Potential for a Catastrophic Flood and the Need for an Advanced Warning System for the Chagrin River Valley in the City of Willoughby Hills

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ABSTRACT

There is a problem with the lack of knowledge about the potential for a flood in the Chagrin River Valley of Willoughby Hills. The purpose of the study is to identify the potential for a flood in the Chagrin River Valley in Willoughby Hills and the need for an advanced flood warning system. The method used was evaluative in nature. The research questions included: What is the scope of the flood problem for the Chagrin River Valley in Willoughby Hills? What is the general populations' perception for the need of disaster planning? Should Willoughby Hills have an advanced flood warning system?

The procedure for the study included: Historical research, interview, and a survey. The results revealed the general perception that a flood response plan was not a priority. The historical data showed a real potential for a catastrophic flood and a disaster response is a priority. The study revealed a significant need for education for the residents that could be affected by a catastrophic flood in the Chagrin River Valley. The education piece should include the risk associated with flood waters.

Research should be conducted on the type of disaster plan that would best meet the needs of the residents of this region. The plan should include a recommendation for an early flood warning system. The final piece would be to educate the residents on how the disaster plan will be implemented.

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INTRODUCTION

Statement of the Problem

The problem is the lack of knowledge about the potential for a flood in the Chagrin River Valley of Willoughby Hills. The purpose of the study is to identify the potential for a flood in the Chagrin River Valley in Willoughby Hills and the need for an advanced flood warning system. The research method used was evaluative in nature. Along with the possibility of a flood warning system, residents that live in the Willoughby Hills floodplain should be educated about flood awareness.

The study revealed a significant need to educate the residents that could be affected by a catastrophic flood in the Chagrin River Valley. The education piece should include the risk associated with flood waters.

Purpose of the Study

The Purpose of this study was to define the potential hazards from flooding in the Chagrin River Valley in Willoughby Hills show the need to provide education to the residents and an advanced flood warning system in the region.

Research Method

Evaluative Research was utilized to access the probability of a catastrophic flood in the Chagrin River Valley. The use of known weather patterns, the frequency of precipitation and recorded floods for this region were used to establish the probability of a localized flash flood.

Research Questions

The following questions were answered by this research:

1. What is the scope of the flood problem for the Chagrin River Valley in Willoughby Hills?
2. What is the general populations' perception for the need of a disaster planning?
3. Should Willoughby Hills have an advanced flood warning system?

BACKGROUND AND SIGNIFICANCE

Flash flooding is historically the most devastating type of flood. As its name implies, flash floods occur rapidly with little or no warning. Victims are often unaware of the occurring flood until they see the rising water. The Federal Emergency Management Agency also known as FEMA developed a Flood Insurance study for the city of Willoughby Hills located in Lake County, Ohio (2002). The FEMA study concluded the following: That notable flooding occurred in Lake County, Ohio during 1913, 1948, 1559 and 1977.

The March 1913 flood produced the greatest amount of recorded precipitation in the Chagrin River Valley. Willoughby Hills recorded 7.56 inches of rain producing a peak discharge of 24,000 cubic feet per second, with a recurrence rate of about 33 years (FEMA, 2002). The next major flood occurred in March of 1948 and produced 4.5 inches of rain in a relatively short period. The peak discharge of the 1948 flood was approximately 28,000 cubic feet per second, with a recurrence rate of about 62 years (FEMA, 2002). Lake County averages 39 inches of rain annually. Ohio averages 25 to 50 inches of snow annually, with the exception of Lake and Geauga Counties, which average 80 to 100 inches of snow annually. The combination of heavy rain and staggering amounts of snowfall contribute to excessive ground saturation and the recipe

for flooding; flash flooding and flooding caused by ice jams as reported by T.W. Schmidlin & J.A. Schmidlin (1996).

According to the FEMA report, the 1948 flood damaged nearly 60 homes and the January 1959 flood combined 2.50 inches of rain with nearly 3 inches of runoff from snowmelt, causing a localized flood inundating the streets of Milann and Trailard. Five people lost their lives due to the swift currents. Nearly 90 homes were damaged; many of the homes' first floors were under water. The estimated peak discharge was 22,000 cubic feet per second with a recurrence rate of once every 25 years. The data provides substantial evidence that the residents of the Chagrin River Valley in Willoughby Hills are at a substantial risk for flooding. The FEMA (2002) report highlighted the fact that the city officials of Willoughby Hills currently obtain river readings during periods of high flow. The FEMA (2002) report also noted that currently no flood protection measures exist for the Willoughby Hills community.

