

Eastern Cape Province has experienced severe flooding during April 2019. The worst affected areas were Greens Farm and Mpantu in Port St. Johns Local Municipality. During this event hundreds of people were displaced.

7.8.1 River & urban flooding

A flood is generally a normal event for any river or stream that could occur over a period varying from several times a year to once every few hundred years in intensity. Floods are caused during heavy rainfall within a certain period of time, snowmelt or storm surge accumulates and overflows the river or stream's normal path onto its banks and adjacent floodplains.

Several factors determine the severity of floods, including rainfall intensity and duration. A large amount of rainfall in a short time span can cause flash flooding. A small amount of rain can also cause flooding if the soil is saturated from a previous wet period, or if the rain is concentrated in areas where the surface is impermeable, such as in developed areas where most of the surface is covered with concrete, tar and other building materials

Topography and groundcover are also contributing factors for floods. Water runoff is higher in areas with a steep slope and low vegetation density. Urbanization of floodplains and manipulation of stream channels have increased both the frequency and magnitude of floods in many areas. Floods are most common in the season of highest precipitation.

7.8.1.1 Flood risk assessment

Flood risk assessment is part of a multi risk assessment to develop a disaster risk profile of a specific area, for example a local municipality of province. This disaster risk profile is used to identify disaster risk reduction measures that are included in a disaster management plan.

The aim of the assessment is to compile a flood risk profile for Eastern Cape Province to be used to identify high risk areas and to identify flood mitigation measures. A multi criteria assessment will be used to develop the flood risk profile with associated high-risk areas. Important to note is that the outcome of the processes used in the modelling cannot be utilised as flood lines in other studies.

The aim of the assessment is to compile a flood risk profile for Eastern Cape Province to be used to identify high risk areas and to identify flood mitigation measures. A multi criteria assessment will be used to develop the flood risk profile with associated high-risk areas. Important to note is that the outcome of the processes used in the modelling cannot be utilised as flood lines in other studies. Use of multi criteria assessment to identify possible flood risk areas.

Multi criteria assessment entails the use of various indicators for the identification of flood risk areas. The indicators include indicators for potential flood hazard area and vulnerability.

Various GIS techniques and modelling was used to analyse the acquired data to identify flood risk areas and to assess the associated risk of each area. Analysis was based on based on ranking from high to low, including inundation to vulnerability. The higher the inundation is, higher the ranking. The same with vulnerability. Indicators that were used to create the flood hazard and risk profile included:

- Possible depth of inundation.
- Land cover
    - Residential
    - Commercial

    - Industrial
    - Agriculture
- Road infrastructure.

These indicators were added together to create Figure 7-41 where red indicates high flood risk. Appendix C provides a more detail description of the methodology used.

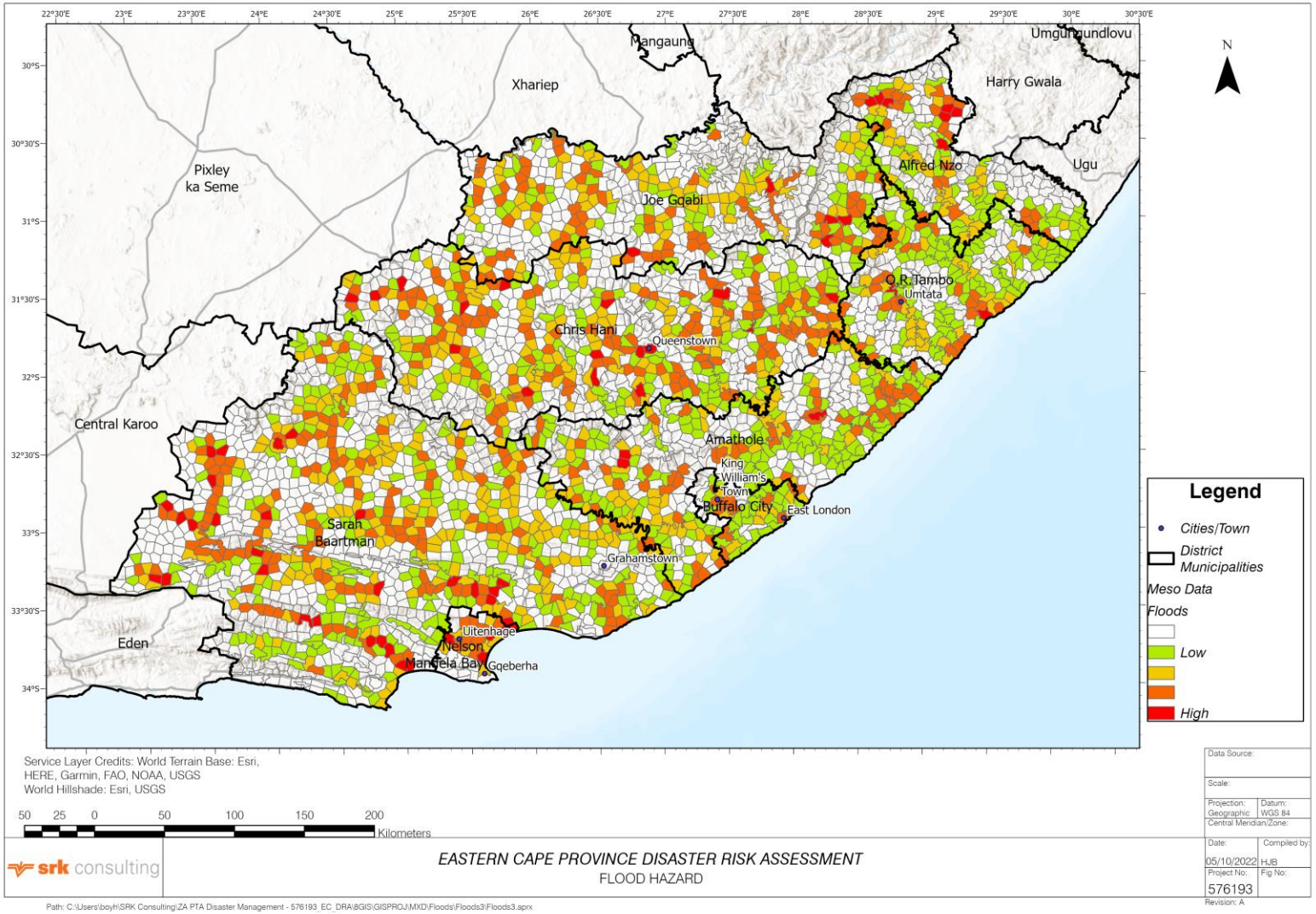

Figure 7-41: Flood Hazard (meso data)

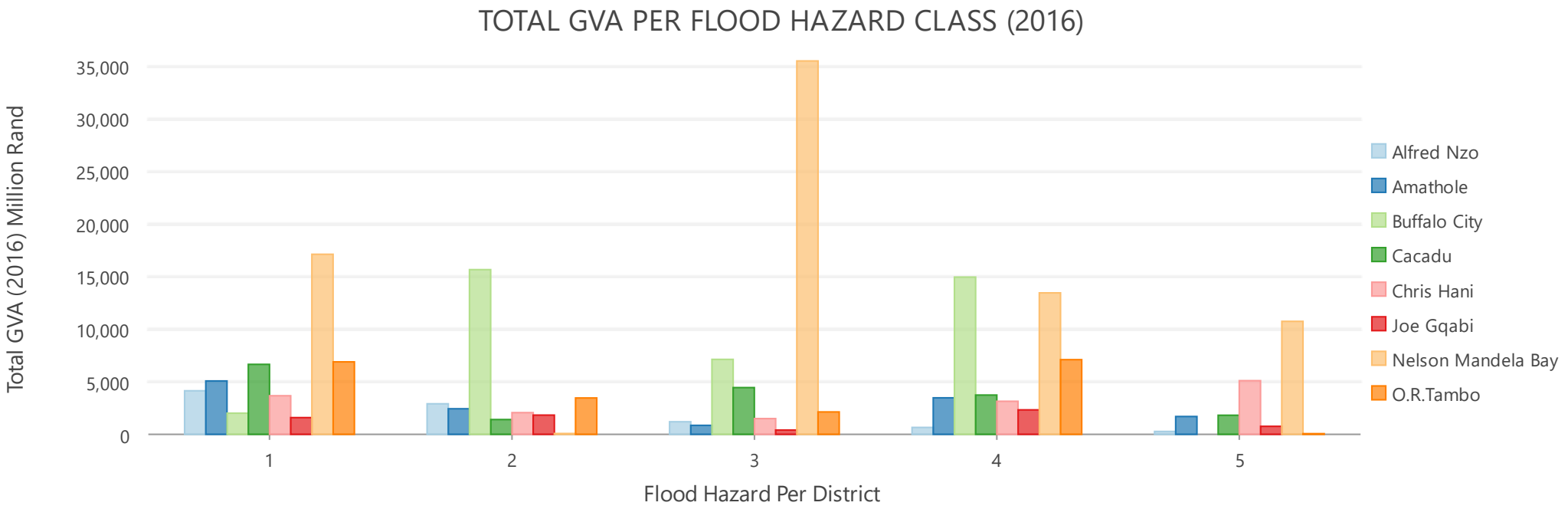

Figure 7-42: Flood hazard impact on GVA

7.9 Geological hazards

Disasters due to geological hazards have a far smaller impact on sub-Saharan Africa than those due to hydro-meteorological hazards (UN Office for Disaster Risk Reduction (UNISDR), 2017). Earthquakes account for 2%, and landslides and volcanic hazards account for 1% of the number of hazards occurring on the African continent, however, the impact of these hazards may change in future (UN Office for Disaster Risk Reduction (UNISDR), 2017). For the purpose of this assessment, geological hazards were divided into three categories, namely:

- Earthquakes;
- Subsidence;
- Landslides,
- mud flows; and
- rock-falls.

7.9.1 Earthquake

UN Office for Disaster Risk Reduction (UNISDR) describes the risk of earthquakes in the southern African region as follows:

“Sub-Saharan Africa is largely a stable intra-plate region characterized by relatively low levels of seismic activity, with earthquakes randomly distributed in space and time. The only parts of sub-Saharan Africa that do not display the characteristics of an intra-plate region are the East African Rift System and the Cameroon Volcanic Line, where earthquakes are associated with active fault zones and volcanic activity.

Earthquakes also occur occasionally in the Cape Fold Belt in South Africa. In this region, the most destructive recorded earthquake was a M6.3 event that took place on 29 September 1969 in the Ceres–Tulbagh region of the Western Cape, which killed 12 people. Aftershock activity had virtually ceased when a M 5.7 event occurred on 14 April 1970, causing further damage in the towns of Ceres and Wolseley.

The impoundment of reservoirs has also been known to trigger earthquakes. Seismicity has been associated with the Gariep Dam in South Africa and the Katse Dam in Lesotho. Mining-related earthquakes pose a significant hazard to mineworkers in the gold and platinum mining districts of South Africa. Thousands of mineworkers have perished during the last century as a result of rock bursting. No member of the public has suffered fatal or even serious injuries due to mining-related earthquakes, although some events have damaged surface structures. The M5.3 event on 9 March 2005 near Stilfontein (South Africa), for example, caused serious damage to schools, commercial properties, apartment blocks, the civic centre, and 25 houses.

The Council for Geoscience is managing a project, funded by the Department of Science and Technology, to create a South African Geological Hazards Observation System. The project aims to create an inventory and database of known geological hazards affecting South Africa and developing techniques for the assessment of geological hazards using remote sensing data (Council for Geoscience, 2018).

South Africa does not normally get large tremors except in the Witwatersrand where they result from mining activities (UN Office for Disaster Risk Reduction (UNISDR), 2017).

Mass movements, which include a range of natural phenomena such as landslides, mudflows, erosion, and siltation, are affected by rock and soil types, rainfall patterns, topography, and vegetation. Human factors that contribute to mass movements include overpopulation, deforestation, and poor land management practices. Landslides and mudflows can cause considerable loss of life, and damage to croplands and infrastructure such as roads, railways, and pipelines.

Figure 7-43 shows the history of the occurrence of earthquakes (blue dots) in and around the Eastern Cape. This information was transferred to the meso data layer and

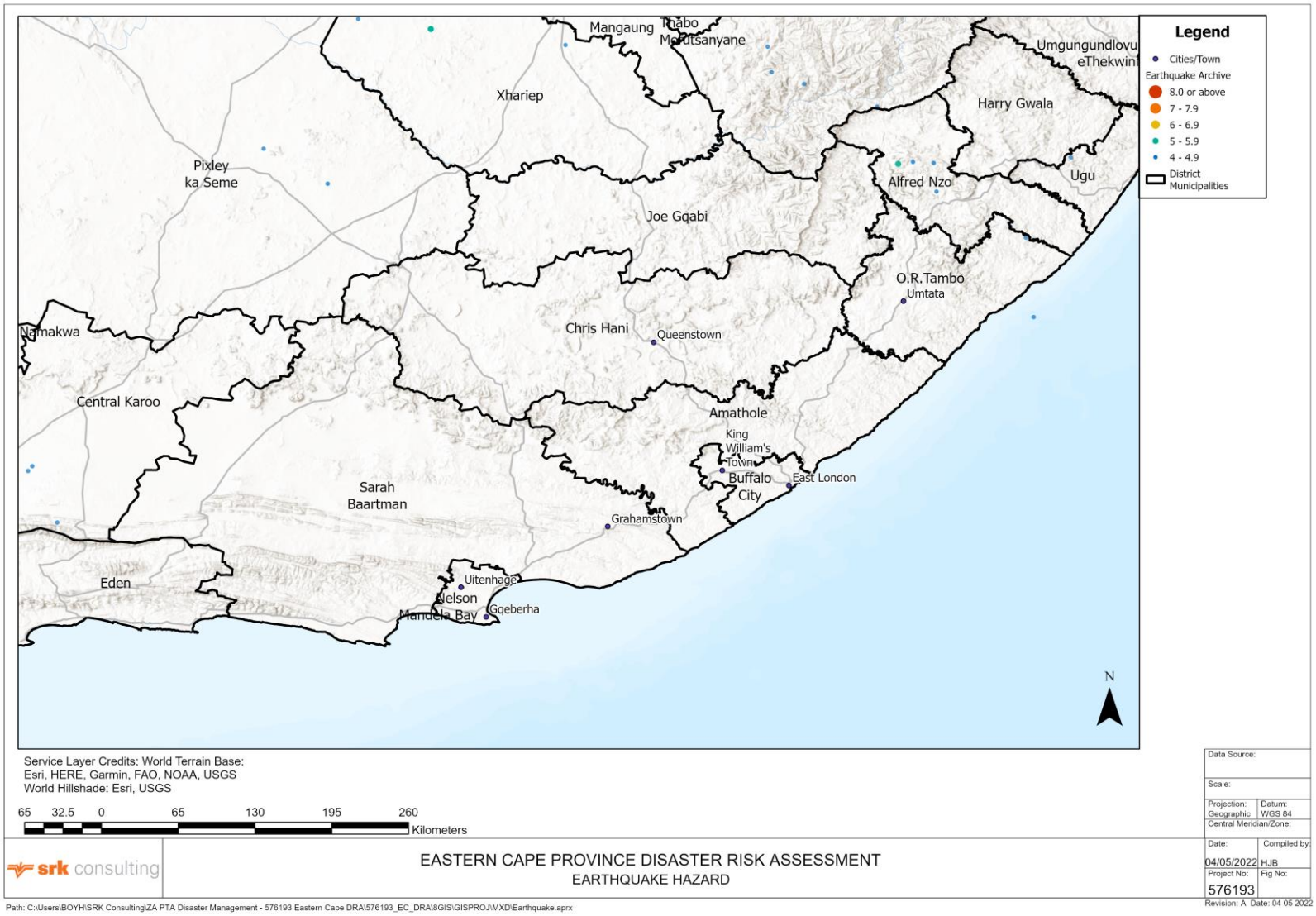

Figure 7-43: Geological Hazard: Earthquake

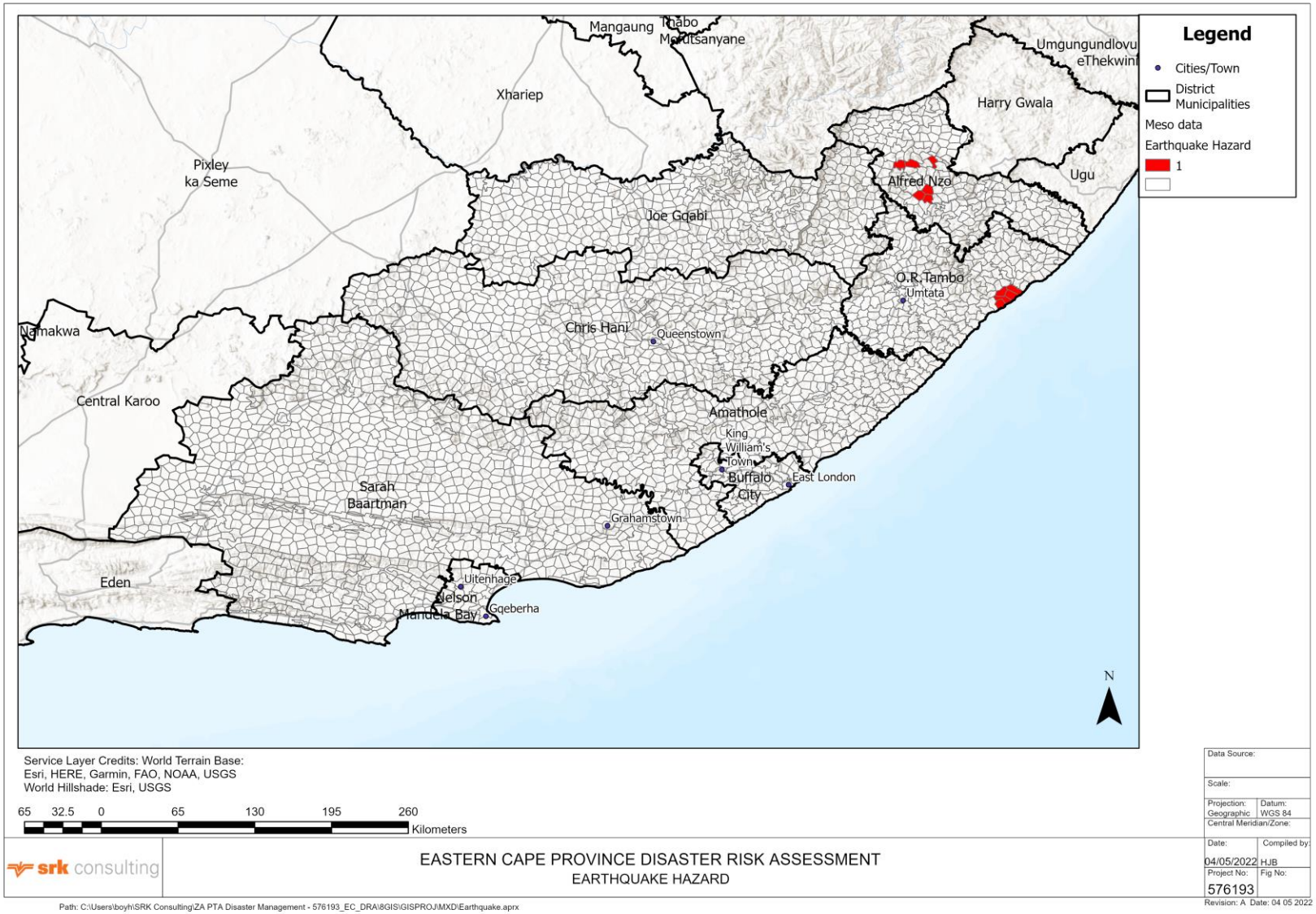

Figure 7-44: Earthquake Hazard (meso data)

Figure 7-44 indicates that several tremors has been recorded by the South African Council of Geoscience near to Eastern Cape Province. The magnitude of these incidents' ranges from 3.1 to 4.9 which are all classed as "minor" to "light" incidents that are felt and may cause minor damage. The interpretation for the magnitude as measured by the Richter Scale is indicated in Table 7-6.

Table 7-6: Richter Scale Magnitude Description (Wikipedia, 2019)

Descriptor	Richter Magnitude number	Damage caused by the earthquake	Frequency of occurrence (Global)
Micro	Less than 2.0	Micro (very small) earthquakes, people cannot feel these.	About 8,000 each day
Very minor	2.0-2.9	People do not feel these, but seismographs are able to detect them.	About 1,000 per day
Minor	3.0-3.9	People often feel these, but they almost never cause damage.	About 49,000 each year (About 134 per day)
Light	4.0-4.9	Objects inside houses are disturbed, causing noise. Things are rarely damaged.	About 6,200 each year (About 17 per day)
Moderate	5.0-5.9	Buildings that are not built well may be damaged. Light objects inside a house may be moved.	About 800 per year (About 2 per day)
Strong	6.0-6.9	Moderately powerful. May cause a lot of damage in a larger area.	About 120 per year
Major	7.0-7.9	Can damage things seriously over larger areas.	About 18 per year
Great	8.0-9.9	Massive damage is caused. Heavy objects are thrown into the air and cracks appear on the ground, as well as visible shockwaves. Overhead highways may be destroyed, and buildings are toppled.	About 1 per 20 years
Meteoric	10.0+	There are no records of anything of this size. The vibration is about the same as that of a 15 mi meteor.	Unknown

7.9.2 Subsidence

Subsidence is the motion of a surface (usually, the earth's surface) as it shifts downward relative to a datum such as sea level. The opposite of subsidence is uplift, which results in an increase in elevation (Wikipedia, 2013).

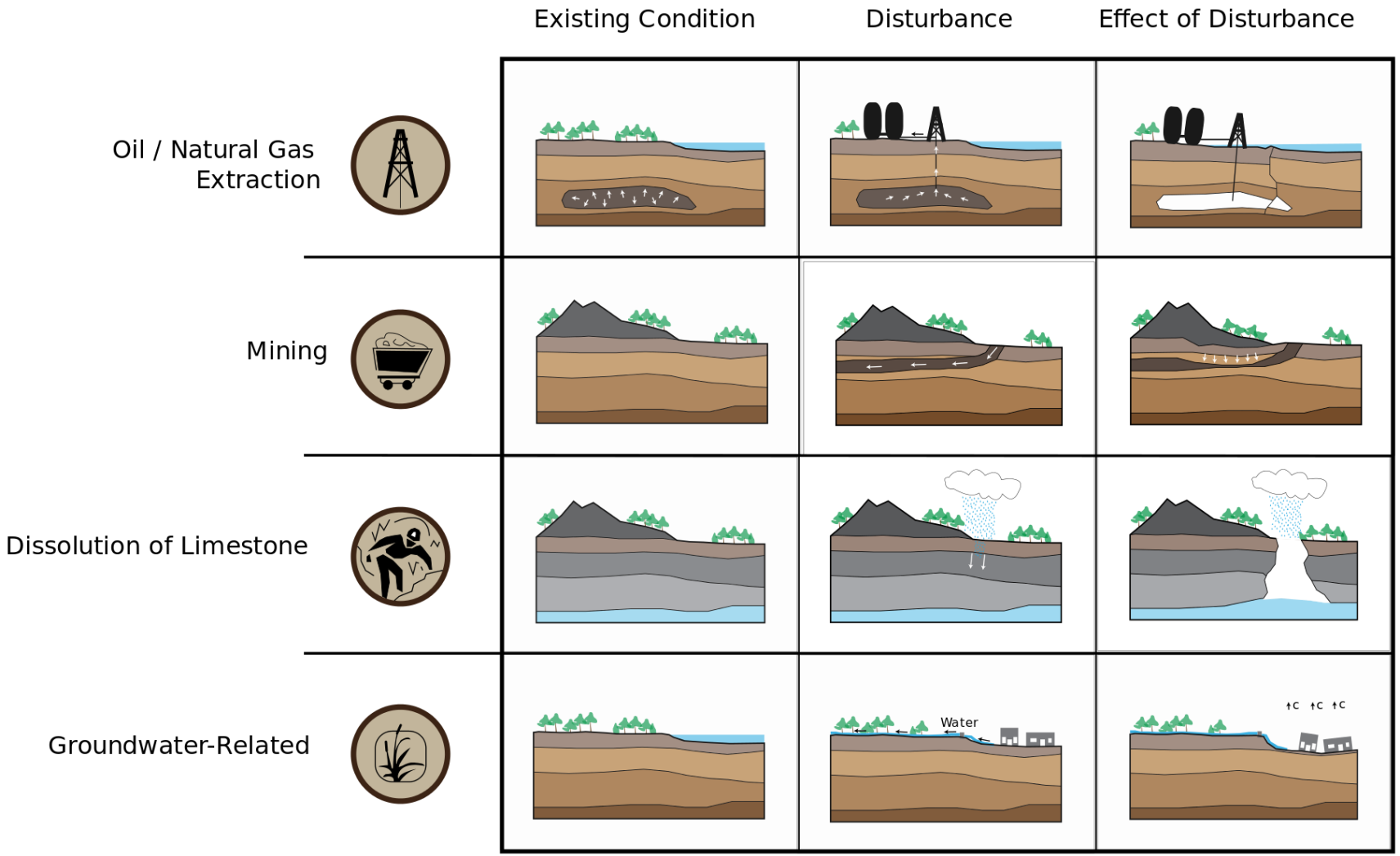

Figure 7-45: Types of Subsidence (Wikipedia, 2019)

In South Africa, subsidence is often found in dolomitic areas. There is no Dolomite in the Eastern Cape Province area, therefore the risk for subsidence is considered extremely low.

7.9.2.1 Landslides, mud flows and rock-falls

Rockfalls are often caused by erosion of earth around larger rocks that then become loose and fall. Earthquakes can also lead to landslides and rockfalls.

The term landslide or less frequently, landslip, refers to several forms of mass wasting [5]that include a wide range of ground movements, such as rockfalls, deep-seated slope failures, mudflows, and debris flows. Muddy-debris flows can start because of slope-related factors and shallow landslides can dam stream beds.

These hazards are mostly associated with areas that have steep slopes. Figure 7-46 indicate areas with steep slopes in red based on the available elevation data for Eastern Cape Province.

[5] Mass wasting, also known as mass movement, is a general term for the movement of rock or soil down slopes under the force of gravity. It differs from other processes of erosion in that the debris transported by mass wasting is not entrained in a moving medium, such as water, wind, or ice

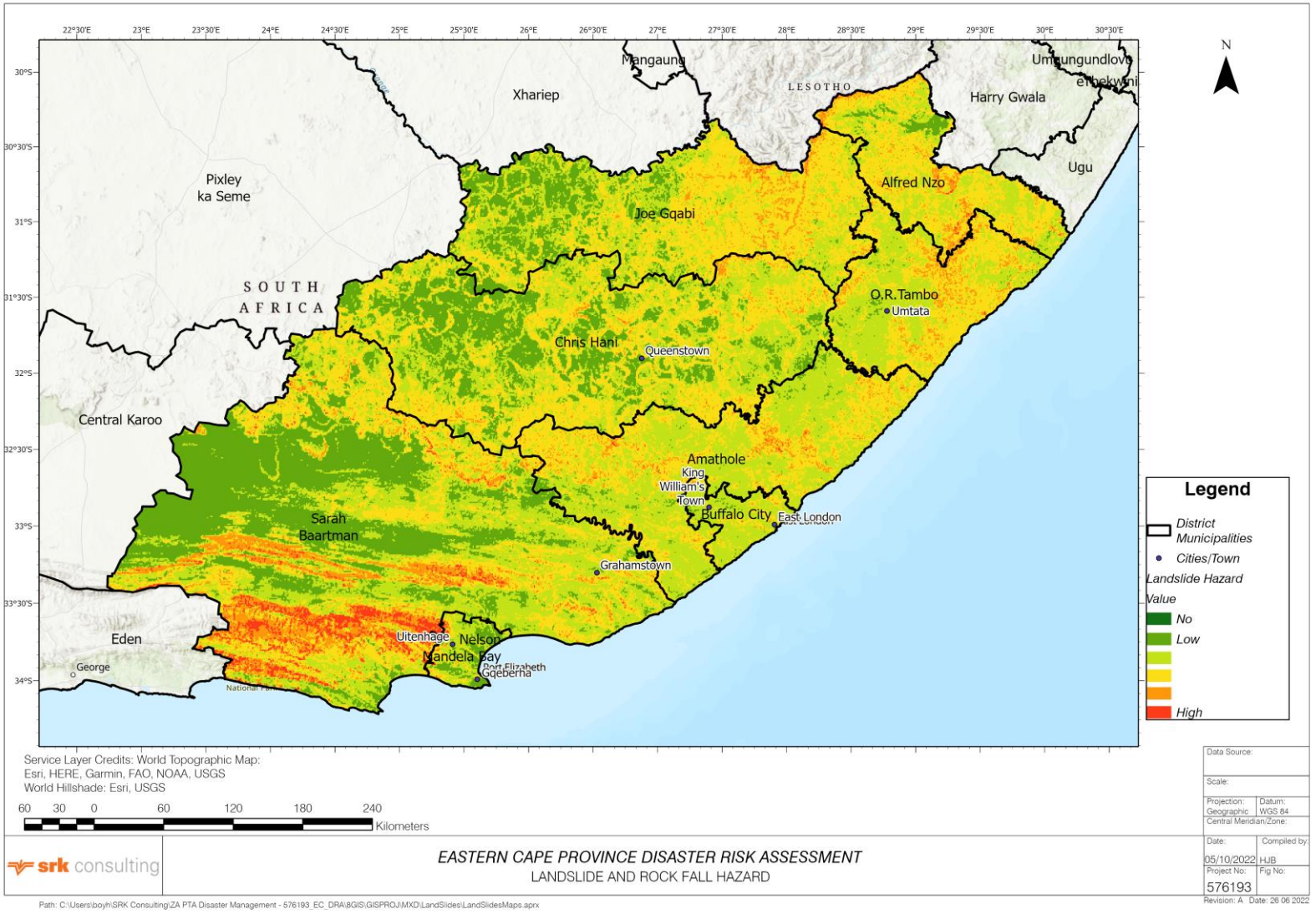

Figure 7-46: Geological: Landslides, mud flows and rock falls

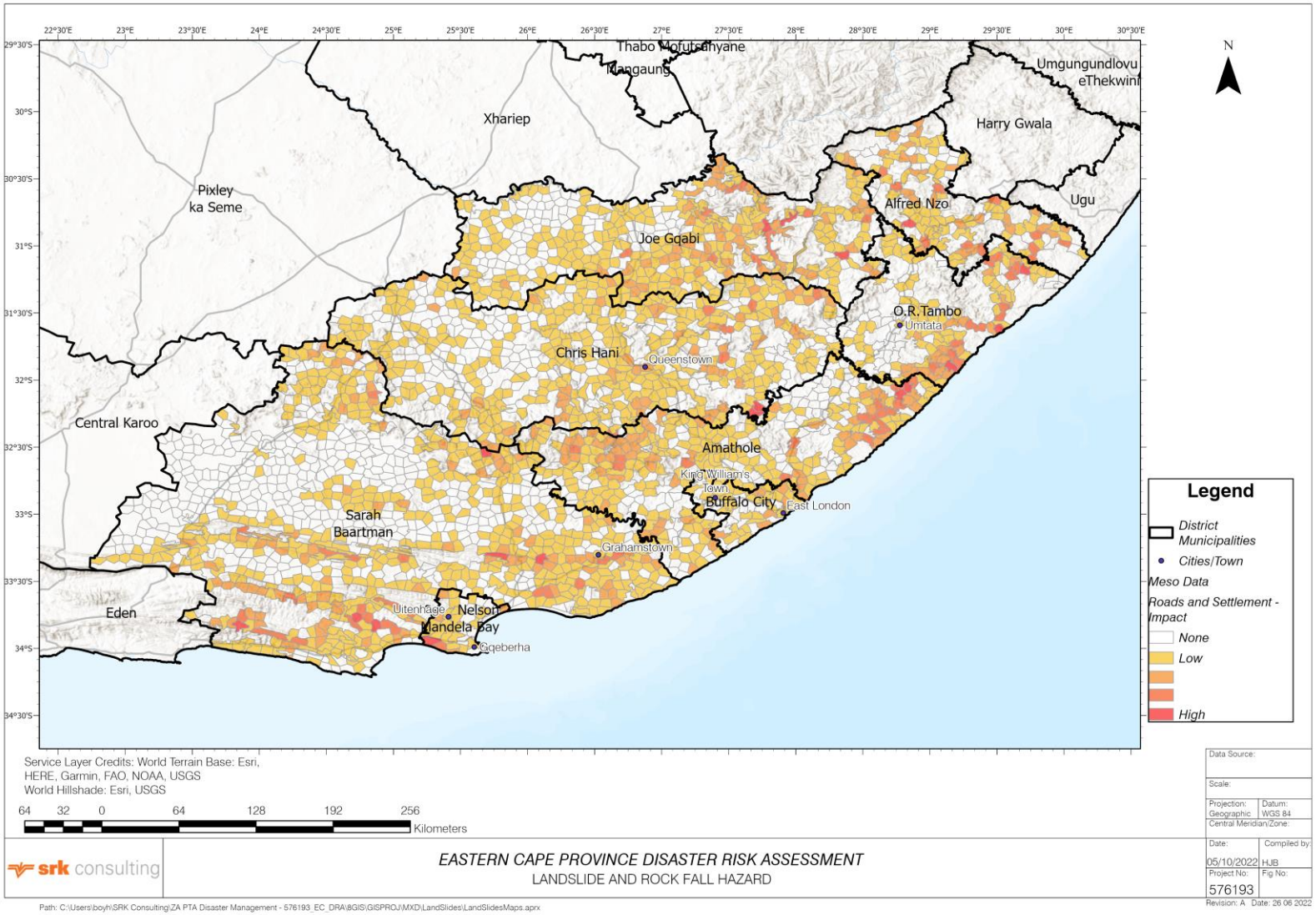

Figure 7-47: Landslide and Rock Fall Hazard (meso data)

7.9.3 Consultation inputs

7.9.3.1 Alfred Nzo

Mudslides due to loss of vegetation. Settlement on floodplain. Disaster Management is not invited during the development of Spatial Development Framework (SDFs)

This is closely related to environmental degradation. People that are settling in dangerous/unsafe areas increase vulnerability. Settlements are also encroaching on wetlands. Heavy rains and climate change contribute to rock falls. Rock-falls are not prevalent but does occur in the rural areas including Ntabankulu. Ward 3, 16, 18 and 21 in Matatiele Municipality also experiences rockfalls.

7.9.3.2 Buffalo City

Two earth tremors have occurred. Major fault, but minor problems.

Poor planning and building on slopes can influence the occurrence of landslides/mud flows.

7.9.3.2.1 Chris Hani

Encobo had a landslide incident in 2020.

Rockfalls incident during intense rainfall, or intense snow fall during winter along R56 route on Barkly Pass in the Sakhisizwe Local Municipality. Rock falls also occur between Elliot and Ugie and Elliot and Barkly East.

7.9.3.3 Joe Gqabi

Landslides/mud flows occur mainly along the roads. On road to Barkley East Barkley Pass close to Eliot. Sterkspruit. Soil erosion does play a part in rock-fall incidents. There are people that live in unsafe areas; thus, homes are damaged by rock-falls.

7.9.3.4 Nelson Mandela Bay

Landslides occurred in Uitenhage in 2013 where a side of mountain came down on highway.

7.9.3.5 OR Tambo

Tremor was experienced about 15 years back.

Landslide occurred in Majola after rains in September 2021. Soil moved down hill to road. Close to house. Was close to Port St Johns. Rock-falls occur in remote areas, along major roads. Sinkholes also occur in Port St Johns, Lusikisiki, etc (along the coast).

7.9.3.6 Sarah Baartman

A hill collapsed in Port Alfred as you enter the CBD. A few houses have been destroyed/condemned. The area is still vulnerable.

Makana has unstable clay. Grahamstown had road collapses.

7.10 Hydro-meteorological hazards

According to the World Meteorological Organization, ninety percent (90%) of all natural disasters worldwide are related to weather, climate and water (United Nations Office for Disaster Risk Reduction, 2015). Disasters in Sub-Saharan Africa are predominately hydro-meteorological and climatological, and comprise cyclones and storms, floods, landslides, extreme temperatures, wildfires and droughts. Drought and floods together account for 80 percent of loss of life and 70 percent of economic losses linked to natural hazards in Sub-Saharan Africa (World Bank, Africa Region Disaster Risk Management Team, 2010)

7.10.1 Drought

Future projections show a net overall global drying trend, and the proportion of the land surface affected by extreme drought is predicted to increase from 1% at present to 30% by the end of the 21st century. The drying trend is related to anthropogenic emissions of greenhouse gasses and sulphate aerosols into the atmosphere (Burke, Brown, & Christidis, 2006). Although droughts under current climate conditions affect many parts of the globe, they are a particular concern in sub-Saharan Africa. A large part of sub-Saharan Africa is susceptible to drought. In southern Africa, severe droughts (such as those of 1982–1983 and 1997–1998) have been linked to the El Niño–Southern Oscillation (ENSO) phenomenon. Nearly all climate change projections signal greater chances of severe droughts over southern Africa, particularly in the central and western areas (IPCC, 2001; Scholes & Biggs, 2004 in ICSU, 2007). According to ICSU the most serious result of drought is famine. Drought and famine are not sudden events but rather the result of long-term degradation of the environment due to poor land use and irrational exploitation of natural resources.

The South African Weather Service defines drought based on the degree of dryness in comparison to “normal” or average amounts of rainfall for a particular area or place and the duration of the dry period. This is what is termed a meteorological drought. The common practice to date has been to use the percentage of normal rainfall as an indicator of drought. Less than 75% of normal rainfall is regarded as a severe meteorological drought but a shortfall of 80% of normal will cause crop and water shortages, which will ultimately affect social and economic factors (South African Weather Services, 2020). Normal rainfall for a particular place is calculated using rainfall figures for at least 30 years (South African Weather Services, 2020).

Drought can be defined in several different ways (University of Nebraska, 2018). Drought always implies a reduction in rainfall, but this reduction can have variable impacts depending on the length of the drought and the deviation from the expected or average rainfall of an area. Drought can therefore have several different definitions:

- Meteorological drought is usually identified when there is a reduction in the expected or average rainfall of an area.
- Hydrological drought implies a deficiency in ground and surface water conditions, often linked only indirectly to rainfall because of interregional water transfers by rivers or pipelines or storage in dams or reservoirs.
- Agricultural drought is a deficiency defined in relation to a particular crop and its requirements. For example, we know how much rain is needed to produce a certain amount of a specific crop type and any rainfall less than that expected or outside the specific crop’s growing season, would lead to a drop in production.
- Ecological drought is a situation in which the rainfall is insufficient to support normal growth of the natural vegetation.

The Eastern Cape Province drought hazard map (Figure 7-52)indicates areas where the impact of a deficiency in water would be more severe. This includes communities and agricultural activities that are dependent on a steady water supply.

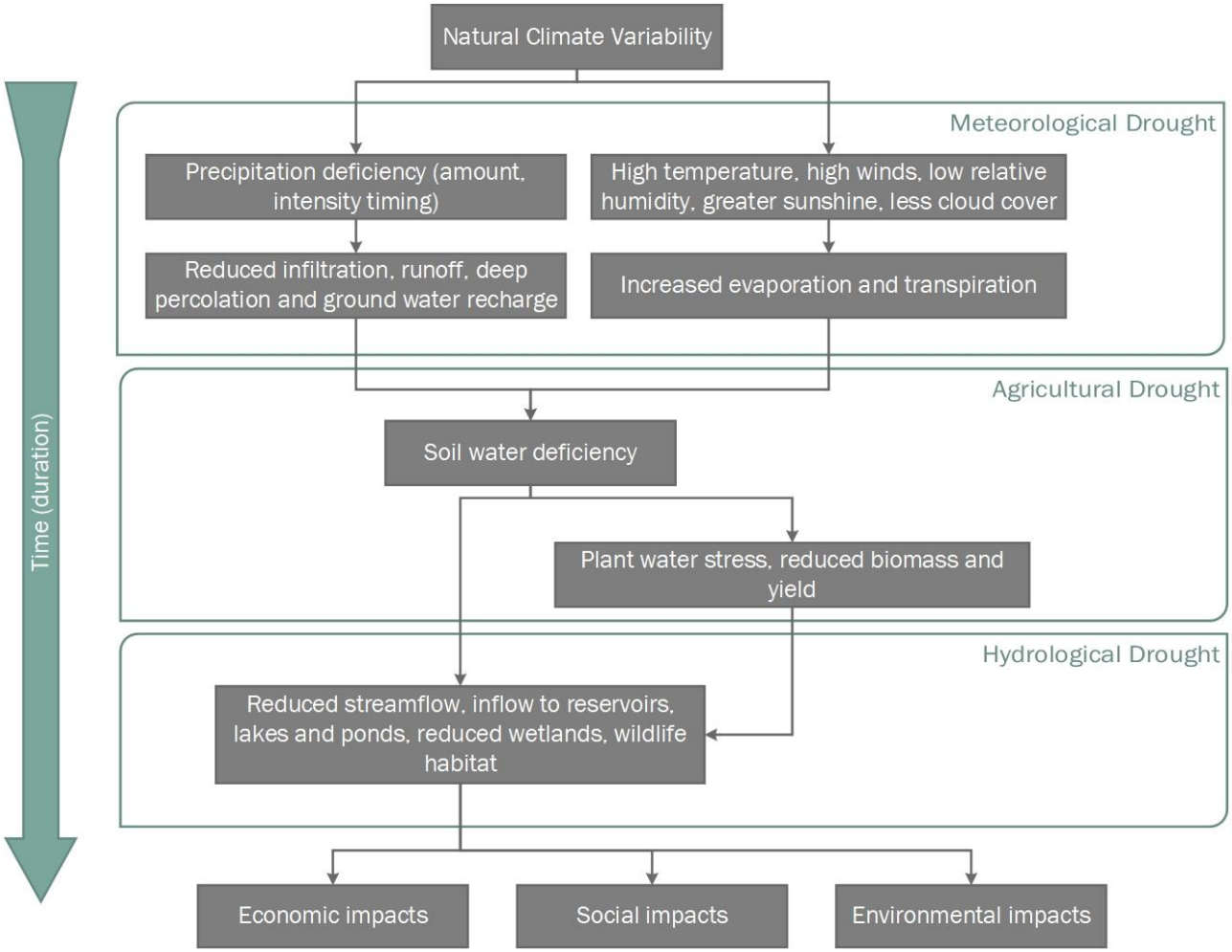

Figure 7-48: Sequence of drought occurrence (University of Nebraska, 2018)

7.10.1.1 Mapping of Eastern Cape Drought Hazard Profile

The Standardise Precipitation Index (SPI) is used to map drought hazard for the Easter Cape. Important to note is that the SPI analyse meteorological drought. SPI estimates the deviation of precipitation from the long-term probability function at different time scales (e.g., 1, 3, 6, 9, or 12 months). Data from Standardized Precipitation Index (SPI) - Overview (arcgis.com) were used as input spatial data for creating a drought hazard profile for the Eastern Cape. Data available is from April 1981 to February 2022 and is structured in such a way that information can be visualised for different time periods. Figure 7-49 represent the 6-month SPI (November 2017 to March 2022) for the Eastern Cape. Figure 7-50 shows the 6-month average for March 2008 to May 2014. Note the difference between the status and how it changes between the time periods mention.

