LAND AND WATER BASED FLASH FLOOD DETECTION AND WARNING SYSTEM

FIELD OF THE INVENTION

This invention relates generally to systems for detecting and providing early warnings for flooding, and more particularly to detecting flash floods on inland rivers.

BACKGROUND OF THE INVENTION

Communities located along river banks are affected by flooding when a river overflows its banks. For most riverside communities, the height and time at which the river will crest can be predicted well in advance. Although, it may not be possible to prevent property damage, in most cases, loss of lives can be prevented with sufficient advance warning to permit evacuation to higher grounds.

However, for communities located in or near hilly or mountainous regions, flash floods are a particular problem. In fact, flooding is the leading cause of weather related deaths in the United States. Often, the cause of the flood is a sudden severe thunderstorms storm, well upstream in some remote, uninhabited area. In addition, the nature of the terrain will often direct a large amount of water rapidly down a usually narrow water channel. These factors combine to make it difficult to predict the time, location and severity of flash floods.

With water travelling at over fifty kilometers per hour, flash floods can happen in a matter of minutes. The narrow path of danger can cause waves over ten meters high with a very high destructive potential, for example, it is not uncommon for cars and even houses and to be carried far downstream.

Most prior art land-based weather sensing and warning systems are based on simple rain and temperature gauges, Doppler radar, and satellite telemetry. These are generally ineffective for detecting flash floods. Rain gauges only measure continuous precipitation at specific locations. Doppler radar only works well on flat terrain, with big weather features. e.g., frontal systems. If the precipitation is frozen, then Doppler reading can under-estimate by a factor of ten. However, low-level radar coverage is restricted due to beam blockage in mountainous terrain. In addition, radar measurements can be inaccurate. Satellite based detection is only representative of cloud coverage, and not actual precipitation at ground level. All of these require some model that can translate sensed data into predictable flooding conditions. None of these give any real-time indication about the actual state of water flowing through mountainous river beds.

Gourley, "Multiple Sensor Estimation over Mountainous Terrain," Master Thesis, University of Oklahoma, 1998, describes a hybrid system using various types of conventional sensors, and threshold checks. The main use of the system is for after the fact storm analysis. Gourley et al. in "QPE SUMS: Quantitative Precipitation Estimation and Segregation Using Multiple Sensors, Salt River Project," 14, 2001, describe a similar web-based system with a "real-time precipitation algorithm," where multiple sensors are used to measure and detect flash flooding. However, the availability of results, for example, one hour 10 minutes for the Sabino Canyon flash flood of 1998, is still too long to give adequate warning in most situations.

Gruntfest et al. "Beyond Flood Detection: Alternative Applications of Real-Time Data," U.S. Bureau of Reclamation Research Grant #98PG8140373, University of Colorado, 1998, describe the Alert System. There, stream, rain, temperature, barometric, and wind sensors are connected to land based systems, and data are available on the Internet. The report also gives a survey of a large number of flooding alert systems in the United States and the rest of the world.

U.S. Pat. No. 6,169,476 "Early warning system for natural and manmade disasters" issued to Flanagan on Jan. 2, 2001, describes an early warning system for most natural and man made disasters. The system collects and analyzes data in real time as disasters occur, and when necessary, transmit early warnings to cause mitigation responses to lessen the disaster impact on lives and property. The system is designed to determine the type of the disaster, the magnitude, speed, direction, and the expected geographic area to be impacted. Early warnings are transmitted to a wide variety of commonly used consumer and commercial devices. A large number of different types of sensors are discussed, as well as satellite and cellular communications networks, and a central processing system. This system is general purpose, and does not include any component parts specifically designed for flash flood detection and warning.

In the field of oceanography and marine weather forecasting, floating buoys with GPS capabilities are well known for water-based weather monitoring systems. U.S. Pat. No. 5,951,346 "Air-delivered position marking device and method," issued to Woodall, Jr. on Sep. 14, 1999, describes an air-deliverable global positioning system (GPS) position marking device. U.S. Pat. No. 6,093,069 "Low watch circle buoy system," issued to Schelfhout on Jul. 25, 2000, describes a circle buoy system that uses global positioning system (GPS) P(Y) code coordinate sensing and transmission to mark its position in water depths up to 40 feet. The buoy system maintains its position with a flotation unit on the water's surface that transmits signals representative of its location. A submerged unit is affixed to a surface at the bottom of the body of water. Tether lines limit the range or watch circle the flotation unit may traverse on the water.

In these prior art type of weather buoys, the buoys are designed to either monitor weather and sea condition at a fixed oceanic location, or to float freely to measure ocean currents, and sea and weather conditions at various locations. As a characteristic, most water-based systems are designed for large bodies of water such as large lakes and oceans, and not for potentially fast flowing rivers.

It is desired to provide a detection and warning system that can accurately detect flash floods without giving false alarms. The system should be easy to install in hard to reach terrain, and have low maintenance requirements.

SUMMARY OF THE INVENTION

The invention provides a land and water flash flood detecting and warning system. The system includes a buoyant waterproof casing secured to land by a detachable tether and an anchor. Accelerometers mounted internally to the casing are configured to measure short-range and short-term positional information of the casing when the casing is in water due to flooding of the land, and a radio transceiver coupled to the accelerometers transmits the positional information to land based receiving stations to indicate a flooding condition.

The casing is armored and has a smooth elongated ellipsoid shape with a major axis substantially greater than a minor axis. The radio includes short-range and long-rage radio transceivers connected to antennas embedded in the