Future-proofing Jersey: Building Resilience for the 21st Century

A report by the Town and Country Planning Association (TCPA) with support from the University of Manchester, commissioned by the States of Jersey, Department of the Environment.

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'Extreme weather has a huge human cost that cannot be quantified. Between 1980 and 2004 the economic cost has been estimated to be US$1.4 trillion. This shows that societies are not resilient to extreme weather today, and our analysis shows that the risk it poses is increasing'.

(The Royal Society 'Resilience to extreme weather'. 2014)

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1.0 Executive Summary

Jersey faces a growing challenge from the impacts of climate change and, in particular, the increased frequency and severity of weather events and sea-level rise. Although some actions are already underway, overall, the findings of this report make clear that action is necessary ***now*** to understand the complexity of the potential impacts and, thereby, to begin to build long-term resilience. The objective of this report is to provide an initial overview of Jersey's resilience to climate change and to raise awareness of the need for action. It provides a summary of the latest risks and vulnerabilities, including economic risks, within the current policy framework for flood defence and spatial planning. The report contains specific outline recommendations which are designed to inform the preparation of future policy development. The recommendations will assist in the identification of priority areas for action to be included in the development of the Jersey climate change adaptation action plan which will start during 2015.

It recognises that there are impacts across all sectors, including Jersey's financial industry where evidence shows that international competitors, also offering offshore financial services, are already taking effective action on climate resilience. There are clear opportunities for Jersey to differentiate itself as a secure, resilient Island.

Building resilience will require multiple actions by different sectors; agreeing the corporate priorities; building institutional capacity across all sectors, and raising awareness with the public and other stakeholders.

This report recommends ten action points which provide the basis for the development of an adaptation action plan for Jersey:

1. **Setting priorities.** Climate change should be recognised by the States of Jersey as the priority issue to secure the future of the Island. This priority needs to be explicitly expressed in both short and long-term strategic policy. This should include the development of a sustainability framework which embeds key agreed data on climate impacts and planned adaptation measures as part of the policy planning process.

2. **Auditing current actions.** Building on the findings in this report, Jersey needs to carry out a comprehensive audit of existing actions, strategies and institutional capacity relating to resilience in order to provide an analysis of strengths and weakness to inform future strategic development. This process could also include the commissioning of a detailed SWOT analysis of current responses to climate adaptation measures.

3. **A comprehensive economic risk assessment.** Gauging the long-term economic risk to the Island is vital and should include an exercise in assessing Jersey's progress in relation to its international competitors, and securing a more detailed economic assessment of climate impacts. This is about developing a detailed understanding of, for example, real estate values and flood vulnerability data, both of which are essential to inform the cost benefit analysis of enhanced action on flood defence.

4. **Coordinating and agreeing data on risks.** A coordinated approach to data collection across all sectors and States of Jersey departments must be taken in order to enhance the knowledge base of risks and vulnerabilities. This process must include cross-departmental and cross-agency agreement on data-sets and risk factors such as sea-level and sea-level rise and might be achieved through the increased functionality of a GIS mapping tool.

5. **Developing an integrated approach to adaptation.** Jersey needs to develop a comprehensive adaptation action plan based on international best practice. This should be part of the corporate priorities of the States of Jersey and set out the key risks and vulnerabilities as well as key sectoral actions in relation to spatial planning, flood defence, transport, economic development, health-care, energy and emergency planning. This report recommends the development of a draft structure for a climate change adaptation action plan for Jersey.

6. **Reviewing spatial planning.** The Island Plan and supporting supplementary guidance should be reviewed to ensure it reflects the growing understanding of climate change impacts. This requires consideration of a range of factors, from long-term spatial distribution, to building-scale actions, to enhance resilience. A priority issue is the interaction of planned flood defences and the projected growth of St Helier. The future of the town must be considered in line with proposed or revised flood defence investment based on climate change/extreme weather data.

7. **The Future of St Helier.** St Helier, a vital asset to the island, faces particular risks from a combination of high tides and storm surges. The future of the St Helier masterplanning project provides a timely opportunity to apply the findings and implications highlighted in this report and to integrate resilience principles into the planning process. This will require a multi-agency and multi-disciplinary approach including the engagement of Department of the Environment, Parish of St Helier, Ports of Jersey, Transport and Technical Services, and other key stakeholders and interest groups.

8. **Building institutional capacity and governance structures.** The process of preparing an adaptation action plan should be seen as an opportunity to review and simplify governance structures. Inter-departmental cooperation is crucial with a clear understanding of how differing roles and responsibilities interlock to shape policy and delivery.

9. **Changing cultural attitudes to climate change.** Delivering action on climate change requires both political will and wider community and stakeholder engagement. Discussion with stakeholder groups showed that there is considerable

interest and concern over climate change but that there is, despite the overwhelming scientific consensus, still some scepticism. A communications and awareness-raising strategy must consider the wider public engagement in this issue and consideration should be given to closer working with existing fora which could inform Government action. An awareness raising conference could be one element within a communications strategy.

10. **Funding for resilience.** Based on the outcomes of the adaptation plan, consideration should be given to enhancing investment in resilience measures. In this regard, new funding mechanisms, such as those being considered in the British Virgin Islands (BVI), should be explored.

2.0 Introduction

Climate change is now widely regarded as the greatest long-term threat to human society. The science of climate change is evolving quickly but the processes are well understood and the impacts clearly measurable through increased global temperatures, increased severe weather events and changes to sea-levels.

Jersey is a thriving and growing place founded on its reputation for international financial services. The Island's future economic success in growing investment will be dependent upon the degree to which it clearly demonstrates a pathway for future resilience to factors such as severe weather. This report identifies particular areas of vulnerability and exposure on the Island which need to be addressed to secure both business confidence, and, the wider wellbeing of the community.

Jersey has already recognised climate change as a key spatial planning issue and has already begun to enhance some aspects of its flood defence. However, this report recommends further action particularly in the long-term spatial approach of the Island and short to medium-term resilience of key assets such as St Helier harbour. The report also concludes by suggesting that new forms of governance may be needed to secure a long-term and coordinated approach to building climate resilience.

3.0 Aims of this report

This report is the first step in the development of a climate change adaptation action plan, the requirement for which is identified in Pathway 2050: An Energy Plan for Jersey 2014[1].

The objective of this report is to provide an initial summary overview of Jersey's resilience to climate change and to raise awareness of the need for action. It provides a summary of the latest risk and vulnerabilities, including economic risks, within the current policy framework for flood defence and spatial planning. The report contains specific outline recommendations which are designed to inform the preparation of future policy development. The recommendations will to assist in the identification of priority areas for action to be included in the development of the Jersey climate change adaptation action plan which will start during 2015.

The report draws on two sets of evidence:

- The output of a series of roundtable meetings with key stakeholder undertaken between December 2014 and January 2015, supported by key policy documents. (Annex 1: List of stakeholders participating in roundtables; Annex 2: List of supporting policy and related documents).
- The output from a geographical information system (GIS) mapping tool, developed by the University of Manchester, which enables a spatial view of different datasets on, for example, flood risk and spatial development.

Part 1 of this report sets out the wider context of climate science and approaches and emerging adaptation approaches which can help enhance the island's long-term resilience.

Part 2 examines the specific context of adaptation for building climate resilience in Jersey.

[1] States of Jersey (2014) Pathway 2050: An Energy Plan for Jersey (online) Available from: http://www.gov.je/Government/Pages/StatesReports.aspx?ReportID=1039

4.0 PART 1: The Global Scientific Context

Climate change is already having global impacts and these impacts are expected to intensify over the coming decades and will more adversely affect the most vulnerable communities who have the least resilience. Recent reports from the IPCC[2], the Royal Society[3] and the Hadley Centre[4] draw together the latest climate science and make it clear that the causes of climate change are now well understood and that our knowledge of the impacts is growing. These impacts are complex but will be felt when the increased frequency and intensity of extreme weather and long-term sea-level rise take effect. The scientific evidence is clear; such changes are happening now and will continue to occur over the very long-term. Globally, we may be able to respond to one metre of sea-level rise by 2090, but, the sea will go on rising for many hundreds of years. We also know that globally there has been little progress towards an effective agreement to reduce carbon emissions. As a result, we are set on a high emission pathway with increasing global temperatures and intensifying climate impacts. Reducing energy demand and emissions through mitigation must remain the highest priority to reduce the scale of these impacts but we need to prepare now for significant and increasing climate change impacts over the long-term.