Other variables should be included e.g., temperature or evapotranspiration in the describing other types of droughts (e.g., agricultural droughts)[6].

[6] https://www.chc.ucsb.edu/data

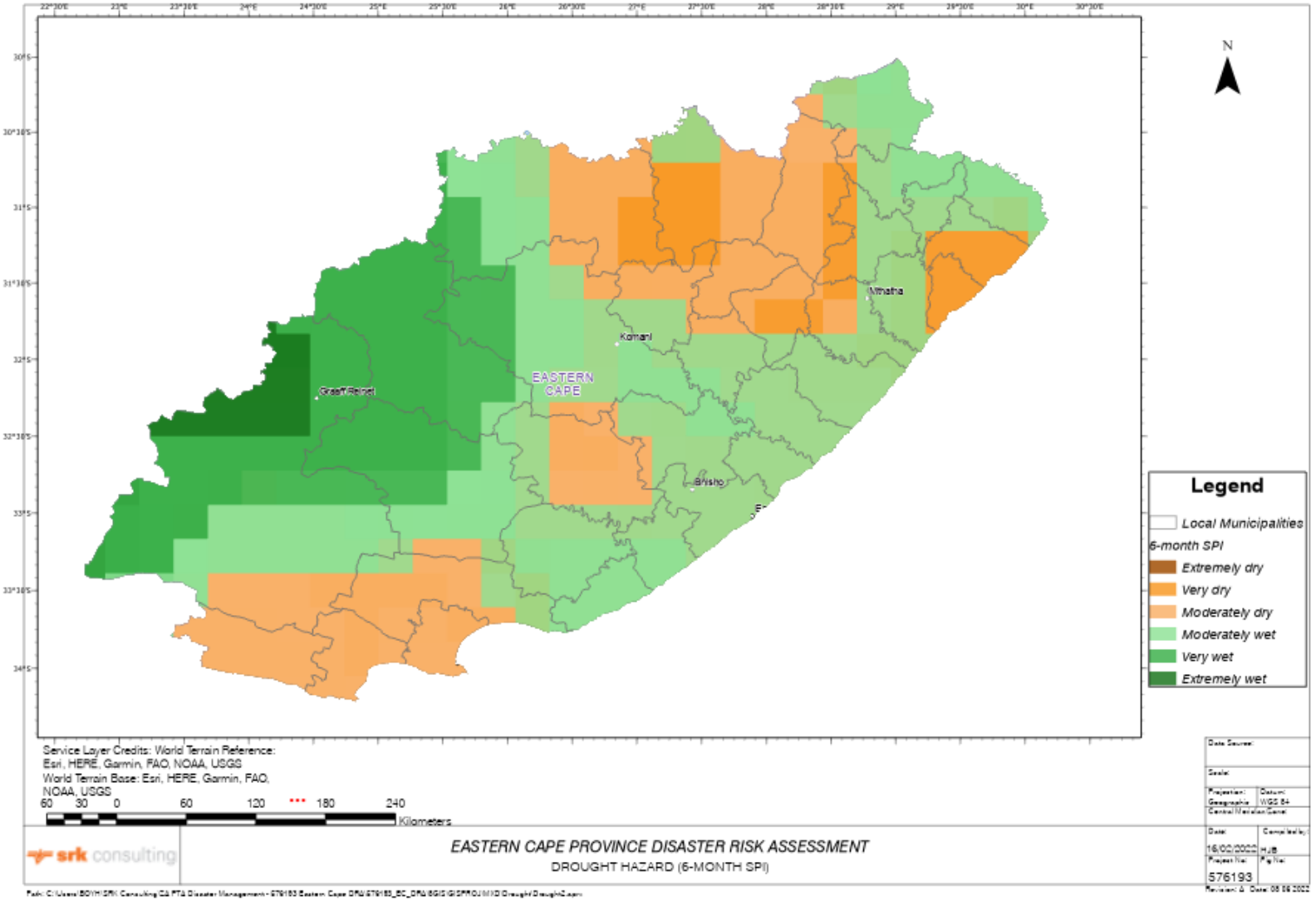

Figure 7-49: 6-Month Standardise Precipitation Index (SPI) from November 2017 to March 2022

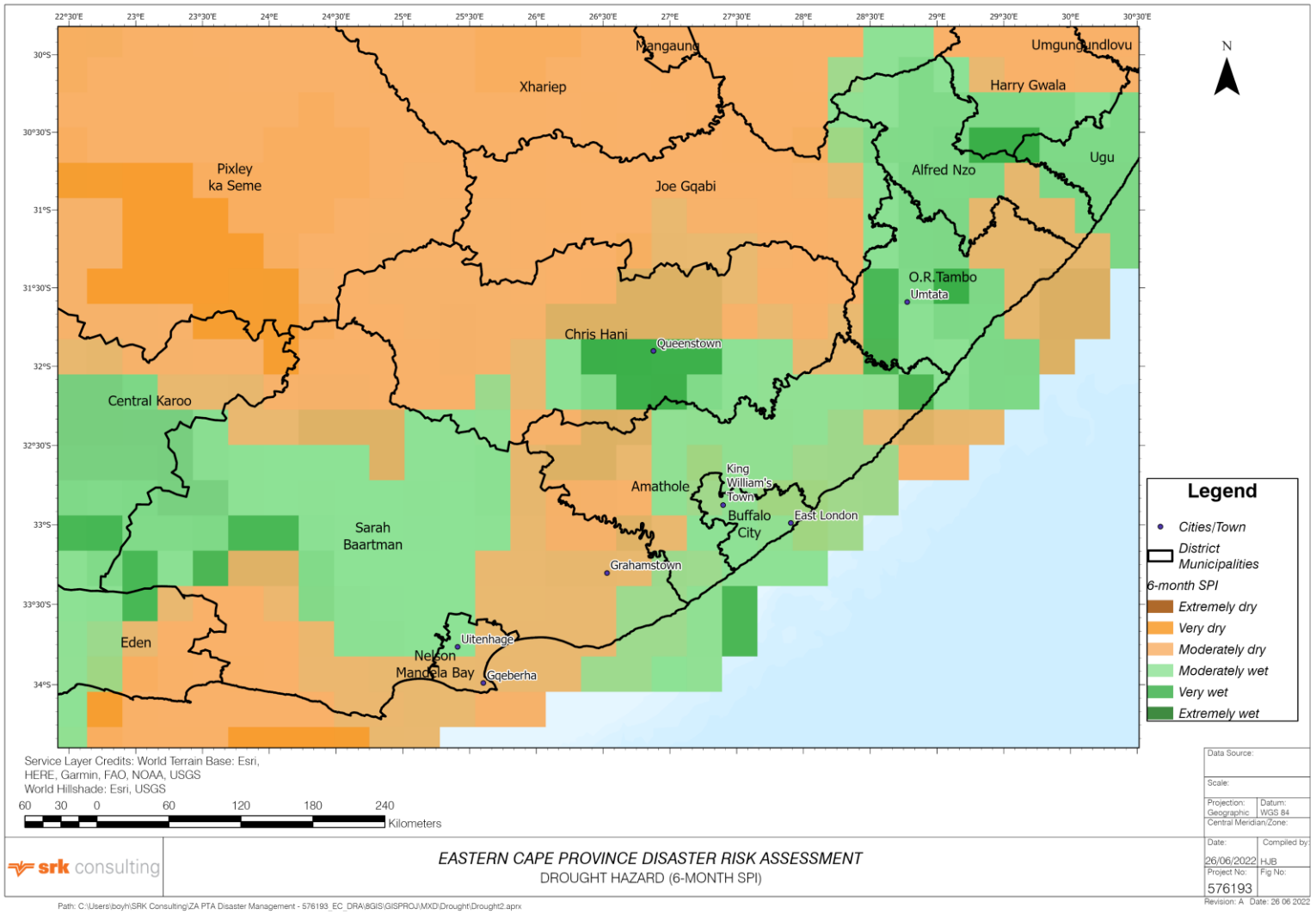

Figure 7-50: 6-Month Standardise Precipitation Index (SPI) for March 2008 to May 2014

To get a representation of the 6-month average over the whole time period from 1981 and 2022, data of the time series was downloaded with resulting overlapping areas (polygons). For example, some areas have information for 1981 and for 2022. For the GIS assessment, a single data point is needed, not different data for the same location in one layer. To incorporate al the datapoints from 1981 to 2022 into the assessment, 175 centroids (centre points) with associated attributes were created from the above-mentioned polygons. Drought data polygons and generated centroids are shown in Figure 7-51.

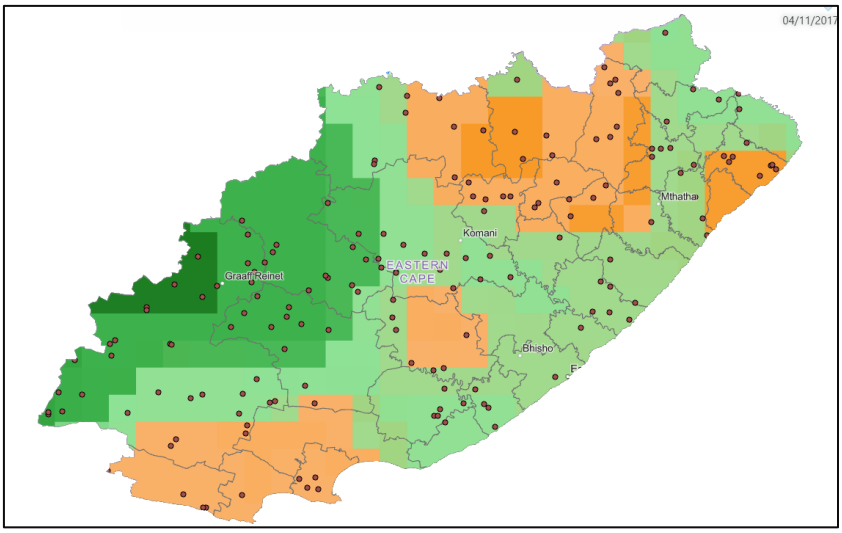

Figure 7-51: Drought data in polygons with generated centroids

Interpolation (Kriging) of the SPI values of these points was done to create a border-to-border drought layer that can be used in the assessment. This created a raster showing spatial presentation of the SPI from 1981 to 2022(Figure 7-52 for the Eastern Cape.

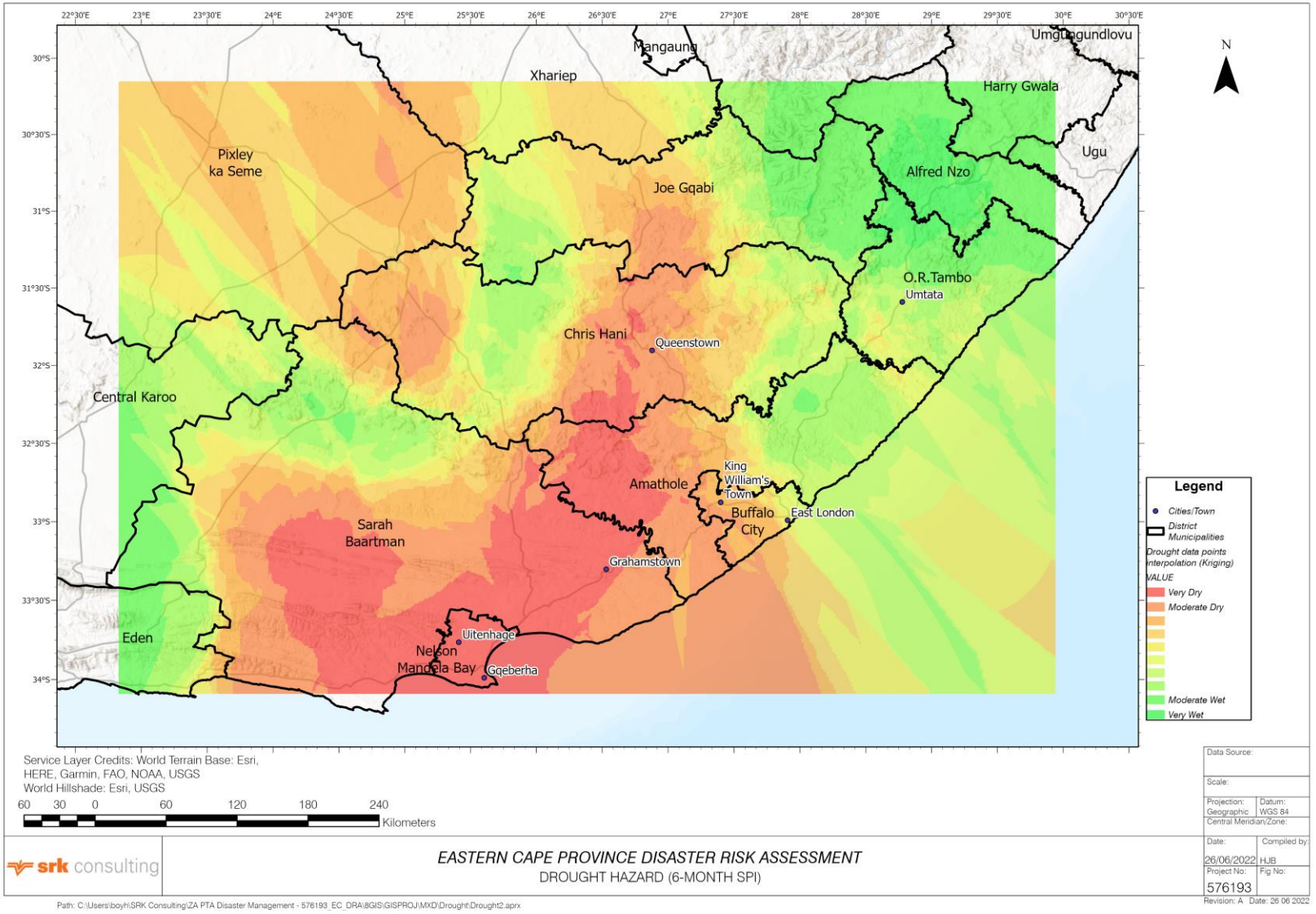

Figure 7-52: 40-year Drought (SPI) hazard for Eastern Cape

Figure 7-52 shows data for 40 years (1981 and 2022) and for an area from Eden to Harry Gwala in the KwaZulu Natal. When looking at the map please do realise that a 40-year period indicates that areas are wet, but this may drastically have changed over the last couple of years.

The values of from Figure 7-52 were converted into 5 classes and transferred to the Meso Data with Figure 7-53 as the result.

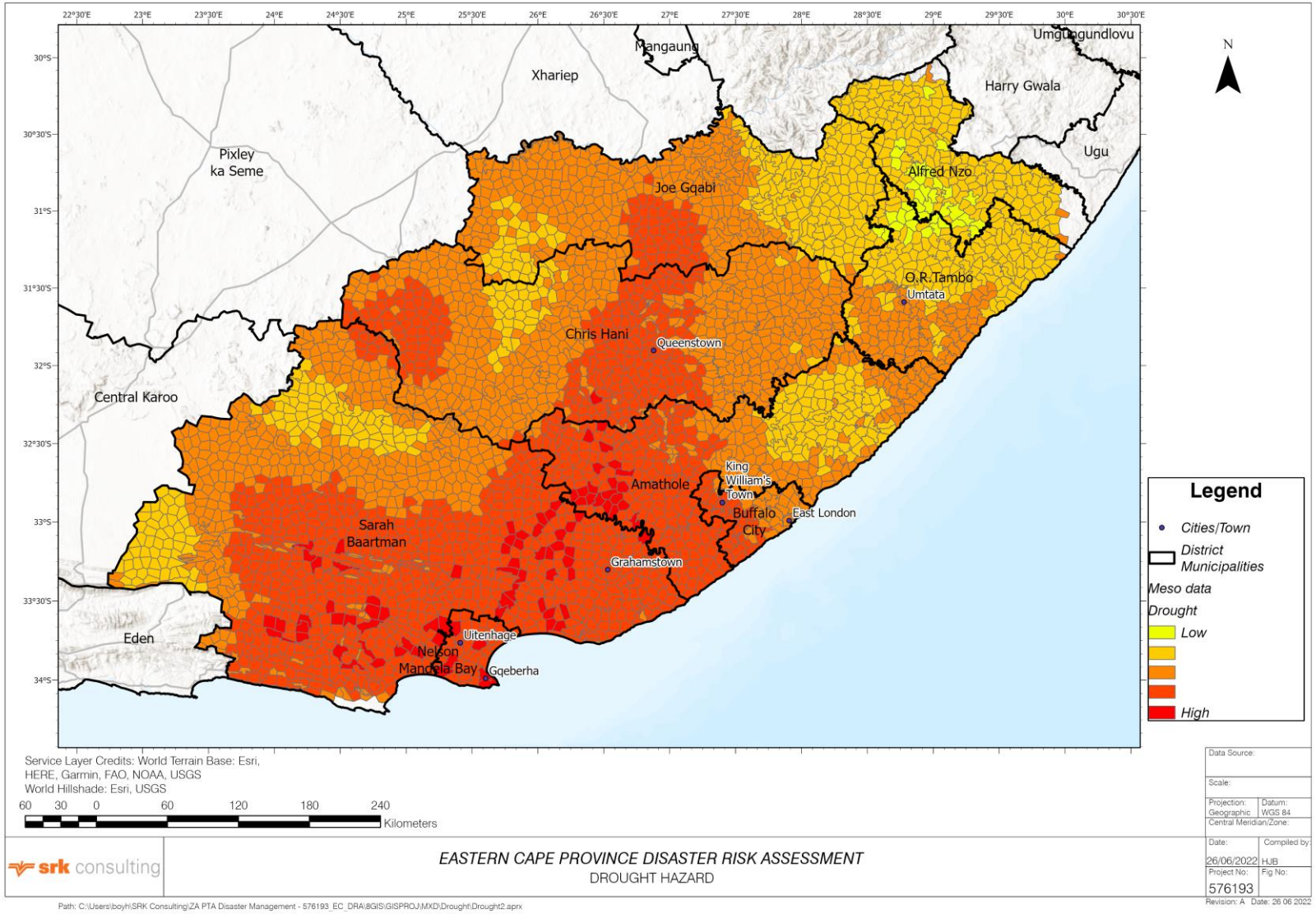

Figure 7-53: Drought hazard with Meso data for Eastern Cape

The drought hazard classes were assessed regarding their possible impact on the population and agriculture. Meso data containing population and agriculture information were combined per Drought Hazard Classes and presented in graph format. Figure 7-54 and Figure 7-55 represent the impact on agriculture and population respectively. Figure 7-54 shows that the agricultural sector of Sarah Baartman can be impacted most in the case of a drought.

Figure 7-55 shows that Nelson Mandela Bay can be severely impacted on regarding population numbers.

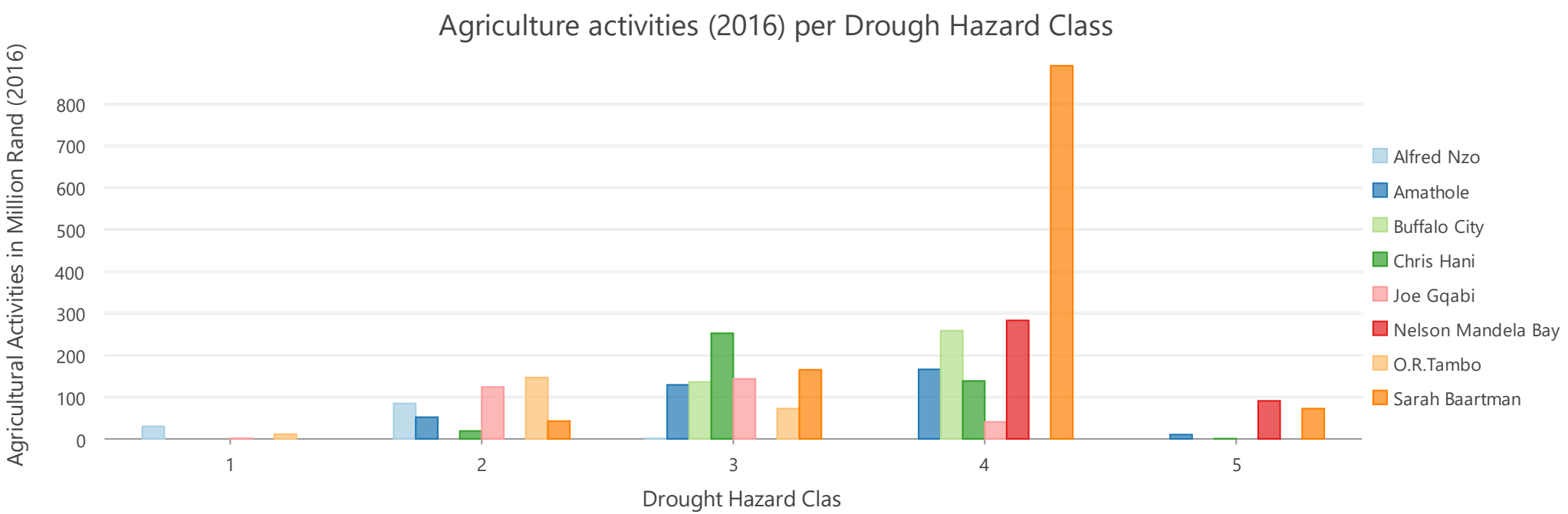

Figure 7-54: Agricultural Activities (2016) per Drought Hazard Class

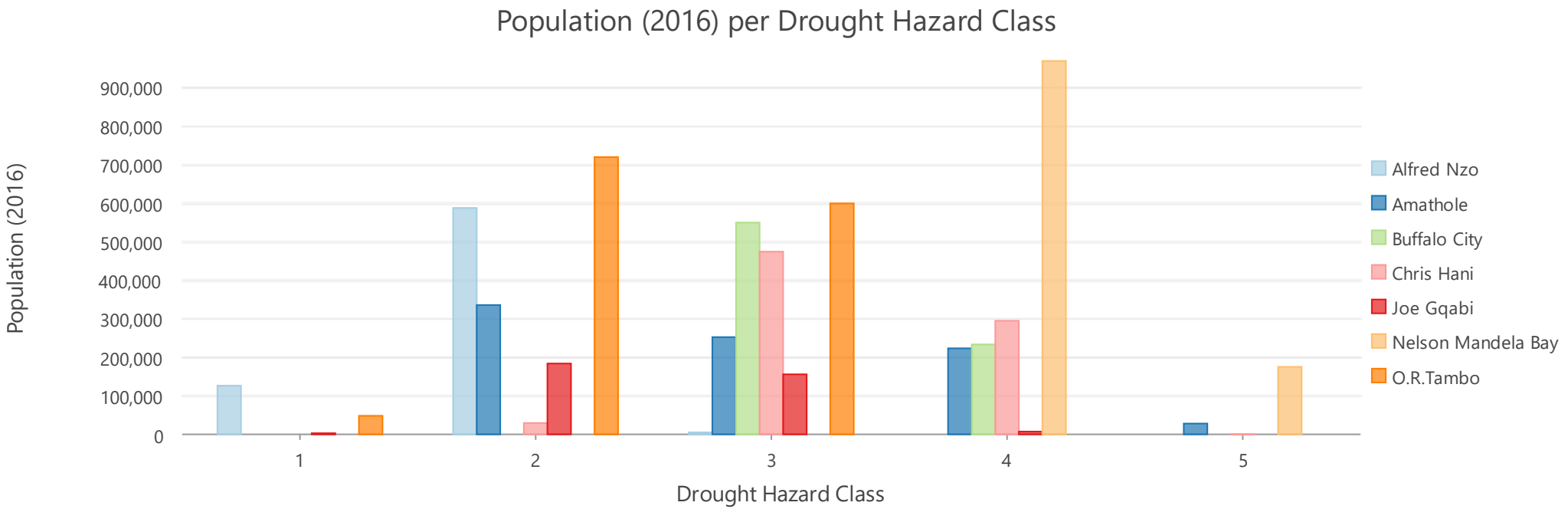

Figure 7-55: Population count (2016) per Drought Hazard Class

Water in Eastern Cape Province is supplied from diverse sources. This is positive from the perspective that diverse sources result in a reduction of risk due to numerous sources. This however makes monitoring complex and difficult.

7.10.1.2 Consultation inputs

7.10.1.3 **Alfred Nzo**

Alfred Nzo has repeated drought declarations. Problems with agriculture. The district has a shortage of water, most dams are below 50% except in Bizana. Will probably declare drought again in 2022.

7.10.1.4 **Amathole**

Drought patterns have changed, especially in Amahlathi. The area was always experienced drought during winter, but this has changed. Increase in primary and secondary water availability. Desalination can alleviate effects of drought.

7.10.1.5 **Buffalo City**

Drought is frequent in Buffalo City. The agricultural sector was hit hard, and the rural communities were extremely affected, resulting in increased urbanisation. Most households that moved to urban areas do not return the villages after a disaster. Below average rainfall results in low dam levels.

7.10.1.6 **Chris Hani**

Chris Hani is generally prone to drought and was declared a disaster in 2012 to 2015. There is good rainfall at the moment but had to declare drought disaster couple of years back. Water table goes down. Underground water dependency is high where the rural areas are affected. There are still villages that only get water during the weekends to manage distribution (Machibini area).

7.10.1.7 **Joe Gqabi**

The Orange River levels were low and water restrictions were put in place. Elundini also has big problems. Drought interventions have been implemented. Long term measures in Aliwal North were implemented. Plans are in place to build a dam in Lady Grey. These measures include drilling of boreholes and water restrictions. Venterstad receives water from Sterkspruit.

7.10.1.8 **Nelson Mandela Bay**

Highest risk of drought. Water purification plants are being built, as well as drilling boreholes. Capacity increased for the pipeline running from Gariep dam to Nelson Mandela Bay. Awareness Programmes are in place.

7.10.2 Severe storms (tornado, wind, hail, lightning, fog)

Severe storms can cause widespread damage, destruction and loss of life. For this assessment, severe storms will be considered to include hail, lighting and rainfall with the assumption that where there are higher frequency and intensity of these events, a higher possibility of storms also exist.

Figure 7-56 indicates the lightning ground flash density for Eastern Cape compiled by the South Africa's Council for Scientific and Industrial Research (CSIR). The map indicates annual lightning strikes per square kilometre. .The above figure indicates that the Eastern Cape Province is in an area with a relatively low to medium lightning density value for South Africa. This figure only represents the density of lightning strikes, and not the average vulnerability of communities to the lightning strikes.

Figure 7-57 shows the hail day frequency of the Eastern Cape and Figure 7-58 the average rainfall for the Eastern Cape.

These three (3) weather elements were combined to create a map (Figure 7-59) that show areas that are at risk for severe storm. The created data was transferred to the meso sone layer and Figure 7-60 shows in red the areas that are most at risk.

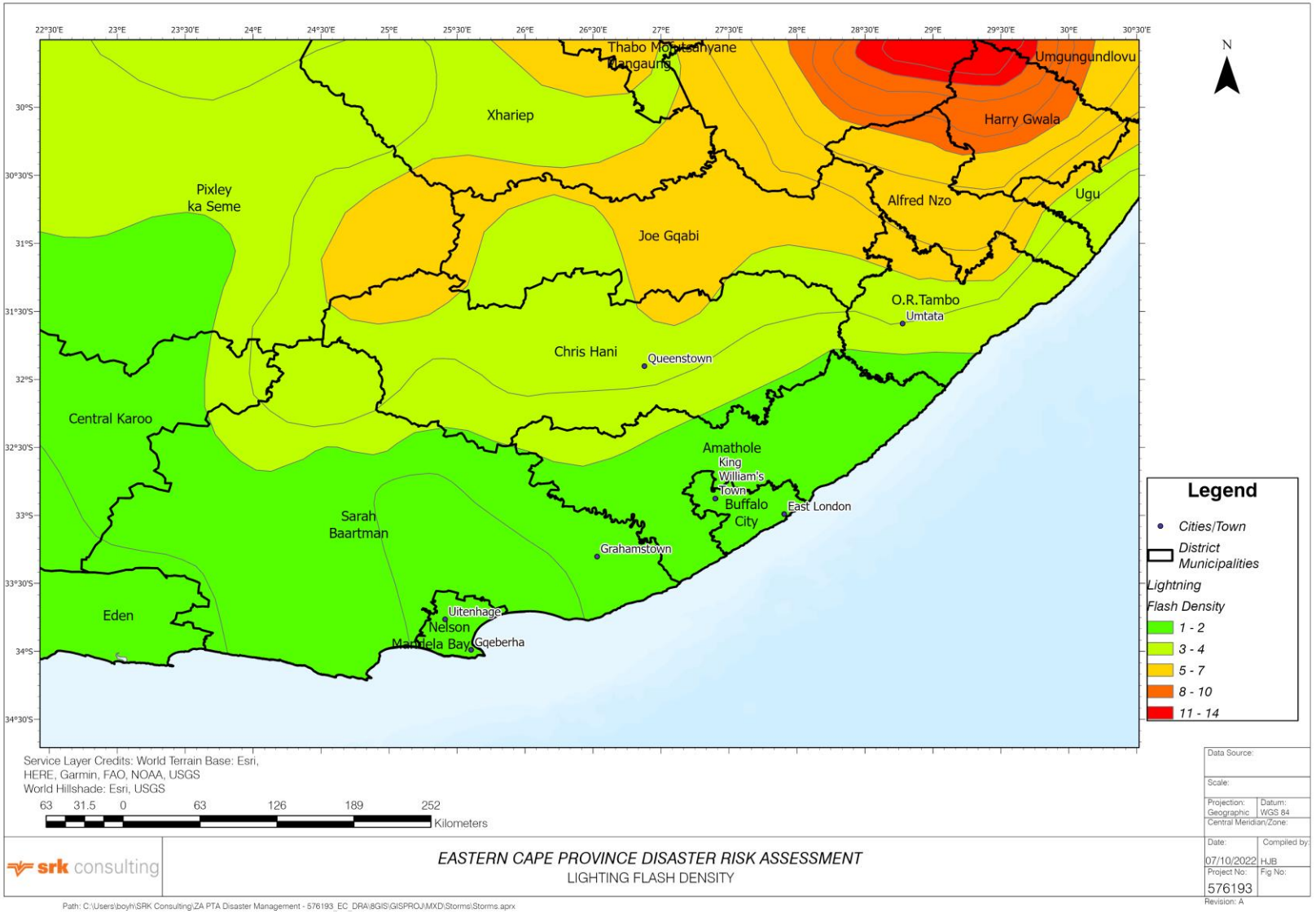

Figure 7-56: Light Flash Density for the Eastern Cape

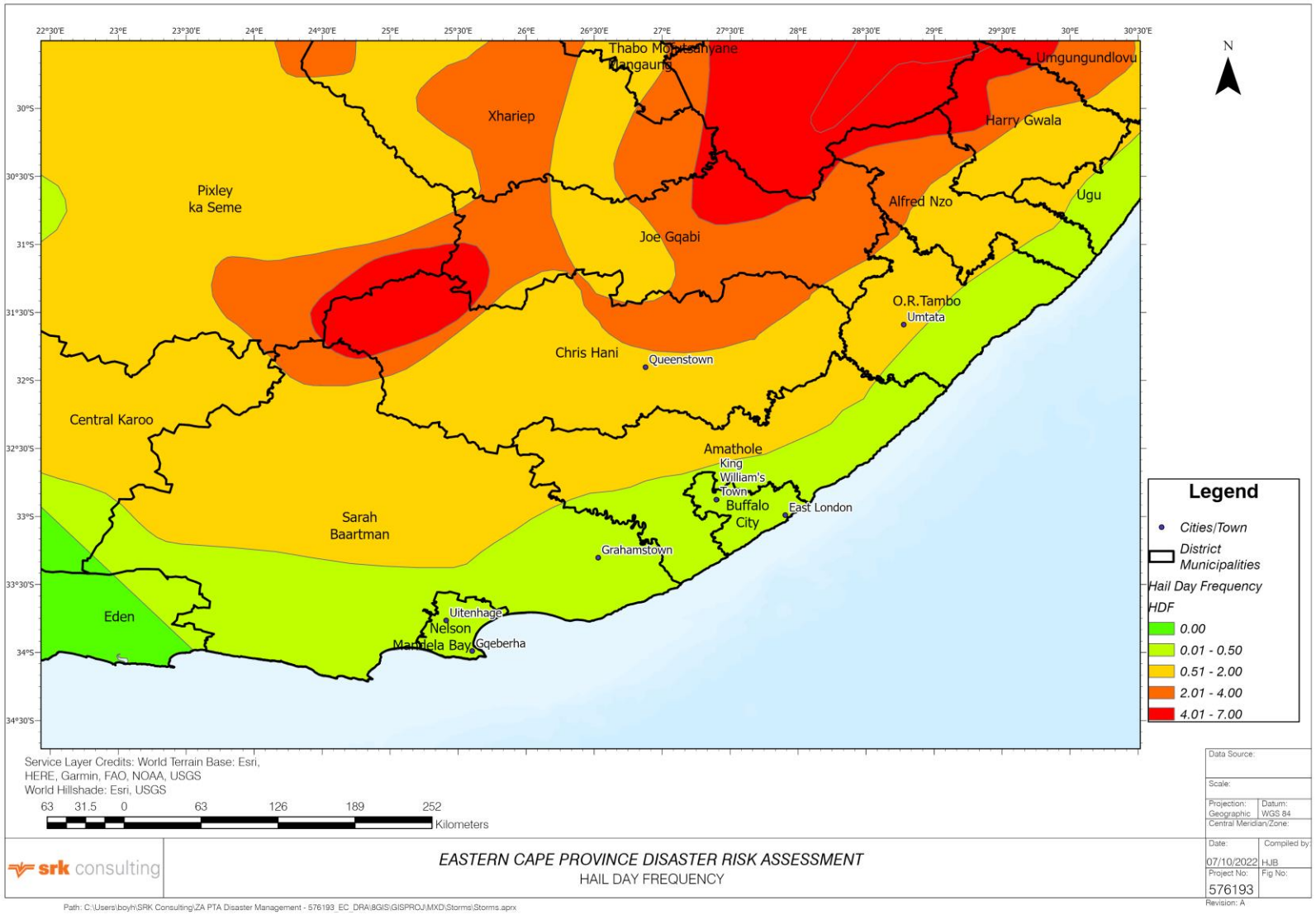

Figure 7-57: Hail Day frequency for the Eastern Cape

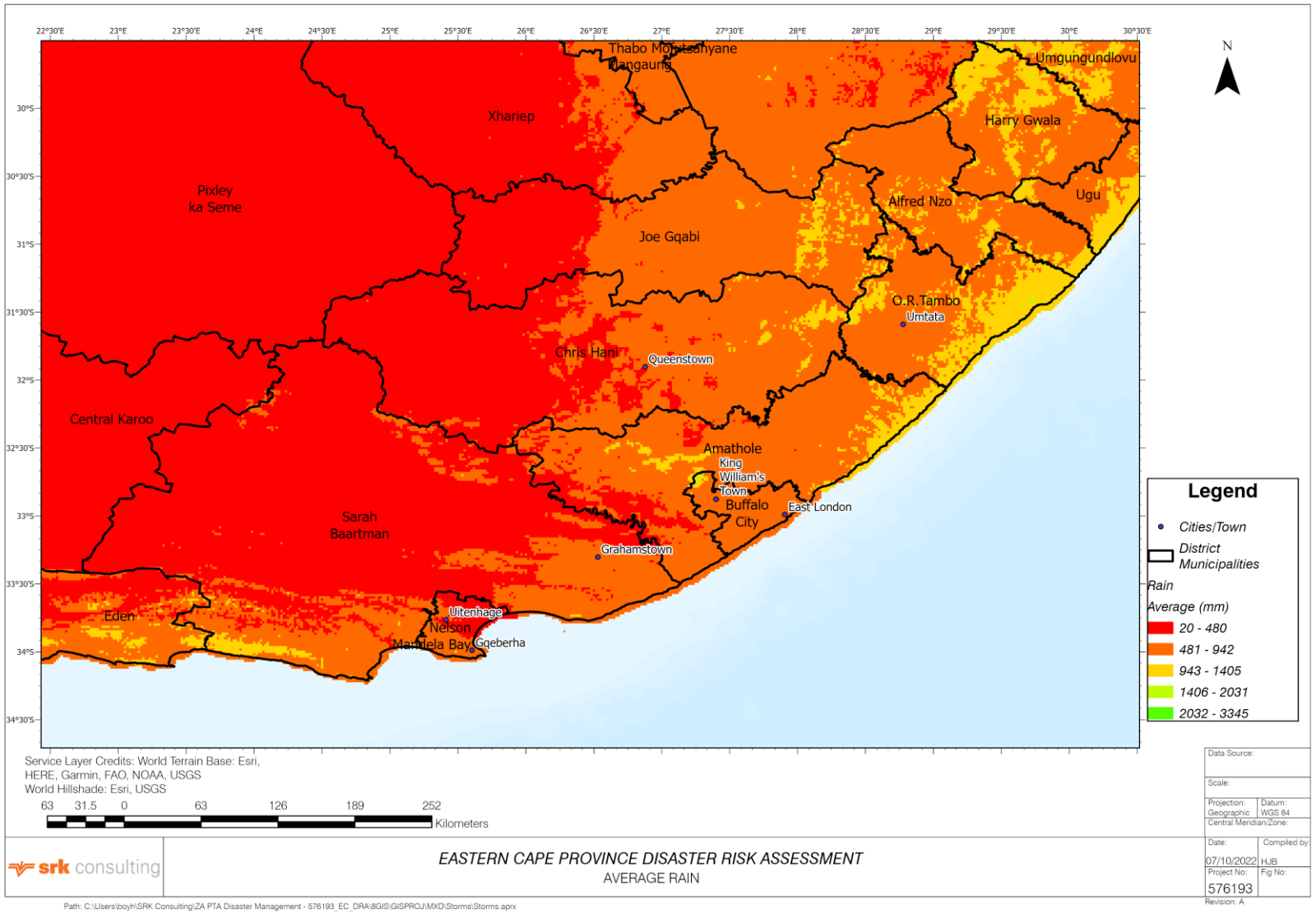

Figure 7-58: Average annual rainfall for the Eastern Cape

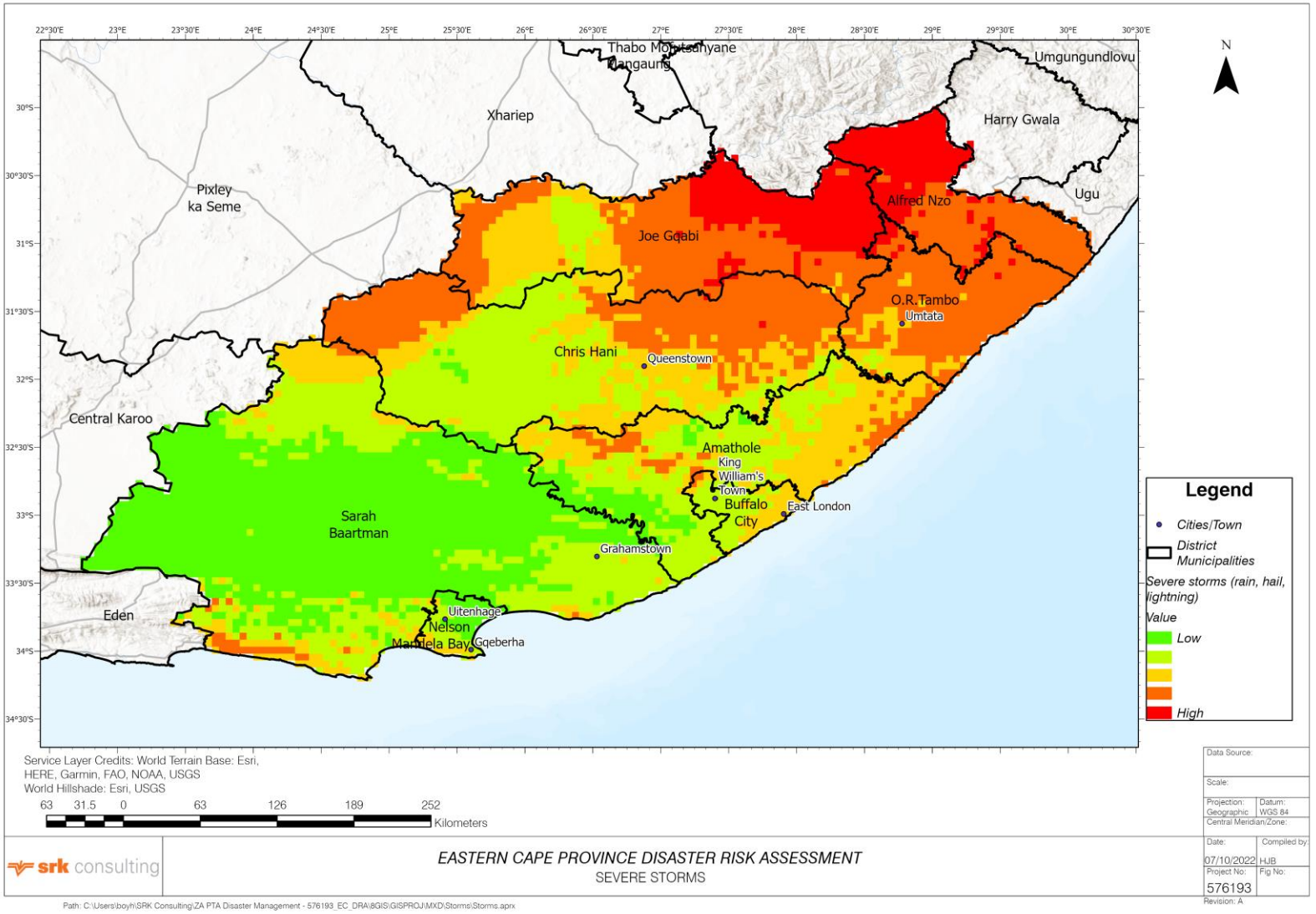

Figure 7-59: Severe Storms (hail, lighting and rain)

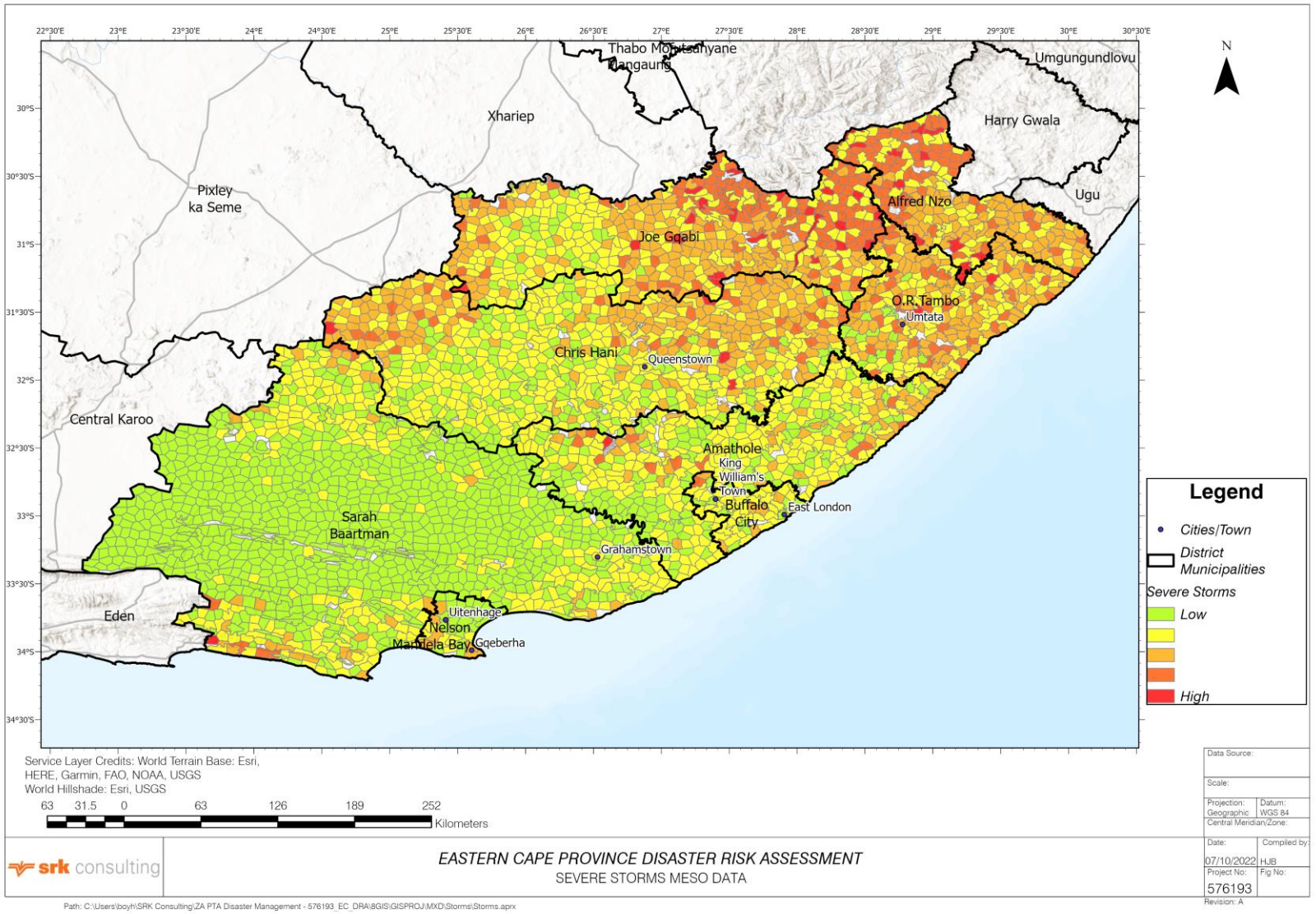

Figure 7-60: Severe Storms (meso data)

7.10.2.1 Consultation inputs

7.10.2.1.1 Alfred Nzo

Severe thunderstorms have been intense between December 2021 and February 2022 within the district. A lot of people live in traditional houses. Coping capacity is low. No households are insured, and many community members rely on grants for coping. About 258 people were displaced in December 2021. Snowfalls can lead to roads being closed.

