Irrigation gate status recorder

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Abstract

The flow of water down an irrigation ditch can be measured using a flume or by measuring the discharge from a well into the cannel. Water is diverted from the cannel into a field by opening gates in the cannel to each field. To calculate the depth of water applied to a field, it is necessary to measure the time duration that the flow in the cannel is diverted to each field and the area of the field. The time that a gate is open to the field can be measured with an irrigation gate status recorder consisting of standard magnet switch used in tipping bucket rain gauges and a Hobo event recorder that records the date and time that the switch is closed. An event is recorded each time the magnet on the gate passes the magnet switch as the gate is raised or lowered.

Introduction

Water conservation and proper irrigation timing and amount require knowledge about the amount of water applied during an irrigation to each boarder in a field. Ideally, the timing and amount of water applied to an irrigated field should be measured automatically without the need for a person to be present to record the flow rate and duration of the flow. Automatic control gate that opened and closed automatically were developed in the 1960 (Bowman , 1968, Calder and Weston. 1966, Humpherys , 1967), but these automated flood irrigation turnout gates were never adapted by the farming community because of the lack of reliability of the systems. Consequently, most flood irrigation control gates are operated manually. The flow rate of water down an irrigation ditch and the controlled turnout into a field through a gate can be measured using a flume or by measuring the discharge from a well into the cannel using a flow meter installed on the well discharge pipe. If the flow meter contains an output single proportional to the flow rate, it can be connected to a data logger to measure the accumulated flow over time and the total volume of water. Generally, the electronic propeller meter contains an electronic rate/totalizer that senses the propeller rotation via a magnetic pickup sensor located in the gearbox and translates these pulses to rate and total flow. The meters contain a 4-20 mA pulse output when the totalizer is connected to an outside power source. This output can be recorded by a data logger that can be an inexpensive single cannel data logger costing $400 or a multi cannel data logger costing up to $1,100.

However, when the irrigator changes the flow down the cannel from one boarder to another, a method of determining when that boarder gate is open or closed is needed to determine volume of water into each boarder or set of furrow irrigations. If a electronic sensor is not available on the flow meter but a total volume mechanical meter is read at the beginning and end of the growing season, and a gate recorder is used to record the time duration and date that each gate for each boarder is open then the proportional time duration that each gate is open can be used to prorate the total volume of water into each boarder at each irrigation assuming the discharge rate of the well into the channel is constant through out the growing season. If the well in use irrigate more than one field, then irrigation gate state recorders must be installed on all gates in all fields.

If the water comes from a main irrigation district cannel turnout then it can be measured using a flume in the field cannel. The depth of the water in the flume over time and thus the flow rate can be measured using a pressure transducer connected to a data logger. The S-M type flumes (Samani, Z. and Magallanez, H. 2000) can be installed quickly and at a cost of $100- $200 into a concrete or dirt ditch cannel. The pressure transducers range in price from $600 to $1000. Again the cost of the data loggers is from $400 to $1100. Water flow in a cannel is measured and the water is then diverted into a field by manually opening gates in the cannel to each boarder. Again, in order to calculate the depth of water applied to a boarder, it is necessary to know the time duration and flow rate that the flow in the cannel is diverted to each boarder and the area of the foarder. The boarder area can be determined by aerial photographs or using GPS equipment.

The objective of the research was to develop an inexpensive irrigation gate status recorder that when combined with knowledge of the flow rate or total flow down the cannel could measure the volume of water applied to each boarder in a field and in turn the depth of water applied at each irrigation date automatically.

Materials and methods

The time that a high flow turnout gate (Fig. 1) is open to irrigate a boarder can be measured with an irrigation gate status recorder. The gate data logger consists of an event recorder (Fig. 2) with an external magnetic switch (Fig 3) attached to the frame of the high flow turnout gate and a magnet attached to the slide portion of the gate.

Fig. 1 Irrigation gate with a data logger

Fig. 2 Irrigation event data logger.

The event recorder switch attached to the frame of the gate is activated as the slide portion containing the magnet pass the switch. The data logger records the date and time the magnet passes the switch each time the gate is opened or closed. The magnet switch and the magnet are attached to the gate using silicon rubber. The magnet switch used is a tipping bucket recording rain gages switch (Hamlin 5801 switch). The magnets used were acquired from a home alarm company. The switches used by the home alarm company can not be used because they are for indoor use and fail after a rainfall event even if covered with silicon rubber. The Hamlin switch is water proof. The event recorder is a Hobo h007-002. The magnet is raised when the gate is raised, closing the switch and recording an event. It is important that the magnet switch be placed closes enough to the magnet to be activated. This distance should be no more than 0.25 inch and do the operation check after installation by rising and lowering the gate several times to make

sure the magnet is operating the switch. As long as the gate is open, no further events are recorded. However, a delay of 1 second is set in the Hobo data logger before another even can be recorded so that multiple recording do not occur when the magnet passes the magnet switch. When the gate is closed at the end of the boarder irrigation another event is recorded. This data along with the integrated flow over the measured time period is used to calculate the water amount diverted into the field.

