# Table of Contents

## Introduction

## Executive Summary

## Consolidation, Expansion and Moves

### The Most Important Factor

## The First Factor: Natural Disasters and Weather

### Vulnerability and Susceptibility

### Natural Disaster Types

### Climatic

### Geologic

### Hydrologic

### Un-natural Disasters

### Hypothetical Future Disasters

## The Second Factor: Workforce and Business Climate

### Workforce

### Quality of Life

### Right To Work States

### Trends

### Studies / Lists

### Business and Government Climate

### Insurance

### Power

### Green Power

### Fiber

### Land

## Site Selection and Risk Management

## City Geography

## Conclusion

## References
Introduction

Many reports, studies and experts expound on what the most important factors are when deciding where to locate a data center. The data center facility, the efficient operation of it and cost factors are at the heart of any business decision for where to build and maintain their critical infrastructure. Businesses small and large alike have a lot of criteria to sift through in order to make the best decision for their company and IT. This paper attempts to break down the decision criteria and options available to those looking to build a data center, business continuity facility or purchase colocation space in an existing facility. It will attempt an exhaustive list of potential factors to be weighed when doing site selection analysis.

When looking for a business continuity facility there are many additional criteria that come into play. There are some that have a primary and backup data center in the same geographic region and a third business continuity data center across the country or drastically far away from the first two. There are many attractive locations worldwide to choose from, but for this paper the focus is on the United States. Several large technology companies have built data centers abroad lately and have indicated where ideal locations are there. Cisco touts Scotland; Google has selected Belgium, Ireland and others; and Yahoo recently selected Switzerland. This paper also generalizes by state. It is understood that there may be cases where a particular condition or factor does not apply to the entire state.

Executive Summary

As companies continue to see the importance of site selection for data centers, review the criteria, and stress the importance of protecting their data and equipment, building close to company headquarters becomes less important. When performing data center site

Intended audience for this paper is anyone performing due diligence on:

- Where to build a company Data Center or Business Continuity facility.
- The best place to partner with a colocation facility.
- How safe and secure their current facility is.
- The best place in which to move or consolidate existing facilities.
selection there are two primary factors to examine. The first is natural disasters and weather, and the second is workforce and business climate. They are broad categories to research and have a lot of specific factors for a data center facility to consider. Natural disaster research includes climatic, geological, and hydrological events. Un-natural disasters such as terrorism and pandemics must also be examined. Business factors must be looked at as well, such as workforce, education, quality of life, tax incentives, power, fiber and land. Other components of site selection include risk management, city geography (once a location is selected), using various tools to aid in the process, and trend analysis.

**Consolidation, Expansion and Moves**

In recent years trends have existed in both data center consolidation and expansion. Fortune 500 and other large companies have focused on data center consolidation. After the dot com bubble and server sprawl of the late 1990’s, companies reflected on having too many facilities, running too many disparate systems and multiplied facility costs. In order to simplify infrastructure and reduce facility operations costs, they laid out plans to build new facilities, with new technologies and to consolidate data centers. When building the new facilities, site selection was very important and a lot of data was considered from the existing facilities for which features were the most efficient and cost effective.

In 2005, prior to hurricane Katrina, the Department of Agriculture moved its data center from New Orleans to Kansas City, Missouri. The move was part of a larger project, but they cited “improving disaster recovery and continuity of operations while reducing costs” as reasons for the move. “Hurricanes frequently shutting the data center down” was also listed as a factor.

Hewlett Packard initiated plans in 2006 to consolidate 85 data centers to 6. The six will run in pairs in Atlanta, Houston and Austin. They cited “availability and affordability of space, power and network bandwidth, as well as a lower probability of impact from natural disasters” as their selection criteria. Sixty two percent of Intel’s data centers were more than 10 years old. They consolidated approximately 136 data centers to eight strategic hub data centers. Two are located in Asia, three in Europe and three in the Americas.
Companies building out massive infrastructures to support web initiatives have looked to geographically expand their data center footprint. Companies like Google, Microsoft and Yahoo have added large data centers in geographically disperse locations in order to take advantage of available and affordable power and land.

**The Most Important Factor**

Before digging into the primary factors of data center site selection, I wanted to explain what I believe is the most important factor. Who ever the decision maker or makers are for site selection, many of the factors listed below bear little importance. They may look at them and discount the ones that apply to where they want to build. To put another way, the most important factor is simply building where their gut feeling is. Businesses seemingly ignore all factors and build where their people and/or office buildings are. Businesses large and small want their infrastructure in close proximity to their business offices. The idea (today) is not a bad one – many IT departments still need a fair amount of hands on time to manage their equipment. Lights-out data centers are a utopia that some have achieved, but for the vast majority this is only something to look forward to.

Even the heavyweights seem to like to keep the data center near home. Microsoft announced a 470,000 square foot data center to support their Live initiatives in January 2007. Instead of locating in a different region of the U.S. they chose to build in Quincy, Washington, a mere 161 miles away from corporate headquarters in Redmond.