7.10.2.1.2 Amathole

Amathole is prone to severe storms, houses that were constructed many years back have proven to be more resilient. Old houses and new houses with old built styles withstand the extreme weather better. Local builders should be trained to build more resiliently and follow guidelines and build accordingly. A suggestion on rolling out of National Building Regulations (NBR) in rural areas was also made. Also, municipalities need to be more proactive in allocation/ planning of land for housing development, i.e., speedily rollout of Spatial Planning and Land Use Management Act (SPLUMA).

7.10.2.1.3 Buffalo City

The varying topography and vegetation results in different weather extremes in different parts of the metro. These include hail, snow as well as tornadoes. Eastern areas receive more rainfall while inland less rainfall. Amathole mountains severe storms. Band that runs through area with hail and snow that has occurred. Western Area is affected because of mud houses are affected by wind and rain. There was a tornado in 1953. Gail force winds along coast. Tents damage due to wind. About 1700 structures severely /partially damaged. Severe storms were recorded on the days: 8 Jan 2022, 19 Feb 2022. During December 2021, mainly on the rural side on 13 December 2021 and 8 January and February 2022.

7.10.2.1.4 Chris Hani

Severe storms were experienced in December 2021 and early 2022. Enoch Mgijima has experienced extremes in storms with downpours of over 100mm accompanied by hail with extreme winds the past summer of 2021.

7.10.2.1.5 Joe Gqabi

Torrential rains and wind caused widespread damage. Elundini and Senqu areas are predominantly rural. December 2021 and January 2022 was classified as Disaster.

7.10.2.1.6 Nelson Mandela Bay

Low incidents of hail. Tornadoes. Cut-off low, wide-spread heavy rain are prevalent.

7.10.3 Extreme temperatures

Extreme temperature hazards include an extreme increase or decrease in temperature which can cause disruption to communities. Extreme temperature hazards not only impact on the health and well-being of humans, especially vulnerable groups, but also cause damage to infrastructure (ICSU, 2018).

The global average surface temperature in 2015 broke all previous records by a strikingly wide margin, at 0.76±0.1° Celsius above the 1961-1990 average. For the first time on record, temperatures in 2015 were about 1°C above the pre-industrial era, according to a consolidated analysis from the World Meteorological Organization (WMO) (World Meteorlogical Organization, 2016)

As shown Figure 7-61, studies on climate change reveal that Africa, like the rest of the world, became warmer during the past century, and temperatures are expected to continue rising in the future. Extreme events such as heat waves are predicted to be among the hazards that will be associated with climate change (World Meteorlogical Organization, 2016)

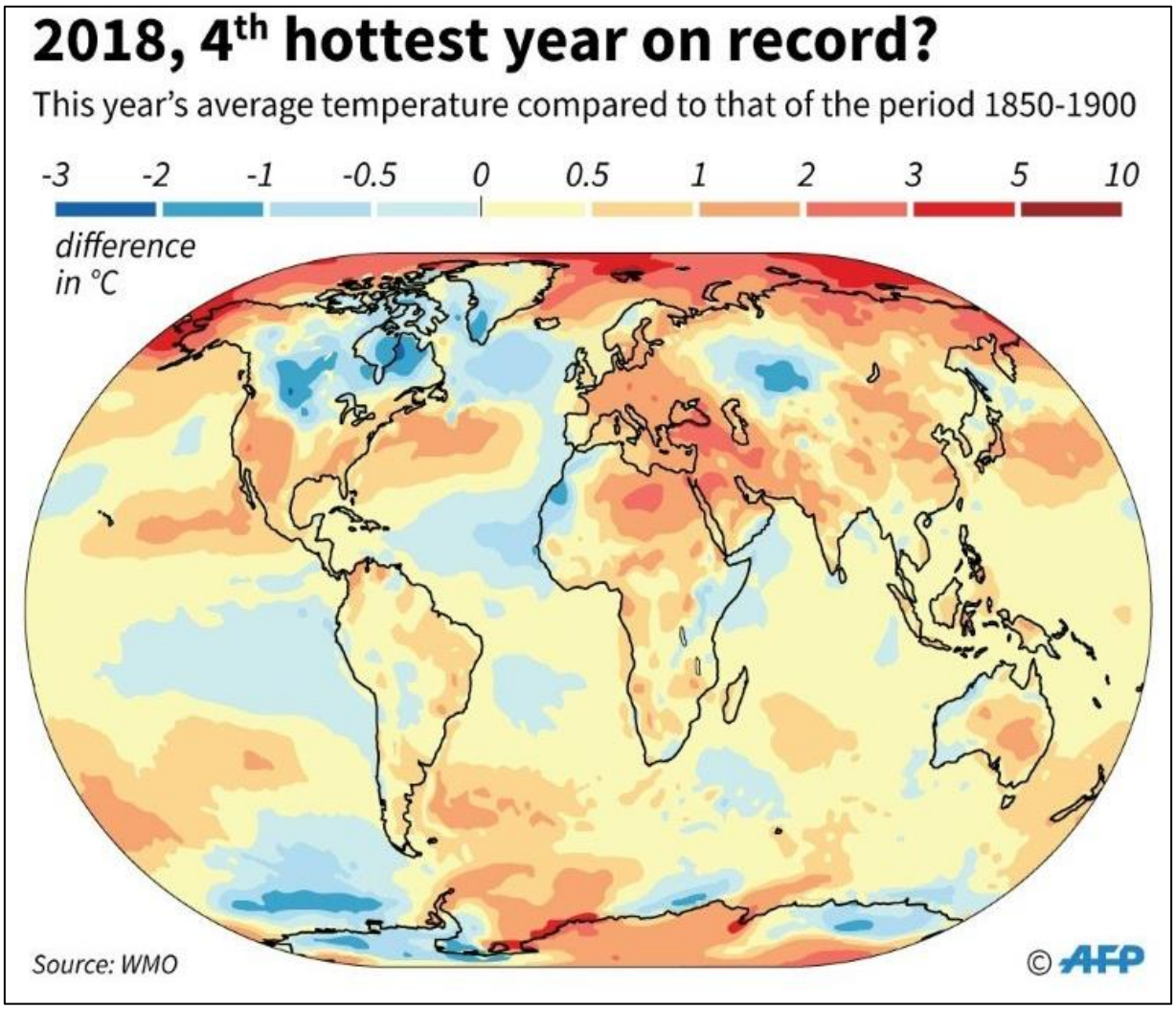

Figure 7-61: Annual temperature anomalies (relative to 1961-1990) (World Meteorlogical Organization, 2016)

The following table gives maximum recorded temperatures as captured by as received from the South African Weather Services.

Table 7-7: Maximum recorded temperatures (Sampson, 2022)

Town	Temperature (Degrees Celsius)
Gqeberha	40.7
East London	43.1
Bisho	42.2
Cradock	43.8
Graaf-Reinet	44.1
Patensie	45.4
Queenstown	42.9
Kariega (Uitenhage)	44.8
Mthatha	42

The high temperatures in a lot of the cases can be contributed to geographical influences such as a “valley” and wind that affect or cause high temperatures (Sampson, 2022)

7.10.3.1 Consultation inputs

7.10.3.1.1 Buffalo City

Discomfort index can get high during summer, which can also be exacerbated by high. Heat waves above average of 3 or more days. Humidity over time has increased.

7.10.3.1.2 Joe Gqabi

Longer summer drought with high temperature is experienced. There is a decrease in snow due to increase in temperature, which affects the water levels of Orange River whose source is Kraai River, and Mthatha dam from Elundini. Temperature has increased since 2014. Barkley East is also hotter than previous years.

7.10.3.1.3 Nelson Mandela Bay

Maximum temperatures ranging between 38 ºC to 40ºC in the Uitenhage area around January- February. with high humidity.

7.10.3.1.4 OR tambo

Above-Normal temperatures affected crops. January 2022 saw temperatures as high as 37ºC and 38ºC.

7.10.3.1.5 Sarah Baartman

Kouga saw abnormally high temperatures of 25ºC -35 ºC and heat waves. It was noted to be abnormal to reach 35ºC within Kouga. Sundays River Valley saw temperature above 43ºC. Blue Crane Route temperature reaching above 40ºC. Extreme cold temperature was also recorded.

7.11 Hazardous material (spill / release / fire / explosion)

Hazardous materials, including hazardous waste, is a major concern for authorities all over South Africa.

For the purpose of this assessment, hazardous materials will be considered in the context of the spillage or release as well as fires or explosion of hazardous material. These events should also be considered not only at the site or facility where the hazardous materials are manufactured, stored or utilized, but also during transportation to, and from the facilities.

A substance may be considered hazardous if it is flammable, explosive, toxic, corrosive, radioactive and cryogenic, or readily decomposes to give off oxygen at elevated temperatures. There are thousands of substances that possess one or more of these qualities and can therefore be considered as hazardous. Multiple hazards can be associated with many substances and the intermixing of chemicals can further complicate the behaviour and hazardousness of a substance.

Compressed gases are especially hazardous as they often involve multiple hazards, such as poisons, oxidizers, cryogenics and the hazard of the pressure in the storage container itself. If the container fails, it could be turned into a projectile or an explosive device. Flammable liquids are slightly less hazardous than gases but are the cause of more incidents as they are more abundant. Commonly encountered flammable liquids include petrol, oil, diesel, paraffin, benzene, alcohols, pesticides and jet fuel.

Industrial activities generate large volumes of hazardous waste and by-products that need to be stored, transported or disposed of safely.

The GIS mapping of hazardous material hazards was done by identifying main transportation routes, and location of industrial and hazardous facilities. The result of the hazard mapping is shown below. Figure 7-62 shows the location of impact areas for possible HAZMAT explosion and spills in the Eastern Cape. Figure 7-63 and Figure 7-64 show the possible impact on the population and Gross Value Added (value of goods and services produced by an industry, sector, manufacturer, area or region in an economy) of the Eastern Cape. Nelson Mandela Bay and Buffalo City can be at the highest risk.

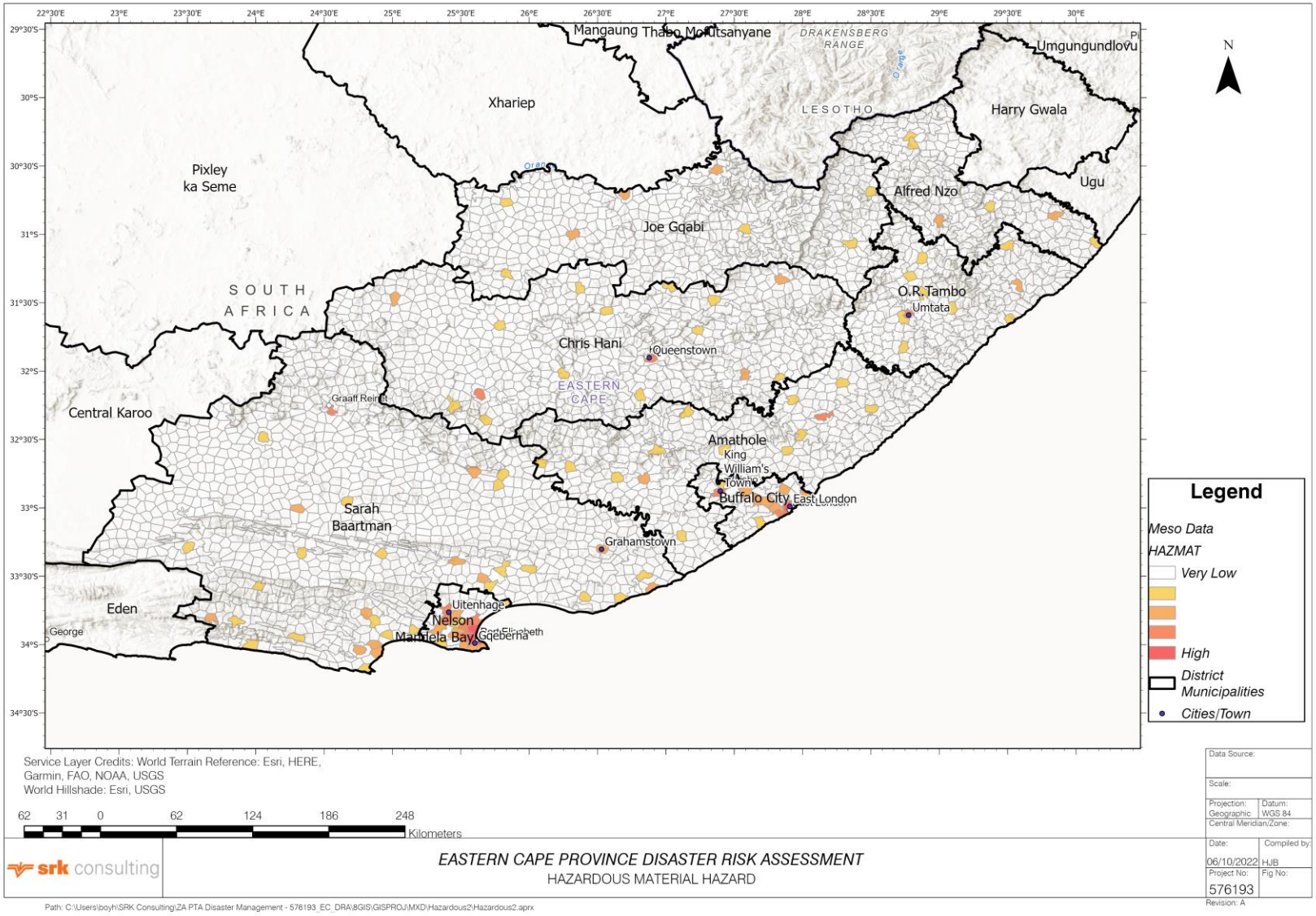

Figure 7-62: Hazardous material hazard (Location) (meso data)

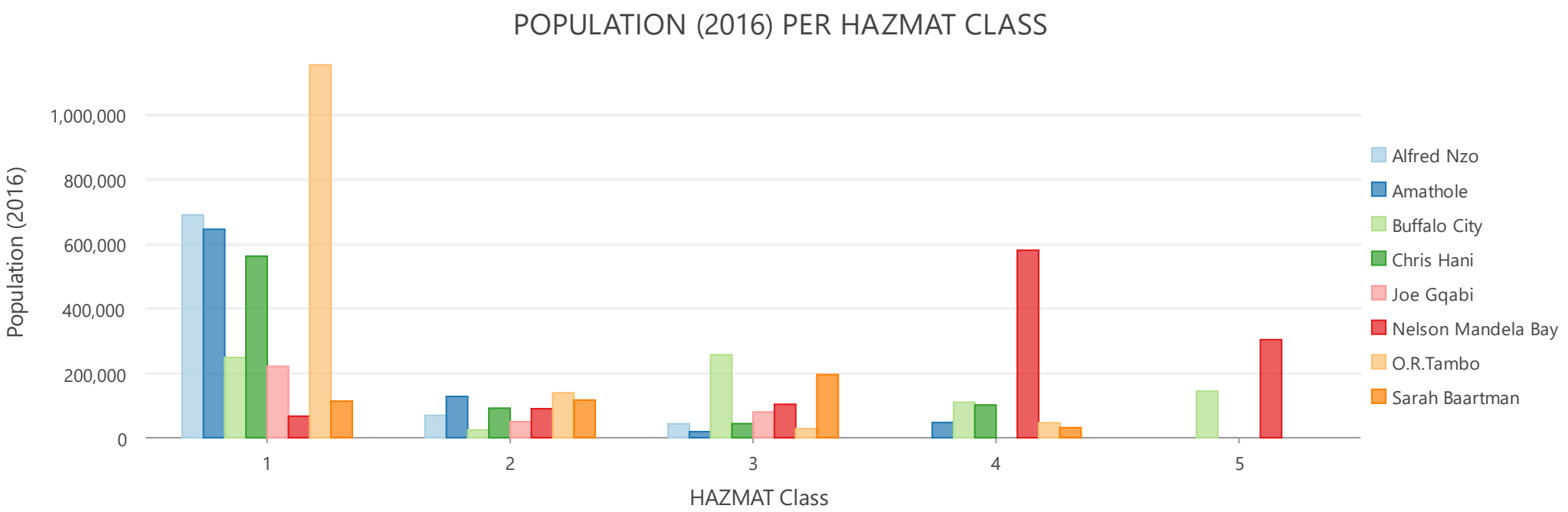

Figure 7-63: HAZMAT locations possible impact on population

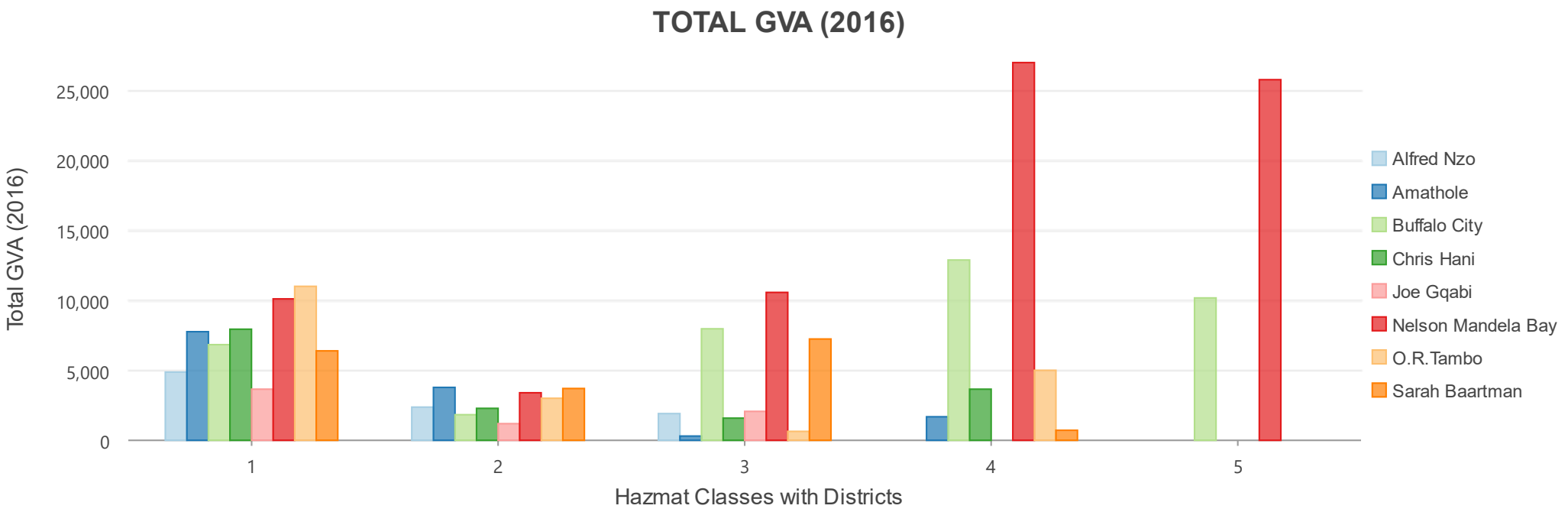

Figure 7-64: HAZMAT locations possible impact on GVA

Major roads and rail routes in Eastern Cape Province are used for distribution and therefore have a consistently high rating.

The International Maritime Dangerous Goods (IMDG) Classes are used to classify dangerous goods that are transported by ships.

- Class 1 – Explosives
- Class 2 - Gases: Compressed, Liquefied or Dissolved under Pressure.
- Class 3 - Flammable Liquids.
- Class 4 - Flammable Solids or Substances.
- Class 5 - Oxidizing Substances (agents) and Organic Peroxides.
- Class 6 - Toxic and infectious Substances.
- Class 7 - Radioactive Substances
- Class 8 - Corrosives
- Class 9 - Miscellaneous dangerous substances and article

The associated hazard was included in the hazardous material transport and spill or release modelling.

7.11.1 Consultation inputs

7.11.1.1 Alfred Nzo

Transportation of Liquefied Petroleum Gas (LPG) from KZN on the R56 and R61. When there is an incident, the owners of the transporting company are usually far. Roadblocks are held by the traffic department to ensure compliance.

Major Hazardous Installations (MHI's) are sometimes not compliant with the regulations. The national traffic department should also be involved. The road between Kokstad and Matatiele is used for transportation of Hazardous Materials (HAZMAT). The plan is in the pipeline to manage the HAZMAT transportation regulations.

Spillage of hazardous material has occurred in the wild coast. The owners of hazardous material are usually far and that makes it challenging to have them take accountability or get to the incident. The effect of spills on the environment should not be overlooked as the material can go into rivers, that is used for water sources.

7.11.1.2 Amathole

Trucks transporting fuel along the N2. SAPS operations to check MHI cards. There is lack of control measures to certification and competency.

Minor spills do occur. Serious accidents also occur but no fire.

7.11.1.3 Buffalo City

Minor to serious incidents. There was a close call involving a fuel truck and bus. There are MHIs in the area.

7.11.1.4 Joe Gqabi

There is Engen Depot in Aliwal North has never reported any incident. Mainly HAZMAT Class 3. Trucks driving along the R56 and R6 sometimes do not comply with regulations. Material Safety Data Sheet (MSDS) does not match requirements which make the handling of incidents difficult. Safety data sheet is key. Training of truck drivers is not up to standard as they are not ready to deal with incidents. An incident has occurred where a truck overturned. Class 7 radioactive and Class 8 corrosive material are transported on the N6, and the authorities are usually not notified when they are passing through. It is important to note that it is difficult to approach if one does not know what the materials are that are transported. Gasses are explosive. No major incident in Sterkspruit as the responding teams are trained in defensive firefighting. Area was temporarily closed.

7.11.1.5 Nelson Mandela Bay

There is a Transnet tank Farm in Nelson Mandela Bay. Sovereign Foods cold storage facilities in the metro. however, plans are in place to move the storage.

7.11.1.6 OR Tambo

Hazardous material across the district is a big problem. Notifications are not being made on a HAZMAT vehicle for it to be escorted. This makes it a serious threat.

7.11.1.7 Sarah Baartman

Hazardous materials are transported through Kouga. Data is put onto the database. Fire services are informed when there is HAZMAT being transported throughout Kou Kamma. HAZMAT is mainly fuel. Manganese transporting truck along the N10, incidents almost weekly. About 2 accidents occur weekly. During recovery, there is no alternative route, which is not conducive. Kouga has hazmat response capacity.

There is a joint operation on the driving issues along the N10, mainly used by trucks

The R72 is vulnerable to HAZMAT as it an alternative route to the N2 running pass Makhanda. Early 2022 a truck carrying cement jack-knifed on the R72 just above the Marina.

7.12 Infestations

Infestation hazards, including plant infestation (intruder plants), animal infestation, insect infestation and over population are often not considered as a traditional disaster risk, but can still cause extensive environmental damage, or serious losses to agricultural related crops. These hazards are discussed in more detail below.

7.12.1 Plant infestations (intruder plants)

An 'alien' species is one that has been introduced by humans, deliberately or accidentally, into an area in which it did not previously occur. In today's globalized world, species often spread effortlessly among countries and continents. While not all alien species thrive in their new environments, some do, becoming 'invasive' by spreading at the expense of indigenous species and causing significant changes to habitats and ecosystem functioning.

One of the main reasons why alien species flourish is that they are no longer controlled by their natural predators and pathogens (diseases) with which they have co-evolved in their natural environment. Indigenous species are at a competitive disadvantage when they encounter such alien species because they have not adapted to their environments together and the alien species may therefore easily outperform indigenous species. Invasive alien species can occur on land, in the ocean, or in freshwater systems, and can be drawn from any group of organisms.

Alien plant invasions have a major impact on biodiversity, ecosystem services, agriculture, forestry, the economy and human welfare. These invasions are also recognized as having the largest impact on biodiversity after direct habitat destruction (Agricultural Research Council, 2010).

According to the National Invasive Alien Plant Survey (Agricultural Research Council, 2010) Invasive alien plants have invaded over 10 million hectares (ha) of South Africa. Over 750 tree species and 8 000 herbaceous species have been introduced, with some 1 000 introduced species now naturalized (that is, neither indigenous nor invasive) and 200 considered invasive. It is further stated that of those considered invasive, 117 are categorized as 'major invaders', and 84 are considered 'emerging invaders. 'Major invaders' are those species that are well established, and that already have a substantial impact on natural and semi-natural ecosystems. 'Emerging invaders' currently have less influence but have attributes and potentially suitable habitat that could result in increased range and consequences in the next few decades. Plants constitute most of the invasive species in South Africa, making up 63% of the 319 species listed as harmful, and they threaten 55% of the Red Data-listed plants in the country. According to the Working for Water Programme, the impacts of invasive alien plant infestations are expected to double within 15 years if left uncontrolled.

Plant infestation also exasperates other hazards such as drought. Figure 7-65 show the spatial distribution of plant infestation through meso data. Figure 7-65 shows the areas of Agriculture, Forestry and Fishing where plant infestation can have an impact. The graph (Figure 7-67) shows that plant infestation can have the biggest impact on Nelson Mandela Bay and Sarah Baartman.

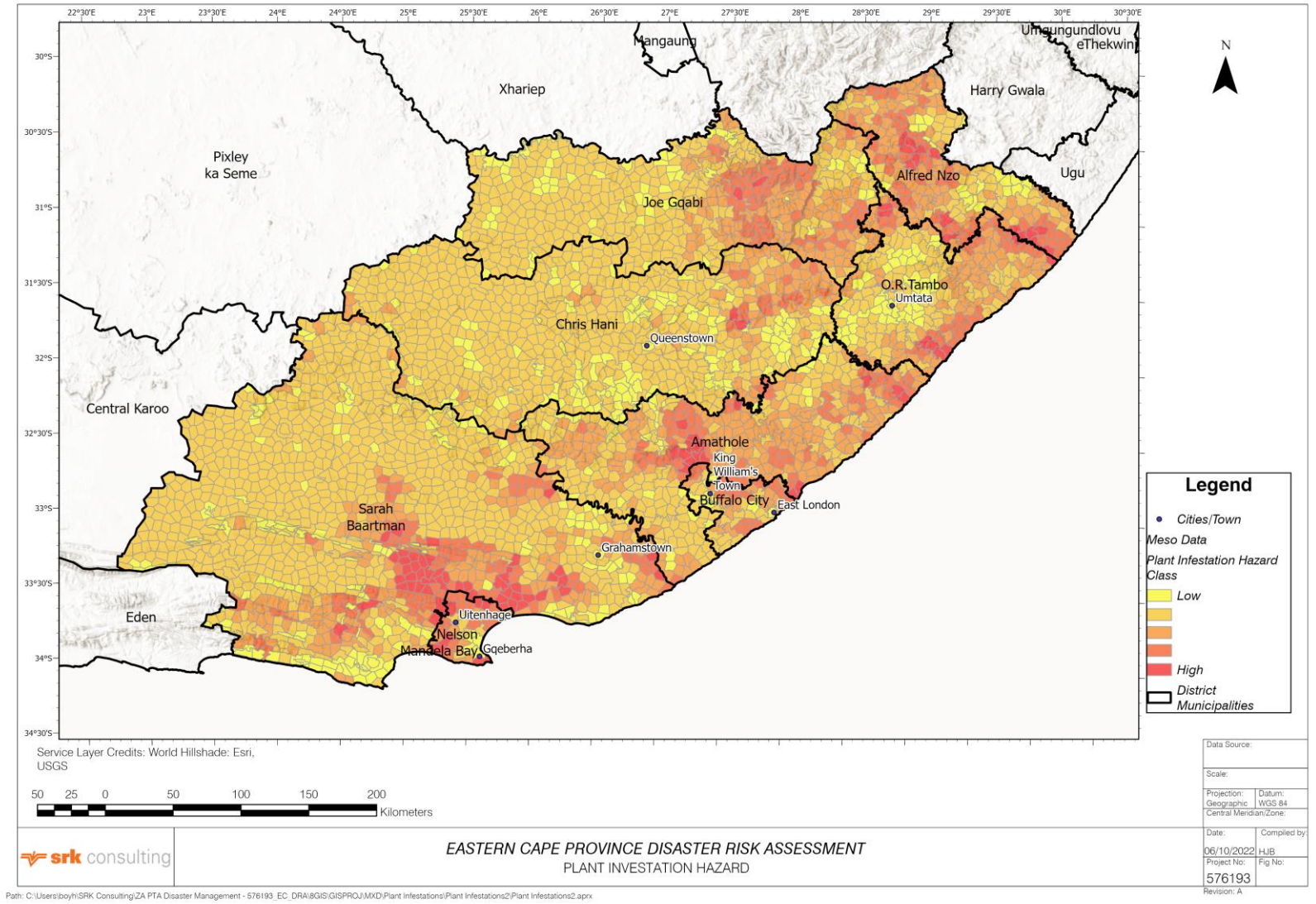

Figure 7-65: Invasive plant density in Eastern Cape Province (meso data) (Agricultural Research Council, 2010)

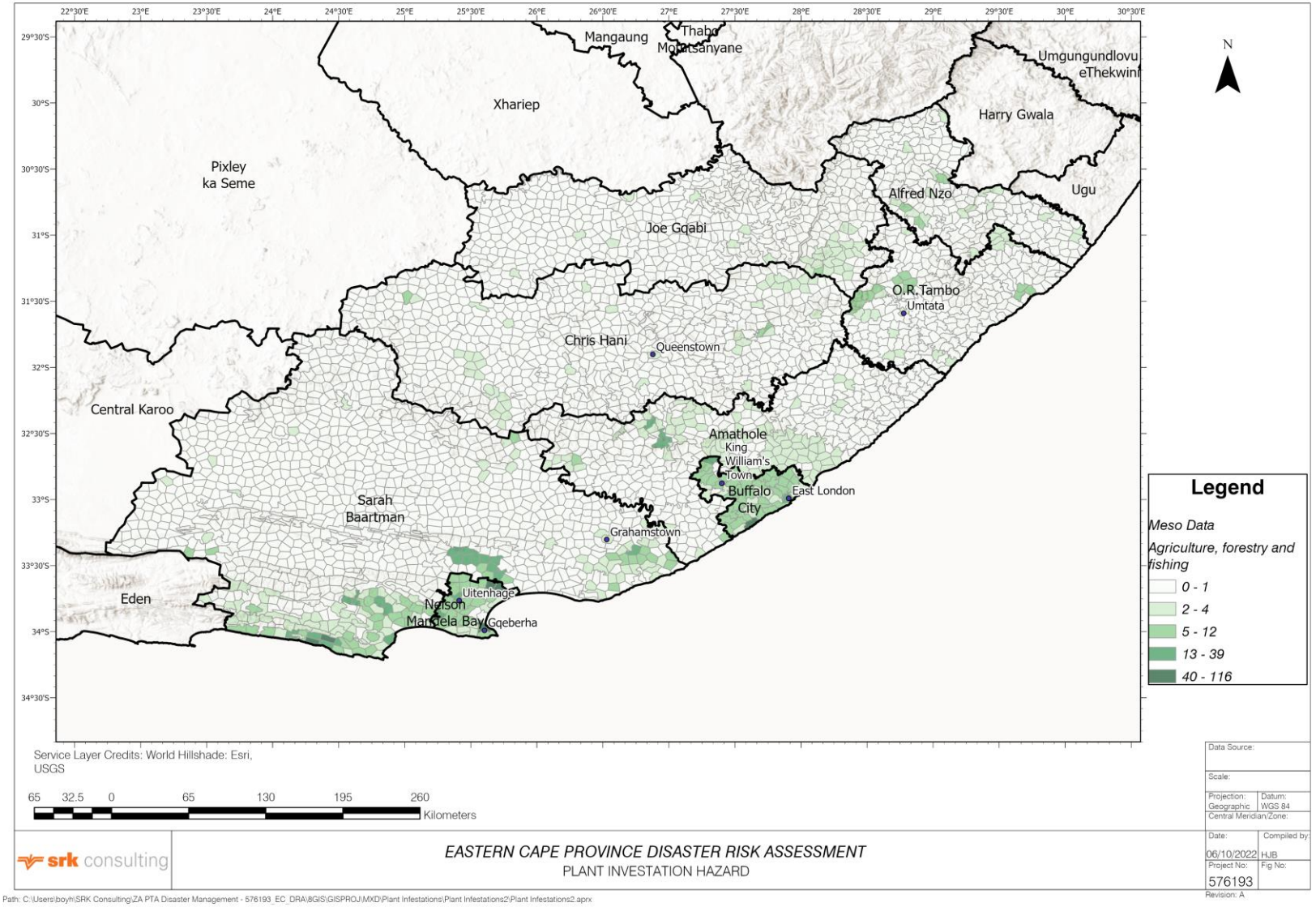

Figure 7-66: Possible impact of Plant Infestation on Agriculture, forestry and fishing (meso data)

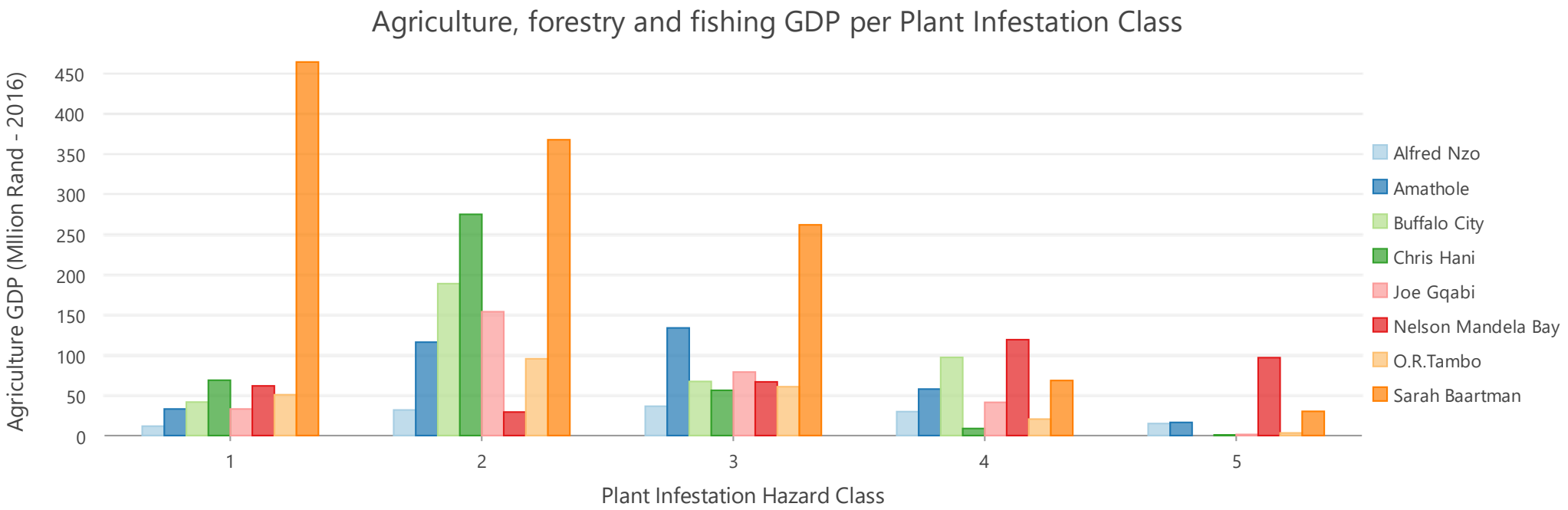

Figure 7-67: Graph of possible impact of Plant Infestation on Agriculture, Forestry and Fishing

7.12.1.1 Consultations inputs

7.12.1.1.1 Alfred Nzo

Black wattle is prevalent and the capacity to manage is low.

7.12.1.1.2 Amathole

Amahlathi area has alien invasives issues which exploits water. No programs to control/eradicate invasive species. Constructive plan is needed to look at controlling alien invasive species. Indigenous tree species can be used as a fire break.

7.12.1.1.3 Buffalo City

Invasive species including Black wattle are prevalent.

7.12.1.1.4 Joe Gqabi

Invasive plant species, wattle is present. Programs are in place to manage the spread thereof. Commercial forest in Elundini area.

7.12.1.1.5 Chris Hani

Enoch Mgijima and Emalahleni local Municipalities have Lapesi (Europsis) (Euryops linearis Harv.). Acacia Karoo is prevalent on the western side. Climate Change is also contributing to the invasion of alien species.

7.12.1.1.6 Joe Gqabi

Black Wattle and Slang Bos (Seriphium plumosum L.) is also prevalent in Joe Gqabi.

7.12.1.1.7 Nelson Mandela Bay

Projects are in place to control intruder plants in the catchment areas.

7.12.1.1.8 OR Tambo

Black Wattle, especially along the rivers is at an increasing rate.

7.12.1.1.9 Sarah Baartman

Wattle trees have impact on water table and can aggravate the drought. About 72km alien vegetation is being removed

7.12.2 Algal bloom (red tide)

Red tide is a common name for a phenomenon known as an algal bloom (large concentrations of aquatic microorganisms) when it is caused by a few species of dinoflagellates and the bloom takes on a red or brown colour. Red tides are events in which estuarine, marine, or fresh water algae accumulate rapidly in the water column, resulting in coloration of the surface water. It is usually found in coastal areas.

Red tide is also potentially harmful to human health. Humans can become seriously ill from eating oysters and other shellfish contaminated with red tide toxin. Karenia brevis blooms can potentially cause eye and respiratory irritation (coughing, sneezing, tearing, and itching) to beachgoers, boaters and coastal residents. People with severe or persistent respiratory conditions (such as chronic lung disease or asthma) may experience stronger adverse reactions.

The indications during the consultation process were that this does not pose a threat to Eastern Cape Province.

7.12.2.1 Consultation inputs

7.12.2.1.1 Buffalo City

There are blooms on inland rivers with no serious outbreaks

7.12.2.1.2 Nelson Mandela Bay

Low impact

7.12.2.1.3 Sarah Baartman

Kouga had red tide, with no serious affects.

7.12.3 Animal Infestation and insect infestation

Animal or Insect Infestation hazards refer to the overpopulation or infestation by a specific type of animal or insect in a specific area. This can include animals such as rats or insects such as locusts.

7.12.3.1 Fall Armyworm

The fall armyworm is a large-scale invasive. It is called ‘armyworm’ because in its larval stage, individuals gather in huge masses (‘armies’), which can destroy large tracks of crops. It is native to South and North America, but alien invasive in Africa (SANBI, 2018).

The fall armyworm’s diet consists mainly of grasses and grain crops. It can feed on leaves, stem and reproductive parts of more than 80 crop species. Primary preference is for maize and other main cultivated crops such as sorghum, sugarcane, rice, cotton, legumes, vegetable crops and pasture grasses (SANBI, 2018).

7.12.3.2 Locust infestation

In May 2022 largest swarm of brown locusts recorded in 25 years affected the Eastern Cape, causing extensive damage to an estimated five million hectares (31000 km^2) of grazing land (Daily Maverick, 2022). The locusts apparently originate from North Africa and migrate down to Southern Africa (SABC News, 2022)

The amount of rainfall in some areas has escalated the infestation and has allowed the locusts to bread more rapidly. This situation was further exasperated by the wind that also plays a role in the migrating of the swarms to the areas where the locusts haven’t been seen before. This includes citrus farms in the Eastern Cape (Monggabay, 2022).

7.12.3.3 Polyphagous Shot Hole Borer

The discovery of this beetle and fungus in South Africa is of major concern to farmers, foresters, landscapers, homeowners and ecologists, as together, these organisms can be aggressive tree killers. It is a 2 mm long ambrosia beetle that is native to Southeast Asia. The female beetle carries several fungal species, one of which is Fusarium Euwallaceae, with it when it infests new trees. It bores through the bark into the sapwood of the tree and inoculates the fungus into the living wood. The fungus grows in the galleries (tunnels) of the beetle and serve as 'vegetable garden' for the beetle larvae, but in susceptible trees the fungus can spread through the sapwood causing disease or even death of the tree (Forestry and Agricultural Biotechnology Institute , 2020).

