Climate Change Health Risk Assessment Model Guidance

Purpose:

The Climate Change Health Risk Assessment Model is made specifically for looking at climate change and the health related issues that may evolve during certain climate change risks. This assessment model is to help in the planning process by ranking the health related issues in regards to the climate risk in order to plan for those areas that will have the greatest effect on the county.

Caution:

All types of assessments will have some supporting data, but ultimately it comes down to bringing together experts within the certain fields in order to make an educated guess of what the consequences are and how big of an impact each consequence will have.

Teamwork:

The need for contacting and working with experts in the field of climate change will help in gathering the necessary information required to come up with the probability of occurrence (explained later). Climatologists will be able to gather observed historical climate data and modeled future climate data that will support the scoring of the probability that an anticipated climate change risk would occur.

Evaluation Process:

The following information will help guide you through the Climate Health Assessment Model. This model will assist you with climate change and health related issues. In the end you will combine the scores for the probability of climate risk occurrence and the magnitude of health consequences to come up with number representing the priority of concern for each anticipated climate risk. This will allow for the ability to ensure that planning for the climate risk that will affect the health of the community is planned for and resources are available in order to mitigate any health related problems.

Climate Risk Descriptions, Likelihood, and Confidence

Drought & Reduced Summer Water Supply

Drought can result from abnormally warm temperatures, reduced precipitation and changes in hydrology. Drought relates to the impacts of when the societal demand for water exceeds the supply. The Willamette River Basin is a mixed rain-snow transient basin characterized by higher stream flows in the winter and lower stream flows in the summer. Most of Oregon's precipitation falls between October and March and much of the summer water supply is stored in the mountain snowpack. Over the last half a century, low to mid-elevation snowpack has been declining in the Cascades (Mote et al. 2005; Chang et al. 2010), but the year-to-year variations in snowpack are quite large. Projected warmer winter temperatures will cause more precipitation to fall as rain rather than snow in the mountains, especially at lower elevations where temperatures are typically close to freezing, likely causing a future reduction in snow pack accumulated over the winter. By 2050, snowpack in the Cascades is projected to decline by about half (Leung et al. 2004; Chang et al. 2010). By the end of the 21st century, April 1 snowpack is projected to decline substantially in the Willamette River Basin. A reduction of snow pack in the winter (and earlier spring melt of snow pack due to projected warming spring temperatures) will lead to a reduction in summer flows in most transient basins that are already at their lowest. An increase in water demand and usage during increasingly hot and dry summers could exacerbate future drought conditions (Chang et al. 2010). By the end of the 21st century, the frequency of droughts lasting 3-6 months is projected to increase in the Willamette Valley and West Cascades (Chang and Jung 2010; Chang et al. 2010).

Likelihood & Confidence

There is high confidence (strong evidence and medium scientific consensus) for historic and future changes in hydrology and reduced snowpack in the Northwest. Reduced snowpack is highly likely, especially in our region, because our high elevation winter temperatures are near the freezing level (32˚F/0˚C) which means that a little warming could make a big difference between how much precipitation falls as snow or rain in the low elevation mountains (Nolin and Daly 2006; Chang et al. 2010). Drought is driven largely by precipitation. There is large inherent variability in Oregon's precipitation and there is a wide range of future precipitation projections for the NW region, but a majority of models project decreases in summer precipitation. There is low confidence that droughts will intensify in this region because of inconsistent projections and drought definitions, as well as observational and modeling deficiencies (IPCC 2012).

Extreme Heat Event

Heat waves are associated with high-pressure systems. An increase in duration, frequency, and severity of heat waves in the future is associated with an increase in mean summer maximum temperature (Lau and Nath 2012). Extreme heat events, or heat waves, are often defined as a certain number of days above the reference period 90th to 99th percentile threshold (i.e. the temperature at which 90-99% of days are cooler than the given temperature threshold). While there has not been a significant increase in historical extreme daytime heat events (defined as 3 or more days over the 99th percentile) in the western parts of Oregon and Washington, the frequency of extreme nighttime temperature events have increased in frequency from 1901-2009

(Bumbaco et al, in review). According to a study by the National Resource Defense Council (NRDC), from 2000-2009 much of the western US, including Benton County saw more extreme heat days (defined locally at the 90th percentile) per year than would be expected given the 1961-1990 reference period (NRDC climate map: http://www.nrdc.org/health/climate/or.asp#mark_97330). Increases in heat wave intensity, duration, and frequency are projected for the Northwest using climate models (Meehl and Tebaldi 2004; Lau and Nath 2012; IPCC 2012)

Likelihood & Confidence

There is high likelihood (greater than 90% chance) that heat waves will increase in length, frequency, and/or intensity over most land areas (IPCC 2012). According to expert assessment, there is a high level of physical understanding and ability to detect changes in heat waves (Lubchenco and Karl 2012). Several scientific studies using different models and different measures of extreme heat project increases in heat waves for the Northwest and most land areas. In sum, there is high confidence that heat waves are highly likely to increase in the future.

