Development of a Simple Rain Gauge Fitted with an Alarm Device

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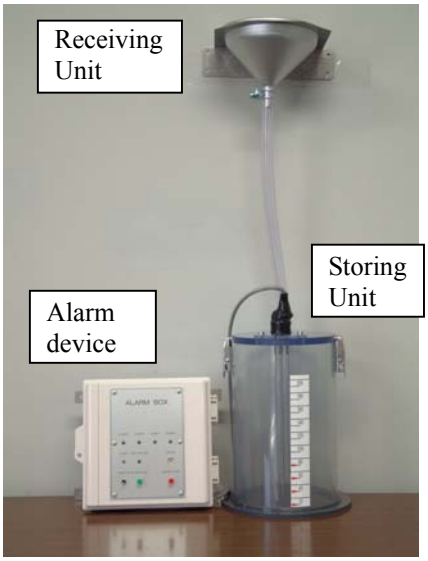
- Useful for a community flood warning; Useful for collecting short-term rainfall data for flood analysis in small river basins and other purposes.
- Inexpensive (affordable even for communities in developing countries); Simple in structure (easy to use by anyone).



1. Introduction

To mitigate damage due to floods, establishment of flood warning systems and flood hazard mapping are being implemented all over the world. These measures will be further promoted in the next ten years especially at the community level in accordance with the discussions at the World Conference on Disaster Reduction (Kobe, Jan. 2005).

Floods are generally classified into two types: floods that occur in large rivers and so-called flash floods that occur in small steep rivers. In the regions of Circum Pacific/Asia, Latin America, the Caribbean and the Himalayas, damage due to flash floods

is conspicuous because a number of small steep rivers scatter across the regions. However, implementation of damage mitigation measures against this disaster has been slow, because mitigation measures are often provided by foreign assistance, which tends to be directed to large rivers.

Flash flood disasters occur at so many locations with so localized scale that it is difficult for them to be the targets of international assistance. Accordingly, the approach to promote measures against this disaster on the global scale should be to encourage local communities to take measures by themselves by establishing flood warning systems and preparing flood hazard maps. The development of a rain gauge with an alarm device is an attempt to support such efforts of communities.

2. Background of development of the rain gauge

In September 2003, Dr. Villagran of the Coordination Center for the Prevention of Natural Disasters in Central America (CEPREDENAC) made a presentation entitled "Community-Operated Flood Warning in Central America" at a disaster mitigation conference in Jamaica: In Central America, flood warning systems had been in operation by community people themselves using manual water level gauges with an alarm device developed by Dr. Villagran himself and manual rain gauges without alarm device.

The main features of the water level gauge are: a sensor is fixed to the manual water level gauge, and every time the sensor detects that the water level has reached the predetermined levels an alarm installed in the room goes off. The advantage of this equipment is that the gauge reader can know the water level in the house and issue a warning without going out to the river to read the gauge at risk of his life under a heavy rainstorm.

In the Caribbean region, the flood warning must be issued not from the water level but from the rainfall, because the majority is small island countries and rivers are mostly small rapids and accordingly the lead time is short.
Therefore attempts are been made to issue a warning from the rainfall measured by the

manual gauge, but there are difficulties: Heavy rains go unnoticed if they occur at midnight; Heavy rains do not occur even though the gauge reader has been stand-by for hours based on advisory/ warning issued by meteorological office.
While, the advanced system that can gauge rainfall and issue a warning by real time, like the one set up in developed countries for the debris flow warning for traffic control, is too expensive to install in each community in developing countries.

Under these circumstances, the author has come to think that, if a simple and inexpensive rainfall gauge fitted with an alarm device is developed, just like the water level gauge mentioned above, it will be very effective for the flood warning for small rapids and will contribute greatly to disaster mitigation for local communities. When I explained this idea to Dr. Villagran, he said he also had the same idea to develop rain gauge with the alarm device following his first invention of the water level gauge fitted with an alarm device.

In March 2004 when I met Dr. Villagran at a conference in Panama, I bought one set of a water level gauge with an alarm device and an ordinary rain gauge without an alarm device from him at a price of US$100, to test it in a Caribbean river.

Dr. Villagran then moved to Bonn in Germany to work for the United Nations University's Institute for Environment and Human Security in October 2004, and his plan to develop the equipment had to be suspended. Production of the water level gauge was also suspended (He had been making this equipment with his own hands in Guatemala.)

During my home leave in April 2004, I met staff of the Ministry of Land, Infrastructure and Transport (MLIT), the Sabo Technical Center, the Japan Sabo Association etc. to explain the need of developing a simple rain gauge with an alarm device. Supporting this idea they suggested that SABO-INTRA Group which has an experience of international cooperation would be an appropriate organization to ask for cooperation. Takuwa Corporation, the secretariat of the SABO-INTRA Group, was kind enough to voluntarily manufacture the rain gauge. Meetings were held several times with the engineers of Takuwa Corporation along with staff of organizations mentioned above to discuss the specification of the equipment.