In its native environment in Southeast Asia, it seems as if the beetle and fungus do not cause serious damage because tree species have evolved with the beetle-fungus complex and have resistance towards them, and because there is most likely a suit of natural enemies of the beetle. The beetle has killed large number of trees in Johannesburg as well as Knysna, this beetle could potentially be one of South Africa’s largest ecological tragedies. In addition, the beetle is currently infesting over 200 tree species from 28 plant families worldwide (Mahayni, 2018).

The Polyphagous Shot Hole Borer (PSHB) has confirmed incidents in Eastern Cape and Durban and could soon also affect Eastern Cape Province. The following figures shows the confirmed cases and 2022 forecast in South Africa (SA Forestry online, 2019)

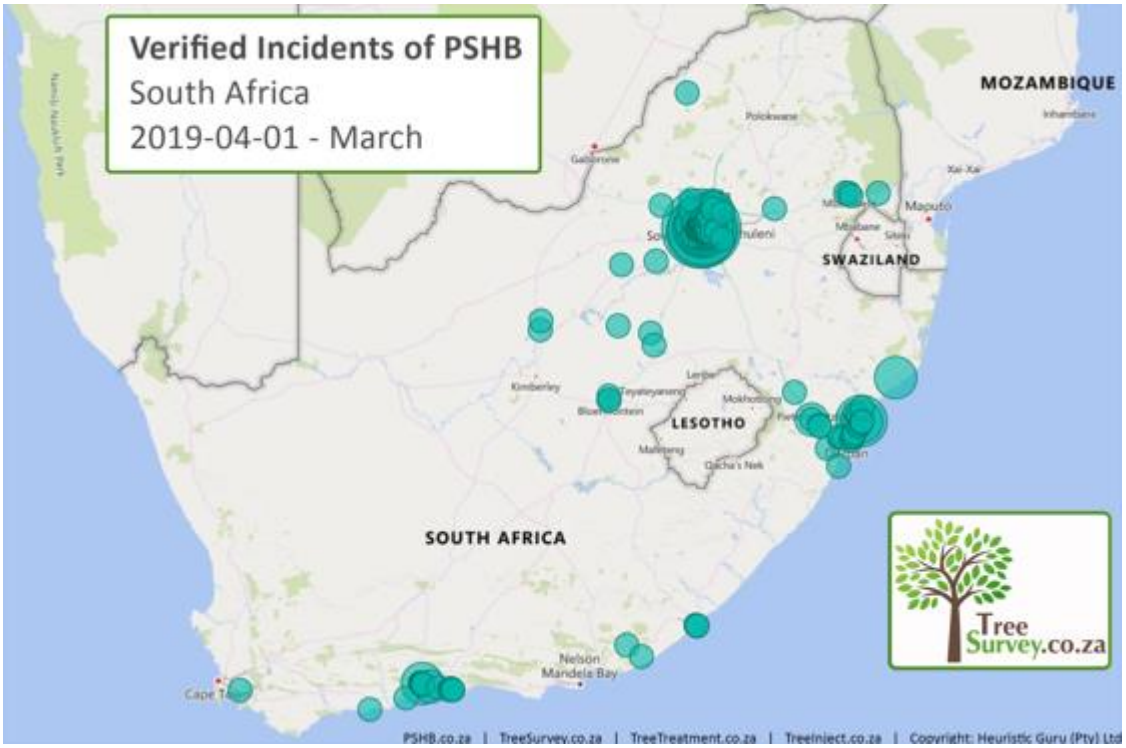

Figure 7-68: Verified incidents of the PSHB (SA Forestry online, 2019)

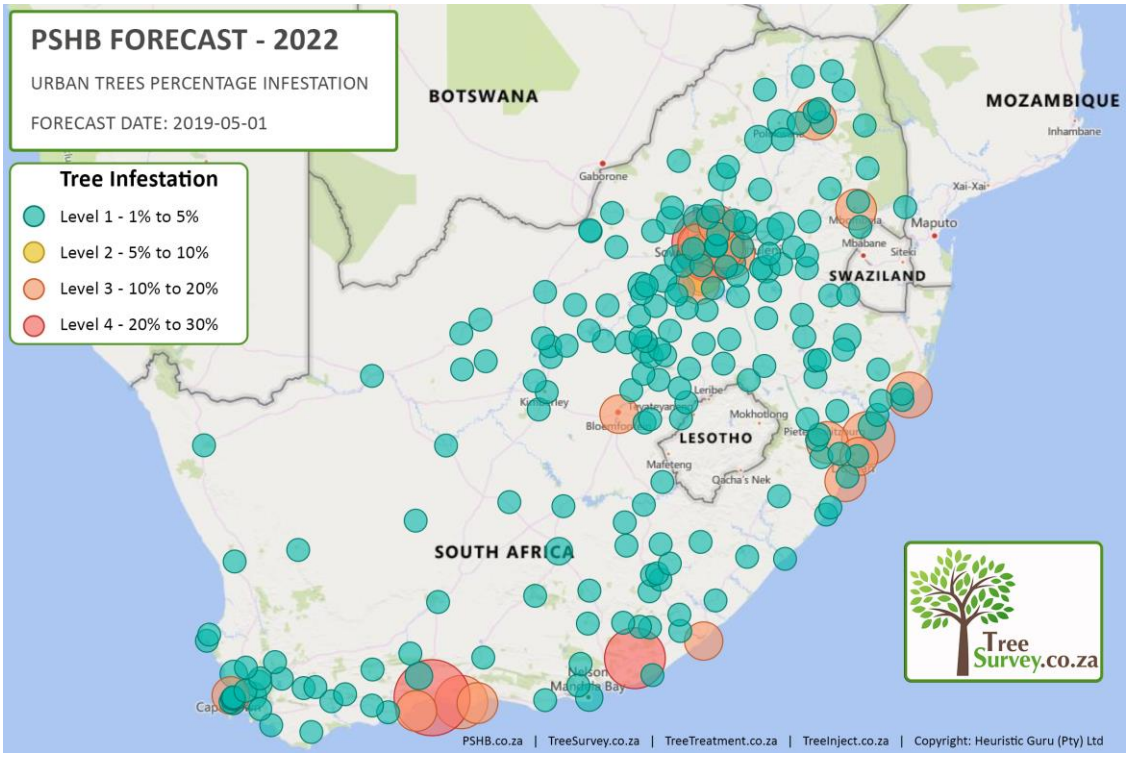

Figure 7-69: PSHB forecast 2022 (SA Forestry online, 2019)

7.12.3.4 Consultation inputs

7.12.3.4.1 Alfred Nzo

Fall army worm outbreaks especially due to late planting of maize.

7.12.3.4.2 Amathole

Possible Shot hole borer and Fall Army Worm were recorded. Brown Locust has not affected Amathole yet.

7.12.3.4.3 Chris Hani

There was locust infestation all over Chris Hani and was controlled with Helicopters. Cradock, Sommerset East had up to 10 000Ha of locusts.

7.12.3.4.4 OR Tambo

Fall army Worm cases were reported within OR Tambo, which subsequently stopped. Fall army worm was successfully managed and no infestation reported lately.

7.12.3.4.5 Sarah Baartman

Dr. Beyers Naude had locust Infestation in 2020-2021. Feral pigs roaming.

7.13 Infrastructure failure / service delivery failure

Infrastructure and service delivery failure hazards are related to the failure of infrastructure systems and processes such as electricity provision, water provision, sanitation systems, information technology and communication systems, and transportation infrastructure.

This failure can be caused by inadequate design, inadequate future planning, and a lack of proper maintenance or uncontrollable phenomena such as flooding or fires. The failure of services can lead to an increased risk of disaster, e.g., disruption of water can lead to community members drinking polluted water, which can lead to an outbreak of disease. However, an unrelated disaster event can also disrupt service delivery, e.g., flooding can damage communication systems or roads, which can disrupt disaster response and recovery efforts.

It is therefore important that infrastructure is designed, constructed and maintained in order to ensure that disruption of the services is avoided as far as possible. The specific types of infrastructure and service delivery failure hazards are briefly discussed below.

7.13.1 Electrical

Disruption of electricity supply is a common problem in South Africa due to cable theft, maintenance problems and supply capacity limitation. Except for the disruption of communities' lives due to electrical failure, regular problems with electricity supply can also affect industry, tourism and the attractiveness of the municipality to foreign investment.

7.13.1.1 Loadshedding

Loadshedding is action taken to reduce the load, in this instance specifically the interruption of an electricity supply to avoid excessive load on the generating plants and infrastructure (demand for electricity exceeds its supply) Eskom is the sole provider of electricity in South Africa.

Loadshedding has a significant impact on the economy and any possible economic growth. Businesses must either stop functioning or spend additionally to put redundancy in place. Loadshedding has a significant impact on normal commuting, delivery of goods and negatively impacts the use of fuel. The extra use of fuel not only impacts the consumer price but also exasperates the effects of vehicles and traffic on the environment.

Research has in shown that healthcare is under more pressure during the power outages and that a rise in both accidental and non-accidental deaths (South African Medical Journal On-Line Version, 2019)

Loadshedding also contributes to of other consequential effects such as:

- Irregular voltage causing damage to infrastructure, homes and equipment;

- Cable theft and stripping of electrical sub-stations, minisubs (opportune time to steal cables and other infrastructure during scheduled electrical outage);
- Theft and overloading etc. can result in fires; and
- Criminals can see scheduled outages as an opportune time engage in criminal activities (cover of darkness as well as ability to see approaching SAPS from a distance).

7.13.2 Sanitation

Failure of sanitation systems can increase the risk of hazards such as epidemics, environmental degradation and pollution.

In order to reduce the risk of sanitation related service delivery or infrastructure failure, it is important to ensure adequate infrastructure development and maintenance is undertaken in each of the local municipalities.

7.13.3 Water

Safe clean water is one of the most basic needs of a community. A disruption or lack of water supply and services can create multiple secondary hazards such as disease outbreaks, reduction in community health, and an increase in pollution.

7.13.4 Consultation inputs

7.13.4.1 Amathole

Pipes get stolen for scrap metal. Scrap metal dealings has a detrimental impact. Studies should be conducted to assess treatment plants.

7.13.4.2 Buffalo City

Transformers, high mast lighting fall over. There is a case where 1 floodlight fell injuring 1.

7.13.4.3 Chris Hani

Enoch Mgijima has problems with infrastructure failure. Infrastructure maintenance is big problem. Traffic lights. Unavailability of spare parts worsens the problem. Water and sanitation issues all over the district

7.13.4.4 Joe Gqabi

Cable theft is a problem in the district. Remote infrastructure is not accessible. Lack of funding contributes to all electrical failures.

Increased rainfall and Tina River flows in Mt Fletcher resulting in erosion upstream and silting of the weir leading to disruption in water treatment and water supply. Ageing infrastructure.

7.13.4.5 Nelson Mandela Bay

There are high risks of electrical failures within Nelson Mandela Bay, which influences large areas. This further has negative economic impacts. Extent of illegal connection also increases fire and other risks. The illegal connections are mainly in the informal settlements.

7.13.4.6 OR Tambo

Storm causes damage electrical infrastructure. This occurred during December 2021 and January 2022. Some villages, especially the King Sabata Dalindyebo Municipality area remain without electricity since December 2021 to date (consultation date 22 March 2022)

Generator theft also affects the water infrastructure as the generators are used to pump water. Sanitation problems related to water as they are both done by same department. Some water infrastructure failure challenges are encountered which is mainly influenced by poor workmanship and incomplete construction. Pit toilets have filled up, collapsed. Some pit toilets have been destroyed by storm.

7.14 Major event hazards

Major event hazards can usually be associated with cultural, religious, political, recreational, commercial or sporting events where large numbers of people gather at a venue or groups of venues. Hazards associated with these events include trampling and crushing injuries due to inadequate crowd management, venue design or structural failure.

Locations where major events could take place have been identified using points of interest for the Eastern Cape. The relevant points were then rated based on the number of people that could be expected at a single event. Figure 7-70**Error! Reference source not found.** indicates hazard ratings associated with the relevant points of interest. The following land uses where used to identify areas where major events can be held and therefor be at risk.

- Airport International;
- Amphitheatre;
- Amusement/Theme Park;
- Athletics;
- Beach;
- Campsite/Caravan Park;
- Christian;
- Club;
- Combined School;
- Community Centre;
- Court;
- Dance Sport;
- Entertainment Centre;
- Muslim;
- Pub;
- Rugby;
- Soccer;
- Stadium and
- Tennis.

A map showing hotspots where abovementioned events take place (Figure 7-70). The data were transferred to the meso layer and Figure 7-71 shows in red the areas that are of higher risk.

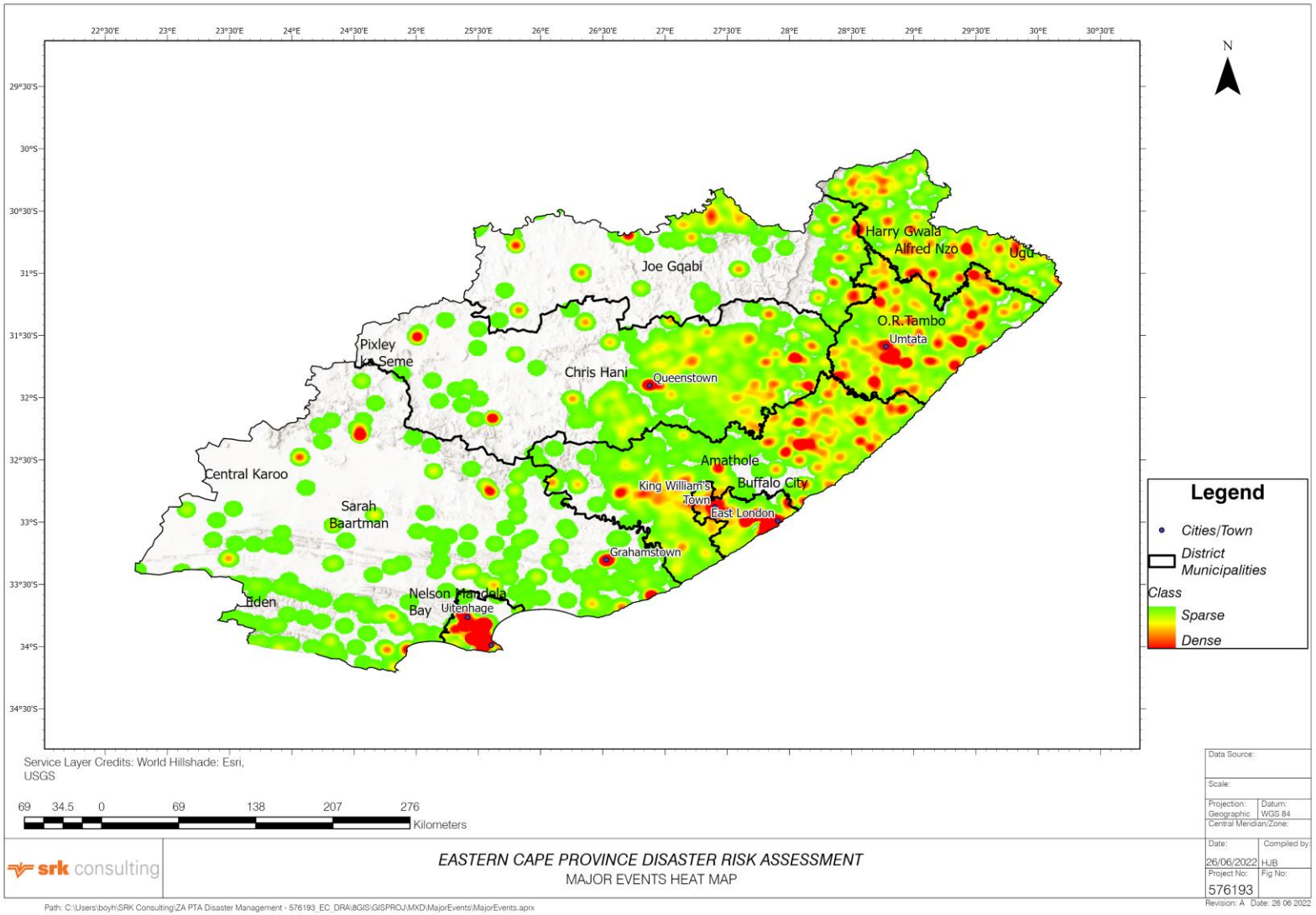

Figure 7-70: Major Event Hazard Heat Map

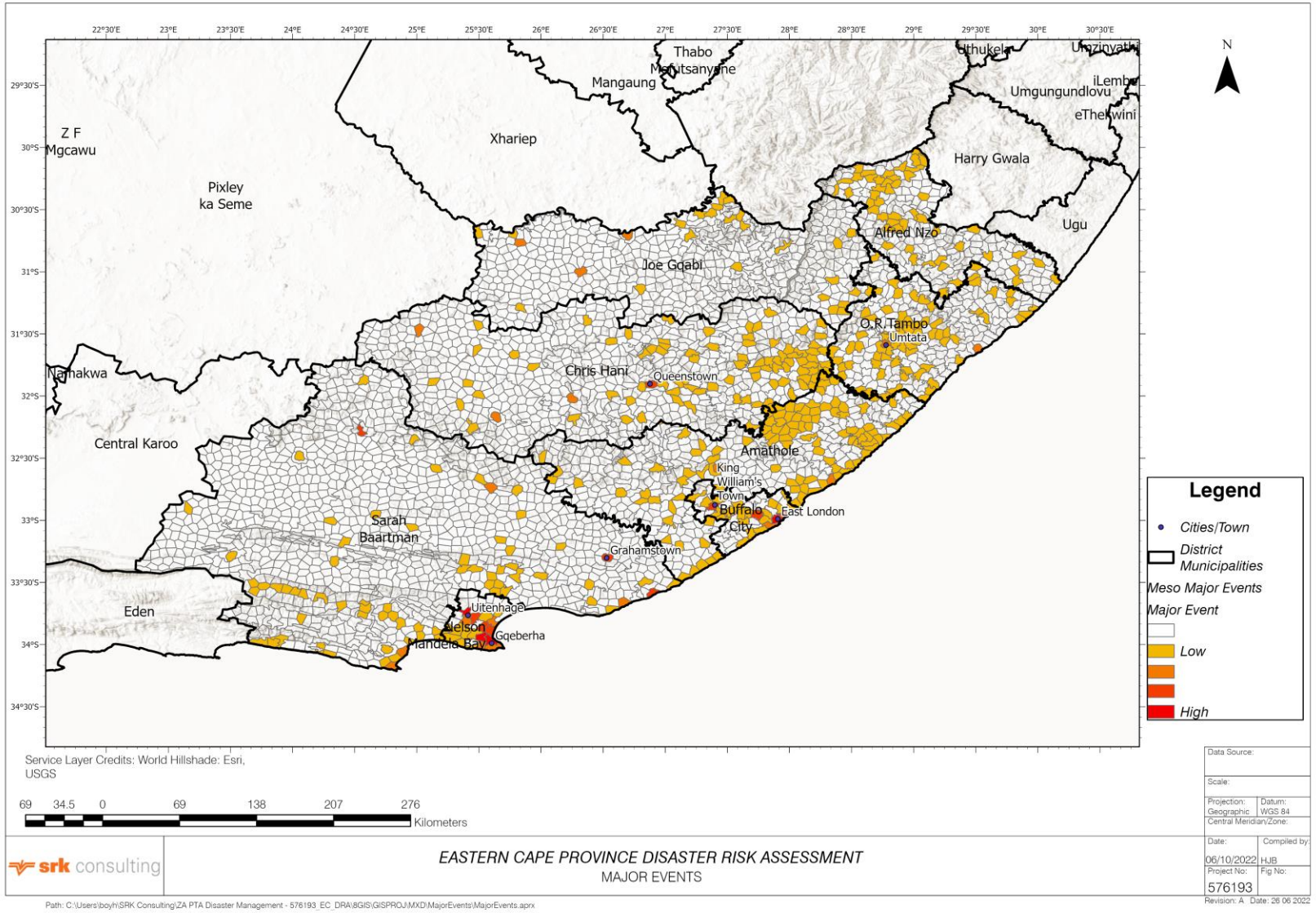

Figure 7-71: Meso Map of Major Events Hazard

7.14.1 Consultation inputs

7.14.1.1 Alfred Nzo

Numerous religious events are being held on regular basis. These include the Shembe church events. Numerous political events and presidential visits also take place within the district. The capacity of major events has been built in the area.

7.14.1.2 Amathole

The Men Christian Meetings will be held in 2022. High profile politicians visit the district from time to time. Urgent approvals are requested at times which can compromise the quality/level of preparedness. This includes instances where tents for an event need to be certified by a registered engineer. (Pr Eng.)

There is also a problem where Bed and Breakfast (B & B's) also used as entertainment areas (clubs). This is prevalent in Stutterheim and Keiskammahoek. Other events include motorcycle events, beach festivals, horse race in Idutywa, as well as the coronation of the king which took place in 2015 and mostly government department-initiated events.

Policy on events management should be developed by the Local Municipalities. Tents, pavilions, and stages should be signed off by correctly qualified people.

7.14.1.3 Buffalo City

Event plans are put in place within Buffalo City. Disaster Management representative should participate in the approval of events. There was once a stampede at Buffalo Park where 7 people were hospitalised.

7.14.1.4 Chris Hani

There are regular marches in Queenstown which are well-managed. Political events are small and not a problem. Recreational events are managed and are also approved before they are held.

7.14.1.4.1 Joe Gqabi

Sondela Youth Festival, a built up of events to the main event, takes place annually in Aliwal North. There is also a new event, Supra Home Coming, that is held during December in Walter Sisulu.

7.14.1.5 Nelson Mandela bay

There is generally an influx in tourism during December and Easter. Other events include Ironman African champs and World Champs as well as the cricket at the St. George's Park.

7.14.1.6 OR Tambo

Major events are generally same as before. Covid has caused it to be scaled down, but it will go back to levels as before

7.14.1.7 Sarah Baartman

Mighty men conference is held yearly in Kouga. Artists usually go to Jeffreys and St Francis Bay.

7.15 Pollution

Pollution can have a detrimental impact on natural areas. Pollution not only impact on the natural beauty in an area, but also has an impact on other activities, such as agriculture. For the purpose of this assessment, pollution was divided into Air, Land and Water Pollution.

7.15.1 Air pollution

The severity of the effects of air pollution is often underestimated. A critical example is the lethal smog that covered the city of London for five days (December 5–9) in 1952, it was caused by a combination of industrial pollution and high-pressure weather conditions. This combination of smoke and fog brought the city to a near standstill and resulted in thousands of deaths (Britannica, 2022). Its consequences prompted the passing of the Clean Air Act four years later, which marked a turning point in the history of environmentalism.

Air pollution can occur due to several activities. These include:

- Fuel combustion from stationary sources – combustion of coal or oil for steam generation and industrial energy requirements as well as domestic coal and paraffin combustion for heating;
- Fuel combustion in mobile sources – cars, passenger vehicles and diesel fuel trucks and buses;
- Industrial and chemical processes – pollutants as alkali metals and fluorides from the ferro-alloy industries and organic vapours from chemical production;
- Solid waste disposal – incineration of industrial, residential and hospital wastes;
- Land surface disturbances – construction activities, waste dumps, agricultural activities and veld fires;
- Extensive use of fire for cooking and heating;
- Illegal burning of garden refuse and waste material; and
- Illegal burning of electrical cables and tyres – to retrieve wire for resale.

Drought conditions, such as frequently experienced in the Eastern Cape can contribute to dust or dust storms and large-scale veld fires that contribute to air pollution through dust and smoke (Mardon, 2022). There are also other contributing factors such as fuel used for cooking such as wood or coal that also indivertibly contributes to air pollution. This is also usually accompanied by lacking sanitation where activities such as burning of refuse is commonplace (Mardon, 2022).

Air quality measures for households that use coal for cooking and heat s are discussed in Appendix D (University of the Free State, 2022)

The presence of certain activities such as mining, industrial activities, large scale road works or agricultural activities contribute to air pollution (Mardon, 2022).

Industrial and mining land cover were used to map areas for possible air pollution with the assumption that these two (2) activities can cause air pollution. Figure 7-72 shows in red areas that are more at risk for air pollution.

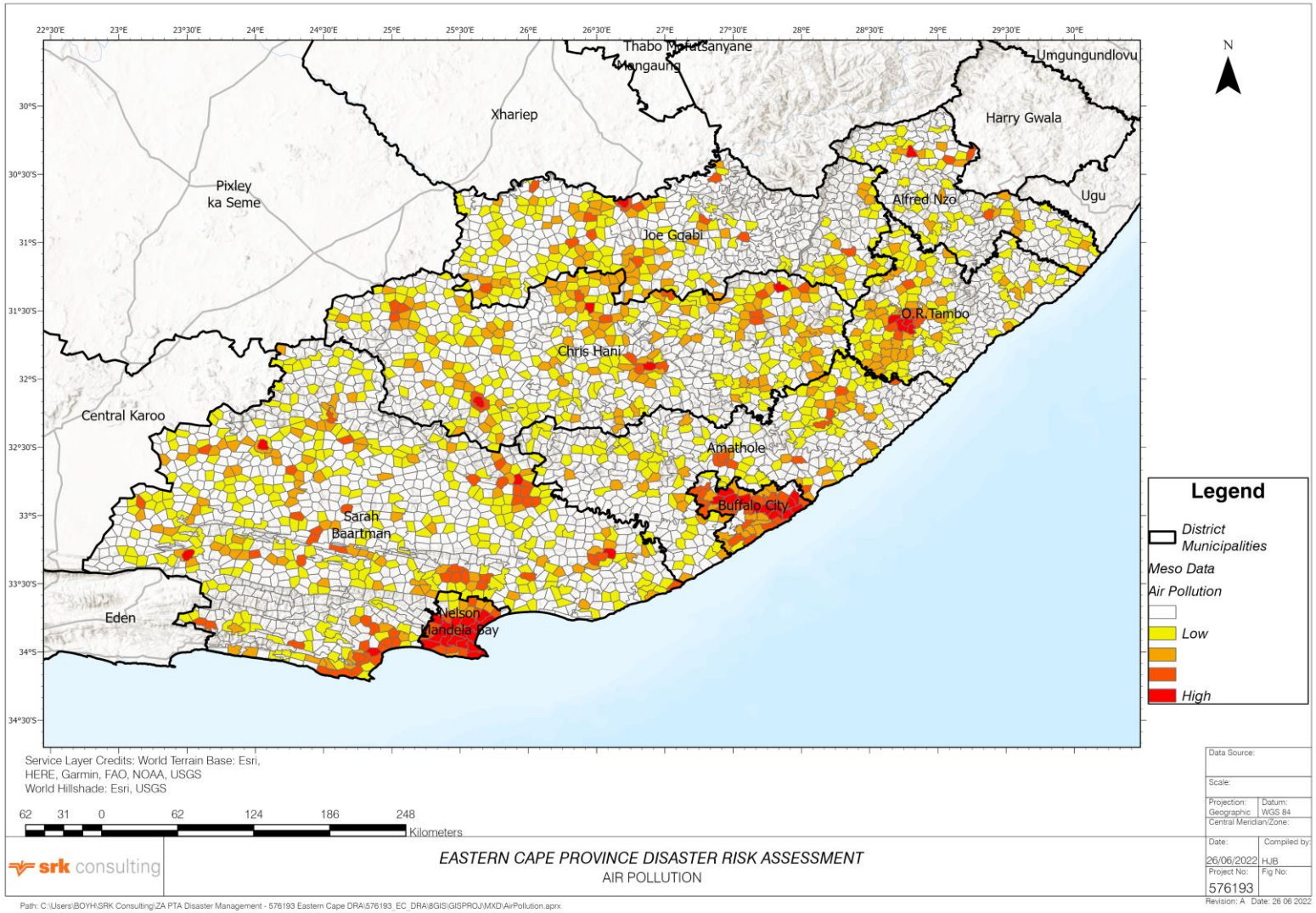

Figure 7-72: Air pollution Hazard Map (meso data)

7.15.2 Land pollution

Although household waste and waste disposal sites are potential sources of land pollution, pollution from industry, health facilities, commerce and mining are generally considered to pose a much greater threat. Eastern Cape Province has large industries and mining activity which can lead to increased land pollution and water pollution.

The provision of potable clean water to communities can significantly reduce their risk related to specific hazards such as human disease hazards. The inadequate management or treatment of sewerage can also have a severe impact on the receiving water bodies.

Pit toilets and refuse disposal sites in Eastern Cape Province contribute to land pollution. It is however not possible to include this hazard with the available data.

During community consultations a large problem with disposable nappies was identified. This can contribute to both land and water pollution. It was indicated that nappies accumulate on river bends. In a lot of the areas. The rivers also serve as the primary water source for people in a large portion of the area. According to the Eastern Cape Provincial Integrated Waste Management Plan 2018 – 2023 nappies constitute a significant portion of the domestic waste stream (Eastern Cape Provincial Government, 2018). A search indicated (various sources) that it will take between 200 and 500 years for nappies to degrade in a landfill.

Other facilities that could also pose a risk of pollution has been identified in the Land Cover data available for the Eastern Cape Province. These include:

- Industries;
- Urban development
- Mining;
- Cultivated commercial permanent orchards;
- Cultivated commercial permanent vines;
- Cultivated commercial permanent pineapples;
- Cultivated commercial sugarcane non-pivot;
- Commercial annual crops pivot irrigated;
- Commercial annual crops non-pivot irrigated and
- Commercial annual crops rain-fed / dryland.

The identified data points were transferred to the meso layer with Figure 7-73 as the result. The red colour show areas of higher risk.

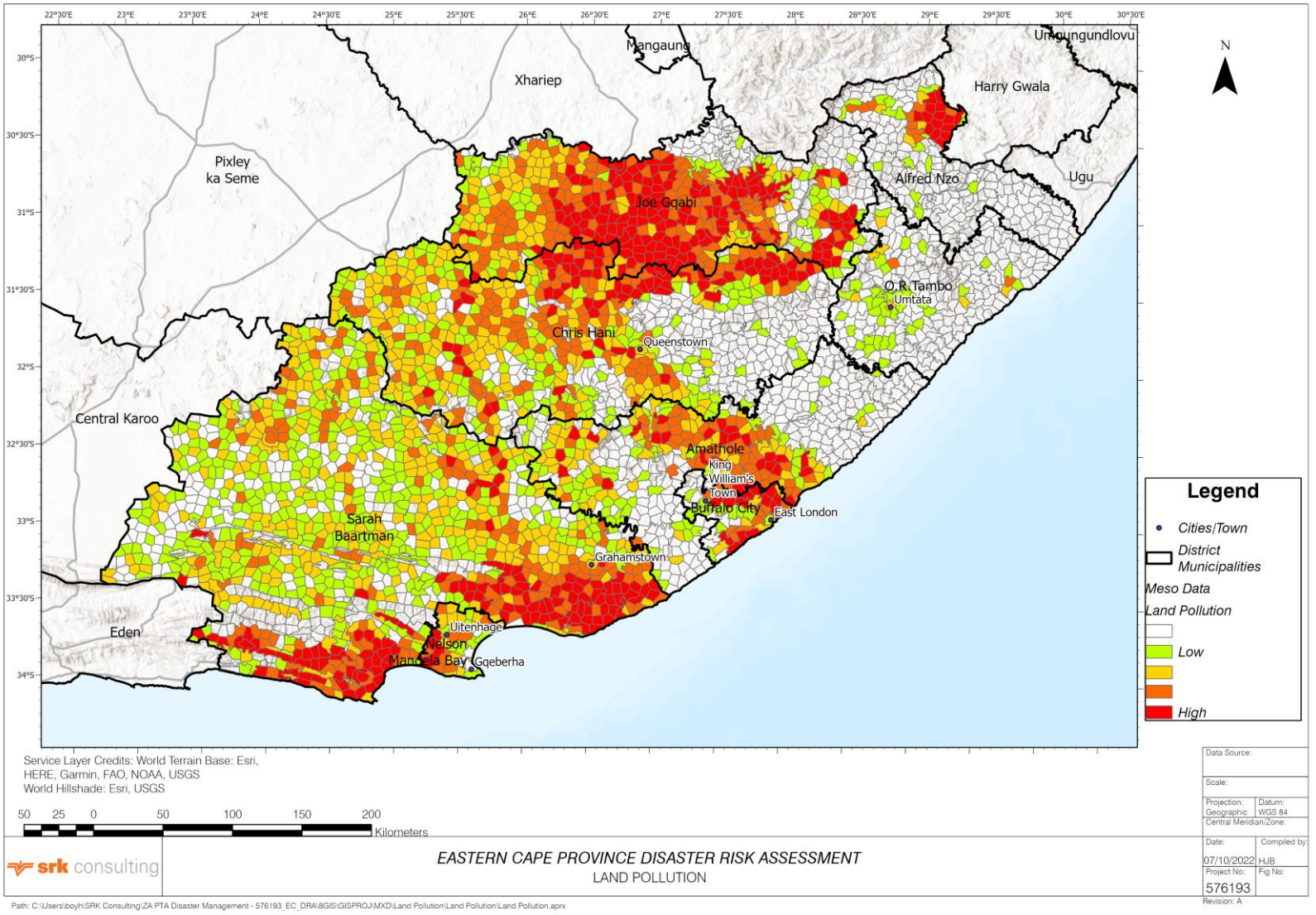

Figure 7-73: Land pollution hazard for Eastern Cape Province (meso data)

7.15.2.1 Consultation inputs

7.15.2.1.1 Alfred Nzo

The high use of wood increases the air pollution within the area. Proposed mine development has been stopped by court. Air quality plan for District can be helpful.

Lacking waste collection is a cause of problems as it has people transport waste to villages. Animals hit and killed by cars are left without being collected for day and has contributes to pollution. Disposable nappies dumping is increasing. No waste collections, especially in the rural areas. Mortuaries in the residential areas can pose risks to the surrounding community.

Waste management plans should be demanded from Local Municipalities. Suitable areas should be identified for mortuaries (demarcation).

7.15.2.1.2 Amathole

Butterworth factories cause air pollutions and affect residential areas. Air Quality monitoring should be done. PM2.5 & PM2.10 (Particulate Matter) associated with fires, especially during fire break burning. Air Quality Monitoring is thus needed, and support thereof. Smoke management plan which requires smoke dispersion index should be developed to avoid detrimental effects on air quality. This applies mainly in Ngqushwa, Raymond Mhlaba, and districtwide.

Medical waste sites are very close to communities. Landfill sites are also not compliant and cause land pollution. Landfill sites are close to settlements, particularly in Ngqushwa

Shipping lane runs next to coast and pollution does occur. Incidents also occurred to the east. Water treatment plans are not up to standards and cause river pollution to. Black rain also results from ash from fires in Free State

7.15.2.1.3 Buffalo City

Buffalo City has a real-time Air quality index visual map (https://aqicn.org/city/south-africa/buffalo-city-metro/east-london/m/ / https://aqicn.org/map/south-africa/buffalo-city-metro/east-london/). Water services in municipality and treatment works and reservoirs. Clinics, hospitals, and schools also contribute to the pollution of water. It is important to have a Water Quality Management Plan in place.

7.15.2.1.4 Chris Hani

Burning of waste, which is not collected, dust from quarries, burning of tyres, as well as Illegal waste sites where waste is burnt influences air pollution within Chris Hani. Illegal and poorly managed landfill sites are also contributing to land pollution. illegal dumping of refuse along most of the roads particularly surrounding most of the towns within this district leads to land pollution.

The entire district has water pollution problem due to water sources and tributaries being polluted by sewage. Old infrastructure also influences water pollution. Water pollution on the river in Elliot is attributed to crime as cable theft led to pump failure and malfunctioning of the system for water reticulation. In some farming areas groundwater pollution results from pesticides used, with some high chemical contents that might have health implications in the long run especially during the dry season, i.e., arsenic etc.

Sewage towns with problems include Cradock, Hofmeyr, Elliot (Slang River) where sewage pollutes rivers

7.15.2.1.5 Joe Gqabi

Landfill sites that burn waste producing toxins and affects communities.

Walter Sisulu economic hub has several illegal dumping due to lack of resources to remove waste. Lesser extent in Senqu. Illegal dumping also results in land pollution.

There was an incident where a filling station polluted Wildebeest River, which was taken to court. Had to relocate water extraction point. Sewage works that are not functional also pollute water sources. Water pollution is prevalent in Burgersdorp, Oviston and Venterstad. Directives were issued. A part of Xhariep dam had also been polluted. And a pump station that was polluting the Orange River is managed.

7.15.2.1.6 Nelson Mandela bay

Industries cause air pollution. South African Weather Services are monitoring air quality and has done an assessment where air quality and human disease have been overlapped to understand the effects thereof.

7.15.2.1.7 OR Tambo

Air pollution is very high around Mthatha. Pollution is caused by vehicles has increased. Burning of tires during winter season also has an impact on air pollution. Enforcement by-laws is important.

There is also an increase in dumping of disposable nappies all over as they are dumped all over, on land. streams, etc. and blocking drains. Human waste ends up in streams.

7.15.2.1.8 Sarah Baartman

Illegal dumping throughout the Kouga Area has an impact on air and land pollution.

7.16 Structural failure

For this study, structural failure hazards were defined as the failure of structures, such as bridges, buildings or dams due to various causes including inadequate maintenance, inadequate design, earthquakes, severe weather conditions, etc. The failure of small structures, such as single houses or small bridges does not usually constitute a disaster risk. However, the failure of larger structures such as dams, multi-lane bridges and multi-storey buildings may constitute a disaster event.

For mapping the structural failure hazard, infrastructure such as dam walls buildings and bridges were mapped. Number of length of bridges were considered and mapped in Figure 7-74.

Examples of buildings that was used include:

- Airport International;
- Amphitheatre;
- Bank;
- Casino;
- Churches;
- Cinema;
- Schools;
- Entertainment Centre;
- Fitness/Recreation Centre;
- Flats;
- Hostels;
- Hotel/Motel;
- Industrial Building;
- Library;
- Night Life and
- Office Complex/ Industrial Complex.

The result of the hazard mapping is shown Figure 7-75 :

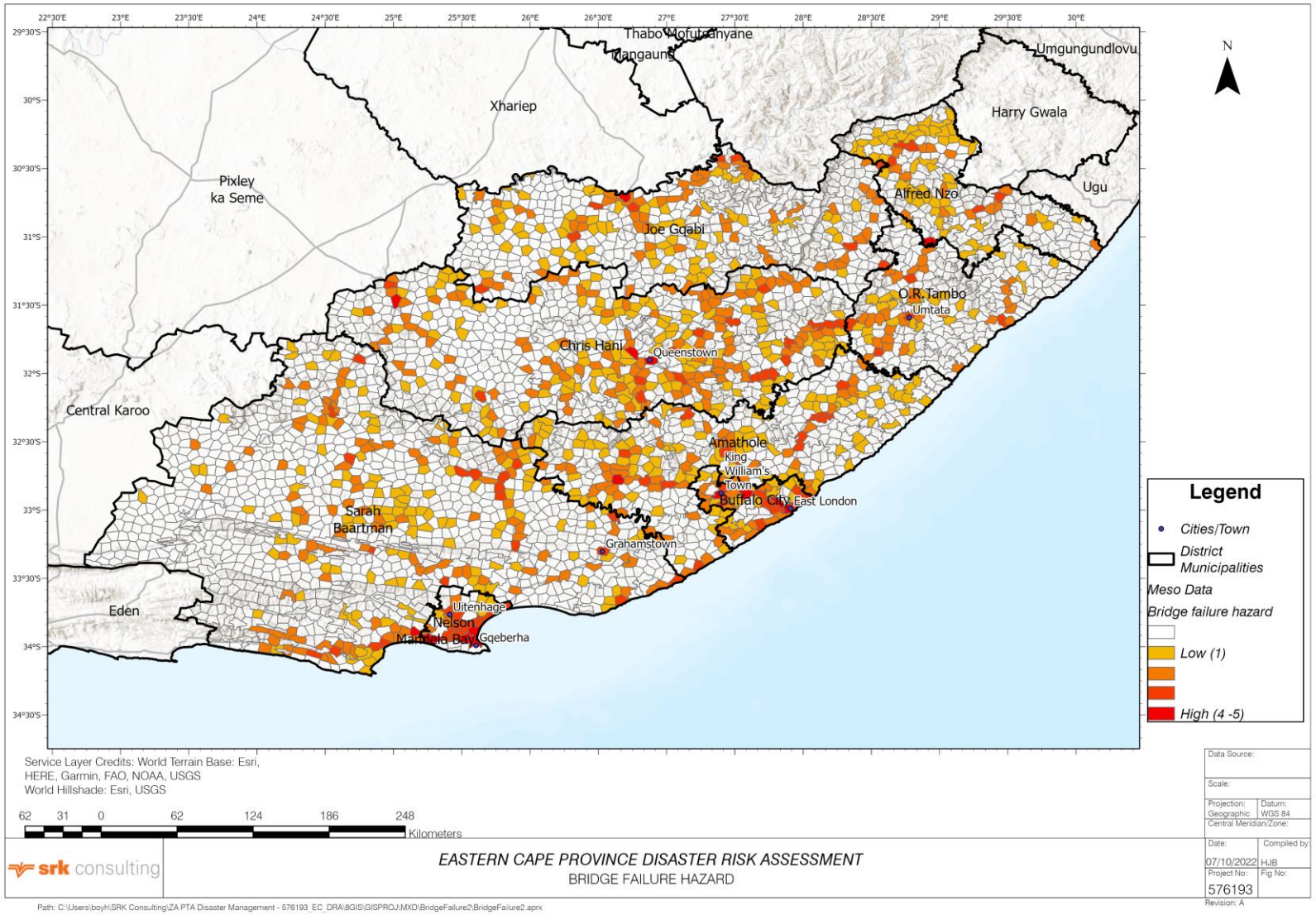

Figure 7-74: Bridge failure hazard (meso data)

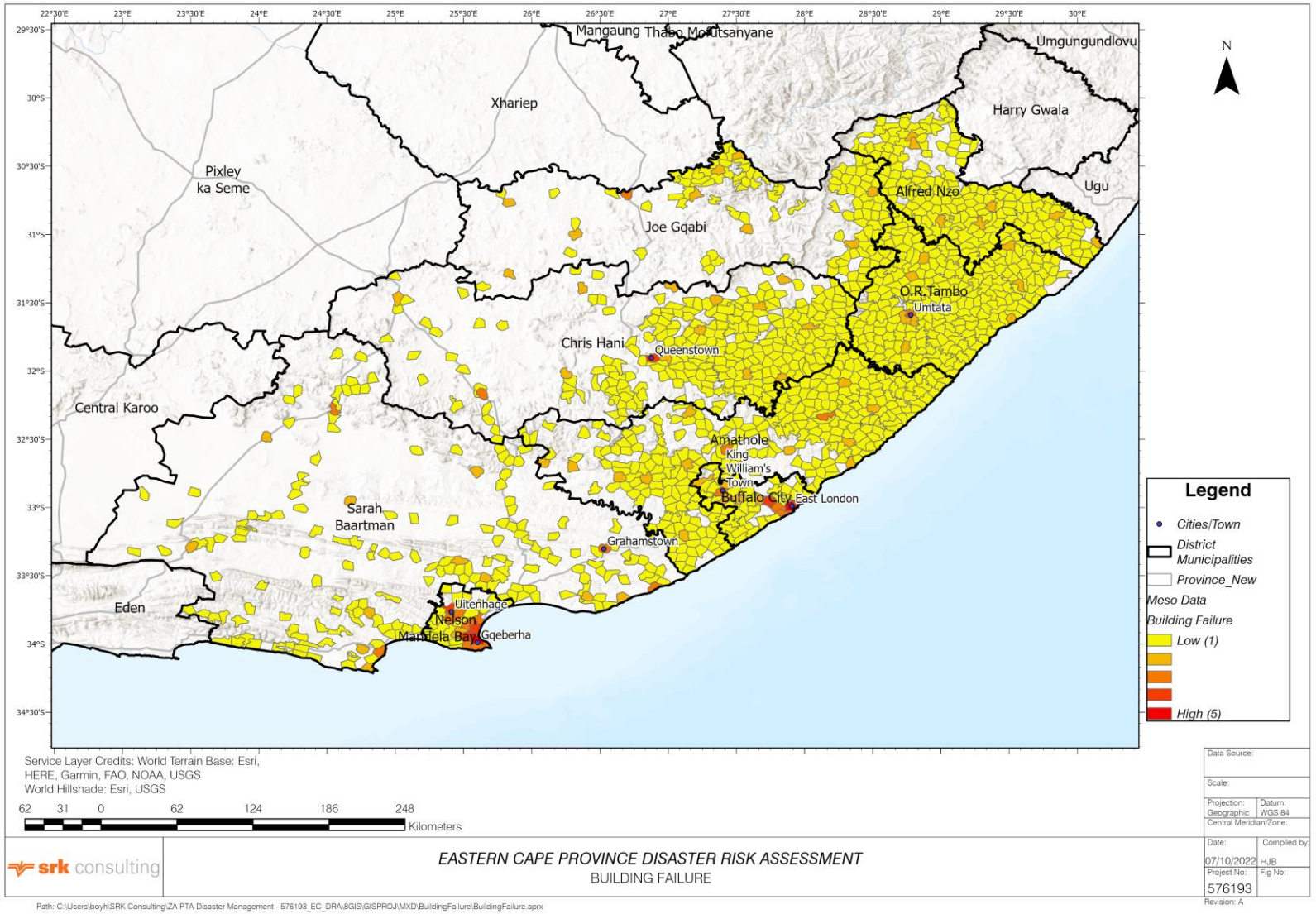

Figure 7-75: Building Failure Hazard (meso data)

7.16.1 Consultation inputs

7.16.1.1 Alfred Nzo

High number of low-lying bridges that are not useable during flood. Ludeke dam in Bizana is one of the biggest

7.16.1.2 Amathole

Low lying bridges increase the risk of flooding and thus shortened life span. Mining of riverbeds change rivers. Erosion can shorten life span of some buildings.

