6.0 Risk Assessment

Adaptation to climate change is fundamentally a risk management strategy, or an insurance policy against an uncertain future. Risk is a combination of the likelihood of any of the previously described climate related events occurring in the future, and the magnitude of the potential consequences. Some processes or events, several years of drought, for example, have occurred often in the past and have a very high probability of occurring in the future, probably more frequently. The consequences of a prolonged drought can be very significant. The product of the probability and consequences of drought and the associated water shortages, therefore, produce a very high risk rating, over both the short and long-term.

The consequences of any particular event may be economic, social, or environmental. A general qualitative assessment of risks has been included in this section, but no attempt has been made to assess specific types of consequences. Additionally, risks for each of the climate-related events that the County of Santa Cruz is expected to face are evaluated for both a short to intermediate time frame (2010-2050), and an intermediate to long-term time frame (2050-2100). Three different levels of Magnitude: Low, Moderate and High, have been chosen, and four different levels of Probability or Likelihood of Occurrence: Low, Moderate, High and Very High.

Processes such as floods and droughts reflect climate variations or fluctuations. The County has adequate records for these types of events, simply because the County has experienced these types of events many times throughout its history. As a result, there is a high degree of certainty that both floods and droughts will occur in the future. The uncertainty lies in how much more frequent and how much more severe these events will be in the future as a result of changing climate.

There are other events related to climate change, those related to sea level rise for example (inundation of low lying coastal areas, a rise in the water table beneath Rio Del Mar Esplanade/Flats), where the future unknowns are higher, simply because of the lack of certainty about future greenhouse gas emissions and how they will influence climate and sea level rise. Despite the uncertainties, it is possible to make some judgment as to the relative level of risk that each of these poses to the County based on some range of future projections. Based on the trends of the past century and the various climate models that have been developed, the risks from each of these climate-related events will almost certainly increase in the future (Figure 6-1).

Over the next 40 years (between 2010 and 2050), it is expected that the highest risks to the County of Santa Cruz will come from:

- Potential water shortages due to the combination of increasing temperatures, changes in precipitation patterns increasing climatic water deficit, increased salt water intrusion, decreased groundwater recharge, and higher demand. This has a very high probability of occurrence and also significant (high) consequences.
- Rising water table beneath the Rio Del Mar Esplanade is already an issue. As sea level continues to rise, the present problems will be exacerbated. The consequence of a continuing water table rise on commercial and residential structures and infrastructure, including the wastewater pump station is high, and the likelihood of this taking place in the immediate future is high.
- Potential increase in future coastal storm frequency and/or intensity will increase cliff retreat rates as well as cause potential damage to oceanfront property or public infrastructure. The coastlines of northern California, Oregon and Washington have experienced increasingly intense winter storms and greater wave heights over the last 25 years, both of which may be leading to more severe winter erosion (Allan and Komar, 2000). The consequence of coastal bluff erosion is high due to the extent of high-value public and private improvements (infrastructure, structures, etc.).

Figure 6-1. Short to Intermediate Term Risk Ranking 2010-2050

(Risk = Probability x Consequence)

Magnitude of Consequence	Low	Moderate	High	Very High
High	• Increased Wildfires	• Increased Wave Run-up & Storm Surge • Increased Threat to Biotic Resources	• Increased Saltwater Intrusion • Rising Water Table • Coastal Bluff Erosion • Gradual Permanent Shoreline Inundation from Sea Level Rise • Increased Flooding • Increased Landslides	• Water Shortages
Moderate				
Low			• Increased Heat Waves	

Likelihood of Occurrence (Probability)

Legend				
Recommended Action Based on Level of Risk	*No Action*	*Monitor*	*Evaluate Further/ Develop Strategies*	*Develop Strategies*