For small and medium size businesses it simply does not make sense to have their company in one primary location, and the data center in a completely geographically different one. Besides the cost and logistics of doing business in another state, the infrastructure and personnel costs exceed the value of data center site selection based on factors discussed here. If the small or medium business is evolved enough to have a business continuity plan, they may outsource disaster recovery plans to a colocation facility in another part of the country. In between the small and medium sized business market and Fortune 500 companies exists businesses that may have offices in multiple locations across the country or that can afford the infrastructure and personnel costs associated with a data center separate from the business facilities. This size of company may utilize a colocation facility or partner when housing their critical infrastructure, or simply utilize those services for
their Disaster Recovery plan. When a mid-size business has multiple geographically disperse offices, they still tend to build data centers in close proximity to these offices. The cost associated with building in a different city or state is outweighed by the desire to have IT close to their employees. Fortune 500 or large corporations have the luxury of doing site selection surveys and building where it makes the most sense for the company. Part of their fiduciary responsibility to stakeholders is to ensure the security and protection of infrastructure, data and facility investment. The education and workforce factors play a larger role for large business because of the staffing needs that will exist where they build.

**Utility Computing**

Will the promises of utility computing change this mindset? Companies promoting utility computing, grid computing or other catch-phrase names are ultimately sold on the idea of compute power, no matter where it is. The physical location of the infrastructure to support that compute power should not matter. The infrastructure is spread out among multiple data centers in geographically disperse locations. Perhaps as utility computing becomes more pervasive, where the equipment is located and the ability to place your hands on it will be further from people’s minds.

Data centers become less of a place for IT personnel to gather and more of a place that equipment is simply swapped out as a part of a larger grid of computing power. The title of facility engineer frequently falls under the IT department as a key player in operations assurance.

**The First Factor: Natural Disasters and Weather**

Natural disasters usually come to mind first when thinking about site selection. Many types of natural disasters exist to examine the effect on a data center and personnel working at the facility. These factors exist only to take in to consideration when deciding on the optimal

---

A *natural disaster* is the consequence of a natural hazard which moves from potential in to an active phase, and as a result affects human activities. Human vulnerability, exacerbated by the lack of planning or lack of appropriate emergency management, leads to financial, structural, and human losses. The resulting loss depends on the capacity of the population to support or resist the disaster, their resilience.

*Source: Wikipedia*
geographic location for a data center. Other factors being considered may perhaps negate the risk posed by any particular natural disaster.

Disaster vulnerability is estimated and studied in a number of different ways. The World Bank estimates this by obtaining hazard-specific mortality and economic loss rates for the World Bank regions and country wealth classes within them, based on 20 years of historical loss data. Human fatalities and economic costs tend to be the primary measurements when looking at an event. When researching for data center site selection both facility factors and impact on employees must be factored. While facilities can be built to withstand many disasters, there is a significant impact on power stability, economics and personnel operating the facility. If a good percentage of your facility budget goes towards fending natural disasters, is the location worth the additional cost? If your fortress is secure and doesn’t have a spec of damage, is it a success if nobody is there to operate it? After looking at the maps that follow, illustrating where particular natural disasters can or have happened, it is apparent that there are very few, if any places that are not affected by one type of disaster or another. The goal should not be to eliminate the risk potential of any natural disaster, but to mitigate the most risk, cost and burden to operating the data center.

SustainLane pulled data from the top 50 cities in the U.S. and weighted it for natural disaster risk. Findings show the lowest risk in Mesa, Arizona and Milwaukee, Wisconsin. The three cities with the highest risk were Oakland, CA, New Orleans, LA, and Miami, FL. See the complete list at [http://www.sustainlane.com/us-city-rankings/](http://www.sustainlane.com/us-city-rankings/).

If you have the luxury of selecting a site anywhere in the U.S. there is a lot of data to sift through. When looking at natural disasters alone, one could discard a lot of the historical data from many decades ago. Technological advancements, advanced notifications and structural integrity of buildings have come a long way in recent years. The total number of disasters seemingly grows exponentially, but one must remember that communication and data collection methods have improved immeasurably over past decades. Considering this with the data that is available in recent years for natural disasters could be beneficial for assessing exact risk of the various types of disasters.
The map below shows the total count of Presidential disaster declarations for the last seven years. Over half of the total disasters listed were severe storm. Administered by the Federal Emergency Management Agency (FEMA), a governor must request a Presidential disaster declaration. Natural disaster conditions include: a blizzard, cyclone, earthquake, hurricane, tornado, severe hail, excessive rain, heavy snow, ice and/or high wind, an electrical storm, several weather patterns sustained over a period of time, including low or high temperatures, and related pests, epidemics, or fires.

**Figure 1**


Flooding and severe storms are a major percentage of event types throughout the country. Globally, storms and floods account for 25% and 32% respectively world wide. The U.S. leads the category of “total amount of reported economic damages for all natural disasters”

Yet another way to look at recent data is a National Oceanic and Atmospheric Administration (NOAA) map of the U.S. that shows data for billion dollar disasters between 1980 and 2006 (Figure 2). It looks at where the big events where the cost of the event was in the billions of dollars.