7.16.1.3 Buffalo City

An old stadium failure, Buffalo Park stadium, resulting in 7 casualties. It is important that high-rise buildings should be audited. Two minor dams have failed.

7.16.1.4 Chris Hani

Bridge failures due to debris associated with excessive rain. Villages were cut off due to failures. The problems are usually resolved quickly.

7.16.1.5 Joe Gqabi

There are several bridges within Joe Gqabi. Lot of bridges were damaged during December 2021 and January 2022. Since 2016 low-lying bridges have been damage during flooding. All three municipalities have issues due to floods. Mid to high bridges also collapse. There was an instance where a car got washed away.

Building construction integrity is often bad and affects the ability of fire fighters to do their work.

7.16.1.6 Nelson Mandela bay

Alien vegetation such as blue gum trees have impact on some bridge failures. In Kragga Kamma, a tree fell on a low-level crossing which led to 1 fatality.

7.16.1.7 OR Tambo

Numerous bridges have failed during rain and flooding in December 2021 and January 2022 where majority was low lying bridges.

Structural failures occur occasionally. Mostly during severe storms. Structural collapse of mud structures. Poverty and unemployment of people that are unable to maintain structures. Poor maintenance can cause houses to collapse, especially in child-headed households or homes with elderly occupants.

Pipe has burst, where water processing plant was unable to draw water from dam and is now drawing from the river. There is water leakage in the area to which more investigation needs to be done.

7.16.1.8 Sarah Baartman

Thunderstorms affect low-lying bridges. Dam wall breaks also cause floods. Stormwater infrastructure failure causes business flooding. Thunderstorms in informal settlements. Blue Crane Route Municipality had floods in October 2021 caused by old infrastructure of the stormwater reticulation system.

7.16.2 Dam failure flooding

Dams for the dam failure assessment were identified by using the 1:50 000 topographic data of the National Geo-spatial Information (NGI), a component of the Department of Agriculture, Land Reform and Rural Development (DALRRD). Water areas data layers that are classified as dams with an area of more than 50ha were included in the assessment. Dam wall information also from NGI were used to identify possible outflow area. Drainage channels created in Section 7.8.1 and inundation of 6m above the drainage line was used to simulate possible areas that can be affected by a dam-failure. 5 Km from the dam wall was selected to provide a cut-off limit to the area of impact. Values from the dam failure inundation were transferred to the meso data layer and Figure 7-76 is the result. Darker red colour indicates a higher value because of more dams with higher inundation values.

De Hoop dam Ludeke dam and Mthatha dam was identified during consultations.

Dam failures are comparatively rare but can cause immense damage and loss of life when they occur.

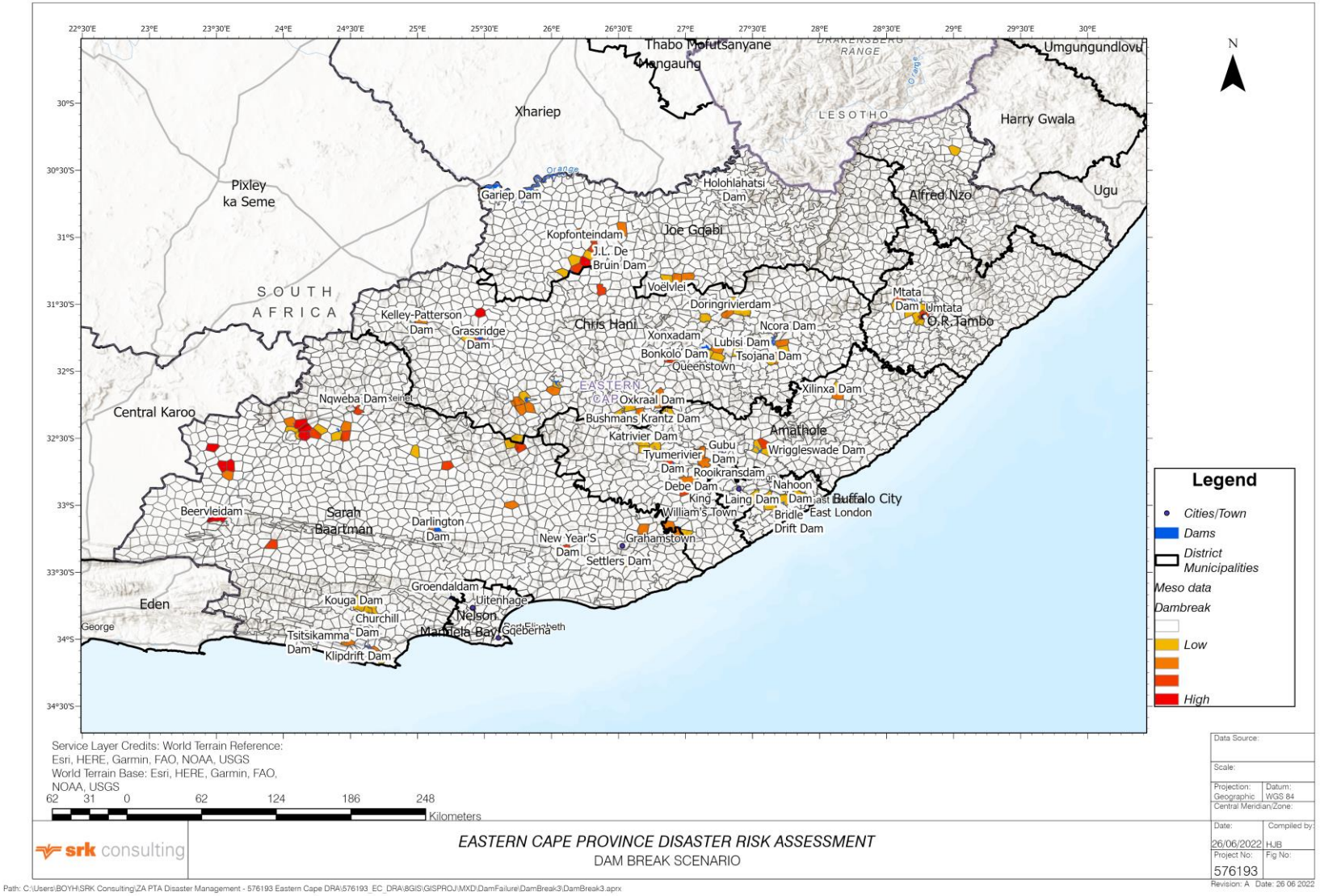

Figure 7-76: Dam failure scenarios (meso data)

7.16.2.1 Mining in the Eastern Cape

The following graph shows a provincial comparison for all the operational mines in South Africa.

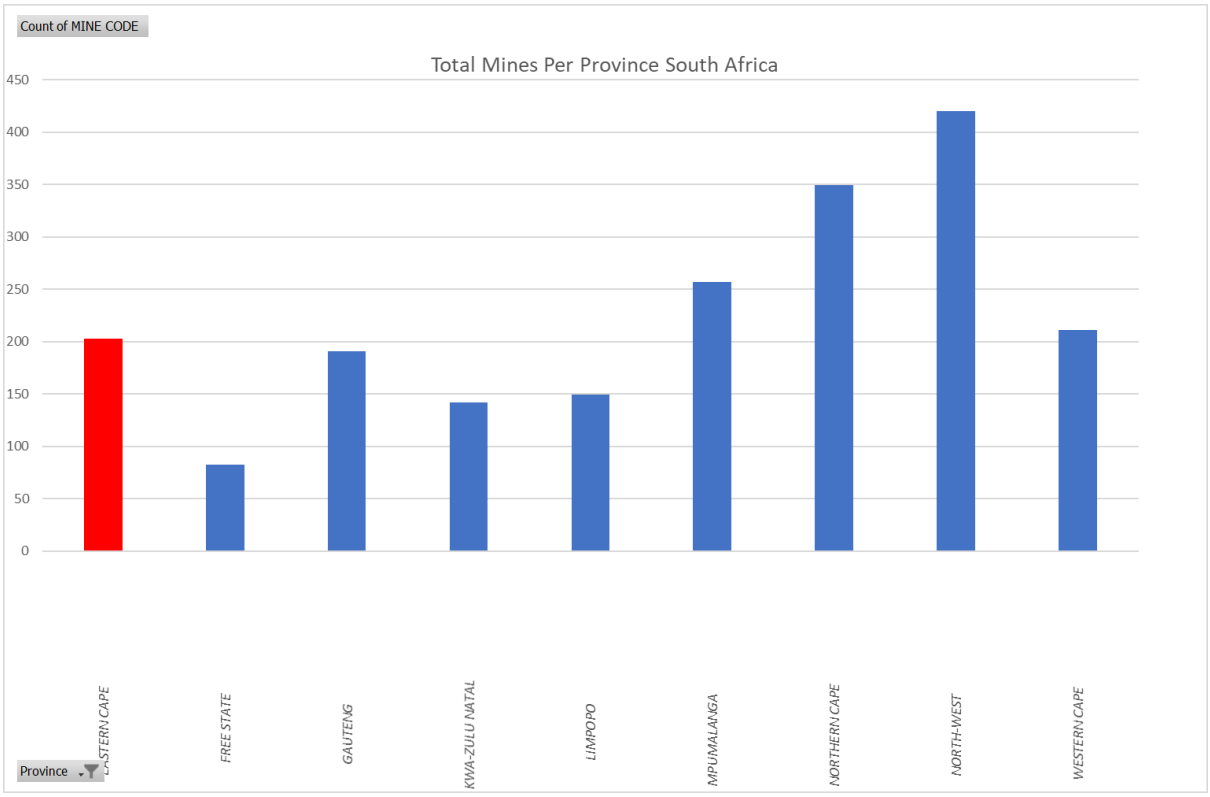

Figure 7-77: Operational Mines per Province (Department of Minerals Resources & Energy, 2022)

The Eastern Cape has 203 operational mines (Department of Minerals Resources & Energy, 2022). The available data indicates that most of the mining in the area is sand and aggregate mining. Aggregate refers to the different sizes of stone that are used in the building, construction and road-making industries while sand is the collective name given to finer grain size components (Department of Minerals Resources & Energy, 2022). Aggregate and sand mines do not have Tailings Storage Facilities. There is however always an element of risk surrounding mining activities. The possibility of pollution, environmental and other impacts were considered in the related hazard categories.

7.16.2.2 Consultation inputs

7.16.2.2.1 Alfred Nzo

An increasing number of people are building houses within flood zones. Floods resulted in displaced people where 258 People were left homeless and just more than 100 affected. Lack of maintenance of water drainage systems is also causes flooding problems.

7.16.2.2.2 Amathole

Great Kei- flooded in January 2022 where water emerges from the ground. This is due to the high-water table in the area. Shacks are built in flood plains. In Mbashe, opposite king Hintsa College, shacks are built next to a river. Low lying bridges are problem in the area. The Cintsa township (±20 shacks) as well as Komga township (±10 RDP houses) Great Kei has a problem of flooding. Flood Line analysis and reports must be intensified.

Shixini and Mditshwa rivers flood frequently. Mbhashe river flooding has led to 5 fatalities.

The EC Department of Housing who drive housing delivery should include Flood Line/Plain Analysis in the housing projects. This will improve mitigate flood impacts.

7.16.2.2.3 Chris Hani

High rainfall results in rivers flooding and further debris build-up in bridges. Flooding also contributes to bridge failure., Great Kei & White Kei rivers flood frequently.

7.16.2.2.4 Joe Gqabi

Flooding in Aliwal North resulted in the abstraction system being clogged up by to silt. Original extraction system was then replaced to extract from the top of the river. Dams are put in place to help with siltation to settle before it goes into the plant. In Lady Grey, water that comes from the mountains have exposed some of the pipelines, making them prone to damage by logs, etc. There was a dam failure at Chiappinisklip in Burgersdorp in 2020. High river flows and poor maintenance contributes to failures and subsequent flooding.

The Barkly East abstraction point was flooded in 2020 from increased flows in the Langkloof River and that disrupted water supply to the town.

7.16.2.2.5 Nelson Mandela Bay

Baakens River floods frequently. Low-lying informal settlements are more affected by the floods. Major flooding is usually associated with low pressure systems such as Cut-Off Low.

7.16.2.2.6 Sarah Baartman

In Kirkwood floods due to drainage system. Dam in Sundays River Valley had flooded due to water channel in the area. Kouga had severe floods in 2011. Establishment of dams in sand dunes causes localised flooding. Lacking maintenance in stormwater infrastructure also contributes to flooding. Hankey and Patensie.

In Sundays River Valley there is an increase in informal settlement during the citrus season where workers build on floodplains. This is mainly in Valentia and Addo where flooding intensifies during rainy season and exacerbated by poor drainage system. There is also staffing issues on response. Flood events also results in road closures and poor communication system. Thunderstorms also cause flooding in informal settlements. Blue Crane Route Municipality: floods in Oct, Stormwater reticulation system. Old infrastructure.

7.17 Oceanographic

7.17.1 Oceanographic – Sea Level Rise

The HAND method, as described in Appendix D, was used to establish a 6m inundation area from the coastline or 0m above sea level. An example shown in Figure 7-78 illustrates the result along the coastline at the Coega area. Residential, commercial, industrial and agricultural land cover were used identify areas that can be affected by the rise in sea-level. The affected road network was also identified. The values of the affected land cover and road network were transferred to the meso data layer. Figure 7-79 highlights areas that will probably be affected the most based on land cover and road network.

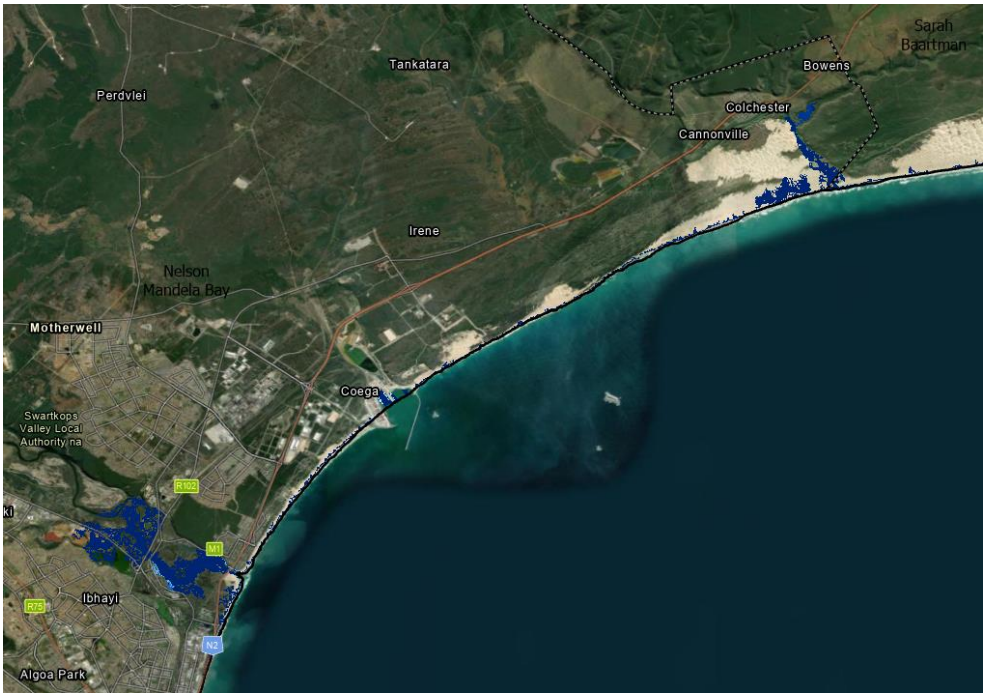

Figure 7-78: 6m Inundation from coastline

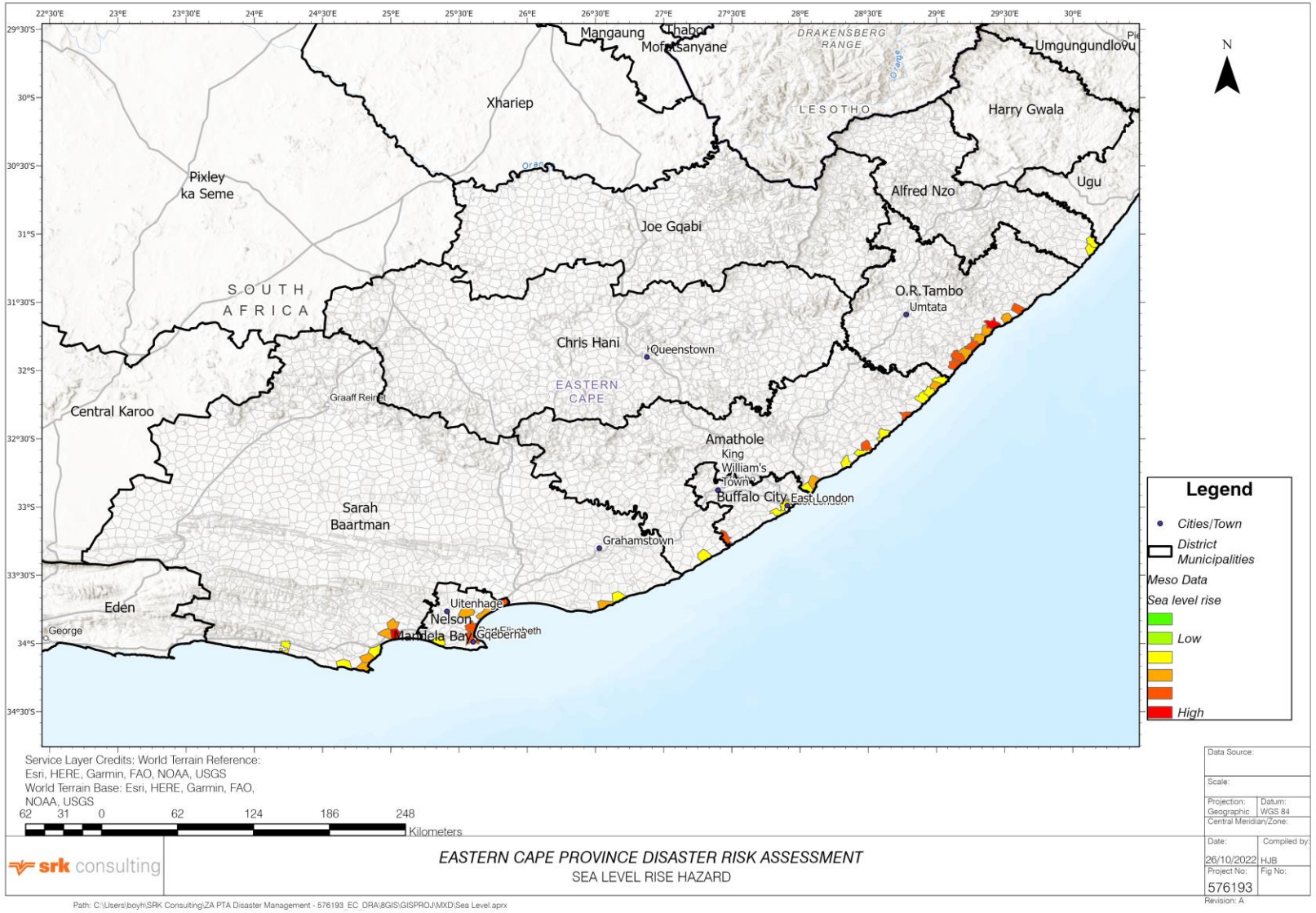

Figure 7-79: Meso data showing areas possibly effected by sea level rise

7.17.2 Oceanographic – Tsunami

A tsunami is a series of water waves caused by the displacement of a large volume of a body of water, typically an ocean or a large lake. Earthquakes, volcanic eruptions and other underwater explosions (including detonations of underwater nuclear devices), landslides, glacier calving[7], meteorite impacts and other disturbances above or below water all have the potential to generate a tsunami (Wikipedia, 2020).

7.17.3 Consultation inputs

7.17.3.1 Amathole

Storm Surge that occurs. Strong winds are frequent during the month of October. Strong winds causing shipwrecks to have also occurred.

7.17.3.2 **Buffalo City**

Sea level rise impacts have led to a closure of a sea front areas for some time.

7.17.3.3 **Nelson** Mandela Bay

Tsunami Incident has occurred.

Sea level rise has affected the setback lines.

7.17.3.4 **OR Tambo**

Storm surge possible in Port St Johns and Tsunami possible but low risk.

7.17.3.5 **Sarah Baartman**

Sea level rise affects formal houses in St Francis Bay and occurs in Jeffreys Bay. Krom River

7.18 Climate change

7.18.1 Understanding of the international, national and local climate change policy landscape

7.18.1.1 International conventions and agreements

South Africa is a signatory to multiple Climate Change agreements and Frameworks, including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the World People's Conference on Climate Change

The UNFCCC

The UNFCCC is an international treaty which was formed as a result of 1992 Rio Earth Summit. It, is a framework convention with 194 parties, making it a near universal membership body. The objective of the UNFCCC is to “stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. The Convention is the umbrella for the Kyoto Protocol. South Africa ratified the Convention in 1997, making it a non-binding legal instrument which South Africa must seek to adhere to.

The Convention is an evolutionary document, which will be expanded upon by protocols such as the Kyoto, Bali and Durban Protocols and plans. Protocols are usually separate legal instruments that are not strictly subject to the Convention. The protocols therefore have their own Parties and ratification processes. South

[7] Ice calving, also known as glacier calving or iceberg calving, is the breaking of ice chunks from the edge of a glacier. It is a form of ice ablation or ice disruption. It is the sudden release and breaking away of a mass of ice from a glacier, iceberg, ice front, ice shelf, or crevasse.

Africa is classified as a developing country in terms of the Convention and is not obliged to adhere to the more demanding commitments placed on developed countries.

IPCC

The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body that falls under the United Nations. It was first established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme.

The IPCC produces scientific reports in alignment with the UNFCCC, with the same objective in the afore mentioned body of this proposal. There are 3 working groups within the scientific report writers, covering scientific, technical and socioeconomics. The IPCC relies on member nation's scientists for information, compiling the reports from peer-reviewed, published scientific literature.

The IPCC is an internationally accepted authority on climate change and in 2007 contributing scientists and Al Gore shared the Nobel Peace Prize.

COP 27

South Africa's response to climate change was initiated at Cop 17 in Durban 2011. While a legally binding treaty was not signed by member states, the conference succeeded in creating a new legally binding deal called the Durban Platform, which was to take affect by 2020. A Green Climate Fund was also established, and a management framework adopted. The fund was considered a massive breakthrough in the climate change policy and will distribute US$100 billion per year to help poor countries adapt to climate-related impacts.

In November 2022 it was the 27th session of the Conference of the Parties of the UNFCCC (COP 27), with a view to building on previous successes and paving the way for future ambition to effectively tackle the global challenge of climate change.

7.18.1.2 National climate change response

The National Climate Change Response (NCCR) Policy White Paper (DEA, 2011), indicates the South African government's approach to climate change. The NCCR is South Africa's contribution to international efforts to stabilise greenhouse gas emissions to within a limit that prevents irreversible anthropogenic influence on our global climatic system. Part of this includes the adaptation to unavoidable climate change impacts and the mitigation of those impacts which may yet be avoided. Through people-centred, sustainable social, economic and environmental resilience policy, South Africa will seek to respond to the effects of Climate Change

The White Paper seeks to achieve this via the following action principles:

- Informed participation: Enhancing the scientific understanding of climate change to achieve public participation at all action levels.
- The Precautionary Principle: An approach which promotes caution and risk adverse action, considering current knowledge limits and the consequences of both decisions and actions.

Emphasis must be placed on those measures aimed at reducing South Africa's contribution to global climate change within existing policy and legislation, whilst respecting the countries current development and social issues which will inform our ability to adapt and mitigate. Eastern Cape Province's contribution to this is vital, as most of our adaptation and mitigation efforts must be emphasised at both provincial and municipal levels, where the integration of climate change policy into IDP's and spatial planning will be most effective.

The White Paper suggests that by 2014, all climate change policy, legislation, strategy, regulations and planning fall within the municipal sphere of interest and align with the National Climate Change Response Policy. The South African Local Government Association have been mandated to support, represent and advise local municipalities such as Eastern Cape Province, in the integration of both adaptation and mitigation measures into governance tools such as IDP's, as well as mass education and awareness to the public.

The mandate for local government to respond to climate change is imbedded in the Constitution (108 of 1996) in that many of the critical climate change response actions identified in the National Climate Change Response White Paper, fall within local government responsibilities, such as basic service delivery (water, electricity, waste), storm water management, roads maintenance, sanitation, disaster management, human settlements, etc

Section 10.2.6 in particular notes the key role of local government in climate change policy: (1) planning and urban development; (2) municipal infrastructure and services; (3) water, energy and waste demand management and (4) local disaster response. The policy indicates the awareness that local government will need support to fulfil these mandates.

Section 5.9 outlines the government's policy for disaster risk reduction and management. The policy states that resilience to climate change-related extreme events, such as heat waves, floods, droughts, wildfires and storm surges, will be the basis for South Africa's future approach to disaster management. The policy continues to say that climate change will require more effective disaster management to deal with the increased number of extreme weather events. The increase in extreme events will strain public resources due to the need to declare and support disaster areas in an immediate crisis as well as during long-term recovery.

7.18.2 Climate change and the relationship to hazards and risks

The Assessment Report 5 (AR5) in 2014 made a shift from previous assessments to focus on the increased articulation the implications of climate change to society. Chapter 19 speaks specifically to emergent risks and key vulnerabilities related to climate change. These risks arise from the interaction of the evolving exposure and vulnerability of human, socioeconomic, and biological systems with changing physical characteristics of the climate system. The AR5 report highlights the interaction of the changing physical characteristics of the climate system with evolving characteristics of socioeconomic and biological systems (exposure and vulnerability) which ultimate produces risk (Figure 7-80). The 2014 report goes on to identify a variety of emergent risks that have not previously been assessed or recognised. The following are the key emergent risks that are relevant to this assessment (Chapter 19 (IPCC, 2014)):

- The risk of climate change to human systems (e.g., agriculture and water supply) is increased by the loss of ecosystem services that are supported by biodiversity.
- Climate change has the potential to adversely affect human health by increasing exposure and vulnerability to a variety of stresses.
- The risk of severe harm and loss due to climate change-related hazards and various vulnerabilities is particularly high in large urban and rural areas in low-lying coastal zones.
- Increasing prices of food commodities on the global market due to local climate impacts, in conjunction with other stressors, decrease food security and exacerbate food insecurity at distant locations.
- The effect of climate change on conflict and insecurity is an emergent risk because factors such as poverty and economic shocks that are associated with a higher risk of violent conflict are themselves sensitive to climate change.
- Risk of death, injury, ill-health, or disrupted livelihoods in low-lying coastal zones due to storm surges, coastal flooding, and sea level rise.
- Systemic risks due to extreme weather events leading to breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency service.
- Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity.
- Risk of loss of marine and coastal ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for coastal livelihoods.

Table 7-8 attempts to highlight the linkages between the internationally recognised hazard classification system and climate change. While climate change is cross cutting there are specific scenarios that could drive or trigger certain hazards. These are linked to the systemic risk of changes in the following weather-related factors:

- Warming trends
- Extreme temperatures
- Drying trend
- Extreme precipitation
- Precipitation trend
- Snow events
- Tropical cyclones
- Sea level
- Tidal surges

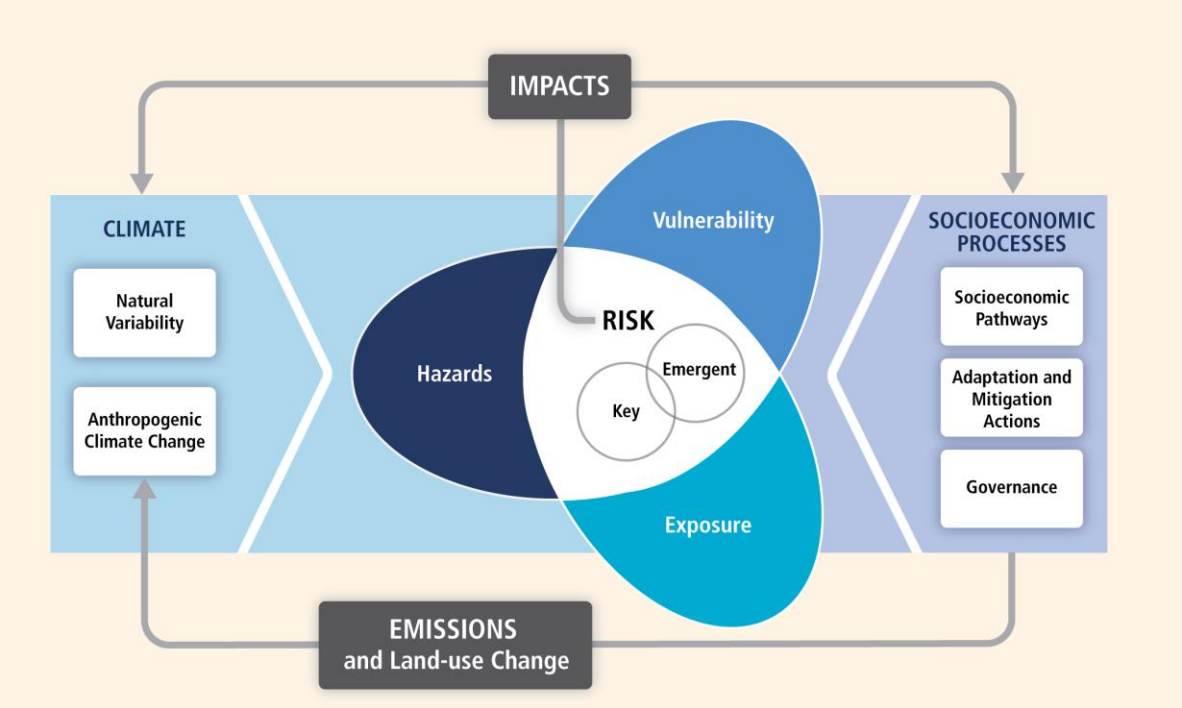

Figure 7-80: Illustration of the core concepts of the reflecting the relationship between climate change and risk. Changes in both the climate system (left) and socioeconomic processes including adaptation and mitigation (right) are drivers of hazards, exposure, and vulnerability (IPCC, 2014)

Table 7-8: Climate change related links to the 54 hazard categories

Hazard category	Climate-related drivers of change[8]	Climate change-related links to hazards[9]
1. Civil Unrest - Armed Conflict (Civil/Political War) 2. Civil Unrest - Crime 3. Civil Unrest - Demonstrations / Riots 4. Civil Unrest - Refugees / Displaced People	• Warming trends • Extreme temperatures • Drying trend • Extreme precipitation • Precipitation trend • Snow events • Tropical cyclones	Access and availability to natural resources can be affected by a changing climate. Extreme weather events, long-term warming and precipitation trends all impact on a community's access to natural resources. Reduced access and availability can result in civil unrest, displacement of people, environmental refugees, riots and demonstrations. Food and water insecurity are driven by climate change and in turn drive civil unrest

[8] Based on the IPCC AR5 Summary for Policy makers (IPCC, 2014)

[9] Based on the LTAS (DEA, 2013) and IPCC AR 5 Chapter 19 (IPCC, 2014)

Hazard category	Climate-related drivers of change[8]	Climate change-related links to hazards[9]
5. Civil Unrest - Terrorism 6. Civil Unrest - Xenophobic Violence	• Sea level • Tidal surges	
7. Disease / Health - Disease: Animal 8. Disease / Health - Disease: Human 9. Disease / Health - Disease: Plants	• Warming trends • Precipitation trend • Extreme temperature and precipitation events	Increases in average temperatures, humidity, annual precipitation and episodic extreme events (e.g., heat waves) resulting from a changing climate may have increasingly significant direct impacts on human health. Examples include heat stress, changes in distribution of vectors of disease (mosquitoes and ticks), malnutrition, mortality rates (storm surges, tropical cyclones, sub-zero temperatures), air quality, communicable diseases (such as cholera) mental and occupational health
10. Environmental Degradation - Deforestation 11. Environmental Degradation - Erosion 12. Environmental Degradation - Land Degradation 13. Environmental Degradation - Loss of Biodiversity	• Warming trends • Extreme temperatures • Drying trend • Extreme precipitation • Precipitation trend • Snow events • Tropical cyclones • Sea level • Tidal surges	Changes in rainfall patterns and temperature trends can result in changes to biodiversity, land cover, soil and costal erosion. Environmental degradation results in the loss or change in functionality of ecosystem services (natural benefits, goods and services provided by functioning ecosystems). Changes to the functionality of ecosystem services results in the potential reduction in access and availability to natural resources.
14. Fire Hazards - Formal & Informal Settlements / Urban Area 15. Fire Hazards - Veld/Forest Fires	• Warming trends • Extreme temperatures • Drying trend • Extreme precipitation • Precipitation trend	Warmer and drier conditions increase the potential for wild fires. Increase in storms can result in higher number of lightning strikes which can also trigger fires.
16. Geological Hazards - Earthquake 17. Geological Hazards - Landslides/Mud flows 18. Geological Hazards - Rock-fall 19. Geological Hazards - Subsidence	• Warming trends • Extreme precipitation • Precipitation trend • Snow events • Tropical cyclones • Sea level • Tidal surges	Increased rainfall events and intensity increases the chance for landslides, mud flows and subsidence. Sea level change and stronger tidal surges can result in damage to coastal regions with increased chance of dune subsidence and coastal erosion.
20. Hazardous Material - Fire/Explosion (Storage & Transportation) 21. Hazardous Material - Spill/Release	• Extreme temperatures • Extreme precipitation • Tidal surges	Impacts to hazardous material movement corridors and storage locations are possible as a result of other climate change related hazards. Subsidence, landslides flooding can impact on hazardous materials transportation and handling. Tidal surges can impact on hazardous storage facilities that are in close proximity to coastal areas.

Hazard category	Climate-related drivers of change[8]	Climate change-related links to hazards[9]
(Storage & Transportation)		
22. Hydro-meteorological - Drought 23. Hydro-meteorological Hazards - Desertification 24. Hydro-meteorological Hazards - Extreme Temperatures 25. Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure) 26. Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	• Warming trends • Extreme temperatures • Drying trend • Extreme precipitation • Precipitation trend • Snow events • Tropical cyclones • Sea level • Tidal surges	Climate change will have a direct influence on the frequency and intensity of hydro-meteorological hazards. Increased drying periods results in a higher chance for drought, more intense rainfall events increased chance for flooding (a higher frequency rate of 1:100-year flood events), extremes in temperatures will become more frequent and increased storm intensity will result in increased hail events, possible higher wind speeds and increased chance of lightning strikes.
27. Infestations - Algal Bloom (Red Tide) 28. Infestations - Animal Infestation / Over Population 29. Infestations - Insect Infestation 30. Infestations - Plant Infestations (Intruder Plants)	• Warming trends • Extreme temperatures • Drying trend • Extreme precipitation • Precipitation trend	Changing climate patterns results in shifting animal distribution patterns, this could result in an increase of pests, alien vegetation, insects, bacteria and fungi. Infestations of these species can have implications to human health, water and food security. Algal blooms can impact on tourism and fishing activities.
31. Infrastructure Failure / Service Delivery Failure - Electrical 32. Infrastructure Failure / Service Delivery Failure - Gas 33. Infrastructure Failure / Service Delivery Failure - Information Technology 34. Infrastructure Failure / Service Delivery Failure - Sanitation 35. Infrastructure Failure / Service	• Warming trends • Extreme temperatures • Drying trend • Extreme precipitation • Precipitation trend • Snow events • Tropical cyclones • Sea level • Tidal surges	An increase in climate change related meteorological events can impact on infrastructure and hinder service delivery. Impacts on transmission lines and pipelines impact on electricity, gas and water provision. Lightning strikes can affect telecommunication infrastructure. Water availability and rainfall intensity can have an impact on sanitation services. Transportation links and services can be severely disrupted as a result of infrastructure failure due to extreme weather events.

Hazard category	Climate-related drivers of change[8]	Climate change-related links to hazards[9]
Delivery Failure - Transport 36. Infrastructure Failure / Service Delivery Failure - Water		
37. Major Event Hazards - Cultural / Religious 38. Major Event Hazards - Political 39. Major Event Hazards - Recreational / Commercial 40. Major Event Hazards - Sport	• Extreme precipitation • Extreme temperatures	Extreme rainfall events or temperatures can result in the cancellation of major events or can result in human health implications and an increased need for temporary medical facilities.
41. Oceanographic - Sea Level Rise (Climate Change) 42. Oceanographic - Storm Surge 43. Oceanographic - Tsunami	• Tropical cyclones • Sea level • Tidal surges	Sea level rise, storm and tidal surges can result in increased damage and risk to coastal populations and infrastructure. These events could also disrupt shipping and trade channels. Increased coastal erosion also has implications for the tourism industry.
44. Other - Space Objects	N/A	N/A
45. Pollution - Air Pollution 46. Pollution - Land Pollution 47. Pollution - Water Pollution (Fresh and Sea)	• Warming trends • Extreme temperatures • Drying trend • Extreme precipitation • Precipitation trend	Climate change affects weather and thereby negatively influencing the dispersal and concentrations of pollutants such as particulate matter (PM), sulphur dioxide, ozone, carbon monoxide, benzene, lead and nitrogen dioxide resulting in health impacts.
48. Structural Failure - Bridge Failure 49. Structural Failure - Building Failure 50. Structural Failure - Dam failure	• Extreme temperatures • Extreme precipitation • Tropical cyclones • Sea level • Tidal surges	An increase in climate change related meteorological events can impact on key infrastructure such as bridges, buildings and dam walls.

Hazard category	Climate-related drivers of change[8]	Climate change-related links to hazards[9]
51. Transport Hazards - Air Transportation 52. Transport Hazards - Rail Transportation 53. Transport Hazards - Road Transportation 54. Transport Hazards - Water Transportation (Incl Marine Accident)	• Warming trends • Extreme temperatures • Drying trend • Extreme precipitation • Precipitation trend • Snow events • Tropical cyclones • Sea level • Tidal surges	An increase in climate change related meteorological events has a direct impact on transportation links and infrastructure

8 Vulnerability Profile of the Eastern Cape

In the context of this study, vulnerability can be described as the degree to which an individual, a household, a community, an area or a development may be adversely affected by the impact of a hazard. Conditions of vulnerability and susceptibility to the impact of hazards are determined by physical, social, economic and environmental factors or processes.

It is important to take cognisance that vulnerability is dynamic, not static, as the vulnerability of communities change due to improvements or degradation of social, environmental and economic conditions, as well as interventions specifically aimed at reducing vulnerability, such as disaster mitigating actions.

For the purpose of this study, the vulnerability of the area of the Eastern Cape Province is discussed later in this document. The first section examines general characteristics of the area based on quantitative and qualitative data and refers to some of the characteristics of the Eastern Cape Province area in the context of the “Progression of Vulnerability”. The second section deals with the spatially represented vulnerability, based on different types of spatial data.