The Chagrin River drains into an area that includes approximately 267 square miles. The Main Branch of the Chagrin River also known as the Upper Main Branch is located above Bass Lake in Munson Township. The Main Branch flows 48 miles before entering Lake Erie in the city of Eastlake. Along its path, the river's other branches join the Main Branch- the Aurora Branch, flowing from the City of Aurora connects in the Village of Bentleyville, and the East Branch, beginning in Geauga County connects in the City of Willoughby (*Retrieved August 1, 2006 from http://www.crwp.org/the_watershed/watershed.htm).* The portion of Willoughby Hills that is within the flood plain of the Chagrin River contains approximately 137 homes. Based on the 2000 National Census there is an average of 2.1 people per household in Willoughby Hills. In the event of a flash flood, 137 homes and nearly 300 people could be at risk (*Retrieved July 27, 2006 Willoughby Hills Tax Office).*

There has been an average of one flood every 3.5 years since 1936. During these 70 years, homes and vehicles in the Chagrin River Valley of Willoughby Hills have been damaged or destroyed as a result of flooding (Willoughby Hills Fire Department, 2006). On January 21, 1959 the watershed was experiencing a thaw; the weather service had predicted heavy rain for the next twenty-four hours and issued a flood advisory. Early in the day, the Willoughby Hills Fire Department and local Civil Defense members issued a warning to all of the homes in the flood plain area. One adult woman, two adult men and a dog were evacuated, but then returned to their Milan Drive home, choosing not to heed the warning issued earlier that day.

Personal communication with C.B. Schumacher, a retired Willoughby Hills Fire Chief and a witness to this flood described the following events that unfolded. The floodwaters surrounded the home of Douglas H. Peterson trapping him, his wife and mother and a 60 to 80 pound dog. According to witnesses the family was safe in their home and was ordered to shelter in place. The Peterson family fearing for their safety chose to exit their home and became trapped by the rising water. Hearing the screams of the trapped adults, two Civil Defense volunteers and two members of the United States Coast Guard attempted a rescue using a small boat. The four would-be rescuers entered the floodwaters at about 10:00 pm and made their way to the trapped adults. The rescuers aided the victims into the boat and began the trek to shore. In a report by bystanders, the adult female reached for her dog, causing the boat to capsize and ejecting all seven adults and the dog into the frigid water.

C.B. Schumacher continued to describe the events further. He explained that initially, the seven adults found their way to tree branches and did their best to hold on. A rescuer from the Kirtland Fire Department launched his boat in an attempt to rescue the seven stranded victims. The Kirtland Fire rescuer became stranded when the flood-swollen river overwhelmed

his boat. The Lake County National Guard and the Navy Reserve arrived shortly after the eight adults became stranded; they each brought one amphibious unit equipped with wheels for land and a prop for the water. Initially, there was some trepidation for the safety of the crew; after a short time a rescue plan was developed.

The National Guard and the Navy Reserve launched a rescue attempt; working with only moonlight to guide them, they successfully rescued the two Coast Guard men and the Kirtland Firefighter. The remaining five adults and the dog lost their lives before a boat could reach them (*C.B. Schumacher, personal communication, August 3, 2006).* The circumstances leading to the deaths of the five adults in the January 21, 1959 flood in Willoughby Hills can be linked to several factors. Did the city officials and the residents of the Chagrin Valley share the same perception of risk caused by a flash flood? Although there is testimonial evidence that a plan was in place for evacuation, no evidence can be found that there was a plan to rescue trapped victims. The rescuers demonstrated a high level of bravery, but possibly lacked the training and equipment needed for swift water rescue.