4.1 The Adaptation Imperative

The purpose of this report is to provide a contribution as to how Jersey can help build its long-term resilience to climate change by successful adaptation planning. There is an extensive and growing literature on climate resilience which provides helpful support to this process. There is no doubt, however, that this new language can also be a barrier to communicating the imperative for action to those people who are most affected. Three basic propositions can be distilled from the adaptation literature:

1. If the emission of greenhouse gases continues at the current rate, extreme weather will pose an increasing threat to places and people. Even if emission rates are reduced, societies will still need to adapt to the effects of climatic changes caused by past emissions. Both mitigation of, and adaptation to, climate change are therefore vital.
2. Action is necessary to reduce societies' exposure and vulnerability both now and in the future. There are a range of measures from flood defences to green infrastructure to sustainable urban drainage systems which can build resilience. In some cases, measures which can speed up recovery times, changes to building fabric and, emergency planning might be more appropriate than major investment in flood defence. This depends on the vulnerability of the population in addition to the severity and frequency of risk.
3. Governments are the main bodies with the resources, powers and accountability to drive action of sufficient scale and pace. In particular, Governments have the

[2] IPCC (2014) Summary for Policymakers. In: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., and White, L.L., (eds). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the InterGovernmental Panel on Climate Change*. Cambridge: Cambridge University Press, pp. 1-32 (online) Available from: http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf

[3] The Royal Society (2014) *Resilience to extreme weather.* London: The Royal Society (online) Available from: https://royalsociety.org/~/media/policy/projects/resilience-climate-change/resilience-full-report.pdf

[4] Met Office Hadley Centre, http://www.metoffice.gov.uk/climate-guide/science/science-behind-climate-change/hadley

capability to think over the long-term time periods necessary to deal with the impacts of climate change.

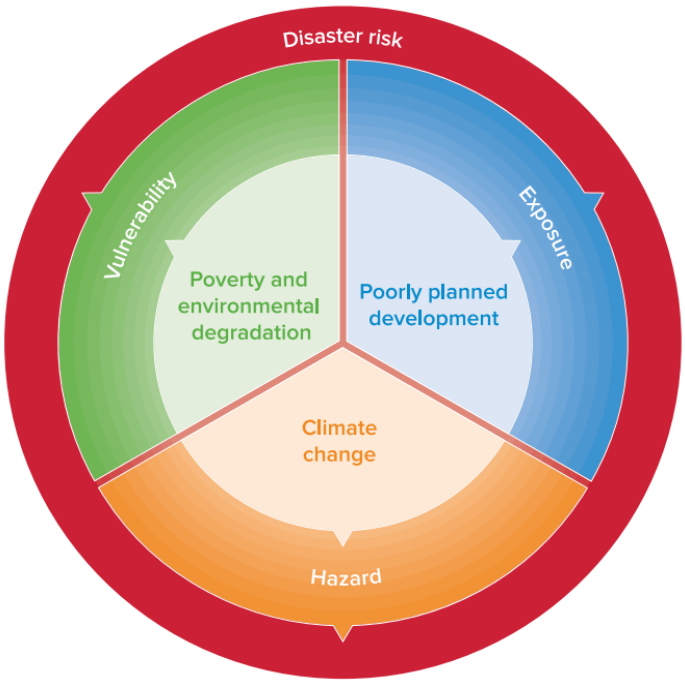
4.2 Approaches to Adaptation

Building resilience to the impacts of climate change is founded on an understanding of the degree of risk that individual impacts present and, crucially, considering the interaction of these risks. The Royal Society[5] has usefully summarised the interaction of risk, vulnerability and exposure in a recent publication, highlighted here by Figure 1.

Having identified these risks - which requires robust data sets and analysis of a wide range of socio economic and environmental factors discussed in part 2 - the second step is a clear process of adaptive management. This process follows a familiar planning cycle of evidence gathering, setting priorities, implementation and review. For Jersey it will mean both the establishment of key corporate policy goals and the integration of adaptation measures in a wide range of existing strategies: from business resilience to the long-term strategic plan.

Figure 1: How risk results from the interaction of exposure, vulnerability and the hazard itself

Disaster risk is determined by the occurrence of a hazard (eg a cyclone), which may impact exposed populations and assets (eg houses located in the cyclone path). Vulnerability is the characteristic of the population or asset making it particularly susceptible to damaging effects (eg fragility of housing construction). Poorly planned development, poverty, environmental degradation and climate change are all drivers that can increase the magnitude of this interaction, leading to larger disasters.



[5] This diagram can be found on page 23 of the following report: The Royal Society (2014) *Resilience to extreme weather.* London: The Royal Society (online) Available from: https://royalsociety.org/~/media/policy/projects/resilience-climate-change/resilience-full-report.pdf

5.0 PART 2: Jersey Challenges and opportunities

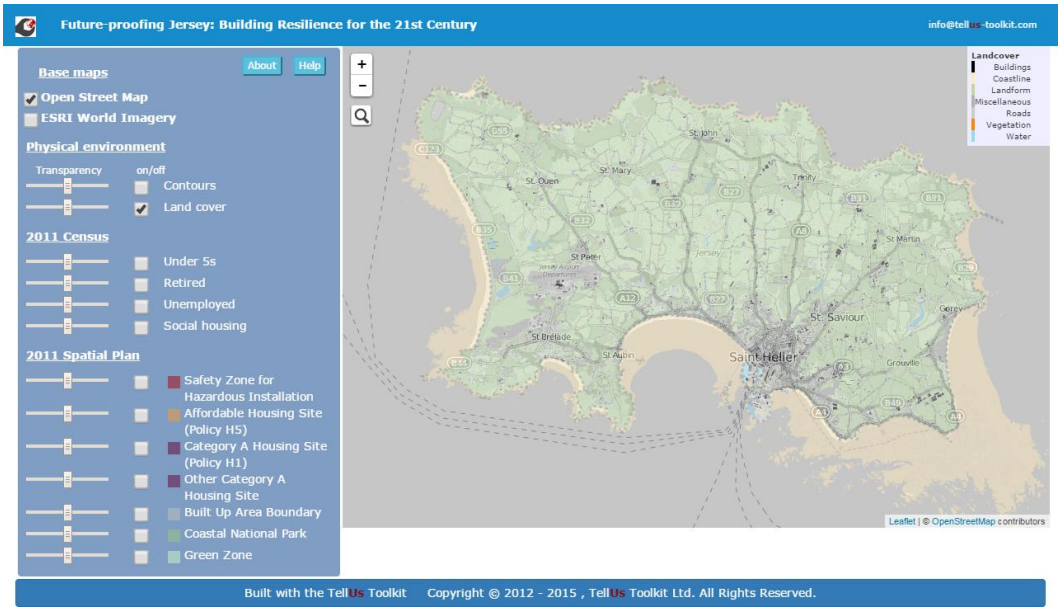
This section of the report examines the relationship between climate change and spatial risk in Jersey by setting out key observable climate trends. It examines current vulnerabilities to climate change in relation to the population of Jersey based on 2011 Census data[6] for enumeration districts. It also considers current and future potential development scenarios based on data provided in the Revised 2011 Island Plan[7].

Certain sectors of society are more vulnerable to climate change than others. These include age-related factors, employment circumstances, tenure and property type. Part of this project was the start of the development of an online mapping based tool with the flexibility to illustrate different risk factors. This report should be read alongside the online tool which has been developed by the University of Manchester. This provides interactive maps created by the user overlaying different data sets on the Jersey base map in order to visualise the potential risks and vulnerabilities of climate change impacts to the Island.

Figure 2 provides an illustration of the tool. The tool enables the user to better understand that there is an important relationship between factors such as vulnerable social groups and key economic infrastructure, and, current and future climate impacts. The long-term question that emerges is how can we make development and growth resilient?

The Jersey tool is in its early stages of development, but it provides an illustration of how pulling together different data sets and looking at them on a map or spatial basis[8], can be a very useful exercise in the development of the adaptation action plan. This report recommends the further development of the tool as an Island resource.

Figure 2: Illustration of online tool



[6] States of Jersey (2014) *2011 Census Results* (online) Available from: http://www.gov.je/Government/Census/Census2011/Pages/2011CensusResults.aspx

[7] States of Jersey (2014) *Revised 2011 Island Plan*, St Helier: Environment Department (online) Available from: http://consult.gov.je/portal/adopted/pd/ip2011

[8] For reasons of data protection, individual houses have not been identified.

5.1 Observable climate trends in Jersey

There is a range of technical climate data for Jersey available from www.gov.je, but data can be difficult to understand and have little impact on the perception or awareness of the general public about climate trends.