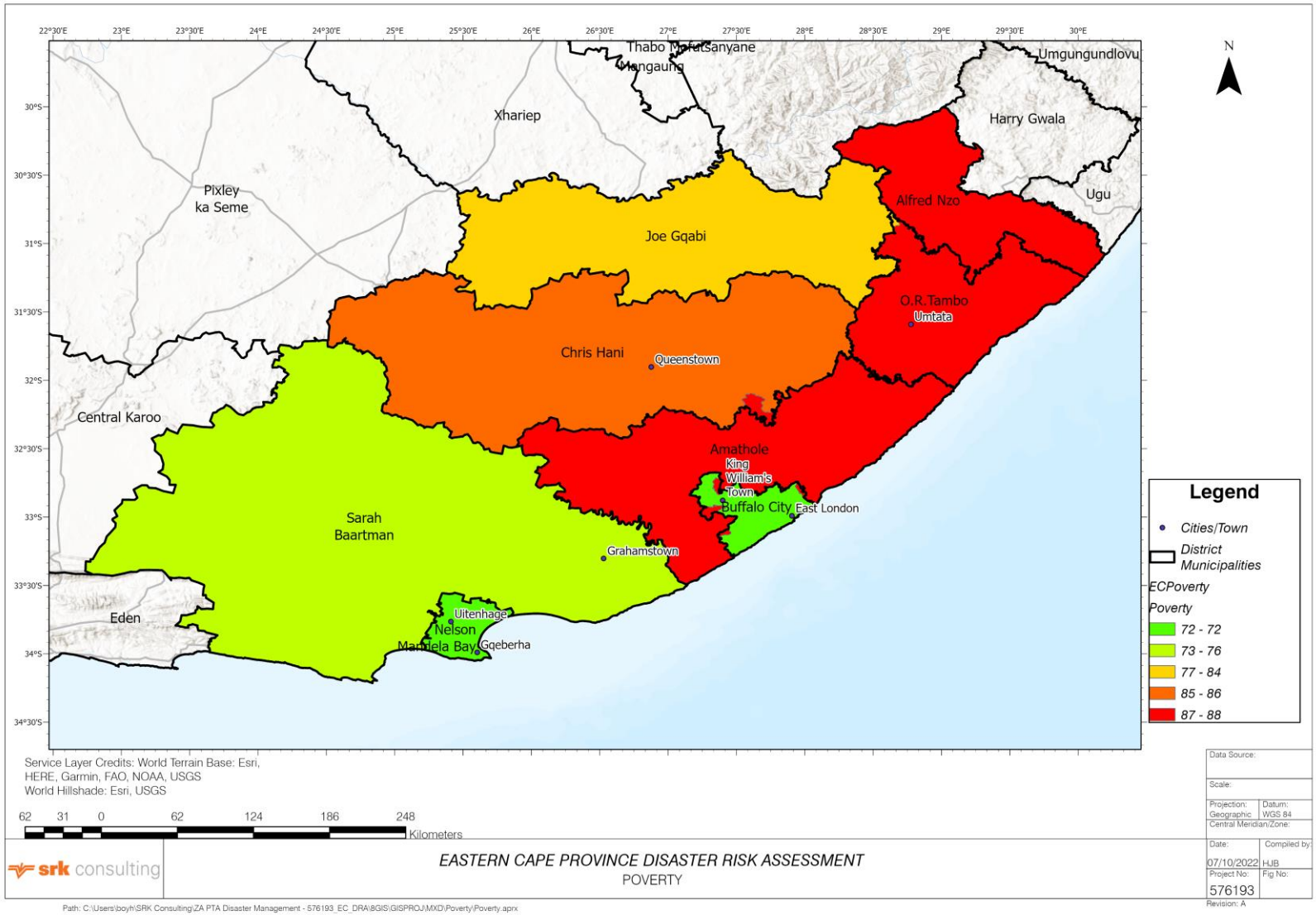

Figure 8-1: Poverty across South Africa based on Stats SA data of income of showing Percentage monthly income of R1600 or less

8.1 Vulnerability considerations in Eastern Cape Province

It is generally accepted that there is a direct correlation between poverty and vulnerability. Wealthy people usually settle in more resilient areas that have formalised buildings, stormwater infrastructure and can recover after they have been affected by a hazard. The poor on the other hand usually settle in more dangerous locations and structures can be unstable or unsafe. The areas generally do not have formalised stormwater and road infrastructure. The poor also do not have the ability to recover after they have been affected by a hazard.

The National Disaster Management Framework defines Vulnerability as "The degree to which an individual, a household, a community, an area or a development may be adversely affected by the impact of a hazard. Conditions of vulnerability and susceptibility to the impact of hazards are determined by **physical, social, economic and environmental factors** or processes."

A lot of the aspects that can contribute to the vulnerability in the Eastern Cape Province were discussed as part of the Status Quo assessment in Section 6, key aspects of the characteristics of the Eastern Cape Province are discussed below.

Physical vulnerability of communities can relate to the type of housing, available infrastructure and the quality of infrastructure. According to Stats SA, an informal dwelling is defined as a *"makeshift structure not approved by a local authority and not intended as a permanent dwelling. Typically built of found materials (corrugated iron, cardboard, plastic, etc.), contrasted with formal dwelling and traditional dwelling."* Informal dwellings, or buildings constructed from low quality material can be considered more susceptible to the effects of some hazards. The percentage of formal and informal dwellings within an area can therefore be used as one indicator of the level of vulnerability of an area.

Due to the important role water plays within communities, including the health of community members, it can be stated that the inadequate quantity or quality of drinking water can increase the vulnerability of communities to the effects of certain hazards. Because of this, access to water can also be used as an indicator of relative vulnerability.

Adequate sanitation is critical to ensure that the appropriate public health conditions are maintained in a community. Inadequate or unsuitable sanitation or disposal of waste can increase the risk of disease and can facilitate the spread of waterborne diseases such as cholera. The access of community members to proper sanitation, including toilets, can therefore be used as an indicator of relative vulnerability.

The type of energy available for cooking and lighting can also serve as an indicator of the relative vulnerability of communities. In areas without electricity, community members need to make use of alternative energy sources, such as paraffin, gas or wood. This can have a detrimental effect on the health of community members and pose an increase in the fire hazard.

The **social characteristics** of a community can also have an impact on the vulnerability of the community. Several characteristics that can increase the vulnerability of communities. These characteristics includes, amongst others:

- Limited access to power, structures and resources;
- Lack of local institutions, training and skills; and
- Lack of ethical standards in public life.

Economic characteristics influencing the vulnerability of communities can include aspects such as the levels of unemployment, levels of income and the percentage of economically active individuals.

Additional **environmental characteristics** that can influence the vulnerability of an area are deforestation, rapid urbanization and a decline in soil productivity.

The following steps can be taken to decrease the vulnerability and reduce disaster risk by increasing resilience in the Eastern Cape Province:

- Increase the access of vulnerable groups to power structures and resources;
- Challenge any ideology, political system or economic system where it causes or increases vulnerability;
- Development of local institutions, education, training and appropriate skill development opportunities;
- Develop and secure local investment and local markets;
- Improve ethical standards in public life (including crime prevention, safety and security)
- Manage urbanisation;
- Protect natural and forest environments;
- Diversify rural income opportunities; and
- Strengthen livelihoods and increase low-income levels.

The vulnerability profile of the Eastern Cape Province was calculated based on the Stats SA 2011 Census data and Community Survey 2016. The indicators used to compile the vulnerability profile included:

- Access to water;
- Sanitation systems;
- Refuse removal services;
- Income Levels;
- Energy used for cooking;
- Employment levels;
- Dwelling type;
- Age Profile; and
- Educational Profile.

The Vulnerability modelling for the municipality was conducted based on relative vulnerability levels associated with social, structural, economic and environmental vulnerability levels in the Eastern Cape Province. Land cover data was used to indicate relative vulnerability ratings for economic and structural vulnerability. Social vulnerability mapping is based on the level of services available to communities, while the environmental vulnerability map is based on a combination of the vegetation protection status map and the conservation status map. Land cover areas with informal and traditional type structures were given a higher vulnerability rating than areas with more formal development.

Social vulnerability ratings are based on the 2011 census data. The availability of basic services was assessed to calculate a vulnerability rating. Wards with more access to electricity, water, sanitation and waste removal were classified as lower vulnerability and wards with less access to services as higher vulnerability.

During the analysis of the Auditor General reports for audits of municipalities in South Africa. We have found that some of the municipalities had poor audit results. Within the Eastern Cape there was only one district municipality there that received a clean audit report. The financial ability of the municipalities directly reflects their ability to provide services to the communities and reflect their ability to cope with emergencies and disasters within the area using financial resources.

The following figure gives us a clear indication what the sources of municipal funding in South Africa is. A large portion more than 28% is contributed by grants and subsidises. This just further emphasise the fact that the local economies cannot support the required municipal services. This can only be rectified by economic growth.

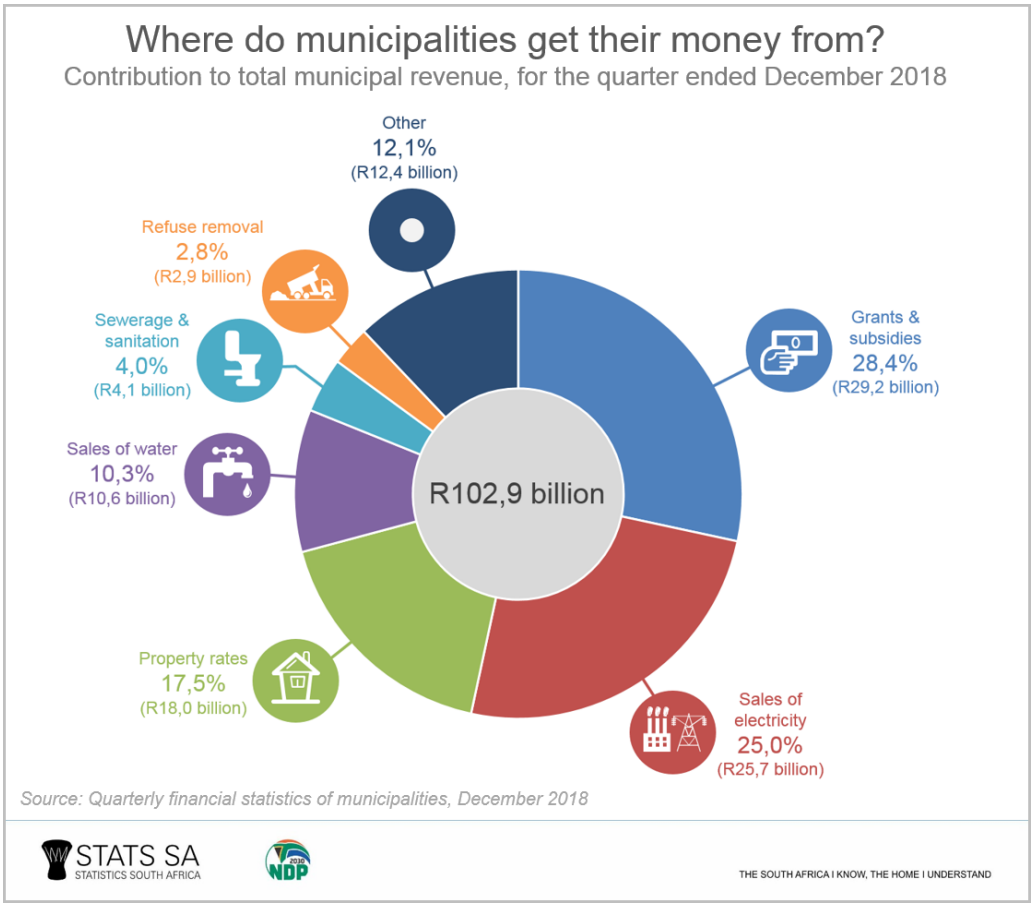

Figure 8-2: Where do Municipalities get their money from? (Statistics South Affica, 2019)

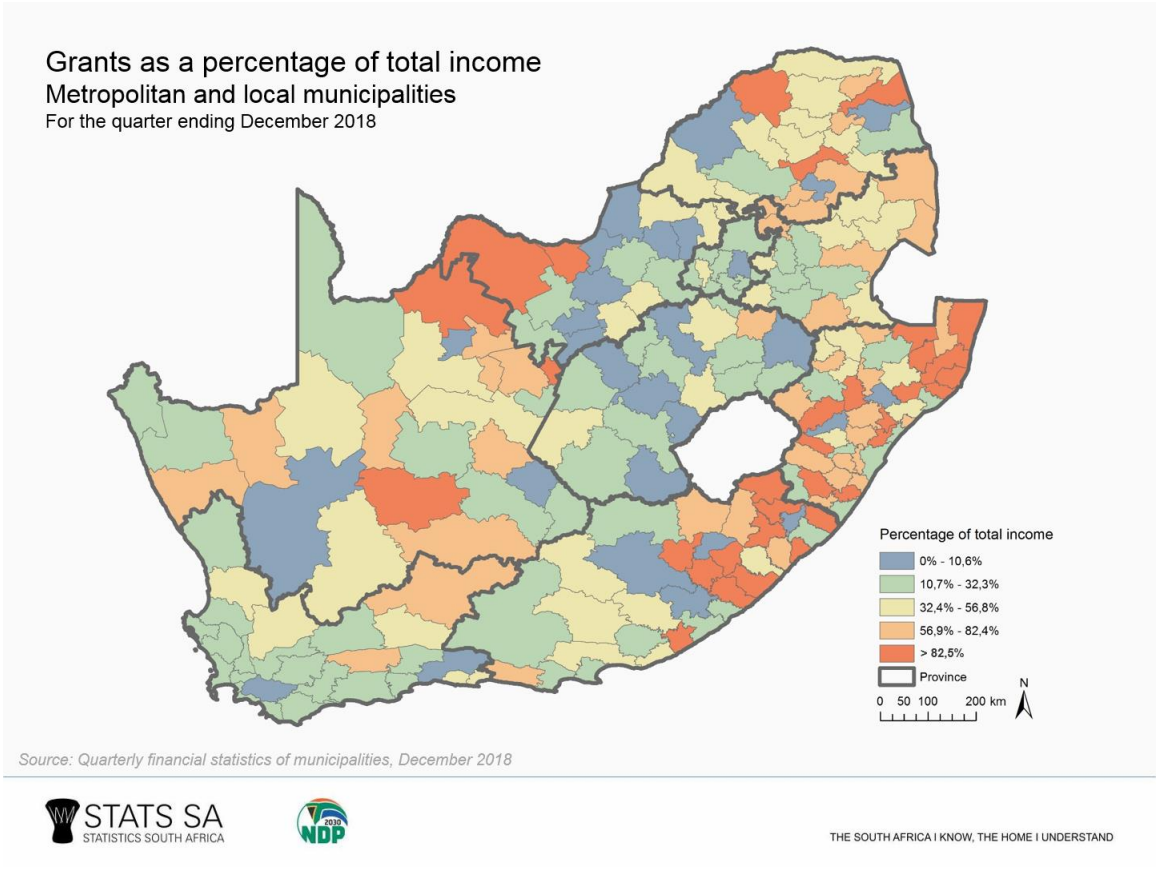

Figure 8-3: Grants as a percentage of total income (Statistics South Affica, 2019)

From Figure 8-3 it can clearly be seen that a large portion of the municipalities within the Eastern Cape province are reliant on grants and subsidises for their income. Based on this we can assume that economic vulnerability exists due to the reliance of these municipalities on these grants and subsidies.

9 Resilience Profile of the Eastern Cape Province

The resilience characteristics relate to the capacity within the Eastern Cape Province area to counter the effects of hazards and vulnerabilities. Resilience levels are measured by quantifying Manageability and Capacity values of an area, and are defined as follows:

Manageability – For the purpose of this assessment Manageability was defined as the combination of all the strengths and resources available within the government departments and line-functions that can be used to reduce the level of risk or the effects of a disaster. This includes the level of staff or human resources, available expertise, suitable experience, available vehicles, equipment, funding or budget allocations, facilities and risk reduction and response plans.

Capacity – For the purpose of this assessment Capacity was defined as the combination of all the strengths and resources available within the community or society that can be used to reduce the level of risk or the effects of a disaster. Capacity was rated by making use of the same classification as Manageability.

Resilience – The Resilience value defines the total 'resilience' level in a specific area or community based on the *Capacity* levels of the community, as well as the *Manageability* levels of the authorities, government department and line-functions to deal with disaster risk or the effects of disasters. The Resilience value is calculated by combining the Manageability and Capacity values.

9.1 Description of resilience role players

A description of the responding role-players as well as the results of the self-evaluation is provided below.

9.1.1 Business, Industry and the Chamber of Commerce

The private sector plays an important role regarding disaster management. It is important that cooperation and coordination between the private sector and the Eastern Cape Province, including disaster management, is encouraged. The private sector, however, does not only play a role in supporting the municipality's disaster management activities, but should also ensure that internal risk management activities, especially related to enterprise risk and business continuity management are in place. This will lead to a more resilient economy in the Eastern Cape Province.

9.1.2 Community

Community groups have played and continue to play a major role in disaster management. They are quick in response, have local knowledge and expertise to their advantage and can also act as important channels for awareness raising and education. Disaster management therefore needs to be a coordinated effort between government, various institutions, non-governmental organisations, community-based organisations and the commercial sector. Where communities are not directly involved and are passive recipients of relief, the result may be the aggravation of a "dependency" syndrome. Existing community networks and agencies can therefore play a major role in disaster management, but the pressing need is for such groups to expand their roles in disaster reduction and mitigation activities and not merely to focus on relief activities.

Based on the above, it is important to consider the community in the Eastern Cape Province not only as helpless victims of disaster events, but as empowered role-players who can play a valuable role in support of both pre- and post-disaster activities.

9.1.3 Healthcare representatives

Healthcare representatives play a critical role in disaster management. This is not only true for post-disaster response activities, but more so for disaster risk reduction. Health related role players can play a valuable role in improving the health of community members, thereby decreasing vulnerability to some types of hazards, but can also play a role in surveillance and early warning to identify the outbreak of diseases.

The location of health-related facilities within the Eastern Cape Province was identified based on GIS data received from the PDMC as well as the NDMC. The location of all the facilities included in the GIS modelling process is shown in Figure 9-1 with a distance buffer around each of the facilities.

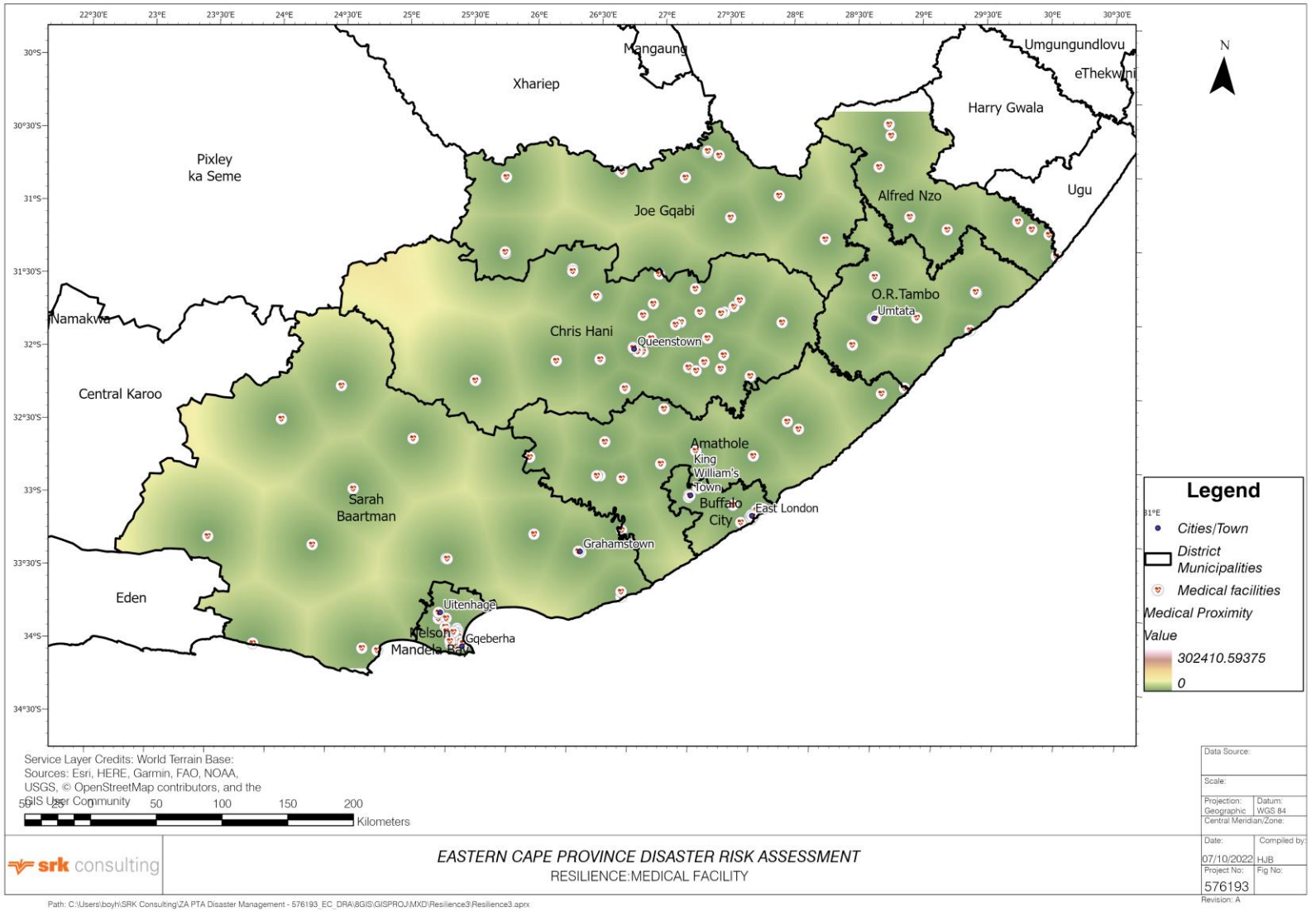

Figure 9-1: Location resilience based on healthcare related facilities in the Eastern Cape Province

9.1.4 Education

Role-players in the education sector not only play an important role in terms of capacity building and raising awareness but can also assist with risk reduction and response initiatives. Schools often also have infrastructure that can be used during the response to disasters.

9.1.5 Department of Social Development / Social Security

The Department of Social Development has the following primary core functions:

- Management and oversight over social security, encompassing social assistance and social insurance policies that aim to prevent and alleviate poverty in the event of life cycle risks such as loss of income due to unemployment, disability, old age or death occurring.
- Developmental social welfare services that provide support to reduce poverty, vulnerability and the impact of HIV and AIDS through sustainable development programmes in partnership with implementing agents such as State-funded institutions, Non-Governmental Organisations (NGOs), Community-Based Organisations (CBOs) and Faith-Based Organisations (FBOs).

9.1.6 Department of Home Affairs

The mandates of the Department of Home Affairs are embedded in legislation, as well as other policy documents. In order to fulfil its mission, the Department executes or participates in the execution of Civic, Immigration and other mandates. Some of the core functions include the following key services,

- Maintaining the National Population Register;
- Management of records;
- Citizenship;
- Travel documents and passports; and
- Identity documents (DHA 2009).

Immigration services provided by the Department include:

- Admissions;
- Inspectorate;
- Refugee affairs;
- Information co-ordination;
- Policy directives; and
- Counter-xenophobia (DHA 2009).

From this overview, it is evident that the Department of Home Affairs can play an important role in Disaster Management. This role is especially important when complex disasters or events such as xenophobic violence occur.

9.1.7 Department of Water and Sanitation

The Department of Water and Sanitation is the custodian of South Africa's water resources. It is primarily responsible for the formulation and implementation of policy governing this sector and has overriding responsibility for water services provided by local government. While striving to ensure that all South Africans gain access to clean water and safe sanitation, the water sector also promotes effective and efficient water resources management to ensure sustainable economic and social development (Department of Water & Sanitation, 2014).

Due to the important role that water plays in influencing the vulnerability, resilience and hazard profile of an area, the Department of Water and Sanitation (DWS) plays an important role in Disaster Management. Even though the DWS will play a critical role in terms of setting policies and strategic management of water resources on national level, the local capacity of DWS representatives will affect the Eastern Cape Province

more directly. Continued cooperation between disaster management and local representatives of DWS is encouraged.

9.1.8 Disaster Management

The role of the Disaster Management centre is described in the Act and related framework documents. The Disaster Management functions are overall disaster risk management and co-ordination, as per section 44 of the Disaster Management Act. This includes a range of activities both during, pre- and post-disaster stages.

9.1.9 Fire Service

The Fire Service plays a critical role in disaster management. This is not only related to emergency response for incidents such as fires and accidents, but also relates to fire risk reduction with inspections and training throughout the municipality.

The location of fire stations within the Eastern Cape Province was identified based on GIS data received from the Eastern Cape Province. The location of fire stations in the Eastern Cape Province is shown in Figure 9-2.

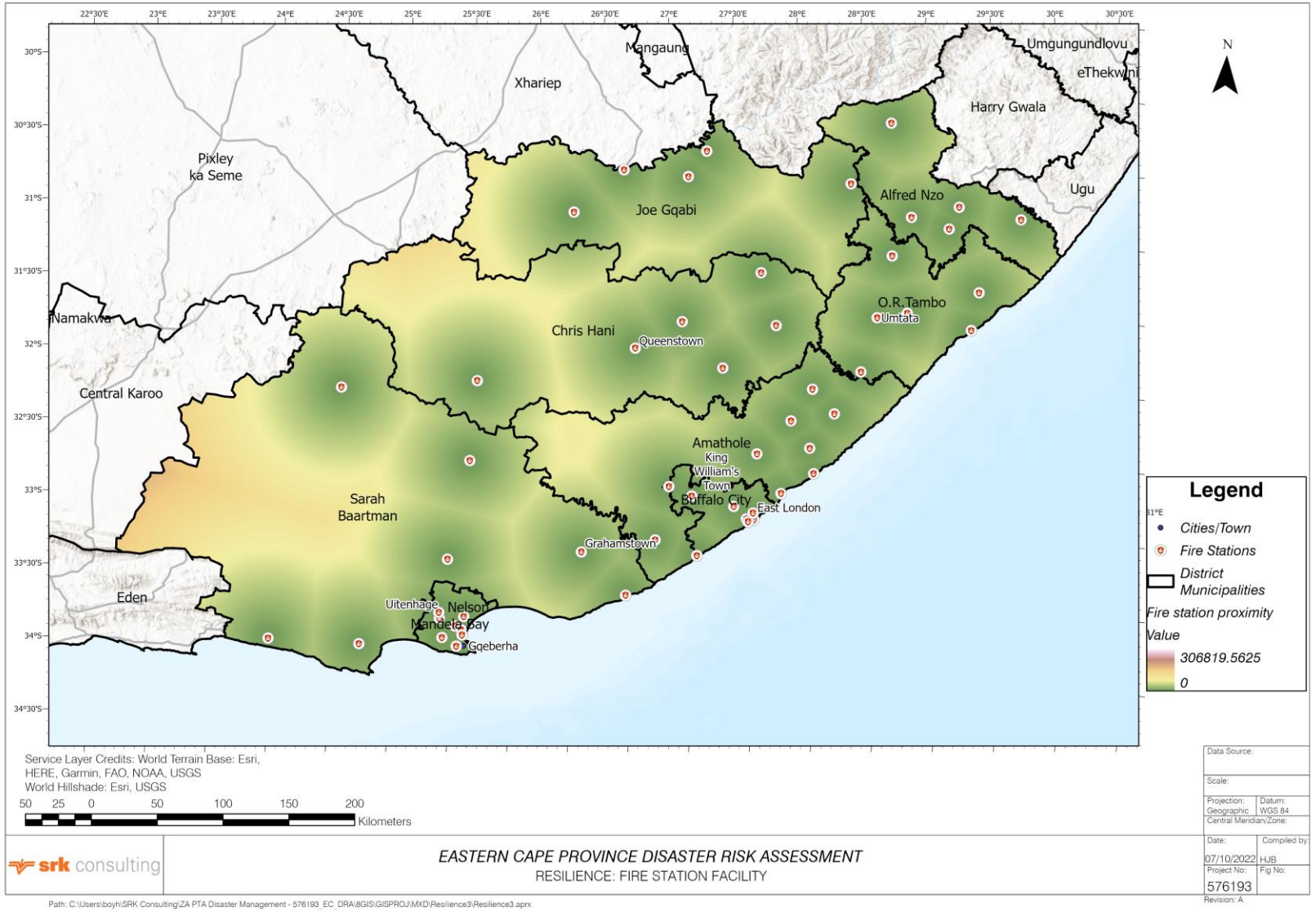

Figure 9-2: Location of Fire Stations in the Eastern Cape Province

9.1.10 Traffic Department

The traffic department can play an important role in both pre- as well as post-disaster situations. Not only does the traffic department assist with managing aspects related to transportation during emergencies and disasters, but the traffic department has an important responsibility with regards to risk reduction and law enforcement which can reduce the risk of transportation related disasters.

9.1.11 Non-Governmental Organizations

Non-Governmental, Religious and Faith Based Organizations can play an important role in disaster management. According to the Green Paper on Disaster Management (GPODM) (1998) *"non-governmental organisations have often played an important relief role in disasters. Some evaluations of past involvement of non-governmental organisations and during disasters have shown that non-governmental involvement has generally been positive. This is not to say that all community committees worked well. Some have been more successful than others. Conflicts between government and non-governmental organisations, and between community groups, can arise, delaying and hampering disaster management activities. Because non-governmental organisations can often provide relief more quickly, and in the case of small disasters, more appropriately, it is important that the government ensure that non-governmental organisations receive information promptly. At the same time, non-governmental organisations have much useful information to offer to the local early-warning system. Non-governmental organisations should therefore be a formal part of the local early-warning system. Even when disasters are so large that they are beyond the resources of the non-governmental organisations, these organisations are often able to provide assistance that is complementary to government. Good links with non-governmental organisations should therefore be promoted at all levels."* The above section highlights the importance of the role of NGOs in disaster management.

9.1.12 South African National Defence Force

According to the GPODM[10] (1998), "the primary role of the SANDF is defence. The SANDF may, however, be employed for service in the preservation of life, health, or property and for service in the provision or maintenance of essential services. The SANDF can also be requested to provide support by other government departments. In the past, the SANDF has provided valuable support and services to national departments and local government where capacity has been lacking. The SANDF's role therefore is cross-cutting and can be used to enhance existing attempts by other government departments to deal with disaster situations more effectively. The SANDF has resources, though limited, to carry out search and rescue operations at land, sea and air, to provide medical support, to transport relief provisions such as food and water, and to undertake the building of bridges, earth removal and roadbuilding. The SANDF can also have access to military assistance in disaster relief operations from the other members of the Southern African Development Community. The SA Air Force can also assist with Search and Rescue Operations. The SANDF has the capability of communicating with the whole defence force and can rapidly distribute information. The SANDF works closely with provinces and at the local level and cooperates with the SAPS through a system of security committees at all levels. "The SANDF can play a critical role in disaster situations. One such example was the role the SANDF played during the Coved 19 in South Africa during 2020.

9.1.13 South African Police Service

According to the GPODM[11] (1998) "the primary role of the SAPS is crime prevention, crime investigation, and the security of citizens. However, the SAPS may be employed for service in the preservation of life, health, or property and for service in the provision or maintenance of essential services and can be requested to provide support by other government departments. In the past, the SAPS have provided valuable support and services

[10] *Sections of quote related to SAPS removed to shorten paragraph.*

[11] *Sections of quote related to SANDF removed to shorten paragraph.*

to national departments and local government where capacity has been lacking. The role therefore is cross-cutting and can be used to enhance existing attempts by other government departments to deal with disaster situations more effectively.

The SAPS has been involved in cases of disaster in crime prevention, control of traffic, maintaining public order and cordoning off and patrolling disaster areas. The SAPS also has a more specialised role in security-related disasters such as civil unrest, bomb explosions and acts of terror. In general, the SAPS are involved in most disasters where negligence is suspected and where people are killed. The SAPS has well-established nodal points which can serve as an early warning system and can be used to enhance preparedness in cases of crisis. The SAPS also has units at the provincial and local levels. It is strengthening its networks and can reach all sectors of our society through the existing Community Policing Forums. These networks are important in mobilizing voluntary support and disseminating information about disasters to communities. In this way, community preparedness can be rapidly activated."

The role that the SAPS play in terms of specialist as well as supporting function regarding disaster management is critical. The location of police stations within the Eastern Cape Province was identified based on GIS data received from the PDMC as well as the NDMC. The location of the stations included in the GIS modelling process is shown in Figure 9-3.

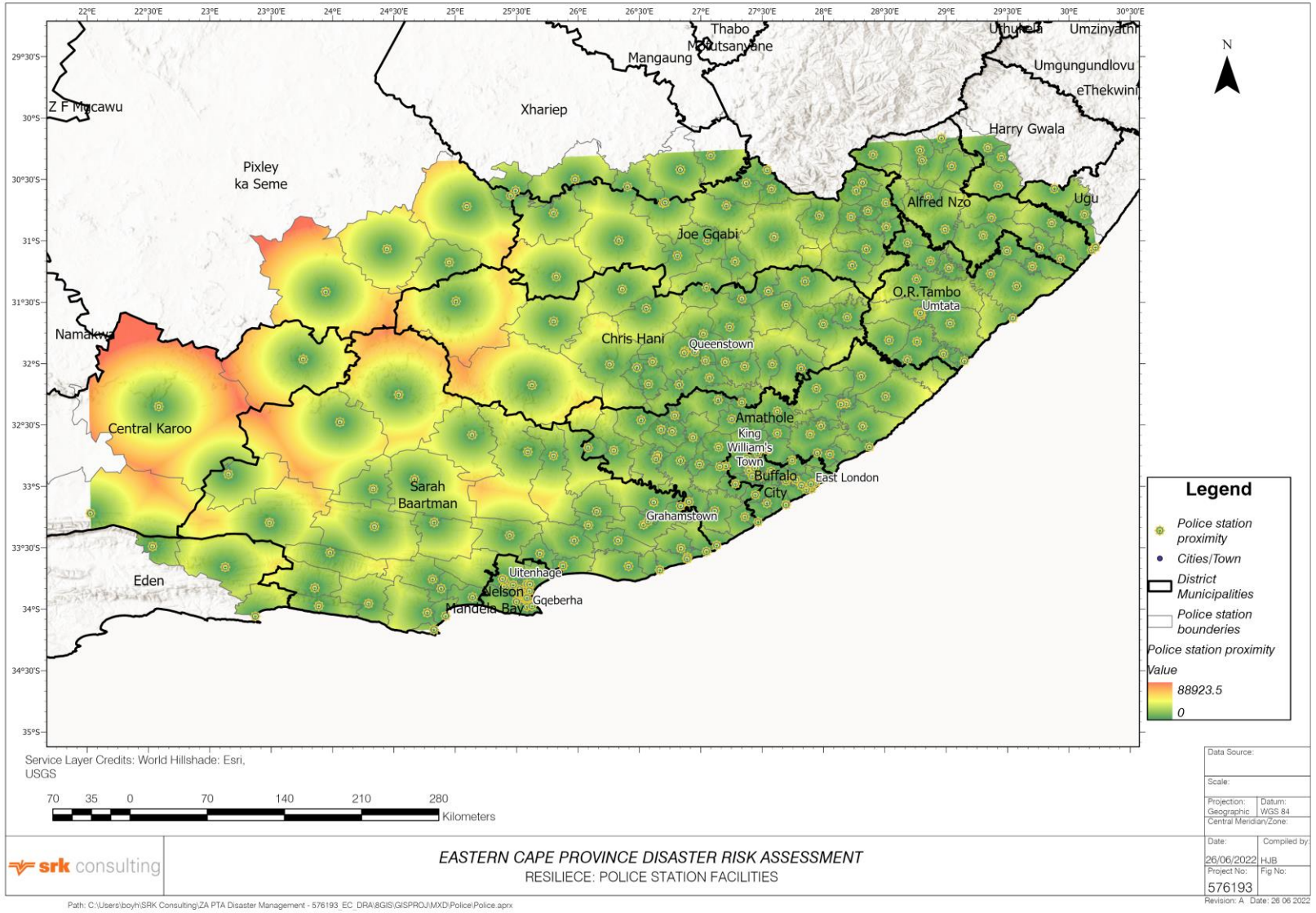

Figure 9-3: Location of Police Stations in the Eastern Cape Province

9.1.14 Weather Services

The South African Weather Service (SAWS) became a public entity on 15 July 2001 in terms of the South African Weather Service Act, Act No. 8 of 2001. In terms of the Act, the company provides two distinct services, namely public good services which are funded by government, and commercial services, where the user-pays principle applies. The South African Weather Service is an authoritative voice for weather and climate forecasting in South Africa and, as a member of the World Meteorological Organization (WMO), complies with international meteorological standards. As an Aviation Meteorological Authority, SAWS is designated by the state to provide weather services to the aviation industry and to fulfil the international obligations of the government under the Convention of the International Civil Aviation Organization (ICAO). The company also provides maritime weather forecasting services for the vast oceans around Southern Africa extending to Antarctica. The SAWS can play a very import role especially in the field of early warning and risk reduction in disaster management.

9.2 GIS based resilience mapping for the Eastern Cape Province

The risk assessment approach also required the spatial mapping of resilience levels in the Eastern Cape Province. This was done as described in Section 5.6. The result of the resilience mapping based on the location of key facilities is shown in Figure 9-4.

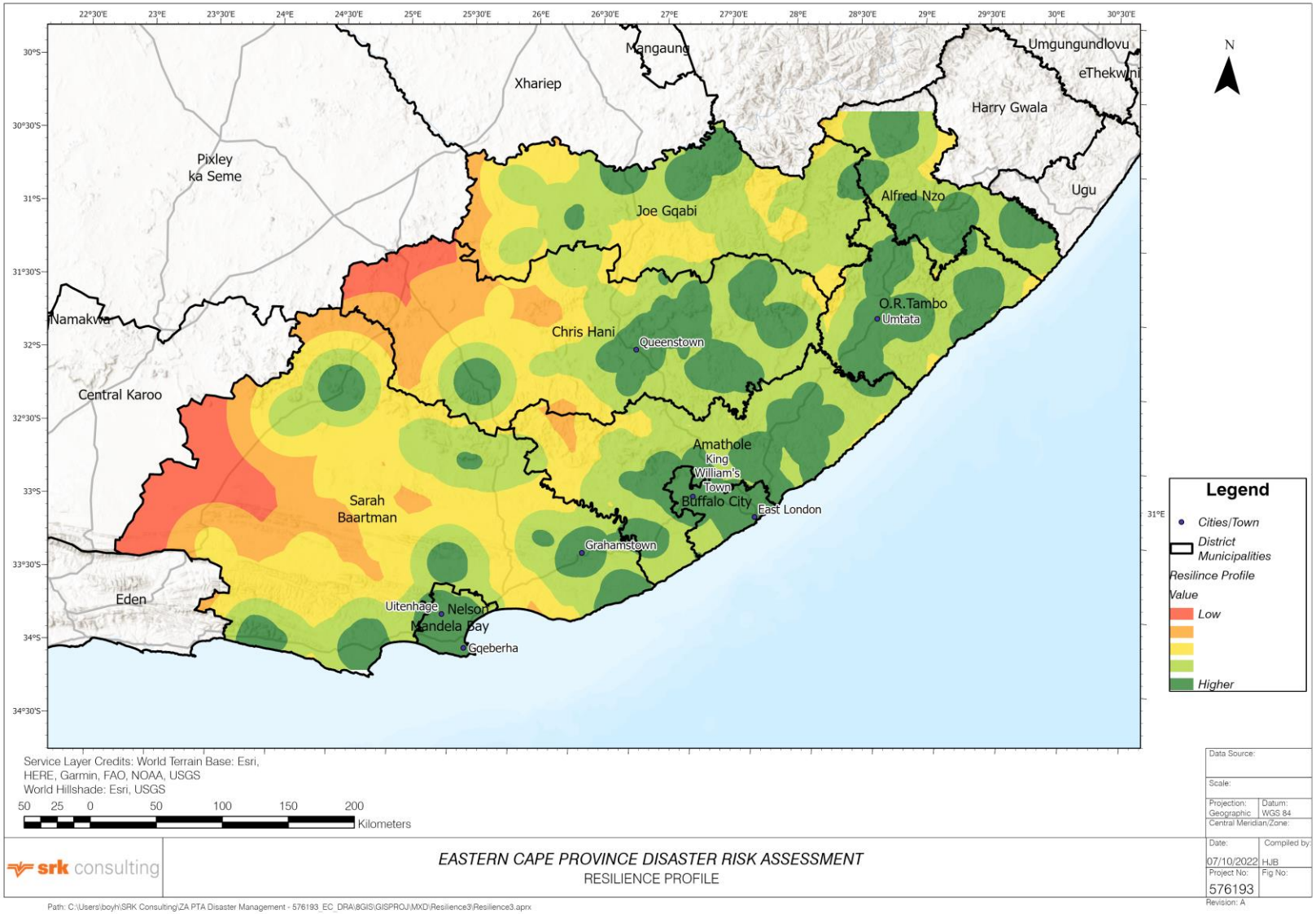

Figure 9-4: Resilience mapping based on location of key facilities in the Eastern Cape Province.

The results show higher resilience around urban areas in Eastern Cape Province that decreases in the rural parts of the province. This analysis is only based on the location of key facilities and does not take into consideration the lack of status or condition of infrastructure such as roads that will have an impact on accessibility to health, fire and police services.

10 Risk Assessment and Modelling Results

The Risk modelling process was completed by using the hazard, vulnerability and capacity data, and calculating the risk levels as described in Section 5. The risk assessment results for the Eastern Cape Province, based on the different risk assessment approached undertaken, are presented below.

10.1 Prioritised risk profile

The prioritised risk profile for the Eastern Cape Province is based on the data received from the workshop consultations, as well as the base data collected during the study. The stakeholder perception data and local resilience data were also compared with the desktop hazard assessment results, and the prioritised risk profile was developed. The numbers indicated is a combination of the hazard, vulnerability capacity and manageability of various hazards categories.

Figure 10-1 shows the relative disaster risk profile of the Eastern Cape. It is a combination of the identified top 10 disaster risks. Each risk was weighted depending on its rank.

The Risk Prioritization for the Eastern Cape Province is shown in the tables below.

