PROBLEMS WITH CLIMATIC AND RELATED DATA IN COASTAL MANAGEMENT PLANNING AND PRACTICES

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Incorporating climatic information into planning and practices along coastal regions is of utmost importance under changing climatic conditions. Potentially critical environmental changes include the effects of sea level rise and impact from the potential of a greater number of more intense storms, particularly tropical systems. Planning for these and other climate-related conditions requires evaluation of climatic information in several forms, including trends in existing data and models of future conditions. However, climatic information and data available to coastal managers is not as clear-cut and easy to interpret as what is printed in the media.

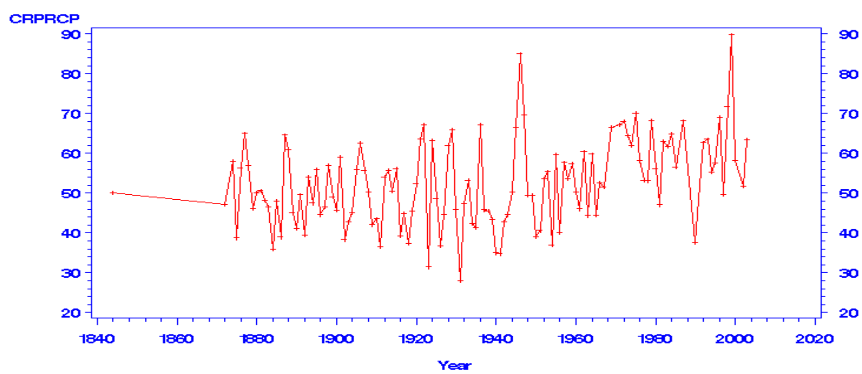
One of the most important points of concern for coastal managers is that not all climatic data presented to the public or available from data centers are of the same quality. For instance, there are several levels of climatic data for individual stations available from the National Climatic Data Center (NCDC). Trends in climatic change at these individual stations may differ from one another despite being within the same climatic division or an individual station may show anomalous periods of change, possibly via a step-function, within the trend of an individual parameter. These problems may arise from several different problems including, differences in station characteristics, nature of data collection, a station move during the period of record and land use changes such as the encroachment of buildings or parking lots into areas close to the station (i.e., urbanization).

There is a basic hierarchy in climatic stations around the country. First-order stations are often those at airports. These stations frequently have much more detailed climatic records available, including hourly readings of temperature, precipitation and sky characteristics. Consequently, these stations may be the most reliable and provide the most detailed information to managers of past conditions, particularly for specific weather events. Unfortunately, many of these "manned" stations were replaced in the mid- to late 1990s by automatic weather stations (ASOS). A comparison of readings between instruments used in the "manned" stations versus those used in the ASOS stations has not been ideal and there often are gaps of a year or more in some records during this transition period.

The second type of climatic station in the U.S. is the Cooperative Observational Network (Co-op) of the National Weather Service (NWS). Individuals volunteer to collect meteorological data with instrumentation provided by the NWS. The type of data collected is more limited than those available from the first-order stations and there is a tendency for more problems with the data, including variability in times when instrumentation is read, missing days and poorer positioning of stations compared to those at airports. Co-op stations may be placed too close to buildings or are located in areas where land-use change around the station has now produced different averages in readings than previously observed. An additional problem that not only affects Co-op stations, but also records from cities where stations are now located at airports, is the relocation of a station. When a station has been moved a significant distance from the location of the original station, the new station is given a different identification number. Unfortunately, the records from both stations may be combined and in the process induce an apparent shift in climatic conditions when, in reality, the different average level for a certain parameter (e.g., temperature) may only be a function of micro-climatic conditions at the new site. It is thus important to check the station history to identify if any change in average conditions coincides with the time of the station move.

Given these potential problems in the records from many climatic stations around the country, NCDC has established the Historical Climate Network (HCN), a subset of the Co-op network (Karl et al, 1990). The HCN consists of a group of stations within each state that are believed to be the most reliable. These stations may have been in the same location for the entire length of record available and many of them have a limited number of gaps in their records. In addition, the records from these stations have been adjusted via different statistical techniques to correct for potential problems (e.g., Easterling and Peterson, 1995). For example, missing data are filled in by various methods of comparisons with surrounding stations. An example of this process comes from the Southport 5N, NC, station (Figure 1), noting in particular, that the magnitude of peaks in the record is different in the adjusted (FILNET) record.

USHCN 318113, SOUTHPORT 5N, NC
Total RAW precipitation (in) 1844 – 2003



Source: CN Williams Jr., MJ Menne, RS Vose, DR Easterling, NOAA, National Climatic Data Center, Asheville, NC

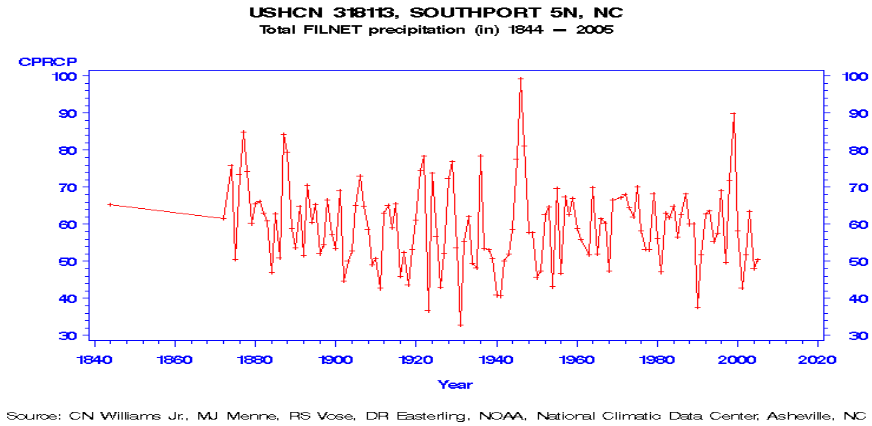


Figure 1. Precipitation records from the Historical Climate Network (HCN) station at Southport 5N, NC. Upper plot shows raw data trend; bottom plot shows adjusted data trend using statistically adjusted data to account for gaps. Note the difference in the vertical axis. Plots available at http://cdiac.ornl.gov/epubs/ndp/ushcn/newushcn.html.