Reviewing the recent history of severe weather events on the island can act as a useful reminder of the changing nature of people's actual experience of climate change. This section includes a snapshot of incidents that have been observed and reported in the local Island media over recent years; it is not a fully comprehensive list, but provides a useful summary and reminder of the kind of impacts being experienced on the Island. A full audit of all media reporting of severe weather events is recommended as a first step in the development of the islands adaptation action plan.

- In 2014, emergency repairs to sea defences cost at least £1.1million between January - October[9]
- Sea walls, piers and other coastal sea defences at Gorey, Beaumont, St Aubin, and St Catherine's have been breached at high tide causing flooding and closure of local thoroughfares such as Victoria Avenue, Route de La Haule and Havre des Pas in 2008 and 2014[10]
- St Aubins Pier was breached by waves (Feb 2014) at high tide accompanied by gale force winds causing damage to property and flooding[11]
- On the coast, record high tides in March 2014 caused the sea wall to give way at Le Bourg and residential gardens on the seafront in St Clements to collapse into the sea wall on the beach[12].
- Damage to existing sea defences at St Ouen and Le Bourg, also to various harbour slipways.

Unpredictable seasonal weather such as rising temperatures, lack of rainfall and longer winters has:

- Reduced the yield of Jersey's potato crop due to drought, hard frosts and long winters which have affected when crops can be planted and how many plants survive through to harvest.
- Created the wildfires which spread across St Ouen and St Peter in 2009 causing 20 homes to be evacuated.
- Caused fears of water shortages during a four week drought in 2011 that followed a drought in 2010.

A higher frequency of severe storm events has:

- Left homes in 11 parishes on the Island without power in 2013.[13]

[9] States of Jersey (2014) *The environment: Challenges for the future*. 3 October. States of Jersey Corporate Management Board, Jersey

[10] Jersey Evening Post (2014) Avenue closed for high-tide. *Jersey Evening Post*. 6 January (online) Available from: http://jerseyeveningpost.com/news/2014/01/04/island-battered-by-hailstorm/

[11] Jersey Evening Post (2014) Counting the cost – and more storms to come. *Jersey Evening Post*. 6 January (online) Available from: http://jerseyeveningpost.com/news/2014/02/06/counting-the-cost-and-more-storms-to-come/_rob3521/

[12] Jersey Evening Post (2014) Coastal calamity. *Jersey Evening Post*. 5 March (online) Available from: http://jerseyeveningpost.com/news/2014/03/04/coastal-calamity/

- Grounded fishing vessels causing the loss of thousands of pounds in catches[14]
- Caused flight cancellations and delays for two days in 2014 due to strong winds – up to 65 mph, while rough seas prevented ferries travelling to and from the Island.[15]
- Overwhelmed the drainage system in 2010 with high volumes of water from intense and heavy rainfall causing damage to the system[16]
- Blocked roads through fallen trees.

When these stories appear in the media, the public does not necessarily connect such events with long-term trends in climate change and this is partly because our experience is of individual severe weather events rather than the longer term pattern of increased frequency and severity. Nonetheless, strategic planning policy in Jersey, as set out in the Island Plan 2011, already recognises that '*we are likely to see more extreme weather events, including hotter and drier summers and rising sea-levels. There will be permanent changes in the natural environment but also, and increasingly, challenges to economic prosperity and social cohesion[17]'.* This remains a sound summary of the likely climate impacts over time with the proviso that some of these impacts are issues for the Island now rather than in the future.

5.2 Changing weather patterns

5.2.1 Temperature changes

2014 was the warmest year on record in Jersey: mean temperatures were above average for nine out of ten months of the year between January and October with an estimated mean of 13.20^{o}C (0.24^{o}C warmer than the current highest annual mean from 2011). Furthermore, with these changing trends in temperature Jersey's autumn in 2014 was:

- the warmest since records began in 1894;
- had an average temperature of 15.3^{o}C (2^{o}C higher than the 30 year average);
- the third sunniest since records began in 1925[18].

5.2.2 Severe weather events

The analysis[19] of the severe weather event in March 2008 indicated the particular vulnerability of the Island to the combination of high tides and storm surges. In essence, the

[13] Jersey Evening Post (2013) Praise for men who restored power to the people. *Jersey Evening Post*. 16 March (online) Available from: http://jerseyeveningpost.com/news/2013/03/16/praise-for-men-who-restored-power-to-the-people/

[14] Jersey Evening Post (2014) Fishermen count cost of the storms at sea. *Jersey Evening Post*. 11 January (online) Available from: http://jerseyeveningpost.com/news/2014/01/11/fishermen-count-cost-of-the-storms-at-sea/

[15] Jersey Evening Post (2014) Another red weather warning issued. *Jersey Evening Post*. 11 February(online) Available from: http://jerseyeveningpost.com/news/2014/02/05/476101/

[16] Jersey Evening Post (2010) Drains fail to cope. *Jersey Evening Post*. 27 August (online) Available from: http://jerseyeveningpost.com/news/2010/08/27/drains-fail-to-cope/

[17] States of Jersey (2014) Island Plan Strategic Policy Framework: Sustainable Development. In. States of Jersey. *Revised 2011 Island Plan*, St Helier: Environment Department (online) Available from: http://consult.gov.je/portal/adopted/pd/ip2011?pointId=1405696217767#section-1405696217767

[18] Jersey Met (2014) Autumn 2014 in Jersey - Warmest since temperature records began in 1894 and 3rd sunniest on record. [Twitter] 2 December. Available from: https://twitter.com/jersey_met/status/539728861991534592

[19] Le Blancq, F. and Searson, J., (2008) The exceptional tide, storm surge and damage on 10 March 2008. St Helier: Jersey Meteorological Department

Island was fortunate that a change in wind direction, two hours before high tide, reduced the level of the storm surge:

'the recorded surge component at high water was +0.77 metres in the morning and +0.29 metres in the evening, but the maximum residual recorded on the 10th was 1.26 metres close to the time of low tide. If this maximum had occurred on the morning high tide it would have peaked at 12.82 metres (slightly over 42 feet) rather than 12.33 metres (40.5 feet). Had the weather system been three hours later, heavy rain combining with a southerly gale and higher surge could easily have resulted in more serious flooding'[20].

During storm surge events, extra height is added to the expected tides (by the low pressure), and water is pushed into bays and estuaries (by the wind), while the volume of water that can flow out is reduced, ultimately leaving water forced inland onto the island. Combined with heavy sustained rainfall, such high water levels could also prevent streams and rivers to run off into the sea causing inland fluvial flooding. Enhanced wave and wind action in the form of storm surges and coastal erosion have already caused challenges for Jersey; the Jersey Meteorological Office (Jersey Met) reported that the wave energy combined with the high sea-level of the 2008 storm surge was greater than that in 1984 .

5.3 Sea temperature and sea-level rise

Sea temperatures around Jersey have been above average for the last consecutive 14 months making 2014 the second warmest on record. Over the longer term, the Proudman Oceanographic Laboratory has identified a clear upward trend in global sea-levels since records began in the mid-1960s[21] - an average increase of 25mm between 1993 and 2005. With the frequency of storm surges forecast to increase[22]; the sea-levels around Jersey slowly rising, and with climate change models strongly suggesting that this trend will continue, sea-level rise must be taken seriously in planning for Jersey's future. There needs to be a shared estimate of sea-level rise for strategic planning purposes using the IPCC's Fifth Assessment Report. Given the long-lasting nature of decision-making about the built environment, estimates should look forward to 50 and 100 year benchmarks. Recommendation 4 highlights the need to review the approach to the sea defence strategy and data in line with these risks and projections.

5.4 The potential social impacts of climate change.

The online tool will enable the user to see the impacts of sea-level rise and severe weather in terms of areas of vulnerability in the population, and key assets such as the economic and social hub of St Helier. In relation to vulnerable populations, it is self-evident that the majority of the Island's population is located in St Helier and along the south and south-east coasts.

There are some sections of the population who are potentially more vulnerable to the impacts of climate change than others. The Climate Just project, funded by the Joseph Rowntree Foundation has recently been published and provides a detailed assessment of

[20] Ibid page 9
[21] States of Jersey (2009) *Turning Point: The ECO-ACTIVE guide to the Science and Impacts of Climate Change in Jersey*. St Helier: Planning and Environment Department (online) Available from: http://www.gov.je/Government/Pages/StatesReports.aspx?ReportID=1098
[22] Le Blancq, F. and Searson, J., (2008) *The exceptional tide, storm surge and damage on 10 March 2008*. St Helier: Jersey Meteorological Department

these vulnerabilities. The joint author of this report was the author for the Climate Just project. For further details see www.climatejust.org.uk.