**Figure 2**


Vulnerability and Susceptibility

Vulnerability refers to not only the possible physical effects of a natural hazard, but the way it affects human life and property. Vulnerability to a given hazard depends on:

**Data Center Site Selection**

RATH CONSULTING
• Proximity to a possible hazardous event
• Population density in the area proximal to the event
• Scientific understanding of the hazard
• Public education and awareness of the hazard
• Existence or non-existence of early-warning systems and lines of communication
• Availability and readiness of emergency infrastructure
• Construction styles and building codes
• Cultural factors that influence public response to warnings

The research being done is site selection for a facility, but a grander picture must be considered. The facility is the focus, but modern facilities can be built or retrofitted to withstand many of the natural disaster types that follow. The overall impact that a natural disaster has on a state or region is what should be considered. How will it affect your employees, local/state economy, transportation, utilities and quality of life?

Natural Disaster Types

Climatic

Hurricane

**Definition:** A severe, rotating tropical storm with heavy rains and cyclonic winds exceeding 74 mi (119 km) per hour, especially such a storm occurring in the Northern Hemisphere. Hurricanes originate in the tropical parts of the Atlantic Ocean or the Caribbean Sea and move generally northward.

**History**

Coastal counties from Texas to Maine have over a century of data to show where hurricanes have hit and what their impact was. The top five hurricanes, ranked by death toll and cost occurred in gulf coast states between Texas and Florida. Summary data from NOAA shows that about 2 major hurricanes make landfall every 3 years. According to this same study, the frequency of hurricanes is on the rise.
Map

Figure 3

"In virtually every coastal city from Texas to Maine, the present National Hurricane Center Director (Bill Proenza) and former directors have stated that the United States is building toward its next hurricane disaster. Hurricane Katrina is a sad reminder of the vulnerability of the United States to hurricanes”


Impact Analysis

Population growth trends show that people continue to enjoy coastal living. The solution for hurricanes lies in education and preparedness. The concern over hurricanes for data centers lies primarily with category 3 or greater hurricanes. Statistics show that property loss and loss of life occur

Source: http://www.nhc.noaa.gov/gifs/hur5005.jpg

Data Center Site Selection
most when a hurricane is classified as category 3 or above. As stated previously, a facility can be built to withstand certain levels of hurricanes. The impact lies in how it affects the utilities, cost of doing business and operations personnel.

**Tornado**

Definition: A localized, violently destructive windstorm occurring over land and characterized by a long, funnel-shaped cloud extending toward the ground and made visible by condensation and debris.

**History**

Although tornadoes have been observed on every continent except Antarctica, most occur in the United States. The 2007 Brooklyn tornado was the strongest tornado on record to strike in New York City. This was rated an F2 tornado and caused an estimated $20 million in damages. The deadliest U.S. tornado was “tri-state” in 1925, with an estimated 625 deaths across Missouri, Illinois and Indiana. There have been 52 F5 or EF5 tornados in the U.S. since 1950. A 1970 F5 tornado in Lubbock Texas proved that even skyscrapers are not safe. The super tornado outbreak of 1974 spawned a total of 148 tornadoes in a 24 hour period. The combined path and length of all tornadoes was 2,598 miles across Ontario, Illinois, Indiana, Michigan, Ohio, Kentucky, Tennessee, Alabama, Mississippi, Georgia, North Carolina, Virginia, West Virginia and New York.
Impact Analysis

When looking at Figure 4 it is important to really read into the data. Buildings are able to be built that will sustain 318 mph winds (F5). Also, the colored areas cover a large region and are over a 48 year period. Many engineering designs for buildings to protect against other weather related aspects and security will play into building a facility able to withstand high speed tornado winds.
Drought

Definition: an extended period of months or years when a region notes a deficiency in its water supply.

History

From 1980 to 2005 the United States sustained 9 drought events that total $1 billion in damages. In 1995, FEMA estimated annual losses from drought to be $6 - $8 billion, which is higher than any other natural weather related disaster, including hurricane and flood.

Map

**Figure 5**

**Palmer Drought Severity Index**
1895–1995
Percent of time in severe and extreme drought

[source](http://www.drought.unl.edu/whatis/palmer/pdi1895.gif)

**Source:** McKee et al. (1993); NOAA (1990); High Plains Regional Climate Center (1996)

Albers Equal Area Projection; Map prepared at the National Drought Mitigation Center

Data Center Site Selection
Impact Analysis

As more data centers are moving to liquid cooling, a plentiful water supply is crucial. Water restriction schedules imposed by cities will have a significant impact on data centers that need water to efficiently cool the facility.

Ice-Storm

Definition: A type of winter storm characterized by freezing rain.

History

The ice storm of 1998 affected northern New York to Southern Maine and caused approximately $5 to $7 billion in damages and 35 fatalities. An ice storm in 2005 left more than 700,000 without power across Georgia, South Carolina, North Carolina, Virginia and Maryland.

Impact Analysis

The impact of an ice storm should be considered in facility engineering and operational capabilities. For regions that experience a regular season of cold temperatures, air economizers can aid in using the cold air to your advantage.

Geological

Earthquake

Definition: shaking and vibration at the surface of the earth resulting from underground movement along a fault plane or from volcanic activity.