Defining a risk assessment that is shared by officials and residents is difficult, as the definition of risk is an event which has not happened, but has a probability of occurring. City officials recognized the dangers of flash floods, and evacuated the affected areas. The majority of the residents complied with the warnings; some did not (Posner, 2004*).* People have a propensity to lose fear in familiar surroundings. In cases such as floods, which may occur over a short period of time many residents may not have lived in the area during the last big flood. In the response to known factors such as snow cover and the anticipated rain the city officials showed a high level of competence. However, there was a tragic lack of training and recognition

for a swift water rescue according to training records of Willoughby Hills and Kirtland Fire Departments (Training Records, 1958).

Over the past fifty years, systems have been developed to aid in flood prediction, flood warning and evacuation of residents from the affected areas of the Willoughby Hills flood plain. (Willoughby Hills, 1936-2006). From the 1940's through the late 1960's, Sam Araps, who lives along the Chagrin River in Willoughby Hills, developed a warning system for the surrounding areas based on his personal knowledge of the river. When Sam determined that conditions were favorable for flooding, he would alert the fire department and civil defense volunteers (*C.B. Schumacher, personal communication, August 3, 2006).*

In the late 1960's, Mr. Araps approached Mayor Campbell of Willoughby Hills and informed him he could no longer provide the flood warning service. Mayor Campbell directed Charles B. Schumacher, Fire Chief of the Willoughby Hills Fire Department from 1960 to 1984, to assume the duties of flood warning for the valley. Chief Schumacher spent two years developing a system to more accurately predict the timeline if flooding should occur. Chief Schumacher re-measured the existing gauges using the riverbed as the starting point; then worked with upriver Fire Departments to add gauges and to provide the Willoughby Hills Fire Department with river level reports during heavy rains. Snowfall was measured and melted to determine average moisture content for run-off predictions and flotation devices were used to determine the speed of the river (*C.B. Schumacher, personal communication, August 3, 2006).*

From the data Chief Schumacher collected, it was determined that the water in the river moved about five miles per hour and that it would take approximately one hour and twenty-eight minutes for water from the southern river border to reach target areas of Willoughby Hills. Chief Schumacher conducted an additional study using members of the fire department, which tracked

the water level at the Eagle Road Bridge and determined what level the river would leave its bank and begin flooding. Through this study it was ascertained that fire department flood operations would begin when the Eagle Road gauge reached nine feet and that flooding began when the gauge reached eleven feet. This system allowed for some advance warning for those downriver under certain conditions when the forecast indicated heavy rain, if weather watchers upriver provided information to downriver communities, or conditions were favorable for a flood to occur. All of the systems in place then and currently in use require human intervention at the river according to Chief C.B. Schumacher (personal communication, August 3, 2006).

July 7, 2003, a heavy rain occurred in the southern portion of the watershed. There was no automatic warning system in place; weather conditions in Willoughby Hills were warm and sunny. Two people were standing in the river; the depth of the river was about six inches at their location. According to bystanders, a wall of water approximately five feet high swept the two adults away, carrying them towards a low head dam in Willoughby. Had it not been for an on scene witness calling 911 and activating the Willoughby and Willoughby Hills Water Rescue teams, there is a high probability these two adults would have lost their lives in the dam. (Willoughby Hills, 2003)

The National Oceanic and Atmospheric Administration (NOAA) defines several factors contributing to flash flooding; the two key factors are rainfall intensity and duration. Intensity is the rate of rainfall and duration is how long the rain lasts. Flash floods can occur within a few minutes or hours of excessive rainfall. Other causes of flash floods are ice jams and or dams from debris in the river such as uprooted trees, boulders and structures that contribute to a back up of water which causes flooding. Rapidly rising water can reach heights of over thirty feet (NOAA, 2002). Furthermore, the report states, rains that cause flash floods can trigger

catastrophic mudslides. There will not always be a warning that the floods are coming. Most flood deaths are from flash floods. The information contained in this research paper will aid in the creation of a flood warning system and flood disaster plan. The combination of hardware, software, public education, response plans and changes in the Willoughby Fire Department policies should create an advance flood warning system to immediately identify changes in the river. This research paper will describe the necessity for communities to have advanced warning systems. Advanced warning systems are the single most important factor for saving lives in the event of a flash flood (NOAA, 1992). The development of a flood awareness program for the residents in the affected floodplain areas of Willoughby Hills is essential for a higher degree of safety and success. Studies have shown that an increase of scientific knowledge along with defining the known risk, have added to safety planning and create a willingness for people to change their views of potential danger. The research provided here included a survey that was sent to all of the homes in the Chagrin River Valley in Willoughby Hills. The significance of this research will help identify the knowledge that the residents of Willoughby Hills have regarding the flood plain and its potential life threatening risks. The conclusion of this research will help identify community educational needs as well as helping the fire department plan for these emergencies to reduce life and property damage in the future. The research shown will help identify the need for an emergency warning system and will help the members of the city government understand the necessity of funding for such a system.