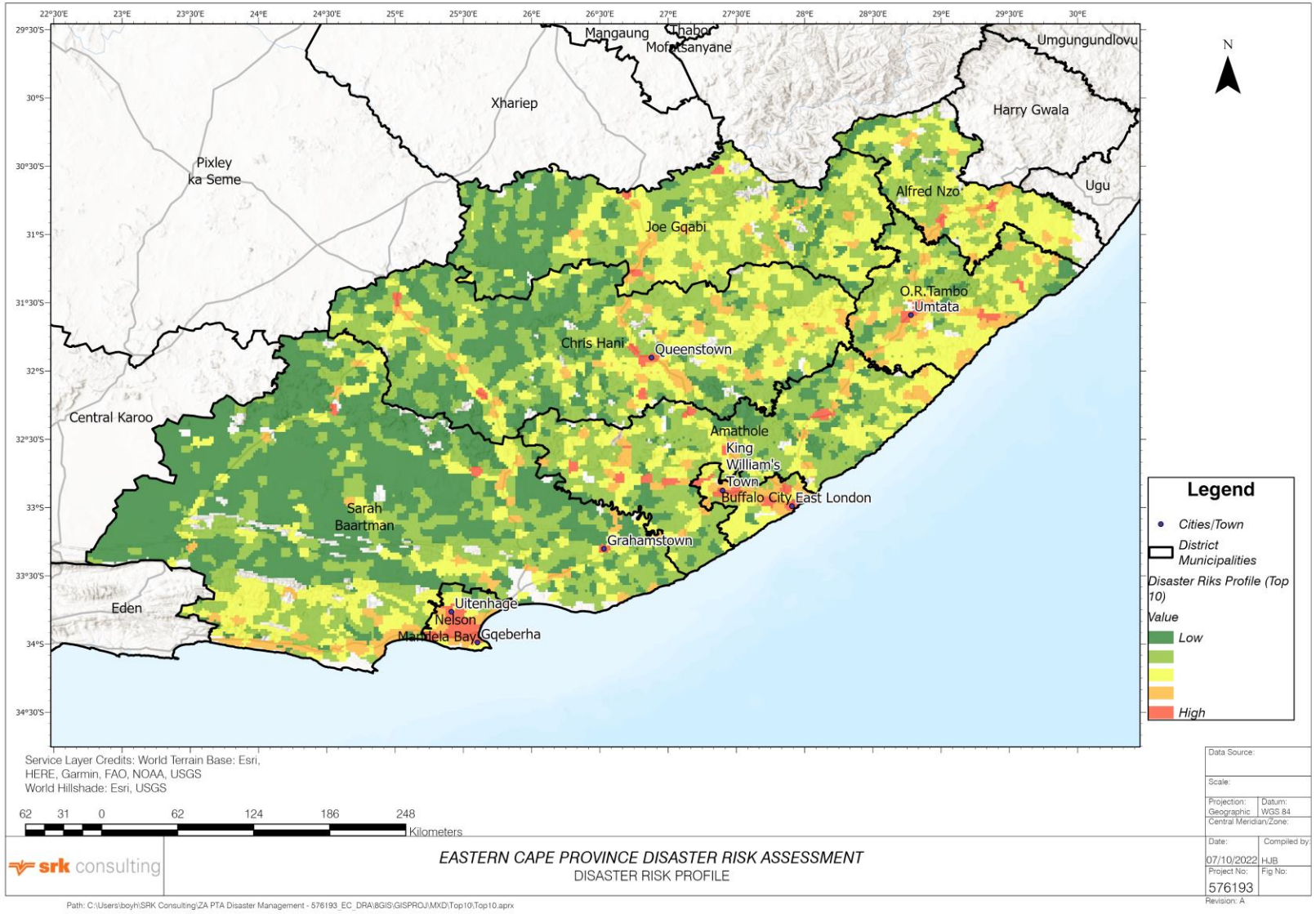

Figure 10-1: Combined Relative Disaster Risk Profile for the Eastern Cape (weighted)

Table 10-1: Prioritized risks for Alfred Nzo District Municipality

Hazard Category	Alfred Nzo District Municipality
Fire Hazards - Formal & Informal Settlements / Urban Area	10.43
Fire Hazards - Veld/Forest Fires	9.83
Hazardous Material - Fire/Explosion (Storage & Transportation)	9.03
Hydro-meteorological - Drought	9.02
Hazardous Material - Spill/Release (Storage & Transportation)	8.93
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	8.93
Pollution - Water Pollution (Fresh and Sea)	7.83
Pollution - Land Pollution	7.83
Transport Hazards - Road Transportation	7.63
Disease / Health - Disease: Human	6.93
Pollution - Air Pollution	6.93
Infestations - Plant Infestations (Intruder Plants)	6.73
Civil Unrest - Demonstrations / Riots	6.43
Major Event Hazards - Political	6.13
Major Event Hazards - Cultural / Religious	6.13
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	6.03
Structural Failure - Dam failure	5.93
Infrastructure Failure / Service Delivery Failure - Electrical	5.93
Infrastructure Failure / Service Delivery Failure - Water	5.93
Civil Unrest - Armed Conflict (Civil/Political War)	5.93
Infrastructure Failure / Service Delivery Failure - Transport	5.93
Infrastructure Failure / Service Delivery Failure - Sanitation	5.93
Environmental Degradation - Land Degradation	5.83
Environmental Degradation - Loss of Biodiversity	5.83
Transport Hazards - Air Transportation	5.73
Major Event Hazards - Recreational / Commercial	5.63
Structural Failure - Bridge Failure	5.63
Major Event Hazards - Sport	5.53
Environmental Degradation - Erosion	5.43
Civil Unrest - Crime	5.33
Geological Hazards - Earthquake	5.23
Disease / Health - Disease: Animal	5.13

Hazard Category	Alfred Nzo District Municipality
Geological Hazards - Landslides/Mud flows	5.13
Environmental Degradation - Deforestation	5.13
Disease / Health - Disease: Plants	5.03
Hydro-meteorological Hazards - Extreme Temperatures	4.93
Infestations - Insect Infestation	4.93
Hydro-meteorological Hazards - Desertification	4.93
Geological Hazards - Rock-fall	4.63
Structural Failure - Building Failure	4.43
Oceanographic - Tsunami	4.43
Oceanographic - Storm Surge	4.33
Transport Hazards - Water Transportation (Incl Marine Accident)	4.23
Infestations - Animal Infestation / Over Population	4.13
Oceanographic - Sea Level Rise (Climate Change)	3.93
Infrastructure Failure / Service Delivery Failure - Information Technology	3.83
Civil Unrest - Refugees / Displaced People	2.93
Geological Hazards - Subsidence	2.43
Civil Unrest - Xenophobic Violence	1.93
Civil Unrest - Terrorism	0.93

Table 10-2: Prioritized risks for Amathole District Municipality

Hazard Category	Amathole District Municipality
Hydro-meteorological - Drought	9.92
Fire Hazards - Veld/Forest Fires	9.52
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	9.52
Fire Hazards - Formal & Informal Settlements / Urban Area	9.42
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	8.92

Hazard Category	Amathole District Municipality
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.52
Transport Hazards - Road Transportation	8.22
Civil Unrest - Demonstrations / Riots	8.12
Civil Unrest - Crime	8.12
Hazardous Material - Spill/Release (Storage & Transportation)	8.02
Infestations - Insect Infestation	7.92
Infestations - Plant Infestations (Intruder Plants)	7.72
Pollution - Water Pollution (Fresh and Sea)	7.62
Pollution - Land Pollution	7.62
Infrastructure Failure / Service Delivery Failure - Transport	7.42
Structural Failure - Bridge Failure	7.42
Oceanographic - Storm Surge	7.42
Major Event Hazards - Recreational / Commercial	7.32
Civil Unrest - Armed Conflict (Civil/Political War)	7.12
Pollution - Air Pollution	6.92
Infrastructure Failure / Service Delivery Failure - Electrical	6.92
Disease / Health - Disease: Plants	6.82
Transport Hazards - Air Transportation	6.72
Hydro-meteorological Hazards - Desertification	6.62
Environmental Degradation - Deforestation	6.42
Hydro-meteorological Hazards - Extreme Temperatures	6.42
Major Event Hazards - Political	6.32
Major Event Hazards - Cultural / Religious	6.32
Major Event Hazards - Sport	6.32
Disease / Health - Disease: Human	6.12
Environmental Degradation - Land Degradation	6.02
Geological Hazards - Landslides/Mud flows	6.02
Geological Hazards - Rock-fall	6.02
Infrastructure Failure / Service Delivery Failure - Water	5.92
Oceanographic - Tsunami	5.92
Oceanographic - Sea Level Rise (Climate Change)	5.92
Infrastructure Failure / Service Delivery Failure - Sanitation	5.72
Structural Failure - Building Failure	5.72
Transport Hazards - Water Transportation (Incl Marine Accident)	5.72

Hazard Category	Amathole District Municipality
Environmental Degradation - Loss of Biodiversity	5.62
Infestations - Animal Infestation / Over Population	5.62
Infrastructure Failure / Service Delivery Failure - Information Technology	5.42
Structural Failure - Dam failure	5.22
Environmental Degradation - Erosion	4.92
Disease / Health - Disease: Animal	4.92
Civil Unrest - Refugees / Displaced People	3.92
Geological Hazards - Earthquake	2.92
Civil Unrest - Xenophobic Violence	2.92
Civil Unrest - Terrorism	2.92
Transport Hazards - Rail Transportation	2.92
Geological Hazards - Subsidence	0.92

Table 10-3: Prioritized risks for Buffalo City Metropolitan

Hazard Category	Buffalo City Metropolitan
Fire Hazards - Formal & Informal Settlements / Urban Area	9.49
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	8.99
Hydro-meteorological - Drought	8.59
Transport Hazards - Road Transportation	8.29
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.09
Hazardous Material - Spill/Release (Storage & Transportation)	8.09
Fire Hazards - Veld/Forest Fires	7.99
Transport Hazards - Air Transportation	7.99
Disease / Health - Disease: Human	7.89
Pollution - Water Pollution (Fresh and Sea)	7.59
Civil Unrest - Demonstrations / Riots	7.49
Transport Hazards - Water Transportation (Incl Marine Accident)	7.29

Hazard Category	Buffalo City Metropolitan
Pollution - Air Pollution	7.04
Civil Unrest - Crime	6.99
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	6.69
Pollution - Land Pollution	6.59
Major Event Hazards - Recreational / Commercial	6.49
Major Event Hazards - Sport	6.49
Structural Failure - Building Failure	6.49
Structural Failure - Bridge Failure	6.29
Major Event Hazards - Political	5.99
Major Event Hazards - Cultural / Religious	5.89
Oceanographic - Storm Surge	5.79
Infestations - Plant Infestations (Intruder Plants)	5.69
Oceanographic - Sea Level Rise (Climate Change)	5.59
Hydro-meteorological Hazards - Extreme Temperatures	5.49
Infestations - Animal Infestation / Over Population	5.39
Structural Failure - Dam failure	5.19
Disease / Health - Disease: Animal	5.09
Civil Unrest - Armed Conflict (Civil/Political War)	4.99
Infrastructure Failure / Service Delivery Failure - Electrical	4.99
Infrastructure Failure / Service Delivery Failure - Water	4.99
Geological Hazards - Rock-fall	4.79
Oceanographic - Tsunami	4.79
Environmental Degradation - Land Degradation	4.69
Geological Hazards - Landslides/Mud flows	4.69
Infrastructure Failure / Service Delivery Failure - Transport	4.49
Infrastructure Failure / Service Delivery Failure - Sanitation	4.49
Infestations - Insect Infestation	4.39
Hydro-meteorological Hazards - Desertification	4.29
Environmental Degradation - Deforestation	4.09
Environmental Degradation - Erosion	3.99
Disease / Health - Disease: Plants	3.89
Environmental Degradation - Loss of Biodiversity	3.69
Infrastructure Failure / Service Delivery Failure - Information Technology	3.59
Civil Unrest - Xenophobic Violence	3.29
Transport Hazards - Rail Transportation	2.99
Geological Hazards - Earthquake	2.59

Hazard Category	Buffalo City Metropolitan
Civil Unrest - Refugees / Displaced People	2.49
Civil Unrest - Terrorism	2.49
Geological Hazards - Subsidence	2.49
Infestations - Algal Bloom (Red Tide)	2.49

Table 10-4: Prioritized risks for Chris Hani District Municipality

Hazard Category	Chris Hani District Municipality
Hydro-meteorological - Drought	9.51
Fire Hazards - Veld/Forest Fires	9.31
Fire Hazards - Formal & Informal Settlements / Urban Area	9.21
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	9.11
Infestations - Insect Infestation	9.01
Pollution - Water Pollution (Fresh and Sea)	8.11
Disease / Health - Disease: Human	8.01
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	8.01
Civil Unrest - Demonstrations / Riots	7.21
Hazardous Material - Spill/Release (Storage & Transportation)	7.11
Pollution - Land Pollution	7.11
Transport Hazards - Road Transportation	7.01
Infrastructure Failure / Service Delivery Failure - Transport	7.01
Hydro-meteorological Hazards - Desertification	6.91
Hazardous Material - Fire/Explosion (Storage & Transportation)	6.71
Civil Unrest - Crime	6.71
Infestations - Animal Infestation / Over Population	6.71
Disease / Health - Disease: Animal	6.71
Infestations - Plant Infestations (Intruder Plants)	6.61
Pollution - Air Pollution	6.51

Hydro-meteorological Hazards - Extreme Temperatures	6.51
Infrastructure Failure / Service Delivery Failure - Electrical	6.51
Infrastructure Failure / Service Delivery Failure - Water	6.51
Infrastructure Failure / Service Delivery Failure - Sanitation	6.51
Disease / Health - Disease: Plants	6.51
Structural Failure - Bridge Failure	6.31
Geological Hazards - Rock-fall	6.21
Geological Hazards - Landslides/Mud flows	6.21
Major Event Hazards - Recreational / Commercial	6.01
Major Event Hazards - Political	6.01
Major Event Hazards - Cultural / Religious	6.01
Transport Hazards - Air Transportation	5.81
Environmental Degradation - Land Degradation	5.71
Environmental Degradation - Loss of Biodiversity	5.61
Transport Hazards - Rail Transportation	5.51
Structural Failure - Dam failure	5.31
Environmental Degradation - Erosion	5.31
Environmental Degradation - Deforestation	5.21
Major Event Hazards - Sport	5.01
Infrastructure Failure / Service Delivery Failure - Information Technology	5.01
Structural Failure - Building Failure	4.41
Civil Unrest - Armed Conflict (Civil/Political War)	4.01
Civil Unrest - Xenophobic Violence	4.01
Geological Hazards - Earthquake	4.01
Civil Unrest - Refugees / Displaced People	4.01
Civil Unrest - Terrorism	4.01
Geological Hazards - Subsidence	4.01

Table 10-5: Prioritized risks for Joe Gqabi District Municipality

Hazard Category	Joe Gqabi District Municipality
Hydro-meteorological - Drought	9.96
Fire Hazards - Veld/Forest Fires	9.96
Fire Hazards - Formal & Informal Settlements / Urban Area	8.66
Hazardous Material - Spill/Release (Storage & Transportation)	8.26

Hazard Category	Joe Gqabi District Municipality
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.26
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	7.66
Transport Hazards - Road Transportation	5.76
Pollution - Water Pollution (Fresh and Sea)	5.56
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	5.46
Disease / Health - Disease: Human	5.16
Environmental Degradation - Erosion	5.06
Structural Failure - Bridge Failure	4.96
Pollution - Land Pollution	4.86
Structural Failure - Dam failure	4.86
Pollution - Air Pollution	4.66
Hydro-meteorological Hazards - Desertification	4.56
Civil Unrest - Demonstrations / Riots	4.46
Civil Unrest - Crime	4.46
Infestations - Animal Infestation / Over Population	4.26
Disease / Health - Disease: Animal	4.26
Infestations - Plant Infestations (Intruder Plants)	4.26
Infestations - Insect Infestation	4.16
Hydro-meteorological Hazards - Extreme Temperatures	4.16
Major Event Hazards - Recreational / Commercial	4.16
Environmental Degradation - Deforestation	3.96
Infrastructure Failure / Service Delivery Failure - Water	3.86
Geological Hazards - Rock-fall	3.86
Environmental Degradation - Land Degradation	3.76
Environmental Degradation - Loss of Biodiversity	3.76
Infrastructure Failure / Service Delivery Failure - Electrical	3.66
Infrastructure Failure / Service Delivery Failure - Sanitation	3.66
Disease / Health - Disease: Plants	3.66
Geological Hazards - Landslides/Mud flows	3.66
Major Event Hazards - Political	3.66
Major Event Hazards - Cultural / Religious	3.66
Major Event Hazards - Sport	3.66
Transport Hazards - Air Transportation	3.46

Hazard Category	Joe Gqabi District Municipality
Civil Unrest - Armed Conflict (Civil/Political War)	3.46
Structural Failure - Building Failure	3.06
Geological Hazards - Subsidence	2.86
Infrastructure Failure / Service Delivery Failure - Information Technology	2.66
Transport Hazards - Water Transportation (Incl Marine Accident)	1.76
Infrastructure Failure / Service Delivery Failure - Transport	1.66
Civil Unrest - Xenophobic Violence	1.66
Geological Hazards - Earthquake	1.66
Civil Unrest - Refugees / Displaced People	1.66
Civil Unrest - Terrorism	1.66
Transport Hazards - Rail Transportation	0.66

Table 10-6: Prioritized risks for Nelson Mandela Bay Metropolitan

Hazard Category	Nelson Mandela Bay Metropolitan
Hydro-meteorological - Drought	10.35
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	10.05
Fire Hazards - Formal & Informal Settlements / Urban Area	9.85
Fire Hazards - Veld/Forest Fires	9.15
Hazardous Material - Spill/Release (Storage & Transportation)	8.85
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.75
Transport Hazards - Road Transportation	8.25

Hazard Category	Nelson Mandela Bay Metropolitan
Civil Unrest - Crime	8.15
Civil Unrest - Demonstrations / Riots	8.05
Disease / Health - Disease: Human	7.95
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	7.75
Transport Hazards - Air Transportation	7.65
Pollution - Air Pollution	7.05
Oceanographic - Storm Surge	6.75
Major Event Hazards - Sport	6.45
Infrastructure Failure / Service Delivery Failure - Electrical	6.25
Infrastructure Failure / Service Delivery Failure - Sanitation	6.25
Transport Hazards - Water Transportation (Incl Marine Accident)	6.05
Major Event Hazards - Recreational / Commercial	5.85
Hydro-meteorological Hazards - Extreme Temperatures	5.75
Major Event Hazards - Political	5.75
Pollution - Water Pollution (Fresh and Sea)	5.65
Pollution - Land Pollution	5.65
Major Event Hazards - Cultural / Religious	5.25
Infrastructure Failure / Service Delivery Failure - Information Technology	5.25
Infrastructure Failure / Service Delivery Failure - Transport	5.25
Disease / Health - Disease: Animal	5.05
Infrastructure Failure / Service Delivery Failure - Water	4.75
Oceanographic - Sea Level Rise (Climate Change)	4.75
Oceanographic - Tsunami	4.75
Disease / Health - Disease: Plants	4.65
Geological Hazards - Landslides/Mud flows	4.55
Environmental Degradation - Loss of Biodiversity	4.45
Structural Failure - Building Failure	4.45
Structural Failure - Bridge Failure	4.25
Hydro-meteorological Hazards - Desertification	4.25
Geological Hazards - Rock-fall	4.25
Environmental Degradation - Land Degradation	4.25

Hazard Category	Nelson Mandela Bay Metropolitan
Transport Hazards - Rail Transportation	4.25
Infestations - Plant Infestations (Intruder Plants)	4.15
Environmental Degradation - Erosion	3.95
Infestations - Animal Infestation / Over Population	3.85
Environmental Degradation - Deforestation	3.45
Civil Unrest - Xenophobic Violence	3.25
Structural Failure - Dam failure	2.95
Infestations - Insect Infestation	2.75
Infrastructure Failure / Service Delivery Failure - Gas	2.35
Civil Unrest - Armed Conflict (Civil/Political War)	2.25
Geological Hazards - Subsidence	2.25
Geological Hazards - Earthquake	2.25
Civil Unrest - Refugees / Displaced People	2.25
Civil Unrest - Terrorism	2.25
Infestations - Algal Bloom (Red Tide)	0.25

Table 10-7: Prioritized risks for OR Tambo District Municipality

Hazard Category	OR Tambo District Municipality
Fire Hazards - Formal & Informal Settlements / Urban Area	10.44
Hazardous Material - Spill/Release (Storage & Transportation)	10.34
Hydro-meteorological - Drought	9.84
Hazardous Material - Fire/Explosion (Storage & Transportation)	9.84
Fire Hazards - Veld/Forest Fires	9.74

Hazard Category	OR Tambo District Municipality
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	9.54
Transport Hazards - Road Transportation	9.24
Pollution - Land Pollution	8.94
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	8.54
Structural Failure - Bridge Failure	7.94
Structural Failure - Dam failure	7.94
Infestations - Plant Infestations (Intruder Plants)	7.84
Pollution - Water Pollution (Fresh and Sea)	7.74
Infrastructure Failure / Service Delivery Failure - Transport	7.74
Infrastructure Failure / Service Delivery Failure - Electrical	7.24
Infrastructure Failure / Service Delivery Failure - Water	7.24
Major Event Hazards - Recreational / Commercial	7.14
Major Event Hazards - Political	7.14
Major Event Hazards - Cultural / Religious	7.14
Disease / Health - Disease: Plants	7.04
Pollution - Air Pollution	7.01
Civil Unrest - Demonstrations / Riots	6.94
Disease / Health - Disease: Human	6.94
Infrastructure Failure / Service Delivery Failure - Sanitation	6.94
Civil Unrest - Crime	6.84
Transport Hazards - Air Transportation	6.74
Disease / Health - Disease: Animal	6.74
Infestations - Animal Infestation / Over Population	6.74
Civil Unrest - Armed Conflict (Civil/Political War)	6.74
Major Event Hazards - Sport	6.64
Hydro-meteorological Hazards - Desertification	6.64
Environmental Degradation - Land Degradation	6.64
Oceanographic - Storm Surge	6.54
Transport Hazards - Water Transportation (Incl Marine Accident)	6.54
Oceanographic - Tsunami	6.54
Structural Failure - Building Failure	6.54
Geological Hazards - Landslides/Mud flows	6.44
Environmental Degradation - Erosion	6.44
Geological Hazards - Rock-fall	6.34

Hazard Category	OR Tambo District Municipality
Geological Hazards - Earthquake	6.34
Hydro-meteorological Hazards - Extreme Temperatures	6.24
Environmental Degradation - Deforestation	6.24
Infestations - Insect Infestation	6.24
Environmental Degradation - Loss of Biodiversity	6.14
Oceanographic - Sea Level Rise (Climate Change)	5.84
Infrastructure Failure / Service Delivery Failure - Information Technology	5.74
Geological Hazards - Subsidence	5.74
Civil Unrest - Xenophobic Violence	4.74
Civil Unrest - Refugees / Displaced People	4.74
Civil Unrest - Terrorism	1.74
Transport Hazards - Rail Transportation	0.74

Table 10-8: Prioritized risks for Sarah Baartman District Municipality

Hazard Category	Sarah Baartman District Municipality
Hydro-meteorological - Drought	10.27
Fire Hazards - Veld/Forest Fires	9.67
Hazardous Material - Spill/Release (Storage & Transportation)	9.07
Hazardous Material - Fire/Explosion (Storage & Transportation)	8.77
Fire Hazards - Formal & Informal Settlements / Urban Area	8.37
Pollution - Water Pollution (Fresh and Sea)	7.97
Disease / Health - Disease: Human	7.17
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	6.77
Transport Hazards - Road Transportation	6.67

Hazard Category	Sarah Baartman District Municipality
Infestations - Insect Infestation	6.17
Civil Unrest - Demonstrations / Riots	5.97
Disease / Health - Disease: Animal	5.97
Pollution - Land Pollution	5.87
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	5.77
Structural Failure - Bridge Failure	5.47
Infestations - Plant Infestations (Intruder Plants)	5.47
Environmental Degradation - Erosion	5.37
Pollution - Air Pollution	5.17
Hydro-meteorological Hazards - Extreme Temperatures	5.17
Structural Failure - Dam failure	5.07
Major Event Hazards - Recreational / Commercial	4.87
Major Event Hazards - Cultural / Religious	4.87
Environmental Degradation - Deforestation	4.87
Infrastructure Failure / Service Delivery Failure - Transport	4.67
Infrastructure Failure / Service Delivery Failure - Water	4.67
Oceanographic - Sea Level Rise (Climate Change)	4.67
Disease / Health - Disease: Plants	4.47
Civil Unrest - Crime	4.47
Major Event Hazards - Political	4.37
Infestations - Animal Infestation / Over Population	4.37
Major Event Hazards - Sport	4.37
Geological Hazards - Landslides/Mud flows	4.37
Geological Hazards - Rock-fall	4.37
Hydro-meteorological Hazards - Desertification	4.27
Environmental Degradation - Land Degradation	4.27
Infrastructure Failure / Service Delivery Failure - Electrical	4.17
Infrastructure Failure / Service Delivery Failure - Sanitation	4.17
Oceanographic - Storm Surge	4.17
Transport Hazards - Water Transportation (Incl Marine Accident)	4.17
Environmental Degradation - Loss of Biodiversity	4.07
Structural Failure - Building Failure	3.97

Hazard Category	Sarah Baartman District Municipality
Transport Hazards - Air Transportation	3.67
Oceanographic - Tsunami	3.67
Infrastructure Failure / Service Delivery Failure - Information Technology	3.17
Geological Hazards - Subsidence	2.27
Civil Unrest - Armed Conflict (Civil/Political War)	2.17
Civil Unrest - Refugees / Displaced People	2.17
Geological Hazards - Earthquake	1.17
Civil Unrest - Terrorism	1.17
Civil Unrest - Xenophobic Violence	0.67

Table 10-9: Prioritized risk for Eastern Cape Combined

Hazard Category	Eastern Cape Combined
Hydro-meteorological - Drought	77.45
Fire Hazards - Formal & Informal Settlements / Urban Area	75.86
Fire Hazards - Veld/Forest Fires	75.16
Hazardous Material - Spill/Release (Storage & Transportation)	68.66
Hazardous Material - Fire/Explosion (Storage & Transportation)	67.96
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	66.66
Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)	61.06
Transport Hazards - Road Transportation	61.06
Pollution - Water Pollution (Fresh and Sea)	58.06
Disease / Health - Disease: Human	56.16
Civil Unrest - Demonstrations / Riots	54.66
Pollution - Land Pollution	54.46
Pollution - Air Pollution	51.28
Civil Unrest - Crime	51.06
Infestations - Plant Infestations (Intruder Plants)	48.46

Hazard Category	Eastern Cape Combined
Structural Failure - Bridge Failure	48.26
Transport Hazards - Air Transportation	47.76
Major Event Hazards - Recreational / Commercial	47.46
Infrastructure Failure / Service Delivery Failure - Electrical	45.66
Infestations - Insect Infestation	45.56
Major Event Hazards - Political	45.36
Major Event Hazards - Cultural / Religious	45.26
Hydro-meteorological Hazards - Extreme Temperatures	44.66
Major Event Hazards - Sport	44.46
Infrastructure Failure / Service Delivery Failure - Transport	44.16
Disease / Health - Disease: Animal	43.86
Infrastructure Failure / Service Delivery Failure - Water	43.86
Infrastructure Failure / Service Delivery Failure - Sanitation	43.66
Structural Failure - Dam failure	42.46
Hydro-meteorological Hazards - Desertification	42.46
Disease / Health - Disease: Plants	42.06
Environmental Degradation - Land Degradation	41.16
Infestations - Animal Infestation / Over Population	41.06
Geological Hazards - Landslides/Mud flows	41.06
Environmental Degradation - Erosion	40.46
Geological Hazards - Rock-fall	40.46
Environmental Degradation - Deforestation	39.36
Environmental Degradation - Loss of Biodiversity	39.16
Structural Failure - Building Failure	39.06
Civil Unrest - Armed Conflict (Civil/Political War)	36.66
Transport Hazards - Water Transportation (Incl Marine Accident)	35.75
Oceanographic - Storm Surge	35.00
Infrastructure Failure / Service Delivery Failure - Information Technology	34.66
Oceanographic - Sea Level Rise (Climate Change)	30.70
Oceanographic - Tsunami	30.10
Geological Hazards - Earthquake	26.16
Civil Unrest - Refugees / Displaced People	24.16
Geological Hazards - Subsidence	22.96
Civil Unrest - Xenophobic Violence	22.46
Civil Unrest - Terrorism	17.16
Transport Hazards - Rail Transportation	17.06
Infestations - Algal Bloom (Red Tide)	2.74
Infrastructure Failure / Service Delivery Failure - Gas	2.35

11 Conclusions and recommendations

The highest-level risks for the Eastern Cape have been identified as:

- Hydro-meteorological - Drought
- Fire Hazards - Formal & Informal Settlements / Urban Area
- Fire Hazards - Veld/Forest Fires
- Hazardous Material - Spill/Release (Storage & Transportation)
- Hazardous Material - Fire/Explosion (Storage & Transportation)
- Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)
- Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)
- Transport Hazards - Road Transportation
- Pollution - Water Pollution (Fresh and Sea)
- Disease / Health - Disease: Human

The relative or combined risk for all the District and Metros indicates that OR Tambo District has the highest combined risk profile in the Eastern Cape.

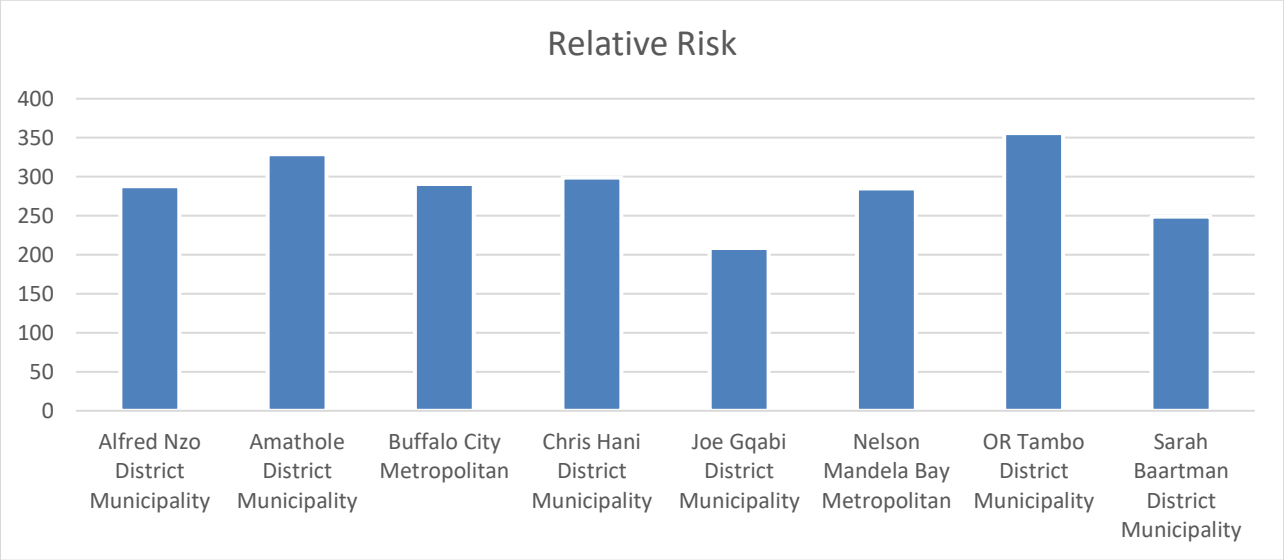

Figure 11-1: Combined Relative Disaster Risk Profile for the Eastern Cape

This indicates that OR Tambo District has the highest combined or relative risk within the Eastern Cape.

The following priorities for building municipal resilience in the Eastern Cape was identified

Table 11-1: Resilience profile (lowest 1 highest 8)

	Resilience
Chris Hani District Municipality	1
Sarah Baartman District Municipality	2
Buffalo City Metropolitan	3
Nelson Mandela Bay Metropolitan	4
Amathole District Municipality	5
OR Tambo District Municipality	6
Alfred Nzo District Municipality	7
Joe Gqabi District Municipality	8

Lower resilience needs attention, and higher resilience needs the least attention. In this context it means that Chris Hani District is the least resilient and Joe Gqabi District is the most resilient. The focus should be to

build municipal resources, resilience and adequate budget to effectively respond to emergencies and disasters in the area.

Table 11-2: Social profile (lowest 8 highest 1)

	Social
OR Tambo District Municipality	8
Amathole District Municipality	7
Alfred Nzo District Municipality	6
Chris Hani District Municipality	5
Joe Gqabi District Municipality	4
Buffalo City Metropolitan	3
Nelson Mandela Bay Metropolitan	2
Sarah Baartman District Municipality	1

The combined social profile refers to the vulnerability of people within the districts and Metros indicates that OR Tambo District has the highest Social Vulnerability while Sarah Baartman and Nelson Mandela Bay has lowest social vulnerability in the Eastern Cape. The focus areas should be on economic development, refuse, sanitation, sustainable water sources, sustainable energy sources and general social upliftment of communities.

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Appendix A: Hazard Categories and Listing

No	Hazard category
1	Civil Unrest - Armed Conflict (Civil/Political War)
2	Civil Unrest - Crime
3	Civil Unrest - Demonstrations / Riots
4	Civil Unrest - Refugees / Displaced People
5	Civil Unrest - Terrorism
6	Civil Unrest - Xenophobic Violence
7	Disease / Health - Disease: Animal
8	Disease / Health - Disease: Human
9	Disease / Health - Disease: Plants
10	Environmental Degradation - Deforestation
11	Environmental Degradation - Erosion
12	Environmental Degradation - Land Degradation
13	Environmental Degradation - Loss of Biodiversity
14	Fire Hazards - Formal & Informal Settlements / Urban Area
15	Fire Hazards - Veld/Forest Fires
16	Geological Hazards - Earthquake
17	Geological Hazards - Landslides/Mud flows
18	Geological Hazards - Rock-fall
19	Geological Hazards - Subsidence
20	Hazardous Material - Fire/Explosion (Storage & Transportation)
21	Hazardous Material - Spill/Release (Storage & Transportation)
22	Hydro-meteorological - Drought
23	Hydro-meteorological Hazards - Desertification
24	Hydro-meteorological Hazards - Extreme Temperatures
25	Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)
26	Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)
27	Infestations - Algal Bloom (Red Tide)
28	Infestations - Animal Infestation / Over Population
29	Infestations - Insect Infestation
30	Infestations - Plant Infestations (Intruder Plants)
31	Infrastructure Failure / Service Delivery Failure - Electrical
32	Infrastructure Failure / Service Delivery Failure - Gas
33	Infrastructure Failure / Service Delivery Failure - Information Technology
34	Infrastructure Failure / Service Delivery Failure - Sanitation
35	Infrastructure Failure / Service Delivery Failure - Transport
36	Infrastructure Failure / Service Delivery Failure - Water
37	Major Event Hazards - Cultural / Religious
38	Major Event Hazards - Political
39	Major Event Hazards - Recreational / Commercial

No	Hazard category
40	Major Event Hazards - Sport
41	Oceanographic - Sea Level Rise (Climate Change)
42	Oceanographic - Storm Surge
43	Oceanographic - Tsunami
44	Other - Space Objects
45	Pollution - Air Pollution
46	Pollution - Land Pollution
47	Pollution - Water Pollution (Fresh and Sea)
48	Structural Failure - Bridge Failure
49	Structural Failure - Building Failure
50	Structural Failure - Dam failure
51	Transport Hazards - Air Transportation
52	Transport Hazards - Rail Transportation
53	Transport Hazards - Road Transportation
54	Transport Hazards - Water Transportation (Incl. Marine Accident)

Appendix B: Dam Flooding

Dam failure flooding

Dams for the dam failure assessment were identified by using the 1:50 000 topographic data of the National Geo-spatial Information (NGI), a component of the Department of Agriculture, Land Reform and Rural Development (DALRRD). Water areas data layers that are classified as dams with an area of more than 50ha were included in the assessment. Dam wall information also from NGI were used to identify possible outflow area. Drainage channels created in Section 7.8.1 and inundation of 6m above the drainage line was used to simulate possible areas that can be affected by a dam-failure. 5 Km from the dam wall was selected to provide a cut-off limit to the area of impact. Figure below shows the result for the Sandile Dam as an example. Values from the dam failure inundation were transferred to the meso data layer and Figure 7-76 is the result. Darker red colour indicates a higher value because of more dams with higher inundation values.

A flood line study using hydrology principals will give a more accurate indication. It is recommended that this should be done as a further study to quantify this risk more accurately.

Dam failures are comparatively rare but can cause immense damage and loss of life when they occur.

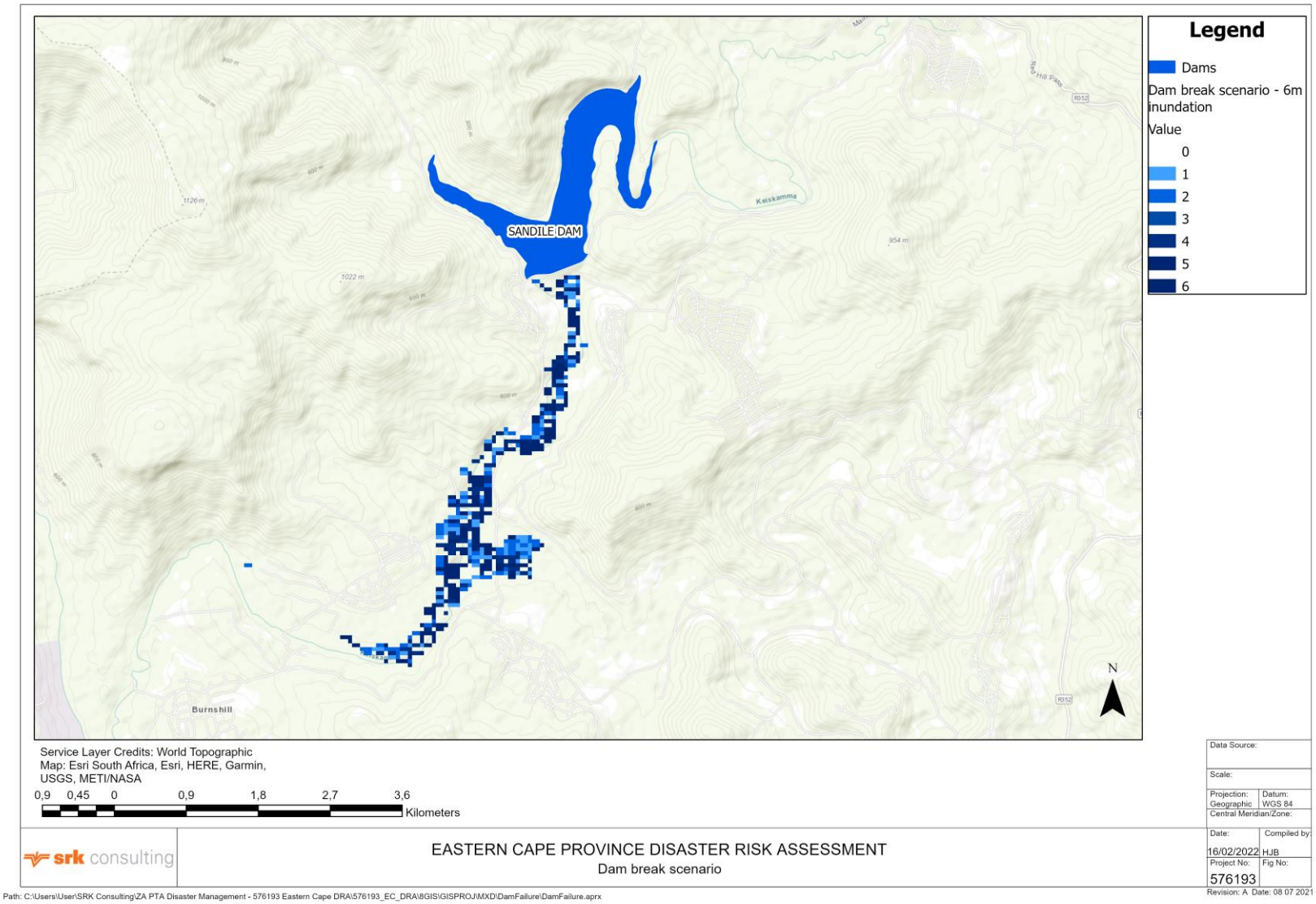

Figure: Inundation (HAND) dam failure assessment for Sandile Dam

Appendix C: HAND Method

Identify the potential hazard area

The first step is to identify the potential hazard area. The lack of flood lines that cover the whole province necessitate the use of alternative ways to identify flood risk areas. Height Above Nearest Drainage (HAND) model was identified (with some assumptions and precautions) as an appropriate method the identify the flood risk areas. The proposed method and data that the model need will ensure that the identification of potential areas can be done for the whole province.

Moore et al., 1992 indicated that Digital Elevation Models (DEM) allow us to analyse, understand and predict water storage and movement of land. With qualitative analysis of DEM's it is possible to develop hydrologically relevant numeric indicators of catchment areas, flow path, accumulated contributing areas and drainage networks.

Height Above the Nearest Drainage (HAND) normalises DEMs according to distributed vertical distances relative to the drainage channel. Furthermore, the model includes the creation of a hydrologically coherent DEM, identify flow paths and delineate the drainage channels. The result of the model is the difference in height along flow paths (draining potential) and produces a normalized DEM as a terrain descriptor with the potential extent of inundation.

Drainage lines were created for the whole province. Figure below shows the created drainage line (in blue) at Kariega which match the river line.

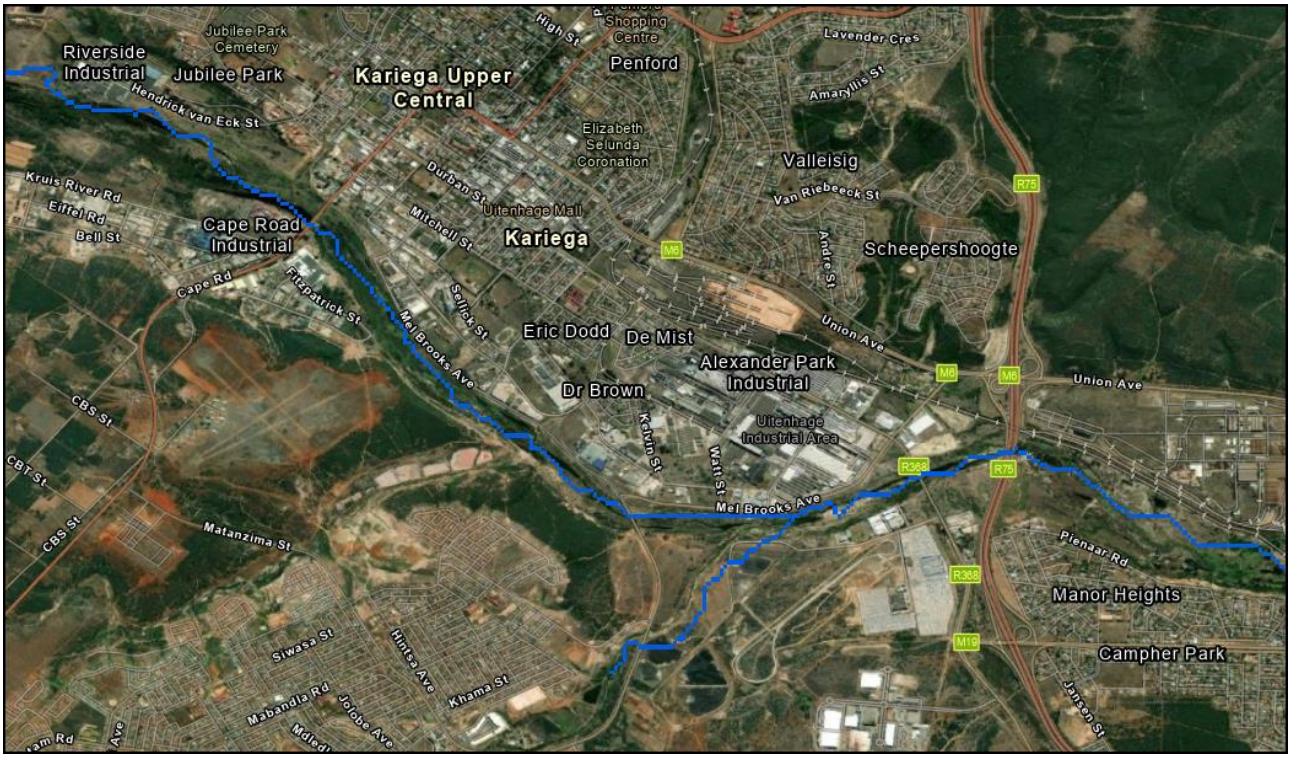

Figure: Drainage lines for the Kariega area

The next process created an area that is 2m above the drainage line taking the topography into account. Figure shows this area in blue.