A model rain gauge was manufactured as early as July 2004. With comments from concerned organizations, some improvements were made, such as an increase of the alarm set points (2 points→ 4 points) and an enlargement of storage capacity (100 mm → 200 mm). The final rain gauge was completed in October 2004.

3. Specification of equipment, installation, and operation

Specification of equipment	Receiving Unit ・Funnel - φ154mm ・Vinyl hose (for connection with the storing area) Storing Unit Storing bottle - φ205 mm, H200mm Usable up to 200 mm cumulative rainfall ・Electrode for rainfall detection - 5 electrodes Four levels of cumulative rainfall are detectable. ・Cable - 1 cable, 5 cores（for connection with an alarm device） Alarm device ・Box - W200 mm, H200 mm, D100 mm ・Display lamp - Power lamp (1), alarm lamp (4), battery exchange lamp (1) ・Alarm buzzer ・Power - DC 9V (No. 3 type battery – 6 pieces)
Installation	・The receiving unit is installed outdoors. The storing unit and an alarm device are installed indoors. ・The detection levels (four levels) are set and the length of the rainfall detection sensor is adjusted. The detection level is determined by considering the “warning rainfall”, “evacuation rainfall”, etc.
Operation	Under normal conditions The equipment is used as an ordinary rain gauge and rainfall is gauged at a fixed times every day. Rainfall gauging can be limited to the rainy season only. Under heavy rain Every time the cumulative rainfall reaches a predetermined rainfall level, a lamp turns on and a buzzer goes off, when the observer records the cumulative rainfall and the time. If the cumulative rainfall exceeds the highest detection level, the observer must start gauging at a constant interval (ex. every 15 minutes) and record the cumulative rainfall and the time. If the cumulative rainfall reaches the predetermined “warning rainfall” and “evacuation rainfall”, the observer must take a necessary procedure for issuing a warning.

4. Application of the simple rain gauge fitted with an alarm device

(1) Community flood warning

A simple rain gauge fitted with an alarm device is used to issue the flood warning directly from the rainfall especially in small rapids for community flood warning.

To begin with, the relations between “cumulative rainfall” vs. “warning rainfall” and “evacuation rainfall” have to be determined in advance, and when the cumulative rainfall reaches those rainfalls, a warning, evacuation order etc. are issued.

As data accumulate in the future, the procedure has to be improved taking into account not only the cumulative rainfall of that day but also those of previous days.

(2) Collection of short-term rainfall data for flood hazard mapping and other purposes

The flood hazard map is being prepared in many countries and regions in the world, in that the insufficiency of rainfall data is the common and fundamental problem. The daily rainfall data are sometimes available to some extent, but the short-term rainfall data which are essential for flood analysis of small rivers are often lacking.

If the rain gauge proposed here is installed, the time and the cumulative rainfall are recorded every time the cumulative rainfall reaches the predetermined rainfall levels. Although the data obtained by this rain gauge are not so detailed as those taken by the automatic recording rain gauge, they are much more so than the daily rainfall data obtained by the ordinary rainfall observation.

Thus, the accuracy of the flood analysis and a hazard map will be much improved by introducing this rain gauge.

5. Limitations

(1) This rain gauge is not an automatic gauge but the “manual type”. Therefore it requires a reliable observer, and accordingly can not be installed in remote mountains where such a person is not available.

(2) The data obtainable by this rain gauge are the “time” when the cumulative rainfall reaches the predetermined rainfall levels, and the “cumulative rainfall” at such times. The cumulative rainfall in the range between two predetermined rainfall levels is assumed to increase linearly, therefore the actual rainfall at shorter interval

is not known.

(3) For the time being, a flood warning will be issued based on the cumulative rainfall only. The rainfall intensity and rainfall of previous days should also be taken into account when enough data are accumulated.

6. Perspective in the future

The practical approach for numerous flood-prone communities in the world to have flood warning systems and flood hazard maps at the earliest time will be to adopt community-operated systems such as the community flood warning using the rain gauge with an alarm device despite some limitations as mentioned above. It is hoped that improvements in the equipment will be made step by step while putting it to use at various places of different conditions.

At present, one rain gauge with two alarm setting points is being used experimentally in a model area of the Typhoon Committee in the Philippines, while the Caribbean region has three rain gauges with four setting points. Using these three gauges, a community flood warning will be started in Barbados, St. Vincent, and Trinidad and Tobago at the beginning of the rainy season of 2005.

To facilitate wider use of the rain gauge, introduction/demonstration are being carried out at conferences, workshops and meetings, such as the Typhoon Committee workshop (Korea, Sept. 2004), Caribbean Region Disaster Prevention Conference (Jamaica, Nov. 2004), and the International Workshop on Water and Disasters (Canada, Dec. 2004), also to JICA staff for use for various JICA projects in developing countries.