Temperature records are also modified to account for urbanization around the station, and some records are changed to account for differences in the time when measurements are taken. The result is the best available set of long-term data presently available for analysis. Unfortunately, even HCN data sets are not perfect. For instance, the existing station for Orono, ME, an HCN station, is located on the roof of a building and consequently, it will often record higher temperatures compared to surrounding stations.

As a result, coastal managers must be aware of trends in climatic conditions that are created by records from all Co-op stations versus those created from just the HCN stations. This becomes particularly true when looking at regional and statewide trends in climate. Each state is divided into climatic divisions that are shown to have very similar climatic conditions. An individual climatic division covers a certain percentage of area within the state and a certain number of stations. Stations within an individual division are combined to provide a division-wide average in the specific climatic parameter, such as temperature or precipitation. The percentage of area within the state covered by the division is a multiplier for the individual climatic parameter. State averages are then determined by combining all divisional data. The problem with the procedure is that all climatic stations are incorporated into the process, and thus the number of stations has increased with time. The result is that the number of stations used to determine the state or divisional temperature in 1920, for example, undoubtedly would be much lower than the number of stations used to obtain the state or divisional average in 1980. Consequently, long-term trends in an individual climatic parameter may not be a function of changing climatic conditions, but may be a function of changes within the larger individual climatic divisions as well as inconsistencies in the number of climatic stations used to develop the records over time (e.g., Keim et al., 2002). The HCN data set thus is better for evaluating long-term trends, although the spatial coverage of the HCN is much less within an individual state. One may, therefore, question whether HCN trends are truly representative of regional or statewide trends in climatic conditions.

Problems with instrumentation is not only restricted to climatic data, but various means to evaluate the impacts of climatic change also may be subject to such problems. One significant record that is used to evaluate changes in water levels along coastal areas including rates of relative sea level change is that available from tidal gauges. There are various types of gauges, but in general, most gauges record a water level as compared to a surveyed datum point. However, these records may be problematic due to the non-continuous nature of some gauges and potential changes in the datum, although adjustments often are made to account for that variable as well as for other atmospheric and oceanographic characteristics (Zervas, 2001). Nevertheless, problems do exist and one must be aware of the resulting trends or numbers. An example of one station that may not be completely reliable as to providing an accurate rate of sea level rise comes from the tidal gauge record at Springmaid Pier, Myrtle Beach, SC (Figure 2). That station has several gaps in the record and a period that has been noted as having problematic data (vertical dashed line). Interestingly, estimated sea level rate in the area of this gauge is almost twice that of other stations in the region. This number may be true, but the linear trend to the data given the gaps and known suspect data points should make one feel cautious in using that value for local sea level rise.

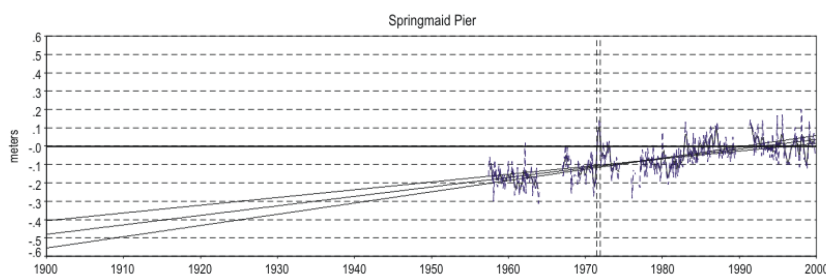


Figure 2. Tidal gauge records from Springmaid Pier, Myrtle Beach, SC, are available at http://tidesandcurrents.noaa.gov. Vertical dashed line represents period with suspect data. Linear trend denoted by solid line with additional best-fit lines representing 95% confidence level.

A second example of a problematic tidal gauge record also comes from the Carolinas. Water level readings from the tidal gauge at Wilmington, NC, may be biased from dredging of the channel where the gauge is located. Although the dredging may not have a bearing on evaluating sea level rise rates, there has been an increase in the range of mean higher high, high, low and lower low water levels since the period when dredging began (Zervas, 2001).

Evaluating and obtaining the most reliable data sets for specific coastal management problems is best undertaken with the collaboration of specific entities including state climatologists, regional climate centers and the National Climatic Data Center. Similarly, coastal communities can contact individuals and offices that develop and utilize data sets related to coastal and marine processes (e.g., Coastal Services Center, NOAA), when needing critical information for decision-making processes. Perhaps one recommendation to come from this paper for coastal communities, in addition to collaboration with the aforementioned entities, is to educate communities on the specific kind of information that is available and from which entities and their nearest local offices; how the data sets may be used in communities' coastal planning and practices; and the practical application of the data in their day-to-day coastal management.

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