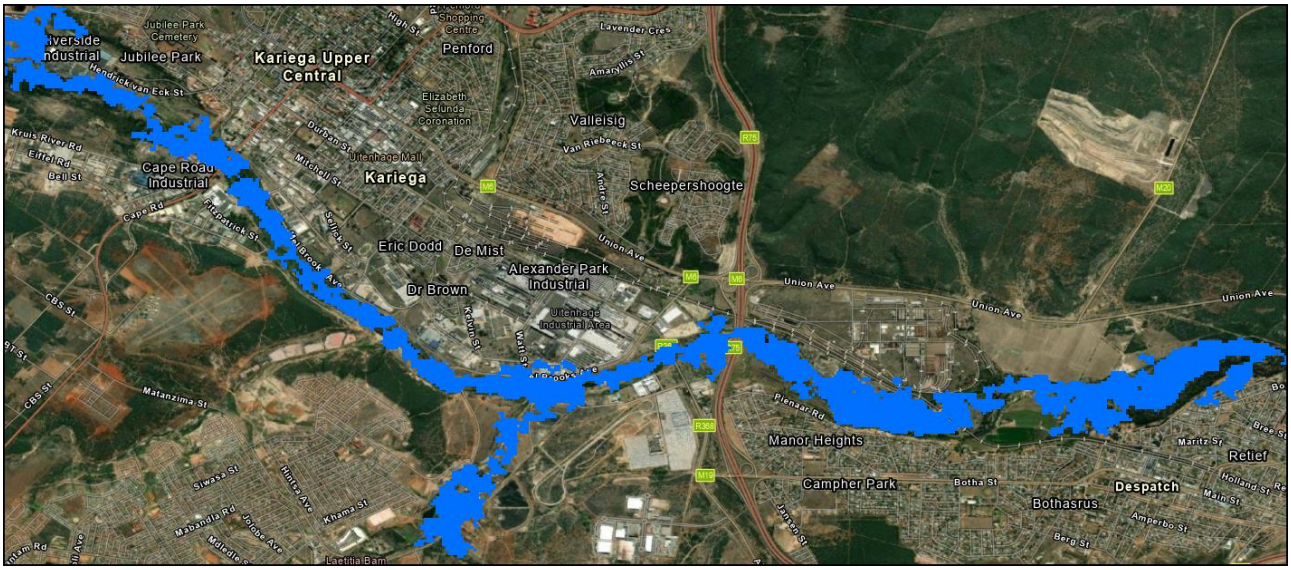

Figure: Area of inundation with 2m above drainage line

The same process was used to identify the 8m above the drainage line and Figure shows the result in blue.

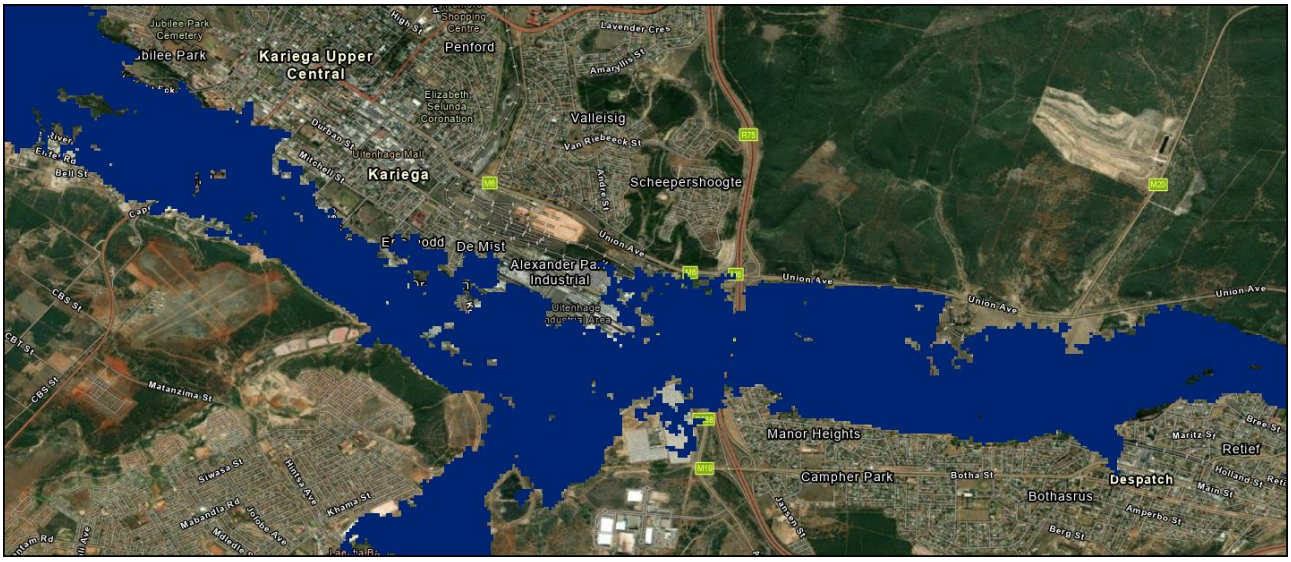

Figure: Area of inundation with 8m above drainage line

The difference is clearly visible.

Please note that only topography was used to identify the areas and no obstacles such as dams, buildings, bridges and flood walls were considered in the calculations.

Identify vulnerable area

The next step is to identify and quantify vulnerability.

Elements of vulnerability that will be included in the flood risk assessment are:

- Land cover data
  - Land Cover data from the Department of Forestry, fisheries & the Environment
  - Classes were identified for urban and agriculture impact.
- Road data
  - Road data is to identify road infrastructure that can be affected.

- The assumption is also that there is a bridge when a road crosses a river and therefor bridges can also be assessed.
- Road classification is used to differentiate between impact. Impact on or damage to a main road will be higher than a secondary road.

Identify vulnerable elements in inundated areas

Land Cover

The inundated area was used to identify the land cover features that can be affected. Figure shows in different colours the various land cover which include Industrial, Residential, Commercial and Villages for urban areas. For agricultural areas Permanent Crops, Temporary Crops, Lands & Old Fields and Planted Forest were identified and used in the calculations.

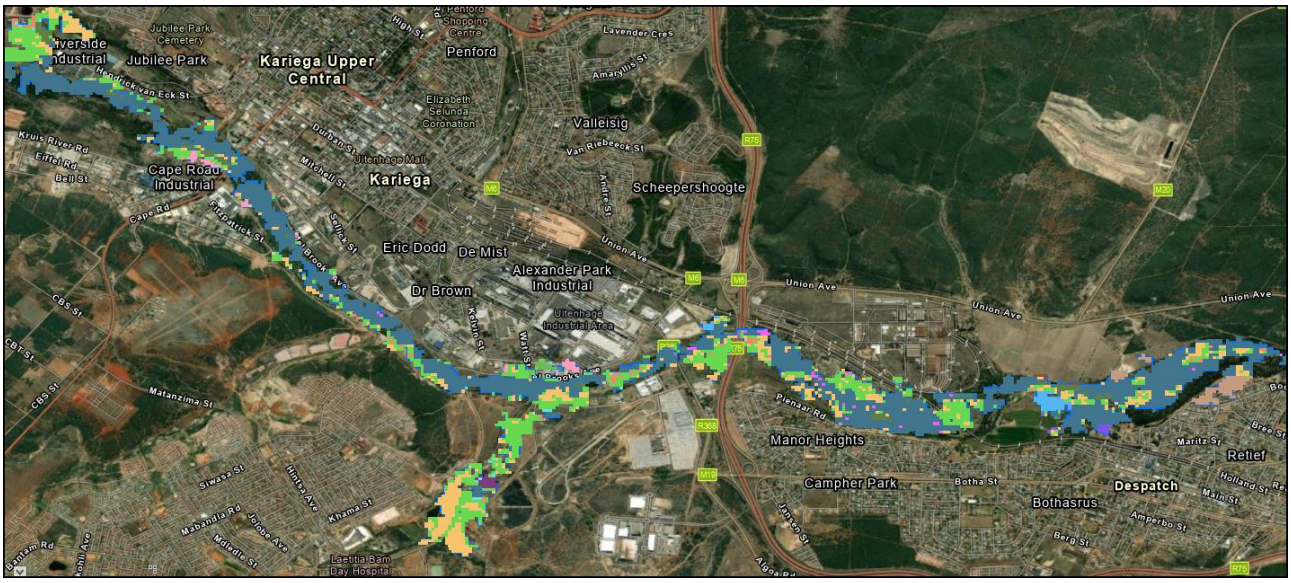

Figure: Land cover of the inundated area

Land cover data was further classified in to show possible impact. Industrial we classified as high and a value of 5 was assigned to the category. Four was assigned to Residential and 2 to Village classification. Figure below shows in green areas with no urban classification. The red area represents industrial area with a value of 5.

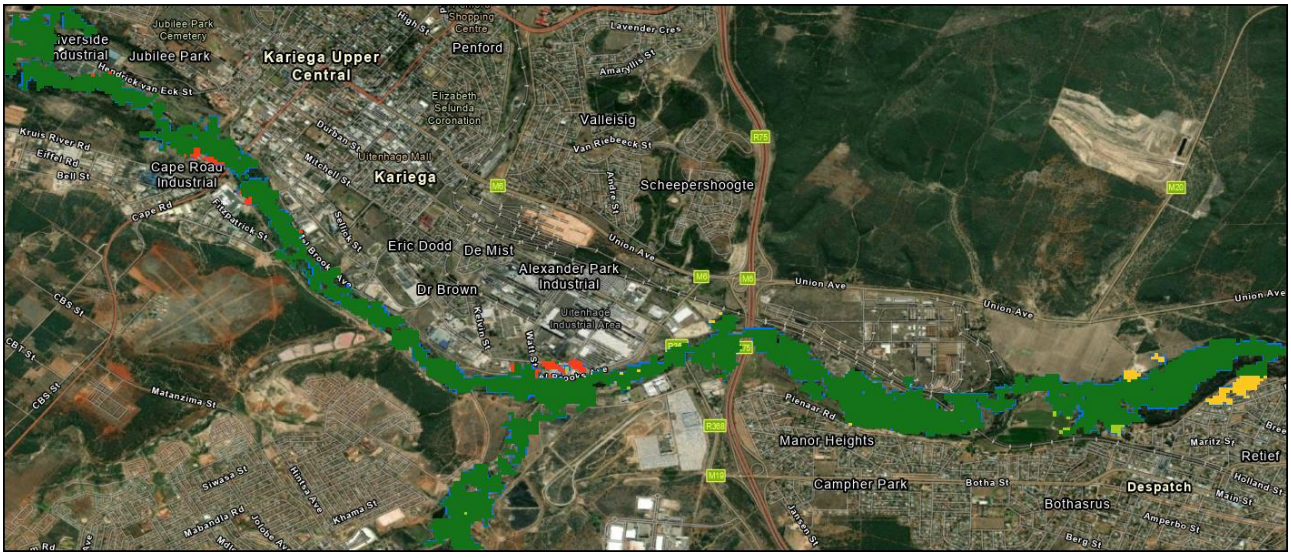

Figure: Classified land used cover for inundated area

Roads

Highway, main roads, arterial and secondary roads were classified with highway with the highest value of 5. Figure below shows the roads in raster format that are used in the risk analysis.

Figure: Road classification for inundation assessment

Figure below shows again the inundated area at 8m. The dark blue shows possible inundation of 7 to 8m. The white area represent inundation of approximately 1m.

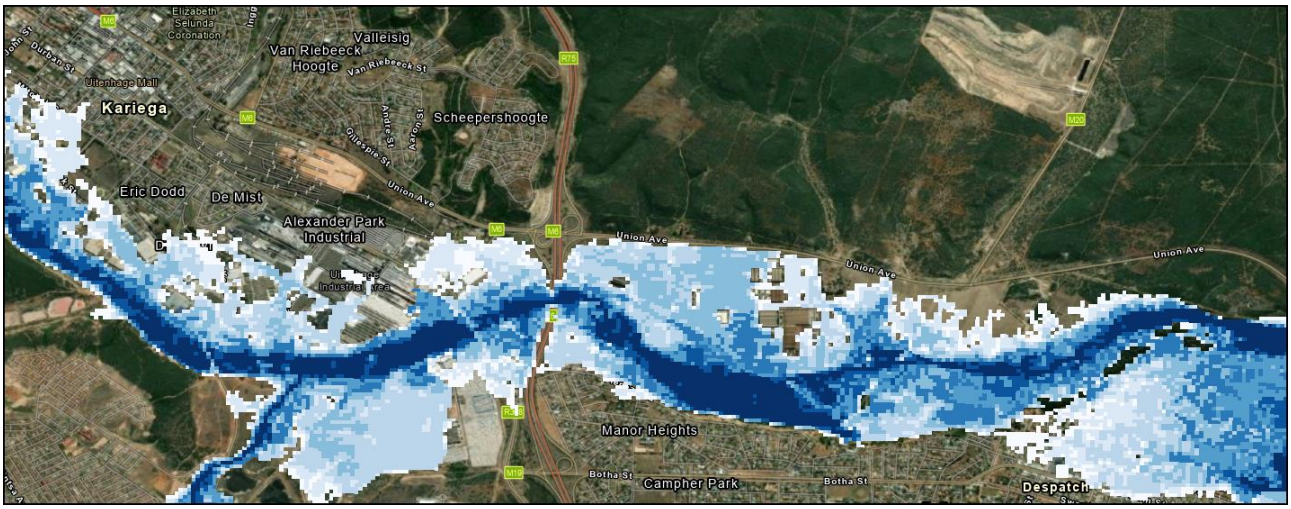

Figure: Inundation area (8m) for road assessment

Figure shows the roads that can be affected by inundation of 8 m above the drainage line. The darker purple shows higher impact because of higher inundation and the classification of the road.

Figure: Roads affected by 8m inundation

A 6m inundation scenario were done for the Eastern Cape and land use and road assessment values were transferred to the Meso Data layer. Figure was created to show the spatial distribution of flood risk in the Eastern Cape. The red show high risk areas because of possible hight of inundation, urban and agriculture activities and impact of roads and bridges across rivers. The graph indicates that Nelson Mandela Bay, O.R. Tambo and Buffalo City have the highest risk.

Appendix D: Additional Risk Reduction Measures

Hazard Name	Causes	Characteristics	General Impact	Predictability	Disaster Needs
Hydro-meteorological Hazards - Floods (River, Urban & Dam Failure)	Natural flash floods due to high intensity rainfall, or flooding due to seasonal weather patterns or human manipulation of water catchment or drainage areas, flood plains or dams	• Flash Floods • Rapid run-off • Dam breakage	• Physical Damage – structural damage • Soil movement • Injuries and public health risks • Fatalities • Drowning • Epidemics • Water supply – Contamination of surface and groundwater • Loss of food supplies or agriculture crops • Loss of animals, agricultural implements, seed	• Flood prediction – Seasonal patterns, capacity of drainage region or dam • Mapping of flood plains, aerial or physical surveys • Early warning	• Evacuation • Search and Rescue • Medical support • Disaster Assessment • Water supply / Purification • Food Aid (Short term) • Epidemiology supervision • Temporary housing / shelter
	Factors increasing risk	**Factors increasing vulnerability**	**Risk Reduction guidelines**	**Preparedness Measures**	**Tools for Impact assessment**
	• Depth of water • Duration of flow • Velocity of water • Speed of rise in water level • Frequency • Seasonality	• Location of Settlements in Flood plains • Lack of awareness on flood risk • Reduction in permeability of soil • Lack of buildings and foundations • Unprotected food material, crops and animals	• Mapping of floodplains and land-use planning / control • Awareness raising • Flood controls, dams, erosion protection	• Early warning • Warning • Awareness • Contingency Planning • Flood Master planning	• Forms to determine damage • Land or air surveys.
	KPIs: Measurable performance targets		**Means**		**Main responsible department / stakeholder responsible**
	• Assessment of dambreak impacts on existing developments. • Dam break flood impacts		• Documentation indicating impacts and consequences		• City Engineering & Maintenance
	• Develop indicative flood mapping, giving an indication of the 100-year and RMF floodlines along the major watercourses. • High frequency and risk of flood events, based on past events		• Major impacts on especially informal and low-income settlements		• Disaster Management Centre
	• High water markers and beacons to indicate depth of rivers. • Maintenance of beacons, and installation of additional high water markers		• Maintaining of beacons; identification of positions for high water level markers; installation of high water markers		• City Engineering & Maintenance
	• Flood hazard assessments for selected watercourses. • Hazard assessment studies, reports and associated maps		• Budget allocation for the various projects		• Disaster Management Centre
	• Ensuring no development and building in floodline areas. • Awareness programmes and law enforcement.		• Awareness communication materials (pamphlets/calendars), Media campaigns		• Integrated Development Planning
	• Stormwater maintenance. • Ongoing stormwater maintenance		• Stormwater asset management register and maintenance scheduled and budgeted for.		• City Engineering & Maintenance

Hazard Name	Causes	Characteristics	General Impact	Predictability	Disaster Needs
Hydro-meteorological - Drought	Immediate cause – Shortage of Rainfall	• Reducing water and moisture availability • Reduced rainfall • Reduced water resources • Agricultural drought / no moisture in the soil	• Reduction of income • Reduce expenditure in agriculture • Increase in prices of stable foods • High inflation rate • Deterioration of food value • Starvation / diseases / deaths • Reduced sources for drinking water • Migration • Breaking up of communities • Loss of livestock and crops • Unemployment	• Periods of unusual dryness are normal in all weather systems. • Rainfall and hydrological data should be carefully analyzed and if there are factors that influence droughts so prior warning is usually possible.	• Measures to maintain food security • Price stability • Food aid • Job creation programs • Distribution of food • Extra food programs • Special programs for livestock and livestock farmers • Complimentary water and health programs • Rehabilitation
	Factors increasing risk	**Factors increasing vulnerability**	**Risk Reduction guidelines**	**Preparedness Measures**	**Tools for Impact assessment**
	Possible underlying causes: • EL Nino • High temperatures due to heat waves • Man-made changes in ground surface	• Location in arid areas where dry conditions are influenced by drought • Farming in marginal areas – subsistence farming • Lack of agricultural contributions to help improve crops • Areas dependent on other weather systems for water supply • Areas where the soil moisture retention is low • Lack of recognition and allocation of resources for drought obstacles	• Early warning system for drought and famine	• Development of an inter-society contingency plan	• Nutrition surveys • Socio-economic surveys • Monitoring of rainfall and hydrological data • Satellite images

Hazard Name	KPIs: Measurable performance targets	Means	Main responsible department / stakeholder responsible
Hydro-meteorological - Drought	• Alternative dams and/or cross-border water supply negotiations	• Budget and programme action plans for specific water supply schemes	• City Engineering & Maintenance
	• Installation of water collection and storage containers in strategic locations	• Budget and location identification for containers	• City Engineering & Maintenance
	• Installation of collection and storage containers at industries and organisations	• Awareness communication materials (pamphlets/calendars), Media campaigns, Notice boards; Warnings via television, radio, newspapers, verbal.	• City Engineering & Maintenance
	• Installation of collection and storage containers at private homes	• Awareness communication materials (pamphlets/calendars), Media campaigns, Notice boards; Warnings via television, radio, newspapers, verbal.	• City Engineering & Maintenance
	• Linkages of data to monitor long term weather patterns vs water demand. • Change monitored and predictions made	• Scenarios indicated and planned for	• Disaster Management Centre
	• Ground water resources usability known	• Ground water quality survey and impact assessment	
Hydro-meteorological Hazards - Extreme Temperatures	• Early temperature risk predictions based on weather	• Early warning system, linked with Weather Services; Warnings via television, radio, newspapers, verbal.	• Disaster Management Centre
Hydro-meteorological Hazards - Desertification	• Link with Weather Services: Monitoring and studies. Draft medium-longer term contingency plans for areas at risk	• Mainly monitoring	• Parks, Sport & Recreation

<table>
<tr><th>Hazard Name</th><th>Causes</th><th>Characteristics</th><th>General Impact</th><th>Predictability</th><th>Disaster Needs</th></tr>
<tr><td rowspan="6">Hydro-meteorological Hazards - Severe Storms (Wind, Hail, Snow, Lightning, Fog)</td><td>A combination of heat and moisture that forms a low pressure core over the tropical oceans latitudes where the water temperatures are higher than 26 degrees C
Wind currents tolls and collect around the increasing low pressure, it increase in speed to the centre and moves in a circuit driven by trade winds
The low pressure area changes to a tropical cyclone when gale force winds reaches 117 miles per hour</td><td>When the cyclone hit the country, causing strong winds and exceptional rainfall and approaching storms with secondary flooding and landslides</td><td>Physical damage: structures damaged by wind, floods, approaching storms and landslides
Accidents and poor public health can be caused by debris that is blown around or flood contamination of water sources that can lead to virus epidemics
Water supply: groundwater can be contaminated by flood water
Crops and food supplies: strong winds and rain may damage crops on the land as well as food supplies
Communications and logistics: widespread disruption is possible as wind blows telephone lines, power lines, antennas and satellite dishes over. Transport to and repairs can be restricted</td><td>Tropical cyclones / severe winds can be followed from their origin
Accurate predictions about when the country hit, usually an hour ahead of time
Unpredictable direction changes can occur</td><td>Evacuation, emergency housing, food supply, search and rescue
Medical assistance
Water purification
Relocation of logistical support and communication
Disaster rating
Spiritual help and support</td></tr>
<tr><td>Factors increasing risk</td><td>Factors increasing vulnerability</td><td>Risk Reduction guidelines</td><td>Preparedness Measures</td><td>Tools for Impact assessment</td></tr>
<tr><td></td><td>Settlements situated in low lying areas
Settlements in adjacent areas (heavy rainfall with floods)
Poor communication and warning systems
Light structures, old and poor quality construction
Elementary infrastructural roads and bridges</td><td>Risk rating and mapping of obstacles
Control of land use and management of floodplains
Reduction of structural vulnerability
Improvement of vegetation cover</td><td>Public warning systems
Evacuation plans
Education and community participation</td><td>Forms to determine damage
Land and air surveys</td></tr>
<tr><td colspan="2">KPIs: Measurable performance targets</td><td colspan="2">Means</td><td>Main responsible department / stakeholder responsible</td></tr>
<tr><td colspan="2">Early storm risk predictions based on weather</td><td colspan="2">Early warning system, linked with Weather Services; Warnings via Television, radio, newspapers, verbal.</td><td>Disaster Management Centre</td></tr>
</table>

Hazard Name	Causes	Characteristics	General Impact	Predictability	Disaster Needs
Geological Hazards - Earthquake & Subsidence	Shifting crust of rock formations all along the degradation or pressure areas and checking back for new direction lines	Earthquakes are caused by waves under the earth's surface that cause: • Surface degradation • After-shocks • Tremors and vibrations • Fusing • Landslides	• Physical damage – damage to structures, infrastructure, fire, dam failures, landslides and flooding • Accidents – often high, especially in densely populated areas, where buildings cannot withstand landslides. • Public health – fracture injuries are the most common problem; pollution of water sources or the collapse of sanitary conditions, the storage of dead bodies and animal carcasses • Water supply – big problems, especially with damage to water systems, pollution from open wells, boreholes and changes in ground levels	• The probability of occurrence can be determined, but not exact timing • Predictions are based on the monitoring seismic activity and appearance and historical observations	• Search and rescue • Emergency medical treatment • Damage needs and valuations programme • Assistance • Emergency housing and food supply • Mortuaries and funerals • Repair en reconstruction • Economic recovery
	Factors increasing risk	**Factors increasing vulnerability**	**Risk Reduction guidelines**	**Preparedness Measures**	**Tools for Impact assessment**
		• Location of settlements in seismic areas • Structures that do not withstand ground movement • Residential buildings with a high occupancy • Lack of information about earthquake risks	• Mapping of barriers and public awareness of training, rating and reducing of structural vulnerability • Control over land use or zoning and the application of construction standards and good construction methods • Insurance	• Earthquakes warning and preparedness programs • Media and radio communication	• Earthquake scale

Hazard Name	KPIs: Measurable performance targets	Means	Main responsible department / stakeholder responsible
Geological Hazards - Earthquake & Subsidence	• Detailed Geological Risk Study in areas at possible risk. Monitoring of types and severity of incidents that may lead to disasters. • Yearly reports and inclusion of data into DMC database	• Contingency Plans for possible occurrences. • Reports submitted to DMC on yearly basis	• Parks, Sport & Recreation

Hazard Name	Causes	Characteristics	General Impact	Predictability	Disaster Needs
Fire Hazards - Veld/Forest Fires	• Abundant seasonal rainfall during growing season • Excessive grasslands and vegetation • Heavy weather activities with static electricity and strong winds	• Veld fires cause the destruction of valuable pastures • Disturbing the ecological environment • Can cause drought	Physical damage: • Destruction of valuable grazing • Damage to infrastructure (power lines, telephone lines and camp wires) • Destruction of animal life, the wildlife and the destruction of valuable vegetation has an economic impact on the field • Contribute to drought conditions	• The probability of the appearance and activities can be determined but not with precise timing • Forecast is based on the density of vegetation due to development	• Fire-fighting equipment and water pumps • Establishment of a fire contingency plan • Medical emergency plan • Adequate fire training • Manpower and transportation • Assistance • Economic recovery
	Factors increasing risk	**Factors increasing vulnerability**	**Risk Reduction guidelines**	**Preparedness Measures**	**Tools for Impact assessment**
		• Excessive and lush growth of grass fields, as well as severe weather activities • The inaccessibility of large areas	• Public awareness, training and the establishment of a fire protection unit • Creating firebreaks	• Regular liaison with rural residents and providing ongoing guidance • Use of communication channels to reduce risk	• Mapping of damage by air or land surveys • Evaluation of contingency
	KPIs: Measurable performance targets		**Means**		**Main responsible department / stakeholder responsible**
	• Residential related fires. Awareness programmes		• Awareness communication materials (pamphlets/calendars) • Media campaigns		• Disaster Management Centre & Fire Services
	• Veld fires. Awareness programme in and around open spaces, fire breaks administered		• Awareness communication materials (pamphlets/calendars) • Media campaigns, Notice boards • Fire breaks		• Disaster Management Centre & Fire Services
	• Early fire risk predictions. Early warning of high fire risk places & times, based on weather and vegetation/field condition		• Early warning system, linked with Weather Services; • Warnings via television, radio, newspapers, verbal.		• Disaster Management Centre & Fire Services

<table>
<tr><th>Hazard Name</th><th>Causes</th><th>Characteristics</th><th>General Impact</th><th>Predictability</th><th>Disaster Needs</th></tr>
<tr><td rowspan="11">Disease / Health - Disease: Human</td><td>• Unhygienic conditions due to over-population and poverty
• Ecological changes that favour breeding of transmitters
• People who are not immune and migrate to epidemic disease areas
• Deterioration of food status
• Contamination of water and food sources</td><td>• The risk that disease may be imported or distributed
• Possibility of major patient case loads
• Severe disease leading to disability or death
• Risk of social or economic disruption
• Lack of adequate professional staff and necessary supplies
• Danger of international transfer</td><td>• Illness and death
• Social and political disruption and economic losses
• Increased trauma in residential areas, villages and emergency camps</td><td>• Epidemics can spread due to an increase in travel or migration of people
• Long term – latent symptoms of sexually transmitted diseases
• Reporting of epidemics may increase due to better medical coverage
• Forecast is supported by epidemiological status, but can be impacted by newly formed settlements and emergency camps</td><td>• Emergency medical assistance
• National and International help if epidemic cannot be controlled</td></tr>
<tr><td>Factors increasing risk</td><td>Factors increasing vulnerability</td><td>Risk Reduction guidelines</td><td>Preparedness Measures</td><td>Tools for Impact assessment</td></tr>
<tr><td></td><td>• Poverty
• Lack of immunity (or immunization) to diseases
• Little or no sex education, unsafe sex
• Poor sanitation, poor nutrition, poor water quality and overcrowding
• Disorganized delivery of health services
• Medication existing disease (AIDS/HIV)</td><td>• Structuring of emergency health services
• Prepare a contingency plan for inventory of needed resources
• Establishment of early warning systems through routine investigation
• Training of National, Provincial and Local staff and volunteers in emergency operations</td><td>Intervention:
• Check and confirm diagnoses
• Identify cases
• Discover the source of the epidemic
• Treat cases and control distribution
• Community education regarding personal hygiene</td><td>• Epidemiological surveys
• Evaluation of health care and emergency response systems</td></tr>
<tr><td colspan="3">KPIs: Measurable performance targets</td><td colspan="2">Means</td><td>Main responsible department / stakeholder responsible</td></tr>
<tr><td colspan="3">• Epidemic statistic tracking and warnings. Early warning of possible epidemics in specific areas</td><td colspan="2">• Awareness communication materials (pamphlets/calendars),
• Media campaigns, Notice boards; Warnings via television, radio, newspapers, verbal.</td><td>• Disaster Management Centre</td></tr>
<tr><td colspan="3">• Ensure potable water supply delivery to all settlements, even informal settlements if possible. Water supply delivery programmes in areas where population density is high but water supply not available</td><td colspan="2">• Budget allocation for water piping & supply projects</td><td>• City Engineering & Maintenance</td></tr>
<tr><td colspan="3">• Immunisation programmes.</td><td colspan="2">• List of areas and places immunised</td><td>• Public Health</td></tr>
<tr><td colspan="3">• Logging system and monitoring of communicable diseases on a daily basis at clinics and hospitals, on a central database. Communicable diseases report including graphs</td><td colspan="2">• Database of communicable diseases updated weekly/monthly; monthly digital reports presented to DMC</td><td>• Public Health</td></tr>
</table>

Hazard Name	Causes	Characteristics	General Impact	Predictability	Disaster Needs
Hazardous Material - Hazmat: Spill/Release (Storage & Transportation) Hazardous Material - Hazmat: Fire/Explosion (Storage & Transportation)	• Disaster / Explosion in factories or stores that handle toxic substances • Accidents during the transportation of chemicals and toxic substances • In proper waste management of chemicals and toxic substances • Technological system failures • Shortcomings regarding the safety design of factories and stores or safety components • Natural barriers 5005 fires, earthquakes, floods and other factors • Arson or sabotage		Physical damage: • Damage to or destruction of structures and infrastructure • Transport accident damage vehicles and other objects with impact • Industrial fires can reach exceptional high temperatures and large areas are destroyed Accident: • Many people could be killed or injured and may require medical treatment Region-wide: • Pollution of air and water resources, land and wildlife could suffer • Areas uninhabitable for humans and animals • Ecological systems can be disrupted on large scale	• The presence of chemical or industrial accidents is expected to increase as industrialization in developing countries and regions increases as well as railway and road transport increases	• Evacuation from the field • Search and rescue • Alternative water sources • Harvesting and cleaning • Monitoring of impact on environment • Emergency housing • Medical support
	Factors increasing risk	**Factors increasing vulnerability**	**Risk Reduction guidelines**	**Preparedness Measures**	**Tools for Impact assessment**
		• Water pollution (surface and underground) • Persons involved and the community • Structures • Living beings • Ecological damage to wildlife • Crops and environmental damage • Closest to the accident are the most vulnerable • Large scale release of air pollution can spread for miles • Lack of safety measures and evacuation plans • Unconsciousness possible disaster conditions in communities	• Create a contingency plan for technical staff to assist • Community awareness of hazardous installations in their areas • Establishment of disaster response plans	• Mapping of barriers • Identification of hazardous substances • Inspection of chemical factories and storage areas • Monitoring of disposal of toxic waste procedures • Improving fire fighting capabilities • Create evacuation plans • Test alarms warning	• Forms for the evaluation of emergency response plan • Liaison with HAZMED • Rate information system
	KPIs: Measurable performance targets		**Means**		**Main responsible department / stakeholder responsible**
	• Survey of industries (for fire and hazardous materials risks); associated updating of hazard severity map; • Compilation of hazardous materials register/database, indicating the location and contents of facilities spatially and in database format; • Stakeholder meetings to confirm and refine the findings. • Integrated register/database		• Database design, development and population; • Exact information, locality and hazardous materials known. • Ensure industries have emergency and evacuation plans in place		• Disaster Management Centre

Hazard Name	Causes	Characteristics	General Impact	Predictability	Disaster Needs
Pollution - Water, Land and Air Pollution	Air pollution - Pollution agents such as: • Sulphur dioxide • Nitric compounds • Carbon dioxide • Lead from industries and transport Water pollution: • Deposit of human waste and domestic waste water • Barrels, ditches and ponds • Runoff of nitrogen from fertilizer Possible heating of the globe: • Accumulation of carbon dioxide from the burning of fossil fuels • Deforestation and methane from livestock Depletion of Ozone: • Chlorine fluoride carbons that are released in the atmosphere thin out the Ozone cover against ultra violet rays		Air pollution: • Damaged agricultural crops (Lucerne / maize) • Structural materials and human health Water pollution: • Distribution of chemicals to the environment • That affects the health of humans and animals Heating of the globe: • Rise in seal level • Climate change • Higher temperatures Thinning of Ozone layer: • Increase in skin cancer • Cataracts of the eyes • Deterioration in function of the immune system	• Pollution is related to the per capita consumption, pollution tends to be increasing as countries develop	
	Factors increasing risk	**Factors increasing vulnerability**	**Risk Reduction guidelines**	**Preparedness Measures**	**Tools for Impact assessment**
		• High levels of industrialization and per capita use • Lack of regulation of pollution agents • Insufficient resources to use against the impact of pollution	• Lay down ambient air standards • Lay down limits for each contamination agent • Set protection measures for water supplies • Reduce the rate of deforestation and increase tree planting • Promote energy efficiency • Regulate the use of aerosols and the disposal of refrigeration units • Prohibit the manufacture and use of chlorine fluoride carbons	• Establish a Local, Provincial and National environmental and safety protection plan • Create educational programs for environmental awareness • Training of Local, Provincial and National staff as part of the development process	• Air, distance and ground surveys • Air, water and ground equipment • Comparison of climatologically data • Socio-economic surveys

Hazard Name	KPIs: Measurable performance targets	Means	Main responsible department / stakeholder responsible
Pollution – Water and Land Pollution	• Specific incidences quickly and effectively reported and information distributed for possible evacuation / response. • Immediate warnings once incidents take place	• Awareness communication materials (pamphlets/calendars) • Media campaigns, Notice boards; Warnings via television, radio, newspapers, verbal.	• Disaster Management Centre
	• Industry, Mining and Private Individuals compliance to pollution control requirements. • Quarterly/yearly reports • Possible polluter-pays measures, • Environmental education of public	• List of pollution-control required industries/mines, waste sites etc, • Specific license requirements; • Database of industries/mines checked for reporting and compliance quarterly/annually • List of public education initiatives	• Parks, Sport & Recreation
	• Agricultural awareness. Awareness programmes with farmers with regard to pesticides, herbicides etc. control	• Awareness communication materials (pamphlets/calendars) • Media campaigns, Notice boards; Warnings via television, radio, newspapers, verbal.	• Disaster Management Centre

Risk Reduction Measures

Hazard Name	KPIs: Measurable performance targets	Means	Main responsible department / stakeholder responsible
Pollution – Air Pollution	• Monitor industrial related air pollution, in areas where applicable. • Quarterly/yearly reports; Bylaws; license requirements; • Possible polluter-pays measures	• Industries providing proof of prevention/minitation • measures	• Disaster Management Centre
	• Awareness and subsequent minimisation of air pollution in communities that utilise fuel for heat and cooking, instead of electricity. • Awareness programmes in informal settlements	• Pamphlets and public meetings where community leaders urge community to utilise electricity rather than fires, where possible	• Disaster Management Centre
Environmental degradation	• Waste site location and management. Integrated waste management plans	• Drafting and acceptance of the waste management plans, and spatial data indicating location of all existing and future waste sites	• Parks, Sport & Recreation
	• Erosion protection, especially where sand and gravel mining is taking place. • Stricter environmental controls	• Decreased erosion and extraction	• Parks, Sport & Recreation

Hazard Name	Causes	Characteristics	General Impact	Predictability	Disaster Needs
Civil Unrest - Demonstrations / Riots / Xenophobic Violence	• Expatriates from other regions • Unemployment and mainly because of conflict and collapse of law and order • Lead to further population displacement and great misery for millions of people	• Risk of urbanization • Possibility of outbreak of conflict • Lack of housing and food • Unemployment increases • Crime is increasing • Poor health conditions • Rapid population growth	• Loss of necessary livelihoods • Loss of adequate food sources • Sexual transmitted diseases and overcrowding • Large numbers of children without supervision • No security for tension and military activities	• Urbanization taking place • Poor housing and no structures • Unemployment increases • Increase of tariffs for essential services • Lack of emergency medical services	
	Factors increasing risk	**Factors increasing vulnerability**	**Risk Reduction guidelines**	**Preparedness Measures**	**Tools for Impact assessment**
		• Poverty • Unemployment • Uprooted people • Refugees from neighbouring provinces and countries • Political conflict • Taxi violence and conflict • Cultural differences	• Providing permanent housing • Provision of essential services • Create job creation programs • Moral and spiritual support • Counselling regarding contraception • Provision of emergency medical services	• Ground and air surveys • Setting up security and protection measures • Job creation programs and projects • Moral and spiritual support	• Spiritual and social welfare workers to defuse situation • Monitoring the situation • National, Provincial and Local support • Guidance and training regarding the risk • Land and air based aid
	KPIs: Measurable performance targets		**Means**		**Main responsible department / stakeholder responsible**
	• Monitoring system implemented. Database with incidents indicated		• Graphs and probability evaluations updated		• Traffic Services And Saps
	• Incident database to be set up and maintained. Incident database updated and maintained		• Incident database designed, developed and • implemented; updated		• Traffic Services And Saps

Hazard Name	Causes	Characteristics	General Impact	Predictability	Disaster Needs
Transport Hazards - Road / Rail Transportation	• Increased road traffic and the privatization of freight • Overloading of buses and “taxi” transport • Deterioration of roads and main roads	• The incidence of road accidents is expected to increase as road traffic increases • The impatience and careless behaviour of drivers • Uncontrolled walking of animals on roads • Ignoring Law and Order by failing to reduce speed to stop • The driving under the influence of alcohol and drugs	• Loss of life and injuries • Economic impact • Loss of manpower • Place burden on the government of the day • Unemployment due to disability	• Road accidents are predictable during holidays, festivals and peak times due to circumstances	• Emergency medical services and ambulance assistance • Rescue and fire crews • Traffic and police services • National, Provincial and Local Government services • Ground and air support • Moral, spiritual and welfare support services
	Factors increasing risk	**Factors increasing vulnerability**	**Risk Reduction guidelines**	**Preparedness Measures**	**Tools for Impact assessment**
		• Impatience, careless behaviour and poor discipline • Speed and driving under the influence • Poor road surface • Non-sufficient rest and fatigue • Straying animals	• Incident management • Aims to improve roads • Stricter enforcement • Awareness programs and training • Regular media coverage • Visible policing		• Traffic and police services • Department of Transport • Ground and air support • Evaluation of impact
	KPIs: Measurable performance targets		**Means**		**Main responsible department / stakeholder responsible**
	• Road maintenance. Road maintenance projects		• Budget allocation for road maintenance and upgrade projects		• City Engineering & Maintenance
	• Railway maintenance. Railway maintenance projects		• Budget allocation for railway maintenance and upgrade projects		• Spoornet & Transnet
	• Specific incidences quickly and effectively reported and information distributed for possible evacuation. Immediate warnings once incidents take place		• Warnings via television, radio, newspapers, verbal.		• Disaster Management Centre
	• Hazmat transport inspections on road. Inspections		• List of hazmat transporters and spot-checks to ensure they have what they are listed to carry, forwarded bi-monthly to DMC		• Public Health & Traffic Services
	• Transport and container inspections by rail. Inspections		• List of hazmat transporters and spot-checks to ensure they have what they are listed to carry, forwarded bi-monthly to DMC		• Public Health & Traffic Services
Transport Hazards Air Transportation	• Monitoring of types and severity of incidents that may lead to disasters. • Yearly reports and inclusion of data into DMC database		• Reports submitted to DMC on yearly basis		• Disaster Management Centre

Hazard Name	KPIs: Measurable performance targets	Means	Main responsible department / stakeholder responsible
Infrastructure Failure / Service Delivery Failure	• Co-ordination between water, electricity and sanitation services to identify cross-impacts and severity of impacts. • Quarterly task group meetings	• Co-ordination and integrated planning	• City Engineering & Maintenance
Major Events Hazard	• Preparation and planning, and informing communities of events and disaster plans relating to it. • Event plans and pamphlets	• Plans designed and distributed well beforehand	• Disaster Management Centre
	• Database indicating all possible venues and available evacuation and other plans for that venue	• Lists of all venues that could house 250+ persons and associated risks for each, submitted to the DMC and/or Districts/Towns	• Disaster Management Centre
Oceanographic-Tsunami, Sea Level Rise, Storms	• Specific incidences quickly and effectively reported and information distributed for possible evacuation. • Immediate warnings once incidents take place	• Warnings via television, radio, newspapers, verbal.	• Disaster Management Centre
	• Early storm risk predictions based on weather	• Early warning system, linked with Weather Services; • Warnings via television, radio, newspapers, verbal.	• Disaster Management Centre
	• Ensuring sufficient breakwater and related protection	• Planning, implementation, inspections	• City Engineering & Maintenance
Plant infestation /overpopulation	• Monitoring of types and severity of incidents that may lead to disasters. • Yearly reports and inclusion of data into DMC database	• Reports submitted to DMC on yearly basis	• Parks, Sport & Recreation
Animal/Insect infestation /overpopulation	• Monitoring of types and severity of incidents that may lead to disasters. • Yearly reports and inclusion of data into DMC database	• Reports submitted to DMC on yearly basis	• Parks, Sport & Recreation
Deforestation	• Monitoring of types and severity of incidents that may lead to disasters. • Yearly reports and inclusion of data into DMC database	• Reports submitted to DMC on yearly basis	• Parks, Sport & Recreation
Loss of biodiversity	• Monitoring of types and severity of incidents that may lead to disasters. • Yearly reports and inclusion of data into DMC database	• Reports submitted to DMC on yearly basis	• Parks, Sport & Recreation

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