The Jersey tool will be able to be used to help advise policy and plans to ensure the impacts on the most vulnerable sectors of the population are considered. Some of these groups and the impacts are explained below.

5.4.1 Young children

Areas of the Island such as St Helier where there are higher proportions of children under five years old indicates an increased vulnerability because young children are more sensitive to the impacts of both flood and heat-related hazards. Young children can be affected wherever floods and high temperatures occur. However, there is a case for the particular targeting of areas where: there are more children exposed; the characteristics of the areas increase exposure; there are poor transport links, or children have other characteristics affecting sensitivity or exposure, such as ill-health or disabilities.

5.4.2 Older people

Adaptation needs to address the specific challenges associated with places both where there is a high density of older people living in an area, and also, places where there may be fewer older people but who may be socially or physically isolated. Responses in places with high concentrations of older people may differ from those in places with low concentrations, i.e. there may be more community organisations, facilities and networks in such areas to support action. These may be used to disseminate good practice and promote appropriate self-help alongside responses delivered through other social services. Development of Jersey based guidance to specifically support this group, e.g. as part of the heatwave and cold weather plans, should be included in the adaptation plan that is developed[23]. Adaptation needs to take account of the ageing population trend in the future.

5.4.3 Unemployed people

Higher proportions of unemployed people in areas such as St Helier indicate an increased vulnerability because of their likelihood to be on lower incomes relative to other people. A lack of financial resources may restrict people's access to prepare for, respond to, and, recover from hazard events. For example, unemployment or irregular employment may reduce the opportunities for obtaining insurance. Unemployment is linked to other social characteristics, such as being in social or privately rented housing and a greater tendency to have physical and mental health requirements. People in this group are significantly more likely have negative impacts on their health and wellbeing in the aftermath of flooding events.

5.4.3 Social housing tenants

Similar considerations must be given to residents in social housing as for unemployed residents, and again, St Helier has a particular concentration of social housing where residents are less likely to have contents insurance but it is the social landlord who is

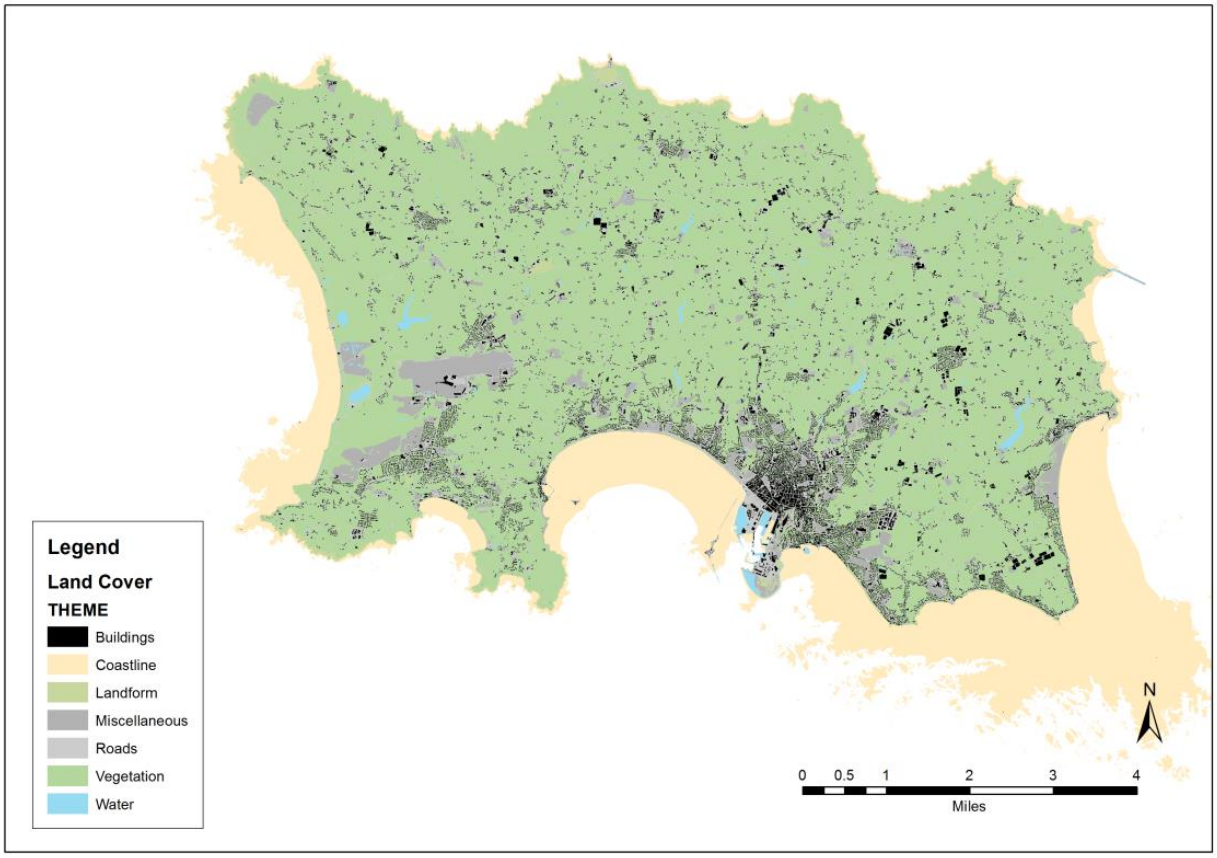
[23] More information about the formal Emergency Preparedness, Resilience and Response Guidance can be found at http://www.england.nhs.uk/ourwork/eprr/sw/#coldplan and http://www.sduhealth.org.uk/policy-strategy/legal-policy-framework/adaptation.aspx.

responsible for property repairs. There are many positive opportunities to embed climate resilience measures into new build and refurbished properties in Jersey. Both the revised building bye-law standards and the proposed new health and safety dwelling law, which will apply to private rented properties, could be routes to deliver building-scale measures on flood resilience which can have long-term cost savings to the States and to individuals.

5.5 Jersey's land cover

The tool provides a land cover map. In terms of the climate change impacts 'hard' surfaces, such as buildings and roads can compound surface water run-off and add to the heat island effect associated with built up areas. These more built-up areas are potentially more likely to have more severe flood and heat-wave impacts. Areas, such as St Helier, with lower proportions of greenspace can be assumed to have less adequate drainage and cooling functions compared to areas with high proportions of greenspace and agricultural land which provide for absorption of water. It is important to note that the implementation of measures such as sustainable urban drainage systems and green infrastructure networks can help positively change the performance of urban areas.

Figure 3: Land cover classifications



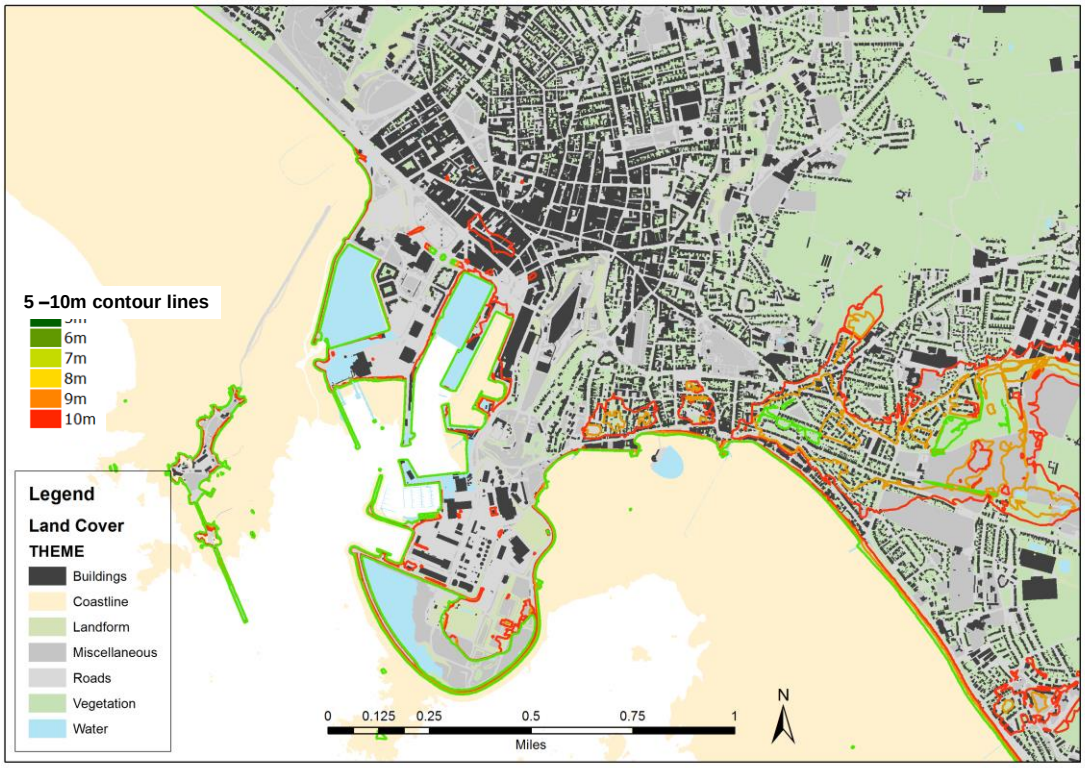
5.6 The possible spatial impact of sea-level rise and spatial risk