LITERATURE REVIEW

Ohio is located in the middle latitudes of the northern hemisphere. The location and elevation of Willoughby Hills provide the necessary elements for four distinct seasons, with a temperature range of one hundred and fifty-three degrees. Northeast Ohio typically has a variety of weather conditions from March through June. As moist tropical southern air currents meet with the colder northern air, severe weather patterns can form. Ohio has experienced some of the most devastating tornados and thunderstorms in our nation's history (T.W. Schmidlin and J.A. Schmidlin, 1996)

Ohio averages 25 to 50 inches of snow annually, with the exception of Lake and Geauga Counties which average 80 to 100 inches of rain annually. Willoughby Hills is located in Lake County, Ohio. Average rainfall for Lake County is 39 inches as compared to the rest of Ohio with 24 inches of rain. The combination of heavy rain and staggering amounts of snowfall contribute to excessive ground saturation and high potential for flooding, including flash flooding and flooding caused by ice jams. Flash flooding is historically the most devastating type of flood, as the name implies flash floods occur rapidly with little or no warning. Victims are often unaware of the occurring flood until they see the rising water (T.W. Schmidlin and J.A. Schmidlin ,1996).

For the over one hundred and fifty years of recorded floods in the United States, many have been classified as catastrophic. The most damaging were either flash floods caused by localized heavy rain, or flash floods caused by ice jams. As with any disaster, the protection of life is the number one concern. In a report published on December 1, 1960 by the Ohio Water Commission, General Miles M. Dawson, Brigadier General, U.S.A. (Ret.) a consulting engineer to the state of Ohio's flood problem, was interviewed. General Dawson responded to a question

about how serious is the flood problem in Ohio said, "It seems to be much more serious right after, than it is right before the flood." What the General was alluding to, is when the media fills the headlines with the tragic cost of floods in the loss of life and human suffering people feel a sense of urgency.

The general opinion is that as time passes the memories of the last flood fade away, to the point where flood prone populations no longer feel threatened by flash floods. General Dawson was investigating the State's flood problem as a result of the January, 1959 flood. The January, 1959 flood took 16 lives across the state, five of the lives lost were in the Chagrin River Valley of Willoughby Hills. In 1913 Ohio experienced the worst flood in recorded history. The 1913 flood caused 367 deaths and 143 million dollars loss, 3 billion dollars at today's dollars. (Retrieved from http://www.westegg.com/inflation "Inflation Calculator") General Dawson observed that by the time the January 1959 flood occurred, that many population areas inundated by the 1913 flood had either forgotten about the 1913 flood or never had knowledge of the flood.

A report on a flood in March of 1978, conducted by the U.S. Army Engineer District of Buffalo, reviewed the history of flooding in the Chagrin River in Willoughby Hills. The report listed some of the significant flooding along the Chagrin River Valley in Willoughby Hills. During the period of March 23 – 27, 1913 an average of 7.56 inches of rain fell with an additional 4.40 inches of runoff in Willoughby Hills. The report indicated the lack of development in the flood plain limited the amount of damage. Another flood occurred in the Chagrin River Valley in Willoughby Hills on March 22, 1948. The 1948 flood produced 4.5 inches of rain and an additional 2.25 inches of runoff. The 1948 flood damaged 60 homes in Willoughby Hills.

January 21, 1959 a storm with heavy rain and significant snow melt caused a flash flood that resulted in a family on Milann drive in Willoughby Hills to become trapped by the rising flood waters. An attempt was made by 2 emergency workers to rescue the 3 trapped people. During the rescue attempt all 5 people were killed when they rescue boat capsized send them into the swift and icy currents of the Chagrin River. Lack of the required equipment and thorough knowledge of swift water rescue were contributing factors in these deaths. On February 24, 1977 a flood caused by ice jams along the Chagrin River caused heavy damage to 20 homes, knocking several of the homes from their foundation. The water rose so quickly that many cars were swept away by the flood waters. One of the vehicles swept away belonged to Willoughby Hills Fire Department, which was lost while crews were attempting to evacuate the residents along Chagrin Drive.