Wildfire

The frequency and extent of wildfires is strongly related to climate. West of the Cascades, forests are more vulnerable to fire danger under warmer and drier summer conditions, which deplete fuel moisture creating favorable conditions for fire (OCAR 2010). Since the mid-1980s, the frequency of large fires increased and duration of the fire season increased by 78 days in the western US and can be explained by changes in climate drivers (Westerling et al. 2006). Under projected climate changes, an increase in fire activity (i.e. area burned) is expected for all major forest types in Oregon. Furthermore, frequent, large fires could become increasingly common in western Oregon forests (OCAR 2010).

Likelihood & Confidence

There is high likelihood in the risk of increasing wildfire frequency and intensity (OCCAF 2010). Estimates of future precipitation changes for the PNW vary, with some projections indicating wetter than present conditions and other projections indicating drier than present conditions. Whether the future climate is wetter or drier will significantly affect potential changes in area burned by fire, as will increases in inter-annual to inter-decadal climate variability (OCAR 2010). However, decreases in summertime precipitation are likely. There is medium to high confidence in the evidence for increased area burned by wildfires in the Northwest.

Extreme Precipitation & Flooding

As the atmosphere warms, it is able to hold more water vapor, which means that more water vapor available to condense and rain out when it does rain resulting in extreme precipitation events. Annual precipitation is dominated by natural climate variability and there is not a clear trend in the recent past in Oregon or Benton County. Even though there has been no clear trend in extreme daily precipitation over the 20th century in Oregon or Benton County, extreme precipitation events are likely to increase in the future for the Oregon Cascade Range (Leung et al. 2004; OCAR 2010) and become more intense in parts of the Northwest (Tebaldi et al. 2006; OCAR 2010). One study analyzed changes in several measures of extreme precipitation from global and regional climate models for Portland, OR and found small, though not significant increases (Rosenberg et al. 2010; OCAR 2010). However, another global and regional climate modeling study found that extreme winter precipitation events that occur every 20 years and every 50 years are likely to increase in intensity or the amount of rainfall (Dominguez et al. 2012). Moreover, most of the extreme flooding events on the West Coast coincide with atmospheric river events in which the atmospheric circulation directs moisture from the tropical atmosphere toward our region.

Likelihood & Confidence

A majority of models project increases in the annual average precipitation in the northern part of North America and decreases in the southern part (Christensen et al. 2007), but the Northwest lies in between and so results are ambiguous with some models projecting decreases of as much as 10% and increases of 20% by the end of the century (OCAR 2010). A majority of models indicate increases in extreme winter precipitation in the Northwest. "There is confidence that flooding will increase in the 21st century, particularly in areas that have a history of chronic flooding" (Chang and Jung 2010; OCCAF 2010). However, there is very little information regarding how the frequency and intensity of atmospheric river events might change in the future.

Ozone Pollution

The high-pressure systems associated with heat waves produce stagnant air masses that can trap and prevent dispersal of atmospheric pollution resulting in higher concentrations of ground-level ozone. With projected increases in heat waves and average warmer temperatures in the Northwest, increasing ground-level ozone is an associated risk, though generally in urban areas and a lower risk compared to the rest of the country (Chen et al. 2009). Land cover changes could also contribute to ground-level ozone concentrations (NCA 2009). The Willamette Valley is prone to diminished air quality during the winter under temperature inversions, which tend to prevent air and any particles in the air at the surface from mixing and dispersing upward.

Likelihood & Confidence

While high temperatures would increase tropospheric ozone levels under low and high emissions scenarios, future ground level ozone projections are dependent on the emission scenario: the low emission scenario has a decrease in certain emissions that lead to ozone formations and thus projects decreases in ground level ozone while the high emissions scenario projects increases in ground level ozone (NCA 2009). The current emission trajectory is similar to the higher emission scenario, though that could change in the future depending on societal behavior and new policies.