Sea level is measured against the Marine Chart Datum which, in Jersey, is currently set to the UK datum of 5.892 metres, this is the existing mean high watermark for Jersey and therefore 5.89m is taken as the current mean sea-level for the tool and report. Based on a climate change scenario for sea-level change predicted at a one metre rise, the coastal

areas that would be at risk from this sea-level rise (assuming no coastal defences were in place) would be all of those areas up to the 6.89m contour - these would be the areas that lie one metre above the current sea-level (i.e. the high water mark which is 5.89m). The existing sea defences that are in place on Jersey are designed to protect up to +0.5m (i.e. to the 6.39m contour. It is worth noting, however, that sea-levels will not rise in a uniform or linear way and that the impacts will depend on funnelling and capture due to street development, drainage, topography and the condition of existing sea defences.

The tool can help to illustrate a range of severe weather scenarios related to storm surges and to sea-level rise. For example, by highlighting areas where water reaches up to the ten metre contour level the tool has been used to model the impact of storm surges on the population profiles discussed in section 5.4. Figure 4 illustrates the high building density of the St Helier area close to the harbour with the red, orange and green lines marking the boundaries of the vulnerable areas that are currently at risk of tidal flooding from the harbour based on the five to ten metre contours (i.e. approximately one to five metres above current mean sea-level). Figure 4 takes into account the existing coastal defences. In practice, one to two metres on top of the mean high watermark could be caused by a storm surge or by future sea-level rise. Paragraph 5.2.2 of this report has identified that Jersey has already been subject to a tidal surge of 1.29 metres. Although this was not at high tide, this previous tidal surge shows there is the potential for the combination of high tide and storm surges to cause serious and extensive flooding.

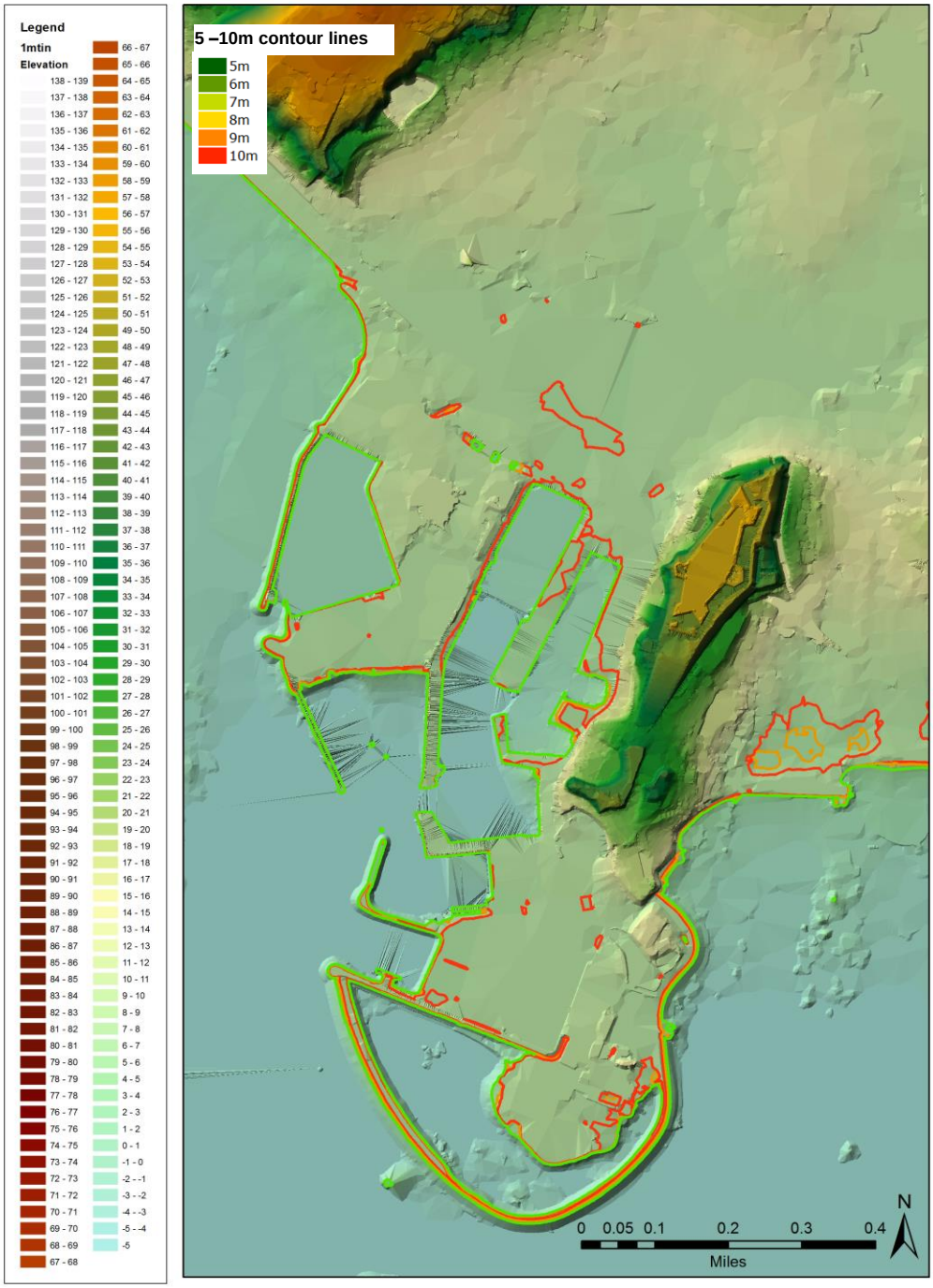
Figure 4: Existing land cover and existing boundaries of vulnerable areas on land between 5-10 metres high



Using the same contour lines as Figure 4 above, Figure 5 highlights St Helier's potential exposure to inundation from the sea due to a rise in the mean high water level and/or a storm event (based on the 5.89m contour baseline and the height of the land in terms of metres above sea-level). It shows the vulnerability of St Helier in relation to the general

topography of the area, illustrating how St Helier is clearly vulnerable to the overtopping of the inner harbour wall because the level of the land slopes downwards, meaning that flood water could pool in the central area of the town. This impact has occurred in the past but could be significantly more severe if a storm surge of 1.29 metres (see para 5.2.2) were to occur at high tide. The master planning and future development of the town should consider potential sea-level rise of around one metre by 2100 and the impact of surface water flooding from heavy rainfall likely to be associated with a storm surge.