- Flooding in Santa Cruz County has occurred in each of the primary drainages and will continue to occur in the future given certain sets of meteorological conditions. Previous occurrences are well documented for all primary drainages with the exception of Aptos Creek, which is not gauged. In addition, low-lying areas such as Rio Del Mar Esplanade/Flats will experience more frequent flooding and inundation from sea level rise and increased wave heights. As a result, the consequence would be high in terms of structural and economic loss, with the probability of such an event occurring also being high.
- Groundwater extraction rates from the Pajaro River Valley groundwater basin have exceeded sustainable pumping rates for decades, causing groundwater levels to drop significantly, resulting in saltwater intrusion and rendering some coastal groundwater wells unsuitable for use. With the rise in sea level in the coming decades, saltwater intrusion will be exacerbated. The probability of saltwater intrusion is high due to the current groundwater overdraft situation in the Pajaro Valley, and the consequence of this occurring is high due to the economic effects of fallowing large expanses of farmland to reduce groundwater pumping. However, efforts are being developed to reduce groundwater pumping and to stop saltwater intrusion. The success of these efforts will be challenged by the additional effects of climate change.

  Many of the wells located within the boundaries of the Soquel Creek Water District are also threatened with saltwater intrusion. A reduction in groundwater pumping will be necessary to meet the protective and target water levels necessary to avoid saltwater intrusion into the wells.

- Heat waves in Santa Cruz County are likely to become more frequent in the future due to climate change; however, due to the marine climate, temperature increases would be moderate. As a result, the consequence would be low while the probability of such an event occurring is high.
- Climate change is expected to result in additional risk of increased fire frequency, size, and severity beyond the historic range of natural wildfire variability due to increasing length of the fire season, drier fuels, and decreasing forest health. These changes are being driven by alterations in temperature and precipitation regimes (generally, warmer and drier). As a result, the consequence would be high while the probability of such an event occurring is low.

Over the intermediate- to long-term, 2050-2100, in addition to water shortages and a rise in the water table, it is expected that other climate change related events would increase to high and very high levels of risk within the County (Figure 6-2):

- Potential water shortages, as described for the period 2010-2050, shift from a high probability of occurrence to a very high probability of occurrence as climate change progresses.

Figure 6-2. Intermediate to Long Term Risk Ranking 2050-2100

(Risk = Probability x Consequence)

Magnitude of Consequence	Low	Moderate	High	Very High
High		• Increased Wildfires	• Increased Wave Run-up & Storm Surge • Increased Threat to Biotic Resources	• Increased Saltwater Intrusion • Water Shortages • Rising Water Table • Coastal Bluff Erosion • Gradual Permanent Shoreline Inundation from Seal Level Rise • Increased Flooding • Increased Landslides
Moderate				
Low				• Increased Heat Waves

Likelihood of Occurrence (Probability)

Legend				
Recommended Action Based on Level of Risk	*No Action*	*Monitor*	*Evaluate Further/ Develop Strategies*	*Develop Strategies*

- Even though many of the areas of highest vulnerability have already been armored with riprap or seawalls, coastal cliff erosion continues to take place. The value of property and infrastructure in this area is very high, and in the long-term, with a rising sea level and increased winter wave attack, this risk is expected to increase to a very high level.

- Rise in the water table beneath the Rio Del Mar Esplanade as described for the period 2010-2050 shifts from a high probability of occurrence to a very high probability of occurrence as sea level rise progresses.
- Shoreline inundation would affect a number of developed areas along the County shoreline, particularly at the maximum projected sea level values for 2050-2100. The potential for flooding of the Rio Del Mar Esplanade and Beach Drive, for example, has a very high probability of occurring with a high consequence if it were to happen. If winter precipitation increases in the longer-term future, although it is not clear from the models that have been run to date that this will occur, the probability will increase, raising the risk of flooding.
- Flooding, as described for the period 2010-2050, shifts from a high probability of occurrence to a very high probability of occurrence as climate change progresses
- Salt water intrusion of groundwater as described for the period 2010-2050 would continue as sea level rise progresses. The probability of saltwater intrusion increases to very high, and the consequence is very high due to the economic effects of fallowing large expanses of farmland to reduce groundwater pumping. Efforts are underway to reduce groundwater pumping to stop saltwater intrusion; however, the success of these efforts will be challenged by the additional effects of climate change.
- Heat waves as described for the period 2010-2050 shift from a high probability of occurrence to a very high probability of occurrence as climate change progresses.
- Climate change is expected to continue to contribute to increased wildfires as described for the period 2010-2050 with the probability of occurrence shifting from low to moderate as climate change progresses.