Flash flooding is historically the most devastating type of flood. As its name implies, flash floods occur rapidly with little or no warning. Victims are often unaware of the occurring flood until they see the rising water. For the over 150 years of recorded flood history there have been many catastrophic floods, the majority of the most damaging were either flash floods caused by localized heavy rain, or flash floods caused by ice jams. As with any disaster, the protection of life is the number one concern. Many of the historical floods predate modern technology such as radar, weather radios, and mass communication, such as television.

However, on July 4, 1969, Northern Ohio was paralyzed when a line of thunderstorms stalled over the north coast at about 7:30 pm. Ohioans from Cleveland to Sandusky were enjoying the Friday holiday; tens of thousands were at parks, schools and beaches to enjoy fireworks, and thousands of boats were on Lake Erie. When the storms subsided many communities had experienced some of the worst flooding ever, 46 people died, 5 missing, 559

injured. Destroyed were: 32 homes, 300 mobile homes, 180 farm buildings, 104 small businesses, 700 boats and 7,000 cars. More than 10,000 homes were damaged and over 250,000 homes lost electricity (Schmidlin & Schmidlin, 1996) and (National Oceanic and Atmospheric Administration, National Weather Service 1992)

An interesting view of risk assessment is that it is always about events that have not occurred and are only possible under certain conditions. A quote describing the concept of risk from the book "Mapping Vulnerability" says:

> Risk is a complex and at the same time, curious concept. It represents something unreal, related to random chance and possibility, something that still has not happened. It is imaginary, difficult to grasp and can never exist in the present, only in the future. If there s certainty, there is no risk. Risk is something in the mind, closely related to personal or collective psychology (Bankoff, Frerks, & Hilhorst, 2004 p.47).

Risk assessment lies somewhere between reality and possibility. The reality is the world's population is ever increasing and there has been a steady increase in natural events combining with populations, resulting in disaster. Many of the shortcomings in risk assessment are at the governmental decision makers' level. There is more concern with emergency response rather than reduced exposure to predictable hazards (Bankoff, Frerks & Hilhorst, 2004). In his book (Junchaya, 1999) illustrated that natural events such as tornados, tsunamis and floods are only disasters when people are involved. His belief is that we exist in a state of denial, building homes in flood plains, developing densely populated areas in the path of hurricanes, and creating similar circumstances leading to a potential disaster. The prevalent thought of "It will never happen here" held by many people living in high-risk areas must be challenged and there is a

need to change the attitudes of people and their governments regarding disasters (Junchaya, 1999).

Cohl (1997) observed that we are much less likely to fear the possibility of a natural disaster than a man made disaster. He also noted that the more familiar the situation, the more humans have a tendency to become fearless and statistics continue to show the majority of accidents and injuries occur in familiar surroundings.

In his book "Living with hazards, dealing with disasters", Waugh, Jr. (2000) concluded s areas subject to frequent flooding generally have taken steps to minimize property damage and the loss of life. The problem is the less frequent 100 year and 500 year floods that exceed the community's ability to respond. While these floods may take place over a relatively short time and demonstrate the potential of the destructive power, many residents may not remember the last time the big flood occurred. This along with little public recognition of the danger and a lack of willingness to invest in mitigation efforts can lead to devastating floods.

The historical record emphasizes the importance of accepting the harsh realities of the world we live in and the dangers it presents. As attitudes change, better planning, risk reduction and changes to our building designs will result in less loss of life. One of the barriers to risk reduction is education. The important component is more education. Those potentially affected are at risk and the science behind the risk should raise their awareness to a level that they are willing to change their belief system (Junchaya, 1999).

Posner (2004) asserted that one of the cultural reasons for failure to recognize, understand or accept the possibility of a catastrophic event is "the abysmal state of scientific knowledge among nonscientists (p. 93). In Posner's study he pointed out only 33% of

Americans know what a molecule is, and just over 50% know that it takes the Earth one year to revolve around the sun.