Figure 5: Exposure to sea-level rise based on the height of the land - St Helier harbour area

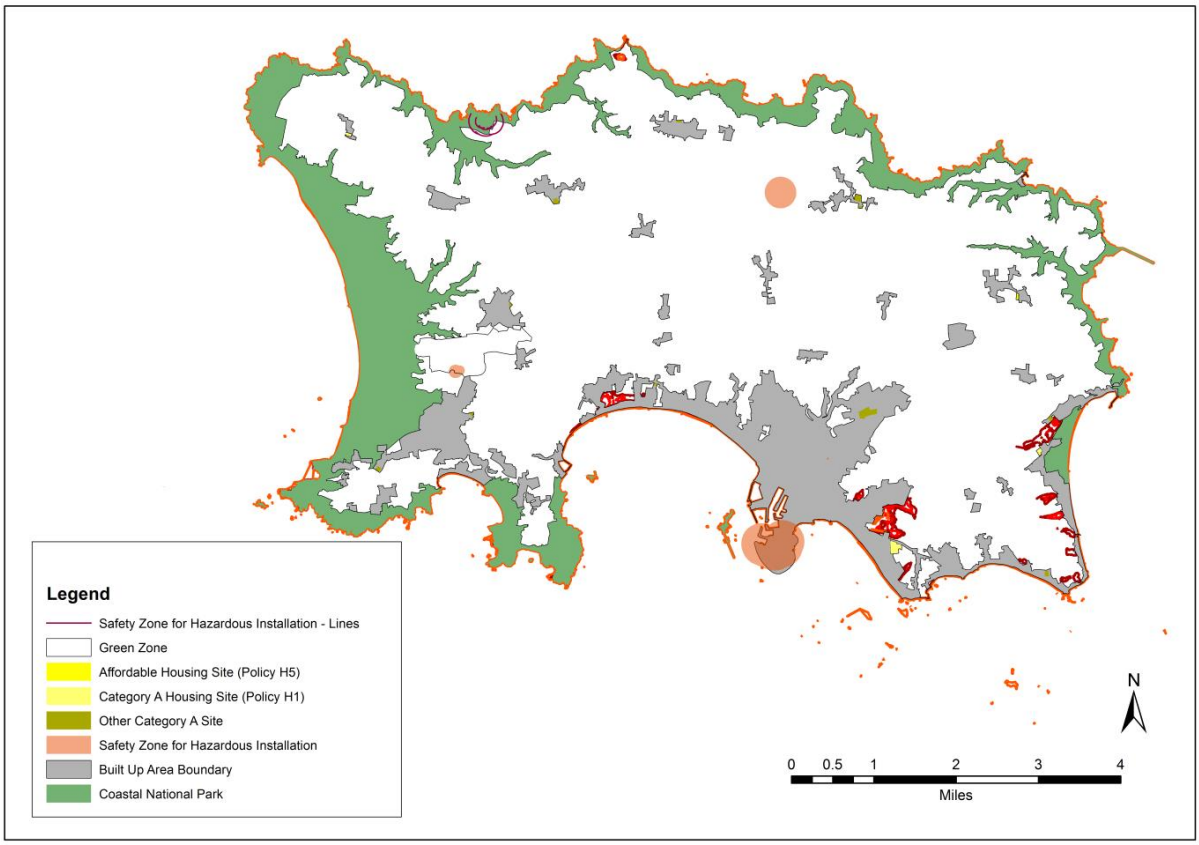


5.7 Planning policy development, sea-level rise and spatial risk

The Island Plan 2011 provides the spatial planning policy for all developments. The broad direction of the plan is to focus development in existing urban areas and on the regeneration and development of St Helier. Consideration should be made towards the types of development that occur in these areas and how that is balanced by improving flood defences. St Helier and other communities, for example on the east coast around Gorey Village, are particularly at risk from future flooding and require specific policy responses which take account of the views and aspirations of local people. The evidence of risks and climate vulnerability explored in the tool suggests future strategic and planning policy should:

- Embed a full understanding of climate-related risk and vulnerabilities in the policy development of future strategic plans.
- Consider different spatial options for growth in areas which are intrinsically less vulnerable to factors such as flooding for example, on higher ground.
- Ensure that when critical infrastructure is built or replaced it is located in intrinsically resilient areas.
- Ensure new development in flood risk areas occurs only after comprehensive flood defence has been secured.
- Promote a range of building scale resilience measures such as sustainable urban drainage systems.
- Require a review of the sea defence strategy taking into account social, economic and environmental impacts as part of the assessment process.

Figure 6: Development Plan policy



5.8 Key Conclusions from Data and Stakeholder sessions

The information and data used to date to develop the tool, as described in section 5, demonstrates the utility of comprehensively mapping the risks and vulnerabilities in Jersey. Further development of this tool would lead to a more sophisticated grasp of risks and vulnerability. It would allow for shared understanding of these factors and greater corporate understanding of the range of data available and the scale of risks which may result. One example of this would be further understanding and discussion on the likely sea-level rise that can be predicted for Jersey by the end of the century. The current Jersey sea defence strategy is based on a sea-level rise of up to 500 mm[24] whereas the UK Government Environment Agency is advising UK local planning authorities to plan for around one metre. The latest IPCC data puts the upward range at between 90mm to one metre. It is understood that the current Jersey sea defence strategy will be revised in 2017/18; this report highlights that there is a need to review the strategy more urgently to enable consideration of adaptation requirements.

The current 2011 Island Plan uses the 2007 sea defence strategy and modelling as the basis for the spatial planning policy and it is understood that the revised Island plan will also use the sea defence modelling and predictions from the Jersey sea defence strategy to inform the development of spatial planning policies. Therefore it is vital that the Jersey sea defence strategy is updated to reflect the latest predictions to enable both the consideration of sea defence and adaptation infrastructure requirements, and also the inter-relationship with spatial planning policies and decisions. There is an imperative to bring forward the update of the sea defence strategy to ensure spatial planning and infrastructure decisions are based on latest data and risk and vulnerabilities assessment, this is reflected in Recommendation 4.

In the immediate short-term, it is understood that supplementary planning guidance will be prepared to facilitate the States of Jersey corporate priorities around the Future of St Helier project. Supplementary planning guidance documents provide an opportunity to introduce adaptation and climate resilience policies such as sustainable urban drainage, greenspaces, design standards for housing and parking into the planning decision-making process. The preparation of the Future of St Helier planning policies must be based on updated sea-level rise predictions.

There are additional data sets, around economic impacts, which could be added to the tool to enrich the information and provide a more sophisticated understanding of risks and vulnerabilities. It is important that, as the understanding of the risk and vulnerabilities grows over time, the data is translated into policy and practical action. The experience of the UK is that some authorities are data rich but action poor. For Jersey the lesson is to integrate the learning on climate change in all aspects of policy and decision making by, for example, embedding adaptation considerations into a sustainability framework for use in policy and decision making.

[24]Brampton A.H. and Powell K.A. (2007) Climate Change, Jersey: Effects on coastal defences (online) Available from: http://www.gov.je/SiteCollectionDocuments/Government%20and%20administration/R%20ClimateChangeJsyEffectsonCoastalDefences%20%2020071031%20HRW.pdf

5.8.1 Economic resilience

This research has highlighted the interrelationship between demonstrable climate resilience and the economic confidence vital to Jersey's future competitiveness. Future investment could be influenced by the Island both delivering and communicating very high levels of resilience and thereby security for investment. Such a policy not only secures current investment, but also offers the potential for competitive advantage through differentiation of the Island. The position of other Island jurisdictions is highlighted below, in summary, while Jersey may be basically more resilient in terms of its geography and underlying geology than places like Grand Cayman, it cannot currently demonstrate as strong an engagement with the climate resilience challenge that it is facing into the future. A comparative assessment of other offshore jurisdictions climate change preparedness and strategies should be carried out as part of understanding the economic resilience issues.

The stakeholder discussions confirmed the need to include economic data in the analysis of the risk and vulnerabilities of the Island. This requires further research into the approach of jurisdictions with similar economic models and detailed assessment of vulnerability of key economic assets in terms of both preparedness and recovery times. Evidence on the insurance costs to business and direct costs to Government of recent severe weather events should form part of this data. Of most immediate value is engaging with major investors who themselves have sophisticated views of climate change on their business models. This dialogue would be one key way to secure long-term business confidence; financial services and investors must be seen as a crucial stakeholder group.

5.8.2 Strategic Planning

Building resilience requires a strong signal that the issue is an overarching strategic policy priority. Such a policy should drive the coordination of the diverse strategies necessary to make action happen on the ground. Jersey has produced four strategic plans in seven years. The Council of Ministers (CoM) is currently producing a strategic priority plan for the term of this Government, which is three years. A final version of the plan will be debated in April 2015. It was noted by the authors, with concern, that climate change does not feature in the version reviewed during the period of this project. Given the science of climate change expressed in the analysis carried out for this report; the past record of severe weather, and the potential vulnerability of St Helier, it seems at least imprudent not to recognise climate resilience as a key priority and a major theme for the Island's strategic plan. It is understood that the plan will signpost the development of a long-term strategic plan, which must recognise climate change as a key risk that must be considered by all strategies.

5.8.3 Spatial Planning

Spatial planning has a particularly important role in building climate resilience from determining long-term patterns of development to building-scale measures. It offers the opportunity for meaningful community engagement in the formulation of solutions. These issues are plainly key for Jersey in the context of the ambition for a growing economy and population. Current strategy[25], set out in the Jersey Island Plan of 2011, strongly recognises

[25] States of Jersey (2014) Island Plan Strategic Policy Framework: Sustainable Development. In. States of Jersey. *Revised 2011 Island Plan*, St Helier: Environment Department (online) Available from: http://consult.gov.je/portal/adopted/pd/ip2011?pointId=1405696217767#section-1405696217767

climate change as an important factor. However, the plan seeks to continue to focus development in existing communities and, in particular, St Helier where there are significant vulnerabilities. This report has made clear that future planning policy should embed a full understanding of climate adaptation and ensure new development is located in low risk areas or defended from flood risk at level equal to long-term challenges of sea-level rise, storm surge and surface water flooding.

