P 1.74

TEACHING ENVIRONMENTAL SCIENCE STUDENTS WEATHER USING REMOTE SENSING TO INTERPRET FLOOD DATA

Shobha Sriharan* and Paula Kovalik**
* Virginia State University, Petersburg, Virginia
** Oklahoma State University, Normal, Oklahoma

1. INTRODUCTION

The inner layer of the atmosphere containing most of the earth's air has a particular set of properties. This is called troposphere. These properties are (1) temperature, (2) pressure, (3) humidity, (4) precipitation, (5) sunshine, (6) cloud cover, and (7) wind direction and speed. The short-term properties of the troposphere at a particular place and time are Weather. Meteorologists use weather balloons, aircraft, ships, radar, satellites, and other devices to obtain data on variables such as (1) atmospheric pressures, (2) precipitation, (3) temperatures, (4) wind speeds, and (5) locations of air masses and fronts[1]. These data are fed into computer models to draw weather maps for each of seven levels of troposphere, ranging from the ground to 19 kilometers (12 miles) up[1]. Computer models use the map data to forecast the weather in each box of the seven-layer grid for the next 12 hours[1]. Other computer models project the weather for the next several days by calculating the probabilities that air masses, winds, and other factors will move and change in certain ways.

Masses of air that are warm or cold, wet or dry, and contain air at high or low pressure constantly move across the land and sea. Weather changes as one air mass replaces or meets another. The most dramatic changes in weather occur along a front, the boundary between two air masses with different temperatures and densities. We sometimes experience weather extremes and these examples are violent storms called (1) tornadoes (which form over land) and (2) tropical cyclones (which form over Warm Ocean waters and sometimes pass over coastal land)[1]. Tropical cyclones that form in the Atlantic Ocean are called hurricanes; those forming in Pacific Ocean are called typhoons. Tropical cyclones (hurricanes) take a long time to form and gain strength. As a result, meteorologists can (1) track their path and wind speeds and (2) warn people in areas likely to be hot by these violent storms. The areas of North America which are most susceptible to hurricanes and tornadoes are East Coast and West Coast, respectively[1].

The students in the environmental science courses (GEAG 150 and AGRI 150) at Virginia State University (VSU) learn about the interactions between weather, environment, and agricultural production, through lecture and hands-on activities. Through lecture classes, they gain knowledge of Biogeography: Climate, Biomes, and terrestrial biodiversity. At the same time, the students who are very enthusiastic in pursuing environmental science education, are encouraged to participate in Internship Program at the National Weather Service(NWS) located in Wakefield, Virginia[2]. This facility is 40 miles from Petersburg, where VSU is located. During the academic year (2002-2003), a student, Ms. Paula Kovalik, worked on a collaborative project between VSU and the NWS. The purpose of this study was to gather flood data in the Piedmont Region of all floods that occurred in the last 10 years to determine how it affected crop yield in those areas. By analyzing the flood data, one can predict the likelihood of a flood having a substantial effect on crop production in a designated area. In this study, the technologies such as Global Positioning System (GPS), Geographic Information System (GIS) [3], and remote sensing were used for accurately mapping the occurrences of floods. This study can become an example for case study for those students who plan to pursue careers at the Federal agencies such as NOAA, Coast Guard, and agencies connected with Weather.