History

Earthquakes happen every day, but it is the large ones and potential for future large quakes that need to be taken into consideration. The west coast of the United States is what is naturally thought of when earthquakes are mentioned. Figure 6, a map from the United States Geological Survey shows a red dot for the largest historical earthquake that had its epicenter in that state. While the majority of major earthquakes happen along
the West Coast of the United States, major earthquakes have happened in other regions. The 1812 Madrid Missouri earthquake was estimated at a magnitude of 8.

Map

Figure 6

Impact Analysis

Data center facilities have a lot of technologies available to protect infrastructure from an earthquake. This should not be surprising with the number of facilities in Silicon Valley alone. Alongside of the considerations for protecting the facility and equipment from earthquakes should be the socio-economic impact potential if a major earthquake event happened.

Volcanoes

Definition: An opening, or rupture, in a planet's surface or crust, which allows hot, molten rock, ash and gases to escape from below the surface.

History

Mount Saint Helens in Washington State is the only U.S. volcano to make the list for deadliest events. The 1980 volcanic activity caused 57 deaths. To show the impact a single volcano can have, the map below shows the ash fallout distribution.
Map

Figure 7

Impact Analysis

Volcanoes exist in Alaska, Arizona, California, Hawaii, Idaho, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming. Impact as depicted above can exist far from the actual volcano. While nobody will obviously build a data center in the same vicinity as a volcano, the far-reaching and environmental impact must be considered.

Hydrological

Tsunami

Definition: A series of waves created when a body of water, such as an ocean, is rapidly displaced. Earthquakes, mass movements above or below water, volcanic

Data Center Site Selection
eruptions and other underwater explosions, landslides, large meteorite impacts and testing with nuclear weapons at sea all have the potential to generate a tsunami.

**Impact Analysis**

Tsunamis are most prevalent in areas outside of the United States, but Alaska, Hawaii, and Crescent City, California have all experienced them.

**Flood**

**Definition:** An overflow of an expanse of water that submerges land, a deluge. Hurricanes, winter storms, snow melt, damaged dams/levees and stalled weather systems are common causes of floods. Flooding is the only natural hazard for which the federal government provides insurance.

**History**

The 1993 Midwest flooding was the costliest ever, at $20 billion. Floods happen in all 50 states. 62 of the 377 Presidential Disaster declarations from 2000 - 2007 were flood related. For a complete list of floods see this Wikipedia article:

[http://en.wikipedia.org/wiki/Floods_in_the_United_States](http://en.wikipedia.org/wiki/Floods_in_the_United_States)
**Map:** This map identifies the significant floods of the 20\textsuperscript{th} century.

*Figure 8*

![Map of significant floods of the 20\textsuperscript{th} century](image)

**Source:** [http://ks.water.usgs.gov/Kansas/pubs/fact-sheets/fs.024-00.html](http://ks.water.usgs.gov/Kansas/pubs/fact-sheets/fs.024-00.html)
(Visit site for details on each flood)

**Impact Analysis**

The impact on the local economy and ability of personnel to commute to a data center are factors to think about in this category. Considering flood as a natural disaster risk must also be weighed by the desire to purposely locate near a river of size in order to utilize hydroelectric alternatives.

**Others To Consider** *(although primarily not a factor for data center site selection)*

- Fire / Wildfire
- Avalanche
- Landslide/Mudslide
- Space (impact event or solar flare)
Un-natural Disasters

Terrorist targets

In recent decades terrorism has been added to the risk factor list. 9/11 brought this to light all too clearly. While New York and Washington D.C. were the primary targets in that instance, many analysts have reviewed since 9/11 where the most vulnerable spots are in the U.S. for potential future attacks. Major cities with the densest population are usually thought of first for potential targets, but there are any number of factors that could make any city or region vulnerable. Proximity to nuclear power plants is also a major factor for consideration in data center site selection. An updated global incident map resides at http://www.globalincidentmap.com/home.php.

Facility security practices are essential when considering this factor. Many data centers are built in large cities where there is no buffer zone between the building and a public street. For the sake of security it is advisable to not be in a multi-tenant building with shared parking lots. To protect the building, there should be a large buffer area between the data center and property boundaries.

The RAND Corporation and Risk Management Solutions (RMS) are teaming up to better understand risk models and giving insurance companies actuarial statistics on how much risk they are taking in selling anti-terrorist insurance in various cities.

The RAND-RMS model attempts to rank cities by how likely they will become targets for a terrorist attack. New York is overwhelmingly the #1 target for a terrorist attack, but once beyond the first six cities it is difficult to differentiate where the risk truly is.

In the model RAND and RMS are working with, the risk of an attack either for a particular city or for a particular building or location within a city is ranked by a combination of the place’s economic value, its symbolic importance to the United States, how easy it is to attack, if attacked how likely it is that it could be destroyed, and the extent to which the target would be familiar to an audience in the terrorist’s home country who would be impressed by the feat.

Source: http://www.international.ucla.edu/article.asp?parentid=3713

Data Center Site Selection
Pandemic

A pandemic is an epidemic (outbreak of infectious disease) that spreads through human populations across a large region. Notable pandemics affecting the U.S. include HIV, West Nile virus, and Avian Flu. According to the World Health Organization a pandemic can start when 3 conditions have been met:

1. Emergence of a disease new to the population.
2. The agent infects humans, causing serious illness.
3. The agent spreads easily and sustainably among humans.