Knowledge of the flow rate through the gate is required. In this study, the discharge from two wells was measured into the cannel using the Sparling meters installed on the wells outlet pipes. The gate flow rate was equal to the combined discharge rate of the two wells because only a single high flow turnout gate was open at a time. If sets of gates are open for an irrigation event, with each turnout gate supplying water to a different boarder in sequence, then one recorder is installed on each gate to determine when it was opened and closed. The total flow in the ditch must be diverted to one boarder at a time for the measurements to be accurate. The flow rate in the cannel if it is constant based on a upstream turnout setting can be measured using a inexpensive S-M flume (Samani, Z. and Magallanez, H. 2000) consisting of two half section of pvc pipe placed in a vertical channel or a single pvc pipe placed in the center of a trapezoidal channel. This flow rate must be recorded by the irrigator at each irrigation event or set to the same flow rate throughout the growing season.

Fig 3. Switch and magnet attached to a slide gate.

Field Experiment

A pecan orchard in the Messia Valley New Mexico was planted in 1970 on 9.7 by 9.7 m tree spacing with a average orchard tree height of 12.8 m and an average tree diameter at breast height of 30 cm. The soil type was a Harkey loam and the orchard was irrigated before the soil moisture reached a maximum allowable depletion (MAD) of 50% based on a tensiometer reading at 30 cm reached 0.6 bar or when more than 8 days would have occurred between irrigations. The study was started in 2003 and the gate recorder was installed on a gate in the first boarder of the field in March of 2003 down stream from a

cannel that received its water from two irrigation wells containing Sparling meter with only totalizing water meters on them (Fig. 4)

The boarders had high flow turnout gates to take the total flow from the two irrigation wells that was around 3600 gpm. Flow measurement throughout the growing season determined that the flow rate from the wells varied less than 2% the accuracy of the flow meters. The event recorder data was downloaded using Onset cooperation Box Car Pro 4 software installed on a portable computer that was taken to the field to read the data logger every two weeks.

Fig. 4. Measuring discharge of the irrigation wells using Sparling meters.

Results and Discussion

Before the installation of the irrigation gate status recorder, in the first year of the research the two Sparling meters were read before and after each irrigation of the monitored boarder. However, because the farmer did not always inform the researchers when an irrigation event was to occur, many irrigation events were missed or more than one boarder in the field was irrigated between meter readings. Also, because it was necessary that the meters be read at the end of the irrigation before changing the gates to irrigate another boarder, a person had to stay at the field during the entire boarder irrigation even which could take 5 hr's.

After the installation of the irrigation gate status recorder, irrigation date, amount and depth were measured automatically (Fig. 5).

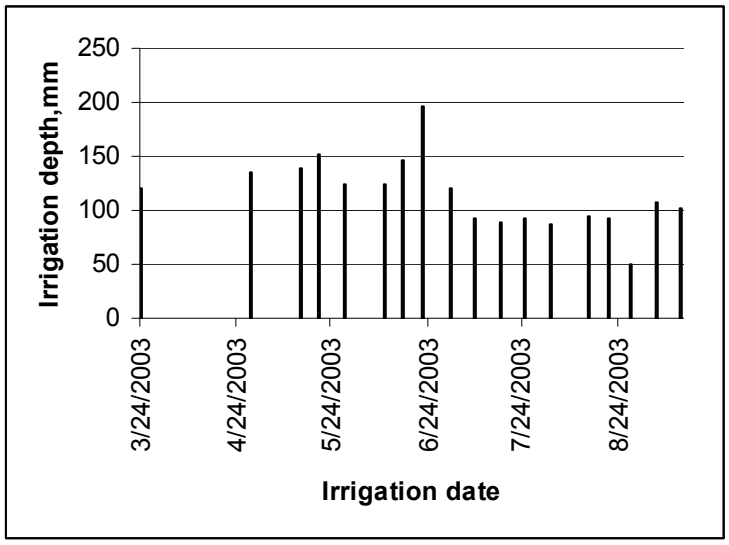

Fig. 5. Depth and amount of water applied to a Pecan flood irrigated orchard in 2003

Occasionally, the event recorder did not record an irrigation event for unknown reasons. Then, a second irrigation gate status recorder was installed on the other side of the gate, so if one failed the backup recorder would work. In a couple of times during the experiment (year 2004 and 2005) the irrigator broke and loosened the magnet switch from the side of the gate and one time the magnet came off the slide portion of the gate. It is recommended that a plastic cover be put over the magnet switch and the wires from the switch to the Hobo event data logger be put in protective pvc for long time installation. Also, it is important when using the Hobo event recorder to observe the battery status of the recorder and replace it when it shows 50% depletion.

Conclusion

A simple irrigation gate status recorder was designed and used to record the date and time a irrigation gate on a high flow turnout was opened and closed. This coupled with the flow rate in the cannel and the area of the boarder allowed for a calculation of depth of water application. The simple irrigation gate status recorder is reliable.Because of the low cost, two gate status recorders are recommended to be installed in case of instrumentation failure so that no irrigation events are missed.

Reference

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