2. METHODOLOGY

Since the goal of this paper is to demonstrate how students can conduct case studies or participate in Internship Programs at the nearby Weather Station, assistance was taken from Mr. Keith Lynch, Hydrologist at National Weather Service (NWS), and Wakefield, Virginia. Ms. Paula Kovalik, a student in the USDA Capacity Building Teaching Project at Virginia State University, participated in this study. Mr. Lynch helped Paula and other students in conducting this collaborative project. Mr. Lynch showed Paula how to analyze the data and interpret the results. Integration of the GPS (Global Positioning System) with the remote sensing enables accurate mapping the occurrences of floods in the region. By analyzing the flood data, one can predict the likelihood of a flood having a substantial effect on crop production in a designated area. The data was collected by Paula through regular visits to the NWS. This facility is located 40 miles from VSU. The data collection was performed by Paula through her regular visits to NWS, during the academic year, 2002-2003. She used NWS Weather Forecast Office Hydrologic Forecast System to collect river flood data for major floods within the last 10 years including Hurricanes Fran and Floyd of 1996 and 1999, respectively. The information was collected about the location, elevation, precipitation amounts, local rivers affecting the area, normal flood stages and the actual flood levels, and dates the floods occurred. The data was collected on Flooding on Appomattox, Nottoway, Meherrin and Blackwater Rivers during the period from 1993 to present. This data was incorporated into a

*Corresponding author address***:** Shobha Sriharan, Virginia State University, Dept. of Agriculture and Human Ecology, VA 23806; e-mail: sriharan@vsu.edu.

database for mapping purposes. By using Global Positioning System (GPS) for data collection of the target region and integration of this data into Geographic Information System (GIS), one can assist in interpreting flood data to aid small farmers in the Piedmont Region of Virginia. Therefore, Paula used GPS and GIS in combination with remote sensing data, to map flooding in the target region (river basins and Franklin)[3]. Crop yield data for the flooding areas within the past 10 years was gathered from the Virginia Agricultural Statistics Service[4].

3. Results and Discussions

The information on location, elevation, precipitation amounts, and local rivers affecting the area, normal flood stages and the actual flood levels, and dates the floods occurred is shown below:

Example of Data for Franklin, VA

- Benchmark of Gauge is 1.56 feet above mean sea level
- Minor flooding Gauge level 13.56 feet above mean sea level
- Moderate flooding Gauge level 15.56 feet above mean sea level
- Major flooding Gauge level 17.56 feet above mean sea level

This information of the flooded areas was mapped for the Franklin area in Virginia (Figure 1). The majority of the flooding occurred primarily during a severe storm, such as a hurricane.

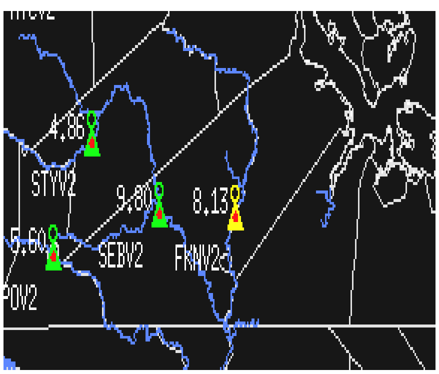

Figure 1: Flooded area in Franklin, VA

The data for Franklin in Virginia and Flooding are shown in Table 1. The Crest stage above mean sea level was determined for each flood (Fran and Floyd). In addition, the time of year the flooding occurred was noted. The information collected was during the years of events (Fran and Floyd) and normal weather, Flooding was categorized as minor, moderate or major.

Date	Crest above MSL	CAT
03/08/1993	12.85	Minor
03/05/1994	15.39	Minor
09/13/1996	13.87	Minor
10/11/1997	13.85	Minor
02/07/1998	16.83	Moderate
09/20/1999	27.96	Major
09/08/2000	15.36	Minor

Table 1: Data for Franklin in Virginia and Flooding

The information was collected on precipitation amounts in important stations in Franklin, Virginia and is shown in Table 2

Station	Amount
Holland	4.81
Hopewell	3.88
Emporia	3.61
Chase City	4.47

Table 2: Precipitation for Franklin

A major focus of this study is the effects of Hurricane Fran in 1996. Several examples of rainfall data for Virginia, Maryland, and North Carolina were retrieved; moreover, the corresponding crop yield information was gathered. In addition to the flood map of major floods that occurred, the data from Hurricane Fran was mapped. The crop yields from this hurricane and from the past 10 years were compared; the conclusion of this study indicates that the likelihood of a crop being damaged by flooding is directly proportional to the percent chance of a major storm or hurricane affecting that area. In this paper, corn production for grain in Franklin, Virginia is presented in Figure 2.