As mentioned earlier, the most secure and impenetrable data center is severely handicapped without its personnel. A 2006 White House report says a “disease pandemic could have more impact than a terrorist attack or a hurricane and might be comparable in scope to a war.”

Researchers at the National Institutes of Health (NIH) conclude that the regional spread of annual influenza epidemics throughout the United States is more closely connected with rates of movement of people to and from work than with geographical distance or air travels. They also found that epidemics spread faster between more populous locations.

Hypothetical future disasters

Other, hypothetical future disasters have been discussed, and can be taken for what they are worth:

- Nuclear warfare
- Super volcano (largest and most voluminous kinds of eruption on Earth)
- Asteroid impact event
- Mega tsunami (very large tsunami wave beyond the typical size reached by most tsunamis)
The Second Factor: Workforce and Business Climate

The second major factor when performing site selection for a data center is the workforce and business climate. There are a number of items to look at in this category that play a major part in the success of the data center and business. While the previous factor looked at what affects the facility and its ability to function under various conditions, this factor looks at the operational side of the facility and what to consider when doing site selection.

Workforce

When Google sets up shop for one of their mega data centers, one of the first things on their list (or perhaps beforehand in their selection criteria) is to establish partnerships with nearby educational institutions. They look for a strong computer science department that will produce future employees. The Boyd company studies, when looking at the ideal places to locate a data center, “substantially weight” the local colleges and their computer science programs. Colleges and universities offer an array of possibilities to partner on research as well as provide quality education for company personnel.

Education is also listed frequently when potential employees are looking for the ideal place to enroll their children. Parents look for quality education and good school systems as a part of their selection process.

Computer Science, however, is not the only program to look at in nearby colleges. The data center is becoming a mix of Information Technology and Facility Management personnel. Strong business schools are also important when considering an educated workforce. Partnerships with colleges or simply the ability to keep people in the same state they graduated (something chambers of commerce love) is an important consideration to make when deciding on a location.

Quality of life
Quality of life is difficult to measure and very subjective, but an important factor in attracting and maintaining a happy workforce. The United Nations, since 1990, has developed the Human Development Report. The first sentence in their 2007 report sums up a definition of Quality of Life nicely:

“Human development is about putting people at the center of development. It is about people realizing their potential, increasing choice and enjoying the freedom to lead the lives they value.”

*The Economist* measured quality of life in a 2005 study by material well-being, health, political stability and security, family life, community life, climate and geography, job security, political freedom and gender equality. The study of quality of life has numerous supporters, notably the Quality of Life Research Center at the Drucker School of Management. Quality of life is a top category in many studies on where is the best state to do business. In the case of selecting a site for a data center, the geek factor comes into play. Fiber to the home, municipal wi-fi; geeks want a fast internet connection. Being spoiled by a fast connection at work and requiring voice video and data means they want a leading edge connection at home.

State slogans are frequently addressing quality of life. The state economic development administrations want to recruit people to live in their state by showing off why they are the best place to pick.

The 9th annual Quality of Life Quotient from *Expansion Management* magazine ranks the top large, midsize and small metro areas. They look at 362 metropolitan areas and measure items in nine major categories. They take the final results and group them by large, midsize and small metros. Figure 9 shows the 2007 results.
## Right To Work States

A Right to Work law secures the right of employees to decide for themselves whether or not to join or financially support a union. The map below outlines which states have right-to-work laws; but with political agendas and constant change, it is wise to verify the current law before final site selection. You can draw your own conclusions on the benefits of right to work laws, but the National Right to Work committee points out that states that have these laws enjoy a higher standard of living than non-right to work states. Many businesses have narrowed down site selection only to have this factor be a major influence in a final decision.

While unions and these types of laws don’t come to mind right away when thinking of a data center, it is still an important factor for future-thinking as well as being an attractive feature for an employee’s spouse or other family members that would benefit from the law.

### Figure 9

<table>
<thead>
<tr>
<th>Rank</th>
<th>Large</th>
<th>Midsize</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rochester, N.Y.</td>
<td>Madison, Wis.</td>
<td>Fargo, N.D.-Minn.</td>
</tr>
<tr>
<td>2</td>
<td>Pittsburgh, Pa.</td>
<td>Des Moines, Iowa</td>
<td>Columbia, Mo.</td>
</tr>
<tr>
<td>3</td>
<td>Austin-Round Rock, Texas</td>
<td>Raleigh-Cary, N.C.</td>
<td>Sioux Falls, S.D.</td>
</tr>
<tr>
<td>4</td>
<td>Boston-Cambridge-Quincy, Mass.-N.H.</td>
<td>Lexington-Fayette, Ky.</td>
<td>Iowa City, Iowa</td>
</tr>
<tr>
<td>5</td>
<td>San Jose-Sunnyvale-Santa Clara, Calif.</td>
<td>Springfield, Mo.</td>
<td>Bismarck, N.D.</td>
</tr>
<tr>
<td>6</td>
<td>Minneapolis-St. Paul-Bloomington, Minn.-Wis.</td>
<td>Omaha-Council Bluffs, Neb.-Iowa</td>
<td>Ames, Iowa</td>
</tr>
<tr>
<td>8</td>
<td>Oklahoma City, Okla.</td>
<td>Wichita, Kan.</td>
<td>Cedar Rapids, Iowa</td>
</tr>
<tr>
<td>9</td>
<td>Kansas City, Mo.-Kan.</td>
<td>Syracuse, N.Y.</td>
<td>Rapid City, S.D.</td>
</tr>
<tr>
<td>10</td>
<td>Richmond, Va.</td>
<td>Boise City-Nampa, Idaho</td>
<td>Waterloo-Cedar Falls, Iowa</td>
</tr>
</tbody>
</table>