5.8.4 The future of St Helier

Framed by a masterplanning process, the regeneration of St Helier provides a real opportunity to embed the outcomes of the growing understanding of risks and vulnerabilities. Where long-term and cost-effective flood defence is possible, then current patterns of development and growth can be sustained. However, the concentration of future development along the south-coast may require review where such development reinforces future vulnerabilities. The same spatial reassessment is required for key assets such as public services which require additional standards of resilience to severe weather.

5.8.5 Short-term resilience issues

The stakeholder events also provided a snapshot of other concerns which can be generally characterised as short-term emergency planning issues. These included food security and warehousing capacity, resilience of key harbour infrastructure, and fuel supplies. The scope of this report has not included a detailed review of emergency planning or business continuity although these stakeholders were involved in roundtable discussion. It is clear that climate change is recognised as a key risk and needs to be recognised in the corporate risk register and associated documents. The recommendation of this report is that emergency planning and business continuity procedures be reviewed in the light of the risk associated with, in particular, severe weather.

5.8.6 Governance

There are multiple departments and agencies involved in policy and delivery of actions around building the Island's resilience. Such multiple responsibilities for data, policy and implementation require review to identify gaps and overlaps. The incorporation of the Ports of Jersey presents a striking example of where responsibilities are split between the Transport and Technical Services department (T&TS) on coastal flood defence for the Island, and the future Ports of Jersey with responsibility for the St. Helier Harbour. Since the Harbour is a critical point of vulnerability for St Helier in a storm surge, it is vital that its resilience is considered holistically and linked to the masterplanning for the regeneration of St Helier and, in fact, any development proposal for the town – or indeed, the Island. The States of Jersey internal policy officer network, a meeting of policy officers from all departments, provides a key governance opportunity to develop a consistent and coordinated approach to policy development. Identification of the key corporate, political and community stakeholders would be a vital first step in the development of good governance. Existing governance bodies, such as the States of Jersey Environment Housing and Technical Scrutiny Panel[26], which already requires an annual update on the progress with

[26] States of Jersey (2015) *Environment, Housing and Technical Services* (online) Available from: http://www.scrutiny.gov.je/panels/Environment/Pages/default2.aspx

implementation of energy policy designed to mitigate climate change, could play a useful role in the oversight of the development and progress of the climate adaptation process.

5.9 Jersey's overall progress on adaptation planning

The TCPA's pan-European climate change adaptation project (GRaBs[27]) demonstrated that there is no national one-size-fits-all approach to the management of adaptation planning. The UK has taken high-level action through enshrining climate change adaptation in legislation in the Climate Act (2008) and the production of the UK National Adaptation Programme which gives a sector by sector view of risk and vulnerabilities. The Committee on Climate Change and the Adaptation Sub-Committee both provide crucially important research and oversight functions. Climate change is a key corporate risk to the UK Government and there is a cross-departmental Committee on Adaptation. Action on the ground, however, is less impressive. At the local level, several Local Authorities have developed individual Adaptation Action Plans. Several EU member states have very strong building codes on design including green infrastructure and sustainable urban drainage which have driven change in the design and delivery of the built environment. Some non-EU nations, such as Switzerland, have made strong progress in cities such as Basel and Geneva.

In Jersey there is evidence of many activities and stakeholder interest, but actions are not well coordinated or focused on climate adaptation, and governance or commitment to addressing the issue is not clear. There is an opportunity to integrate climate adaptation into many levels of policy and practice and, potentially, to extend the remit of existing fora in respect of governance on climate change. Jersey has an opportunity to use its planning and building control functions more strongly to set high standards that ensure climate resilience for both existing and future developments.

[27] Green and Blue Space Adaptation for Urban Areas and Eco Towns project

Case Study: Climate change policy in other small Island states

A brief international comparison with two other smaller Island states has been carried out. This shows a variety of practice in Gibraltar, for example, the Department of the Environment has established a high-level policy that identifies future risks and set up a climate change forum which draws together expertise acting as a technical advisory group to Government[28]. The British Virgin Islands, (BVI) which has significant vulnerabilities, has gone further using support from the UK Department for International Development (DFID), and began an Adaptation Plan in 2007[29] agreeing the following policy:

> *In order to reduce shocks to the insurance/banking industry from Climate Change impacts, the Government of The Virgin Islands commits to take the following adaptation actions:*
> *1. Reduce the exposure of The Virgin Islands insurance and banking sector by updating and improving the Building Regulations 1999 by adopting relevant "climate proofed" international building codes and producing a local supplement to address climate specific hazards by 2014;*
> *2. Require the establishment of Climate Change risk management protocols for the finance sector;*
> *3. Impose a Climate Change Financial Risk Management Levy on offshore registered companies that would go towards a Trust Fund dedicated to reducing the Climate Change risks of the financial sector by implementing measures that would reduce the vulnerability of The Virgin Islands to Climate Change impacts and protect the economic base of the Territory.*
> *Carbon levy+ Climate change financial risk management levy =* ***US$15.6m per year***
> *Virgin Islands Climate Change Trust Fund due to be established by end of 2014.*

It may be significant that both Gibraltar and BVI have maintained their position in the ranking of off-shore states and that BVI has addressed how the private sector might contribute to secure long-term climate resilience.

Grand Cayman was discussed by several of the stakeholders partly because Jersey was perceived to be a net beneficiary of investment which flowed out of the Caymans after severe weather events. In September 2004, Hurricane Ivan swept past Grand Cayman Island with devastating winds at speeds up to 185mph causing storm surges up to 8ft high that flooded the Island from the north (early on in the storm) and later from the south[30]. In addition to the hurricane force winds, storm surges and heavy rainfall, the Island was buffeted by heavy wave action resulting in coastal erosion on the south of the Island. These direct impacts of Hurricane Ivan caused serious and catastrophic damage to the infrastructure, the population and to the Island itself.

[28] Government of Gibraltar (2014) *Department of the Environment* (online) Available from: https://www.gibraltar.gov.gi/new/health-and-environment

[29] Burnett Penn, A. (2010) *The Virgin Islands Implementation of the Enhancing Capacity for Adaptation to Climate Change in the Caribbean UK Overseas Territories (ECACC) Project Report to the Virgin Islands London Office Conservation and Fisheries Department [Technical Report 5C/ECACC-10-06-1*]. Belize: Caribbean Community Climate Change Centre (online) Available from: http://www.caribbeanclimate.bz

[30] Young, S.R. (2004) *Impact of Hurricane Ivan in Grand Cayman: Understanding and quantifying the hazards*, Montserrat: GeoSY Ltd. (online) [Available from: http://stormcarib.com/reports/2004/SRYCAYMAN.PDF

Just one year previously, the Cayman Islands' Government had commissioned a report from the Tyndall centre[31] exploring the impacts of climate change and severe weather. Following the storm**,** the UK Department for International Development commissioned a comprehensive assessment[32] of the storm including the interaction of wave action, storm surge and rainfall.

Key Conclusions

Jersey is taking some action on resilience but it is striking, particularly in light of international comparisons, that as yet, there is no high-level corporate priority for climate change adaptation nor a robust risk and vulnerabilities assessment of climate change impacts. Consequently, climate change does not appear to figure as a dominant priority in the published draft corporate or spatial development priorities. Climate change must be taken into account in the longer term investment decisions for defence and adaptation of key infrastructure and for the spatial development of the Island

Jersey has many of the key assets it needs to achieve progress from the excellent data of the Meteorological Office to the experience of flood defence and spatial planning in the environment and transport and technical services departments. The key recommendation from this report is to use the ten recommendations to prepare a comprehensive and detailed Adaptation Action Plan for Jersey.