Longer Growing Season

Increases in temperature and carbon dioxide concentrations affect the growing season length and production of vegetation. Increasing mean annual temperature contributes to an increase in the length of the frost-free season, defined as the number of days between the last spring frost and the first fall frost. Over the 20^{th} century, the average frost-free season in the US has increased by about 2 weeks, and has increased by even more than that in the western US at a rate of 19 days per century (Kunkel et al. 2004). This increasing trend in the length of the frost-free season is expected to continue in the future with warming temperatures (IPCC 2007). Increase in the length of the frost-free season is associated with earlier spring blooming. In the western US, honeysuckles and lilacs bloomed earlier in the 1980s and 1990s than in the 1960s and 1970s (Cayan et al. 2001; OCAR 2010). This may affect the length of the pollen season for some plants. The ragweed pollen season has been increasing as a function of increasing latitude in central North America by 13-27 days above 44 degrees latitude since 1995 (Ziska et al. 2011). In Oregon, 9.9% of adults and 8.3% of children have asthma; a higher burden than the overall US population (Garland 2009; OCAR 2010). Rising temperatures and CO_2 levels could increase pollen production in some plants and make some aeroallergens more allergenic (OCAR 2010).

Likelihood & Confidence

There is high likelihood and confidence that the length of the frost-free season will increase because it is a result of generally warmer temperatures, which has a high likelihood of occurring in the future. There is lower confidence in how increasing temperatures and CO_2 concentrations will affect the allerginicity of plant allergens because this topic has been largely unexplored so documentation is limited including only certain plant species in limited experiments. There is more confidence that higher temperatures and CO_2 concentrations will almost certainly alter the production, distribution, and dispersion of plant-based allergens from trees, grasses, and weeds (Ziska and Beggs 2012). Note that documentation is limited including only certain plants.

Climate Risk and Probability of Occurrence

Obtaining observed historical climate data and future climate projections from climate models pertaining to each climate risk will help in determining the probability of occurrence: a number from 1-10 with 10 being the most likely to occur. Based on the historical and future climate data and confidence level in future projections provided by climate experts, the group will subjectively, yet systematically, assign a number to each climate risk representing the probability of occurrence. When determining which number to assign, it is useful to take into account the likelihood of the projected climate risk occurring based on climate research and the confidence in the evidence supporting the likelihood judgment. Confidence is determined by assessing the quality of evidence and the level of scientific consensus (Moss and Yohe 2011). A qualitative description of the likelihood and confidence of each climate risk is provided in the previous section as a resource to the group going through the exercise.

The following chart was utilized by a group of health professionals to provide a way of assigning a number to the Probability of Occurrence for each risk based off of the climate data provided for Benton County and explained in the prior paragraphs.

Probability of Occurrence	Scale
High	9-10
Medium	5-8
Low	1-4

Useful definitions of high, medium, and low probability of occurrence based on qualitative determination of likelihood and confidence are summarized in the table below:

		Confidence in the Evidence		
		L	M	H
Likelihood of Risk	L	1-4	1-4	1-4
	M	1-4	5-8	5-8
	H	5-8	5-8	9-10

This table may be useful in determining whether the probability of occurrence is low, medium, or high, but the final assigned number to be used in the risk assessment exercise will be determined by group consensus through voting and discussion and may not ultimately fall within these boundaries.

Public Health Consequences

The Climate Health Assessment Model is broken down into three areas Health and Safety, Response Capacity, Providers, and Public Health Infrastructure. It is necessary to take a look at each area and assess a number value of 1-3 with 3 being the highest impact to each category within the health related fields. As numbers are assessed to each area it will be added up in section and the average of all the numbers will be put into the Public Health Consequence section. This section will then be times by the Probability of Occurrence and will give the overall Public Health Risk in association with the Climate Risk area, which will allow for ranking the importance of each Climate Risk and assist in the planning for the health consequence associated with each Climate Risk.

Health and Safety

The Potential Health Risk is broken down into 9 different areas (fatalities, chronic disease, communicable disease, respiratory diseases, waterborne/foodborne diarrheal disease, Vectorborne disease, vulnerable populations, food access/quality, and air quality). Each of the fore mentioned areas are talked about later on in this document, which will help in determining what number to give each area as it pertains to climate change risks.

Public Health Infrastructure

Public Health provides many different important roles that are necessary to protect the community they serve. The different climate risk will affect Public Health in many different ways. The following will explain how to determine what number goes into the potential health risk areas.