*Source: 2007 Quality of Life Quotient, Expansion Management*

Figure 10: Right to Work States

Source: http://www.nrtw.org/rtws.htm

Trends

The U.S. census web site has a lot of useful information for gathering data on site selection possibilities. There are population statistics and trends, economic census data, city data sheets containing general characteristics, social characteristics, economic characteristics, housing characteristics and many other useful maps. Population trends are important to look at for their future impact on natural resources, economic development, workforce, and quality of life.

Another trend to monitor is how many other data centers exist or are being built in the area. If there are other facilities in the area, it makes it easier to attract workers and proves that others have selected the city as ideal for their situation.

Studies / Lists

Many magazines and websites pore through data and evaluate “the best” places for business, family and particular industries. The following are just some of the articles that should be reviewed in the process:
• Boyd: (http://www.theboydcompany.com/)
  o Study: Annual cost for skilled labor, taxes, utilities, corporate travel, the availability of land and other operational expenses.
  o Study: Most/least expensive places to build: Annual operating cost (one finance and one healthcare focus, 150k square foot facility with 150 employees)

• Forbes: (http://www.forbes.com)
  o Best Places for Business and Careers (http://www.forbes.com/2005/05/05/05bestplaces.html )
  o Best States for Business

• Money Magazine
  o Best places to live

• Kiplinger
  o Quality of life
    http://www.kiplinger.com/tools/bestcities_sort/

• CNBC
  o Top State for Business
    http://www.cnbc.com/id/19558099/

• Expansion Management:
  o 2007 Best Cities for Business Recruitment and Attraction
Business and Government Climate

Site selection for a data center is similar in many aspects to locating company headquarters (or re-location), but also unique in many other ways. Because the evaluation criteria in the first factor (Natural Disasters) are such a large part of the decision, the business climate must be a nice complement to the site selection process to make the choice easy. There are many facets to evaluating a site based on business climate.

An excellent resource for evaluating a state and where its business climate is forecasted to go in the next five years is Moody’s Precis State research at Economy.com

Financial Analysis (tax breaks, incentives and cost of doing business)

Attracting data centers to cities and states is big business. Cities go all out to offer whatever they can to companies that will bring this type of business to their area. Internet companies have received unprecedented incentives and tax breaks to locate their data centers throughout the U.S. Once site selection has been narrowed down geographically there a number of avenues to take when working with local governments to receive the maximum benefit in tax breaks for your business. The Tax Foundation releases an annual report titled the State Business Tax Climate Index. This acts as a tool for people to compare how their states’ tax systems rate against others. Wyoming was the best state in the 2007 edition. States continue to be very aggressive in this area and leverage it frequently when trying to win a business over.

Browsing through the 2007 Inc Magazine 500 Fastest Growing Companies it is easy to see how much competition there is in attracting the small to medium size businesses. Here is a breakout of where the 2007 Inc. 5000 companies were based:

- 20.8% in the Midwest (North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Michigan and Ohio)
- 17.6% in the West (California, Oregon, Washington, Alaska, Hawaii)
- 17.4% in the Southeast (Arkansas, Louisiana, Mississippi, Tennessee, North Carolina, South Carolina, Georgia, Kentucky, Alabama, Florida)
• 15.9% in the Northeast (New Jersey, New York, Rhode Island, Connecticut, Massachusetts, Vermont, Vermont, New Hampshire, Maine)
• 12.1% in the Mid-Atlantic (Virginia, West Virginia, Washington D.C.)
• 10.8% in the Southwest (Arizona, New Mexico, Oklahoma and Texas)
• 5.4% in the Rocky Mountains (Nevada, Utah, Idaho, Wyoming, Montana, Colorado)

Knowing the demographic that reads Inc. magazine, the states market heavily to entice businesses to locate there. The September issue of Inc. magazine contains ads from Michigan (“The Upper Hand”), Iowa (“Life | Changing”), Oregon (“Oregon is open for business”), Georgia, and Louisiana (“More bandwidth than you’ll know what to do with”).

Insurance

Weather-related catastrophe losses in the U.S. property/casualty sector have grown from a few billion dollars a year in the 1970’s to an average of $15 billion a year in the past decade. Insurance has changed in recent years as the rate of natural disasters has increased. Large disasters such as hurricane Katrina wipe out a good portion of the industry’s surplus. Specific programs exist for floods, earthquakes, hurricanes and other disasters. The issue, for site selection, is calculating how much extra insurance costs will be for the potential locations being considered.