[31] Tompkins, E.L., Nicholson-Cole, S.A., Hurlston, L.A., Boyd, E., Hodge, G.B., Clarke, J., Gray, G., Trotz, N., and Varlack, L. (2005) Surviving Climate Change in Small Islands – A guidebook (online) [Available from: http://www.tyndall.ac.uk/sites/default/files/surviving.pdf]

[32] Young, S.R. (2004) *Impact of Hurricane Ivan in Grand Cayman: Understanding and quantifying the hazards*, Montserrat: GeoSY Ltd. (online) [Available from: http://stormcarib.com/reports/2004/SRYCAYMAN.PDF]

6.0 Recommendations and next steps

Jersey faces a growing challenge from the impacts of climate change and, in particular, increased frequency and severe weather events and sea-level rise. Although some actions are already underway, overall, the findings of this report make clear that action is necessary **now** to understand the complexity of the potential impacts and thereby to begin to build long-term resilience. The problem is particularly acute in relation to Jersey's financial industry when evidence shows that competitors also offering offshore financial services are already taking effective action on climate resilience. Building resilience will require multiple actions by different sectors - from agreeing the corporate priorities; building institutional capacity across all sectors, and communicating/raising awareness with the public and other stakeholders.

6.1 Recommendations

The following outline recommendations provide a basis for such action by the States of Jersey:

1. **Setting priorities.** Climate change should be recognised by the States of Jersey as the priority issue to secure the future of the Island. This priority needs to be explicitly expressed in both short and long-term strategic policy. This should include the development of a sustainability framework which embeds key agreed data on climate impacts and planned adaptation measures as part of the policy planning process.

2. **Auditing current actions.** Building on the findings in this report, Jersey needs to carry out a comprehensive audit of existing actions, strategies and institutional capacity relating to resilience in order to provide an analysis of strengths and weakness to inform future strategic development. This process could also include the commissioning of a detailed SWOT analysis of current responses to climate adaptation measures.

3. **A comprehensive economic risk assessment.** Gauging the long-term economic risk to the Island is vital and should include an exercise in assessing Jersey's progress in relation to its international competitors, and securing a more detailed economic assessment of climate impacts. This is about developing a detailed understanding of, for example, real estate values and flood vulnerability data, both of which are essential to inform the cost benefit analysis of enhanced action on flood defence.

4. **Coordinating and agreeing data on risks.** A coordinated approach to data collection across all sectors and States of Jersey departments must be taken in order to enhance the knowledge base of risks and vulnerabilities. This process must include cross-departmental and cross-agency agreement on data-sets and risk factors such as sea-level and sea-level rise and might be achieved through the increased functionality of a GIS mapping tool.

5. **Developing an integrated approach to adaptation.** Jersey needs to develop a comprehensive adaptation action plan based on international best practice. This action plan should be part of the corporate priorities of the States of Jersey and set out the key risks and vulnerabilities as well as key sectoral actions in relation to

spatial planning, flood defence, transport, economic development, health-care, energy and emergency planning. This report recommends the development of a draft structure for a climate change adaptation action plan for Jersey.

6. **Reviewing spatial planning.** The Island Plan and supporting supplementary guidance should be reviewed to ensure it reflects the growing understanding of climate change impacts. This requires consideration of a range of factors, from long-term spatial distribution, to building-scale actions, to enhance resilience. A priority issue is the interaction of planned flood defences and the projected growth of St Helier. The future of the town must be considered in line with proposed or revised flood defence investment based on climate change/extreme weather data.

7. **The Future of St Helier.** St Helier, a vital asset to the island, faces particular risks from a combination of high tides and storm surges. The future of the St Helier masterplanning project provides a timely opportunity to apply the findings and implications highlighted in this report and to integrate resilience principles into the planning process. This will require a multi-agency and multi-disciplinary approach including the engagement of Department of the Environment, Parish of St Helier, Ports of Jersey, Transport and Technical Services, and other key stakeholders and interest groups.

8. **Building institutional capacity and governance structures.** The process of preparing an adaptation action plan should be seen as an opportunity to review and simplify governance structures. Inter-departmental cooperation is crucial with a clear understanding of how differing roles and responsibilities interlock to shape policy and delivery.

9. **Changing cultural attitudes to climate change.** Delivering action on climate change requires both political will and wider community and stakeholder engagement. Discussion with stakeholder groups showed that there is considerable interest and concern over climate change but that there is, despite the overwhelming scientific consensus, still some scepticism. A communications and awareness-raising strategy must consider the wider public engagement in this issue and consideration should be given to closer working with existing fora which could inform Government action. An awareness raising conference could be one element within a communications strategy.

10. **Funding for resilience.** Based on the outcomes of the adaptation plan, consideration should be given to enhancing investment in resilience measures. In this regard, new funding mechanisms, such as those being considered in the British Virgin Islands (BVI), should be explored.

Annex 1: List of stakeholders participating in roundtables

Construction Council
Dyson and Buesnel Architects
Jersey Architects AJA
Jersey Citizens Advice Bureau
Jersey Climate Action Network (J-Can)
Jersey Consumer Council
Jersey Gas
Jersey Heritage
Jersey In Transition
Jersey Voluntary and Community Sector
Jersey Water
Fuel Supplies (CI) Ltd (RUBIS ENERGIE)
Highlands College
National Trust
Petroleum Distributors (Jersey) Ltd
Price Waterhouse Coopers
RBC Wealth Management

Annex 2: List of supporting Jersey policy and related documents reviewed

Climate Change, Jersey: Effects on Coastal Defences, Transport and Technical Services Department
Pathway 2050: An Energy Plan for Jersey, Environment Department
Revised 2011 Island Plan, Environment Department
The Environment: Challenges for the future, States of Jersey Corporate Management Board
The Exceptional Tide, Storm Surge and Damage on 10 March 2008, Jersey Meteorological Department

Annex 3: The TCPA and University of Manchester's climate change adaptation experience

The TCPA has developed a strong track record in research, policy formulation and political influence on climate adaptation and mitigation in the context of spatial planning. The organisation has hosted the Planning and Climate Change Coalition (PCCC) for ten years and has played a major role in influencing national policy. The TCPA was the lead partner for the pan- European INTERREG IVC Green and Blue Space Adaptation for Urban Areas and Eco Towns (GRaBs) project on climate change adaptation which developed a series of policy and practice outputs in relation to understanding and mapping vulnerabilities to climate change to inform planning for adaptation options. The TCPA is a partner in the Lifelong Learning Programme's CLIM-CAP project which is developing climate change adaptation training for built environment professionals to bridge the gaps in knowledge and skills required for proactive planning for climate change. This, along with many other works streams, has positioned the TCPA as leading organisation on spatial planning and climate change adaptation.

The University of Manchester has developed an international reputation in responses to climate change impacts and policy effects, in the context of adaptation and mitigation strategies. One of the main areas of its expertise is a focus on vulnerability to climate change impacts, especially within the context of adaptive societal responses. This includes the development of web based decision support tools which are now being deployed through the University's newly created spin-out company TellUs Toolkit Ltd.

Annex 4: Glossary of terms

Climate change adaptation terms used in this report. These definitions have been taken from the IPCC[33] and the European Climate Adaptation Platform[34].

Adaptation: the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Adaptive management: a process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables

Climate change: the European Climate Adaptation Platform defines 'climate change' as: any change in climate over time, whether due to natural variability or as a result of human activity. The United Nations Framework Convention on Climate Change (UNFCCC), defines 'climate change' as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'.

[33] IPCC (2014) IPCC WGII AR5 Glossary (online) Available from: http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Glossary_FGD.pdf

[34] European Climate Adaptation Platform (2015) *Glossary* (online) Available from: http://climate-adapt.eea.europa.eu/glossary

Disaster risk: the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period. With knowledge of the prevailing hazards and the patterns of population and socio-economic development, disaster risks can be assessed and mapped.

Extreme weather event: an event that is rare at a particular place and time of year. By definition, the characteristics of what is called extreme weather may vary from place to place. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g. drought or heavy rainfall over a season).

Impacts (Consequences, Outcomes): effects on natural and human systems. In this report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health status, ecosystems, economic, social, and cultural assets, services (including environmental), and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea-level rise, are a subset of impacts called physical impacts.

Mitigation: an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies and measures to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. Examples of mitigation measures are renewable energy technologies, waste minimization processes and public transport commuting practices, etc.

Resilience: the capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation[35].

Risk: the combination of the probability of an event and its negative consequences.

Storm surge: the temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions (low atmospheric pressure and/or strong winds). The storm surge is defined as being the excess above the level expected from the tidal variation alone at that time and place.

Urban heat island: The relative warmth of a city compared with surrounding rural areas, associated with changes in runoff, effects on heat retention, and changes in surface albedo.

Vulnerability: the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

[35] Arctic Council (2013) Glossary of terms. In: *Arctic Resilience Interim Report 2013*. Stockholm Environment Institute and Stockholm Resilience Centre, Stockholm, Sweden