Health Scale

When looking at the different areas that are related to health it is necessary to rank them with a number of 1-3. By ranking these areas 1-3 it helps in determining the overall health related issues in regards to climate risk. This will help in the planning process and it is very important to make sure that health data that is used is specific to the county.

The following paragraphs will breakdown each of the health consequences associated with the climate risk. It will also provide a scale of 1-3 to help in making the decision of what number should be put into the boxes.

Health Related Ranking Scale

Scale	Number
Low Health Impact	1
Medium Health Impact	2
High Health Impact	3

Potential Climate Change Health Risk

The consequences of climate change can and will have a huge impact on different health related issues. It will be up to each Health Department to be ready to respond or provide resources when there are health issues that are occurring due to climate change.

This tool will help to identify what each county will need to plan for in the Climate Health Adaptation Plan. When conducting a meeting to fill out this portion of the chart it has been found to be easy to use clicker technology. This allows for participants to provide quick response feedback, and there are immediate results after each question.

Make sure that you go through the filling out of the tool before discussion occurs. Discussion at the end of the session will allow for response on the tool, and to allow for discussion on certain areas that may have been too close to call.

Fatalities

Looking at the climate change risks think about how the certain areas will affect the fatality rates. Will there be an increase of fatalities, and if so how big of impact may this have on fatalities due to the climate change risk.

What kind of impact may each climate risk have on fatality rates within the county:

1. Low Health Impact
2. Medium Health Impact
3. High Health Impact

Chronic Diseases

When looking at chronic disease there is a need to really think about the different chronic diseases that could be affected by the different climate variables. The following is a list of chronic disease, but it is not all-inclusive:

- High Blood Pressure
- Diabetes
- Cancer
- Arthritis

What kind of negative impact may climate change risk have on chronic diseases within the county:

1. Low Health Impact
2. Medium Health Impact
3. High Health Impact

Communicable Disease

Communicable diseases are types of diseases that affect the community, and may or may not be easily spread. Examples of communicable diseases are as follow, but not all-inclusive:

1. E. Coli
2. West Nile Virus
3. Lyme disease

Will the climate change risk increase certain communicable diseases (1 or more), and if so how big of impact may these increases be:

1. Low Health Impact
2. Medium Health Impact
3. High Health Impact

Respiratory Diseases

Respiratory illnesses can be increased due to climate change. Asthma and chronic obstructive pulmonary disease are of concern. There are many different ways that climate change can affect respiratory illness whether chronic or acute in nature.

What kind of negative impact may each climate risk have on respiratory illnesses within the county:

1. Low Health Impact
2. Medium Health Impact
3. High Health Impact

Waterborne/Foodborne Diarrheal Diseases.

Waterborne and foodborne diarrheal disease can be affected by climate risk change. There could be a negative impact on the community if climate change increases the contamination of the many different diseases that are out there (E.Coli, Salmonella, Shigella, Cryptosporidium, etc.).

Would this climate risk have an effect upon the different diseases, and cause problems for the community. If there would be an increase in waterborne/foodborne diarrheal (1 or more) diseases how would this climate change risk impact the increase of these disease(s):

1. Low Health Impact
2. Medium Health Impact

3. High Health Impact

Vectorborne Diseases

There are many different Vectorborne diseases that could be affected by climate change. This negative affect would have a negative impact on the community as a whole.

Would this climate risk change increase Vectorborne diseases (Lyme, rabies, tick fever, West Nile virus, etc.)? If so how would it impact the Vectorborne diseases (1 or more):

1. Low Health Impact
2. Medium Health Impact
3. High Health Impact

Vulnerable Populations

Special considerations must be given to the needs of community members who may face systemic barrier (no car, deaf, hearing issues, language barrier, etc.) in accessing.

What kind of negative impact may each climate risk have on vulnerable populations within the county:

1. Low Health Impact
2. Medium Health Impact
3. High Health Impact

Food Access/ Quality

Food access/quality has to do with the ability to obtain food that is nutritious for individuals to consume. Certain climate change risks will have a direct bearing on food availability and the quality of the food.

What kind of negative impact may each climate change risk have on food access/quality within the county:

1. Low Health Impact
2. Medium Health Impact
3. High Health Impact

Air Quality

Air quality is a concern when it comes to climate change risk. If air quality is poor it can have a major effect on people who have respitory problems. Air quality will be affected by different climate change risks.

What kind of negative impact may each climate risk have on air quality within the county, which would affect the breathing of the community within the county:

1. Low Health Impact
2. Medium Health Impact
3. High Health Impact

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