Other factors in Posner's study, included temperament and the culture of everyday dangers: His analogy was that the combination of scientific illiteracy and daily dangers were not unlike an ancient hunter studying the 1:1000 odds of being struck by lighting instead of planning for the 1:10 odds of being killed by a predator. In both cases the thought of a catastrophe is inconceivable.

On April 18, 1997 Grand Forks ND and East Grand Forks MN experienced the most severe flooding from the Red River in recorded history (retrieved from http://www.fema.gov/pdf/hazard/archive/grandforks/chronology.pdf). The publication "EMS Rescue Technology, September 1997 reported on the Grand Forks flood. In the cover report Mike Spivak, reported that "this was the worst flood to hit this region this century and that the residents were certainly used to flooding but nothing could have prepared them for this" (p. 14). In the case of the 1997 Grand Forks ND flood predication and planning, there have been several well document floods affecting this region. During the fifty years preceding the 1997 flood, Grand Forks ND had nine significant floods; the 1979 Grand Forks flood was the second worst flood in the region's history inundating over one million acres of land. (Retrieved http://www.rrbdin.org/about/flood-tables.jsp) (http://nd.water.usgs.gov/photos/1979RedFlood/index.html) The long history of frequent flooding should have triggered a worst case scenario flood response plan. However, the views of Mike Spivak in his report and the lack of effective planning support General Dawson's view that flood planning is only urgent after the flood.

Hogan & DeBoer (2005) outlined four important stages of knowledge and skills that an organization must move through for effective emergency readiness. Although their work is based on security planning, much of the material is appropriate for disasters, whether caused by man, nature or both.

Stage 1: Unconscious Incompetence is the stage where an organization is incompetent for response to a predictable hazard, but not aware that they are incompetent.

Stage 2: Conscious Incompetence, or the risk assessment stage, is achieved through evaluation of potential hazards and response capabilities in the event of a disaster. It is not uncommon for an organization to find shortcomings in their abilities at this stage. However, once an organization has identified the potential for a disaster, and an inadequacy in response, they must take action to mitigate the exposure. Failure to move beyond the "conscious incompetence" stage may cause the entire organization to be held liable in the event of a disaster.

Stage 3: Conscious Competence is developed by planning, training and practice. At this stage the hazards have been identified, plans have been developed and the organization is capable of responding and mitigating the emergency. Mistakes and some indecision still occur at the "conscious competence" stage, but overall the emergency will be handled.

Stage 4: Unconscious Competence: the plans and skills are so well developed and practiced, their execution seems routine. Although this is the ideal stage for every emergency response, in reality it may not be achieved for every hazard plan, but should be the benchmark for responders.

Waugh, Jr. (2000) reported that certain geographical areas subject to frequent flooding generally have taken steps to minimize property damage and the loss of life. The problem is the less frequent 100 year and 500 year floods that exceed the community's ability to respond. While

these floods may take place over a relatively short time and demonstrate the potential of the destructive power, many residents may not remember the last time the big flood occurred. This along with little public recognition of the danger and a lack of willingness to invest in mitigation efforts can lead to devastating floods.

National Oceanic and Atmospheric Administration and National Weather Service (1992) stated that it is most important that the community provide an advance warning system. There are several components to an efficient warming system; river gauges that transmit live data to a local receiving station, sharing data locally, regionally and globally, education of the population, developing and posting a local response plan, which includes the responses to various flood levels (*retrieved from http://www.sidneyoh.com/riverflood/ACTION%20STAGES.htm*).

The initial research was intended to identify the need for an advanced flood warning system in the Chagrin River Valley of Willoughby Hills. The literature reviled a correlation that a lack of knowledge regarding disasters, resulted in an increased risk to people. This correlation became the basis of the paper. The survey was used to indentify the level of flash flood knowledge the people in the affected area possessed. The literature established a long history of flooding in this area. The literature also identified a global pattern of peoples behaviors during disasters.

PROCEDURES

The initial research for this paper began with a phone call. Mel House, operation division director of the State of Ohio EMA, was contacted for advice on resources regarding floods in the state Ohio. His direction led to the Chagrin River Watershed Partners (CRWP). Amy Holtshouse, Associate Director of the CRWP, indicated that there are limitations on flood data and suggested that the National Weather Service (NWS) be contacted. The NWS did not have data assessing the potential for catastrophic flood of the Chagrin River or similar streams.