Power

With a 14% annual growth of electrical use by data centers in the U.S. it is no surprise that it is a factor in site selection to study carefully. According to a recent study funded by Advanced Micro Devices (AMD), U.S. businesses spend $2.7 billion on electricity to run and cool their servers. For assistance in finding utility rates, reference the Utility Economic Development Association web site at http://www.utilityeda.com/economic_development_contact_finder.asp The following are primary areas to research:

• Do the power companies in the area have plans for expanding and meeting a rapidly-growing need? Do they have environmental efficiencies initiatives?
• What is the rate (in cents per kilowatt hour)? The U.S. Energy Information Association publishes average retail prices for each state, but it is best to inquire with the local utilities to get actual rates. Cost of electricity has been listed as one of the top reasons, if not the top reason in many site selection processes. If selection has been narrowed down to a few choices, power costs will be an easy tie-breaker.

• Rolling blackouts and power grid diversity: In August of 2003 the North East United States experienced the largest blackout in North American history. The reliability and vulnerability of all electrical power grids was called into question. After the event, AFCOM’s Data Center Institute took a survey and concluded that 6% of data centers affected lost over $1 million each. Knowing on which power grid your potential locations are is a good idea. Researching the reliability of the particular power grid and proximity to a secondary grid is also valuable information. Figure 11 shows the power grid regions in the United States.

Figure 11
Source: http://www.eere.energy.gov/de/us_power_grids.html
Green power

Many utility alternatives and supplements are available today. With numerous green initiatives under way in corporations, there are a number of green factors to consider. The U.S. Environmental Protection Agency (EPA) web site lists all of the green power options by state that are available to companies. These technologies range from biofuels, wind, hydro-electric and photovoltaic. The state by state database can be viewed at [http://www.epa.gov/greenpower/locator/index.htm](http://www.epa.gov/greenpower/locator/index.htm). The EPA web site also lists the top local governments in their Green Power Partnership program.

Abundant, low-cost hydroelectric power put Quincy, Washington on the map by attracting numerous high profile data centers. Microsoft, Yahoo, Sabey Corp., Intuit and Ask.com have data centers in the area. Google’s massive data centers have also focused on hydroelectric for many of their site selections. They selected Council Bluffs Iowa because of hydroelectric power from the Missouri river and the fact that western Iowa leads the nation in the production of renewable fuels (such as ethanol and a growing amount of wind power). As many of the problems experienced with power outages and brownouts happen with greater frequency, the question of alternative green power sources come up more and more. Locating close to a river or source of hydroelectric power, or where a local government or state is aggressive with green power alternatives and incentives can be a large factor in final site selection.

Fiber

The availability of fiber at a potential data center location is paramount. Demand for dark fiber is growing rapidly as companies use it to enhance security, increase scalability and realize a cost savings benefit. Demand is growing because of the need for fast connectivity between offices and the data center, as well as companies having multiple data centers with geographic diversity, expansion plans or disaster recovery centers.

Research the availability of fiber in the region. State or local governments will point you in the right direction, or nation-wide firms such as fiberlocator.com and CFN Services ([http://www.cfnservices.com/fibersource.html](http://www.cfnservices.com/fibersource.html)) will assist in the research.
Years ago fiber was a larger issue, as it was primarily available only on either coast of the U.S. Now fiber is much more prevalent and the smallest town in Middle America can attain connectivity equivalent to a large metropolitan business.

**Land**

Availability of land, zoning and property tax are common criteria when selecting a site for a business. For data centers these are common factors as well, if not for different reasons. The type of plot available for a data center needs to be large enough for the initial square footage planned as well as potential expansion. With large generators on site, the zoning and mix of compatible neighbors comes into play as well. When Google selects land for one of their data centers, they purchase much more than is needed for just the facility. Upon purchase, they will build up boundaries of the land for the sake of security and privacy.

**The Process**

Now that the two primary factors have been thoroughly examined, some other components of site selection should be reviewed. What is the risk management policy for your company? If government regulations play a part in your business or future business, what information and qualifications should be considered? Once the city has been selected, what other items should be considered for the ideal plot of land?

**Site Selection and Risk Management**

Risk is the net negative impact of the exercise of a vulnerability, considering both the probability and the impact of occurrence. Risk management is the process of identifying risk, assessing risk, and taking steps to reduce risk to an acceptable level.

One potential way to evaluate risk in the site selection process is to apply the risk-level matrix from the National Institute of Standards and Technology. Their Risk Management Guide for Information Technology Systems document outlines a risk matrix that pairs threat likelihood and impact. When multiplied together, a risk level is determined. Applying a risk-level scale like this could aid in identifying which sites are preferred and what level of risk a company is prepared to take.
The 2006 Regional Disaster Resilience Guide identifies a series of needs for risk assessment and mitigation. This report was published by the Infrastructure Security Partnership, an organization that was formed shortly after the 9/11 tragedy. Two of the needs identified in the report include:

- An assessment capability to predict accurate and comprehensive consequences to a full spectrum of threats—including a pandemic—over a wide range of time frames to include the destabilization of various markets and the reestablishment of new forms of business.
- A metrics-based regional threat assessment approach that examines risk from a systems standpoint and takes multihazards into account.