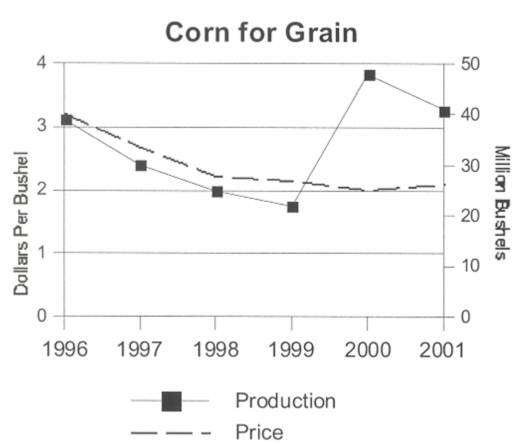

Figure 2: Corn Production for Grain in Franklin, VA

The results of this study showed that corn production was greatest (48,180 bushels) for years with minimal flood events (2000 with minor flood and 2001 with drought). Minor flood event years (1997 and 2000) have greater production than moderate (1998) or major flood event (1996) years. The minor flood production by Hurricane Fran had less of an effect on corn production than major or moderate floods. Drought year of 2001 had greater corn production than 1996 (Fran year) or 1999 (Floyd year). The collaborative study between VSU and NWS included comparison of peanut and cotton production with flooding by Fran and Floyd.

The above investigations involved a student in collection of data who worked closely with meteorologists in the Weather Forecast Office, procuring information on crop production through VSU's Cooperative Extension Services, Virginia Agricultural Statistics Service, Richmond, Virginia, to show the target region which was flooded due to extreme weather conditions (e.g. hurricanes Fran and Floyd), and mapping of the region by using the GPS and GIS technologies. This study serves as an example case study for those who plan to learn about weather and its impact on environment and crop production.

4. CONCLUSION

The conclusion of this study indicates that the likelihood of a crop being damaged by flooding is directly proportional to the percent chance of a major storm or hurricane affecting that area. The case study by Paula, serves as an example for other students. Paula is now pursuing a Bachelor's degree in Meteorology, at Oklahoma State University, Normal, Oklahoma. This research is supported by the USDA Capacity Building Project 2001-38820-11439

5. ACKNOWLEDGMENTS

The author, Shobha Sriharan, acknowledges the case study prepared by the student, Ms. Paula Kovalik, who is pursuing a Bachelor's degree in Meteorology at the Oklahoma State University, Normal, Oklahoma. The author is grateful to Mr. Keith Lynch, Hydrologist, Mr. John Billet and Mr. Anthony Siebers, meteorologists at the National Weather Service, Wakefield, Virginia for providing training to Paula Kovalik and use of facilities. This study led to exposure of NWS for educational opportunities to VSU students. The funding for this study was through the USDA Capacity Building Teaching Grant, "Applications of Geographic Information System and Remote Sensing in Agricultural and Natural Sciences" to Virginia State University.

6. RFERENCES

[1] Miller, G. T. Jr., 2003: Biogeography: Climate, Biomes, and Terrestrial Biodiversity; *In: Living in the Environment (Principles, Connections, and Solutions) Thirteenth Edition*, Thompson Learning, 10650 Toebben Drive, Independence, KY 41051.

[2] Weather Forecast Office, 2003: National Weather Service, Wakefield, Virginia.

[3] Virginia Agricultural Statistics Service, 2003: Department of Agriculture and Consumer Services, Richmond, Virginia.

[4] Introduction to ArcView GIS, 2002: Environmental Systems Research Institute (ESRI), Inc., ESRI Educational Services, 380 New York Street, Redlands, CA 92373-8100.