As the floodgates of information were not opened in the first few attempts to gather data, a different approach was necessary. Since there was no available data on small river floods, this author began exploring the nature of catastrophes, including people's reaction, awareness, effectiveness of advance warning systems, and timelines for implementation. This phase of research began at the Cleveland Public Library including Science, History, and Government Documents where the material listed in the literature review were located.

While the library provided the social data on the human reaction to catastrophe, the city engineer provided technical data on the potential for catastrophe. This data was in the form of one hundred and five hundred year flood maps. Continuing to explore other resources within the city, the zoning inspector supplied a copy of the 2002 FEMA Flood Insurance Study for the City of Willoughby Hills.

An interview was conducted with Charles B Schumacher, retired fire chief of Willoughby Hills for a historical perspective of a fatal flood, which occurred in the city. Chief Schumacher was also interviewed on the effectiveness of the flood disaster plan during his tenure as chief. Based on the interview with Chief Schumacher, historical records and newspaper articles were procured from the Willoughby Hills Historical Society.

A survey of all homes in the flood plain were conducted to assess the: number of people living in the flood plain, percentage of the population with physical impairments, percentage of the population that have a perceived risk for flooding, and the percentage of the population that understand the early warning system in place. The survey was mailed to each of the 137 homes with a self addressed stamped envelope. Of the 137 surveys delivered 60 were returned.

Limitations of the Study

Limitations of the study include, lack of compliance from the residents to complete and return the survey. Residents receiving the survey may not have understood the definition of a flood plain. Training records from Kirtland and Willoughby Hills fire departments may be inaccurate due to the age of the records. There may be potential for personal bias of Chief C.B. Schumacher in his recollection of the events from the 1959 flood. Since it has been approximately 50 years since the flood, changes may have occurred in the topographical terrain in the Willoughby Hills flood plain due to natural erosion.

Definition of Terms

The city of Willoughby Hills uses these standard hydrologic terms for describing floods that equal or exceed on the average during any 10, 50, 100, or 500-year period. These terms are generally described as a 10, 50, 100 or 500-year flood. These floods have a 10%, 2%, 1% or 0.2% respectively of occurring any year. For example, any area that has a 1% chance of a flood occurring in a given year is a 100-year floodplain.

RESULTS

The results of the survey were 42% or 60 of the residents responded. Of these respondents, 86% knew they live in a floodplain. However, only 56% believed that a severe flood would affect their home; the remaining 44% did not believe that a severe flood would affect their home. Only 22% of the respondents knew the definition of a floodplain. The flood insurance maps for the Chagrin River Valley show that nearly every home that was surveyed was located within the 100 year floodplain. The exception is Milann Drive where 34% of the homes are not within the 100 year floodplain. However, local records indicate that these homes are affected by floodwaters when the Eagle road gauge reaches 22ft. Small stream flash floods such as the 1991 flood in Shadyside Ohio can produce a wall of water 26ft to 30ft high. Records indicated that the potential for a catastrophe similar to the Shadyside flood can occur in the Chagrin River Valley of Willoughby Hills. Without a community based flood awareness program and an integrated warning system, the potential for the loss of life is high in the event of a catastrophic flood.

The desired effect of an integrated flood warning system would be to continually collect pertinent information on the status of the river. The system would also include built in benchmarks that notify emergency workers of potential threats of flood and use the information to provide the public with early notification. Finally, development of an appropriate response plan based on the current flood condition is desirable. Such a flood warning system should provide time for mitigation of human exposure and removal of property such as vehicles and small personal items.

DISCUSSION

There is a problem with the lack of knowledge about the potential for a flood in the Chagrin River Valley of Willoughby Hills. The purpose of the study was to identify the potential for a flood in the Chagrin River Valley in Willoughby Hills and the need for an advanced flood warning system. The method used was evaluative in nature. The research questions included: What is the scope of the flood problem for the Chagrin River Valley in Willoughby Hills? What is the general populations' perception for the need of disaster planning? Should Willoughby Hills have an advanced flood warning system?

The procedure for the study included: Historical research, interviews, and a survey. The results revealed the general perception was that a flood response plan was not a priority. The historical data showed a real potential for a catastrophic flood and that a disaster response should be a priority. The study revealed a significant need for education for the residents that could be affected by a catastrophic flood in the Chagrin River Valley. The education piece should include information on the risks associated with flood waters.

Research should be conducted on the type of disaster plan that would best meet the needs of the residents of this region. The plan should include a recommendation for an early flood warning system. The final piece would be to educate the residents on how the disaster plan will be implemented.

The results of the survey were 42% of the residents responded to the survey. Only 86% of the residents who responded knew they live in a flood plain. However, only 56% of those believed that a severe flood would affect their home. The remaining 44% did not believe that a

severe flood would affect their home. Only 22% of the respondents knew the definition of a flood plain. The flood insurance maps for the Chagrin River Valley show that nearly every home that was surveyed was located within the 100 year flood plain.

In his book, Living with hazards, dealing with disasters: (Waugh, Jr., (2000) concluded seven areas subject to frequent flooding generally have taken steps to minimize property damage and the loss of life. The problem is the less frequent 100 year and 500 year floods that exceed the community's ability to respond. While these floods may take place over a relatively short time and demonstrate the potential of the destructive power, many residents may not remember the last time the big flood occurred. This along with little public recognition of the danger and a lack of willingness to invest in mitigation efforts can lead to devastating results from floods. One of the barriers to risk reduction is education. The important component to education is identifying those that have the potential to be affected and are at risk. The science behind the risk information must be at a level such that those at risk are willing to change their belief system (Junchaya, 1999).

The information contained in this research paper is intended to aid in the creation of a flood warning system and flood disaster plan. The combination of hardware, software, public education, response plans and changes in the Willoughby Hills Fire Department polices should create an advanced flood warning system to immediately identify changes in the river. This research paper will describe the necessity for communities to have advanced warning systems. Advanced warning systems are the single most important factor for saving lives in the event of a flash flood (NOAA, 1992).

RECOMMENDATIONS

Research should be conducted on the type of disaster plan that would best meet the needs of the residents of this region. Contacting other communities within Ohio or neighboring states that are located in flood plains and that have established flood warning systems would be helpful in developing strategies to begin a plan for Willoughby Hills. A plan needs to be developed to educate community leaders on the benefits of developing a disaster plan from the beginning. Educational needs of the community need to be met and communities with plans already in place may have ideas on that process as well. Research needs to be conducted on the availability of grant funding for the flood warning system. Recent tragic events in Louisiana with Hurricane Katrina may have opened up larger potential for grant funding for flood plain areas.

This entire process must be a collective project developed by community leaders, safety forces and the residents. A strategic process must be utilized to develop this plan and the life saving potential must be encouraged at all times to ensure a successful plan.

It has been shown throughout this research paper how much the City of Willoughby Hills will benefit from a flood warning system. This paper will be the beginning of the education that needs to be accomplished to make the City of Willoughby Hills safer place for all the residents.

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APPENDIX 1 – SURVEY

July, 2007

1. How many years have you lived at this address? (Please round to the nearest complete year.)

2. Please list the number of people living at this address

3. Number of invalids living at this address

4. Do you live in a flood plane? (yes or no)

5. What does the following year mean: 100 year flood?
    a. That a severe flood will happen about once every century
    b. There is a one percent chance that a flood may occur in any given year
    c. A major flood will affect the city for 100 years
    d. Don't know

6. Is there an outdoor warning system near this address? (yes or no)

7. Do you feel confident that a severe flood along the Chagrin River would affect this address? (yes or no)

APPENDIX 2 – SURVEY RESULTS

Number sent: 137

Number returned: 60

Number Vacant: 3

Longest time at address: 68 years

Shortest Time at address: 1 year

Average time at address: 23.03 years

Aver people per house (Most in a household, least): Most: 7
Least: 1
Average: 2.183

Total number of invalids: 6

Number of people knowing they live in flood plain: 49

Number who know the definition of a 100 year flood: 13

Number who know there is an outdoor warning system: 29

Number who feel confident that a severe flood will affect their address: 32:

Number who feel a severe flood would NOT affect their address: 25