**City Geography**

Once the choice is made for a city in the selection process, there are a number of other factors to consider. These are important for the safety and risk reduction aspects of operating the data center. Factors to consider include if your data center is:

- At least 1 mile away from
  - All railway lines
  - a highway
  - a hazardous cargo route
  - a fresh or wastewater treatment facility
  - any hazardous production facilities
- 5 miles from an airport
- Sufficient distance from a nuclear plant
- Out of any floodplains and away from inundation zones of dams

Another category of site factors include survivability features. This is military-grade, end of the world type scenario that bunker data centers often tout. While many of these are extreme, there are business or government functions that require this level of protection. Bunkers can negate many of the vulnerabilities of above ground data centers, but also bring on another set of factors to consider for site selection. If a nuclear event happens there are
potentially more things to worry about than if a server is still running and networked. Survivability features include:

- 3 foot thick reinforced concrete, all-subterranean construction.
- Equipment is shock-mounted on isolation pads.
- Nuclear/Biological/Chemical (NBC) air filtration.
- EMP (Electromagnetic Pulse) shielding.
- Able to survive a megaton nuclear blast.
- Six day fuel reserve.
- Freshwater reserve tank.

**What the Big Guys Are Doing**

Perhaps another angle to take in this analysis is to look where the large internet companies have built or announced data centers in recent years. Google, Microsoft, HP and others have teams of people for site selection and go through rigorous site selection methodologies to make sure they are picking the optimal spots to maintain their massive infrastructure.

- Google has had a lot of activity in recent years for data center announcements and is building massive facilities throughout the world. Google has a presence in at least 16 U.S states, as well as overseas data centers in Ireland and Belgium. Lists of specific sites they have announced recently include:
  - The Dalles, Oregon
  - Lenoir, North Carolina
  - Pryor, Oklahoma
  - Goose Creek, South Carolina
  - Blythewood, South Carolina
  - Council Bluffs, Iowa

- Microsoft has also announced and built several mega data centers throughout the United States. Some of their recent site selections include Quincy, Washington; San Antonio, Texas; and they have hinted that a European data center is next.
• Equinix is one of the largest colocation companies in the market. They have been cited as saying that their market dictates they build in top tier cities. This drives the point home about people ultimately wanting to be close to their equipment. If a Los Angeles-based company is going to collocate with a data center, they will most likely shop for a facility in the greater Los Angeles area.

Conclusion

After being inundated with data on factors to consider in site selection, what is the best way to go about the selection process? Like any other business decision, the objectives must be set by management and a formal process set forth to make the best selection. Careful definition of data center requirements are crucial to laying out the selection process. Each business and person has their preferences and particular reasons for favoring one factor over another or interjecting a custom factor to the process.

The Tools

Many resources exist to aid in the selection process. For the visual learner and ease of getting the 10,000 foot view (literally) there is Google Earth. This amazing tool covers every inch of the earth with satellite images and allows you to zoom in most anywhere. There are a number of layer views that will display anything from restaurants and hotels to geographical features and points of interest. It is a great tool to scope out an area and get a feel for city layout.

Once a short list of sites is established, MapInfo’s AnySite is an appropriate tool to use. It is an application designed for site selection and has a ton of demographic data and powerful reports and maps.

Many have used the Analytic Hierarchy Process (AHP) as a decision making guidance tool. AHP formalizes the process where there are a limited number of choices, but each has a number of attributes and it is difficult to formalize some of those attributes. This process is particularly handy for site selection as it allows you to weight particular criteria and analyze
the collected data. The end result is a score that can be applied to each location being evaluated.

**Outside Help**

If your project can afford outside advice and is looking at a wide-spread geographic area, employing consultants or others to help gather and analyze data is a benefit. Many consulting and real estate firms offer such guidance and each have their own expertise. You know your data center and particular needs though, and because of this you need to drive making the short list, the importance of various evaluation criteria and final decision. If budget or time don’t allow outside advice, then there are plenty of resources to make an informed decision. Utility companies are frequently partnered with workforce and economic development councils in order to provide the valuable statistics that will help businesses decide to move there. Many resources described in this paper will assist in providing the data for your selection and decision making process.

Because the data center is a very unique property with special needs, certain factors like utility costs and disaster avoidance will always be key evaluation criteria. The trend is perhaps shifting though as businesses not headquartered in top tier cities look to build data centers in mid-market cities because they don’t want to travel to the large cities, and businesses headquartered in top tier cities look to build outside of their city to protect the company and infrastructure. Internet businesses with a large customer base to support are ones to watch to see where and how many data centers they erect. To support the enormous and scalable data center they require, selection of site location is an indicator of what factors they consider to be most important. Make the selection that is best for your business, the longevity of the data center, and protection of the bottom line.
References

2. Economy.com: http://www.economy.com/home/products/products.asp?pid=1-00000-00&src=serviceOverview
8. NOAA: http://www.nhc.noaa.gov/pastint.shtml
10. Quality of Life Research Center: http://qlrc.cgu.edu/about.htm
13. SustainLane: http://www.sustainlane.com
17. Tulane University: http://www.tulane.edu/~sanelson/geol204/introduction.htm
19. Wikipedia: