TRENDS IN ADVANCEMENTS IN HYDROLOGICAL INSTRUMENTATION

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1. INTRODUCTION

1.1 The hydrological parameters requiring measurements can be broadly categorised as follows:

A) Hydrometeorological

B) Surface water

C) Groundwater

Under category 'A' fall: Rain/snow fall, wind velocity and direction, relative humidity, air temperature, solar radiation, evaporation, soil moisture etc.

Category 'B' covers: Flow/discharge (current velocity, depth), water level/stage, suspended sediment concentration, bed load, water quality.

Finally, the 'C' category includes: water level and water quality.

1.2 Measurements of these parameters require techniques that need to address the basic requirements of accuracy and reliability of measurment. In addition, some functional requirements that are equally important have to be met such as unattended operation, *insitu* data logging/storage/recording, tele-transmission etc.

1.3 With the fast developments in electronics, and its widespread use in almost every field of science, measurement science has not been an exception, and so instrumentation today is electronics based to reap the tremendous advantages that accrue. The entry of electronics in hydrological instrumentation is slow, but sure.

2. HYDROLOGICAL INSTRUMENTATION: PRESENT STATUS

2.1 General

2.1.1 The scenario on the advancements in hydrological instrumentation the world over show a mixture of achievements such as improvement in the existing techniques, introduction of new techniques, incorporation of data logging capabilities and tele-transmission capabilities. These advancements are mainly due to the availability of electronic gadgets at affordable costs and incorporating them in instrumentation elevating their capabilities manifold and yet keeping their costs at affordable levels.

2.2 Advancements

2.2.1 Hydrometeorological parameter measurements: Rainfall is an important parameter to be measured. The conventional Standard Rain Gauge (SRG) and Autographic Rain Gauge (ARG) have been in use so far. A number of problems have been experienced in their use and needed to be eliminated or improved upon using better techniques. Introduction of Tipping Bucket Rain Gauge, a new technique has not only eliminated the problem of manning the above mentioned rain gauges but has provided avenues for easy to read *insitu* digital display electronic, low power, battery operated counter, data logging using battery powered data loggers for unmanned operation and interfacing for teletransmission of rain data for remote data collection. Similarly, mercury thermometers have been replaced by electronic devices such as thermistors, Platinum Resistance Thermometer (PTR) and the wet bulb thermometer is replaced by polymer film based relative humidity sensor. The most important advancement is in automatic data logging of all parameters commonly known as Automatic Weather Station (AWS) over a desirable period and has tremendous advantages over manual reading procedures. As such the instruments used for measuring each parameter have to be transformed into 'sensors' using electronic techniques. For example, cup type anemometers are provided with devices that generate electrical pulses and wind-vane with potentiometer.

Hydrometry: Instrumental techniques for measurement of stream discharge include the conventional currentmeter method and in its absence the float method.

2.2.2 Cup type current meters are used on many well-manned sites. It is a tedious and time consuming method, needing a boat or a cradle attached to a cable way or a bridge across the stream. Propeller currentmeter, which is also widely used, has advantages over the cup type in respect of its insensitiveness to oblique flows. An electro-magnetic currentmeter has now been developed and is being marketed which is intended to replace the above rotating element type currentmeters of the cup type or the propeller, as it has no moving parts.

2.2.3 The moving boat equipment technique has been introduced wherein the measurement time has been drastically reduced compared to the currentmeter method and yet have the discharge measured accurately. This is achieved through integrating activities like sensing, collecting and analysing the data through electronic gadgets such as sensors and on-board computers.

2.2.4 The ultrasonic (acoustic) method has also been proven now for measurements of stream discharges. The system which is characterised by one time installation and very high accuracy of measurements is most suitable for automated discharge measurements, particularly for streams having deep gorges and stable cross sections. This method is particularly suited for flashy streams. Ultrasonic systems have been installed over streams having widths over 30 to 150m. The International Standards Organization (ISO) has produced standards for both the Moving Boat Method and the Ultrasonic Method for employing them. Each of the above mentioned methods become applicable, site conditions permitting and meeting measurement accuracy.

However, it can be stated that not one of the methods discussed above is applicable in all site situations.

2.2.5 For small streams, flow measuring structures such as weirs and flumes prove promising. For shallow hilly streams tracer (dilution) method offers better accuracy and in some cases the only alternative.

2.2.6 Stream cross section determination has to be done by carrying out depth measurements. Echo sounders provide the best means. Echo sounders are available with digital display and with chart paper recording, the latter being costly. An ISO standard is available for right choice.

2.2.7 Water stage (level) measurements is an essential important measurement. It has to meet varied requirements imposed due to site conditions, which could be:

a) variations in ranges and accuracy requirements

b) remoteness of site

c) frequency of record

d) essentiality of data logging and/or tele-transmission

2.2.8 There are a number of water level variation sensing techniques. The direct method is sensing the water surface elevation from known datum. Staff gauges both vertical and inclined are manual reading type. The float method is the most established one, provided it is installed in a stilling well. Stilling wells are costly structures to construct and do need careful design and attendance where silt problems are predominant. To obviate this difficulty, other techniques using hydrostatic pressure sensing devices have been introduced. Pressure sensing is carried out underwater, where a pressure sensor is installed in the stream or reservoir and the signal is taken through a suitable cable to the recording/indicating instrument. Pressure sensing is done outside water also, wherein pressurised air is passed through a tubing to purge out the underwater, through its tip installed at a convenient point.

2.2.9 There are other types of devices also developed and used. They mainly include:

i) the ultrasonic types, where reflections of sound waves sent by the acoustic transmitter range the water surface,

ii) the capacitive or resistance staff gauges with relevant electronics and display,

iii) magnetic float placed in a non-magnetic pipe with magnetic reed switches mounted along the pipe length,

iv) pointer gauges with electronic sensing and digital display (for ranges upto 1 m),

v) electrical sonde (for bore wells).

2.2.10 The controversial strip chart recording techniques are being increasingly replaced by solid state memory storage devices. This has necessitated development of water level sensors. Even the float type devices now incorporate shaft encoders so as to act as water level sensors.

2.2.11 Suspended sediment concentration measurement is reliably made by conventional sampling techniques. These include the hand sampler like DH–48 for shallow wadable streams, depth integrating sampler like D–49 for streams upto 5m depth, point integrating sample such as P/063 for deeper streams, and pump samplers. Electronic instruments such as turbidity meters are available for use, which work on the optical principle. However, their accuracy is heavily dependent on calibration which has to be carried out *insitu* before the measurement. Nucleonic suspended sediment concentration gauges are available for *insitu* determination. Bed load measurements are again carried out by sampling techniques which in all cases use mechanical gadgets. This, however, does not mean that advanced electronic techniques such as laser techniques cannot be used for the purpose, but the cost/performance ratio is prohibitively high, making such techniques unaffordable.

Water quality measurements, being an independent area, has not been discussed here.

3. THE INDIAN SCENARIO

3.1 The hydrological parameters discussed above (para1) are presently being measured using mostly conventional and traditional instruments/ methods. These are mostly based on mechanical design and are manual reading types. Exceptions, being equipment like the echo sounder. Experience of all users on the instruments used presently, has not been very satisfactory owing to the problems associated with them. Advanced instruments are not finding access in the Indian market with the same ease as they had in advanced countries. An analysis of the situation indicates firstly, that the manufacturers and suppliers of these instruments are from the small scale industry sector (because of unpredictable demand situation) and as such there has been very little attempt and hesitation to improve and/or modernise the products involving electronic gadgets for fear of lack of market demand. Further, after-sales-service is almost non-existent for lack of the requisite infrastructure of these small scale industries. Actually, it is the user groups that should normal *insist* with industry on introducing desirable improvements based on their valuable experience on the use of these instruments and provide them with instruments with improvised advancements which are at par with the developments in other countries. On the other hand, industry should incorporate the advancements in their subsequent products which are at par with world standards. The Bureau of Indian Standards (IS), which are normally quoted (more often than not, blindly) during purchases of these equipment are old and are not updated frequently enough to accommodate new developments. In fact, the Indian Standards may often, become, a deterrent to the manufacturers in introducing new improved versions of instruments, though they have been introduced long back and widely used in other parts of the world, for the simple fear of no-sales-potential. As a result, introduction itself, leave alone use, of instruments with improved performance and superior features is getting affected. Nonetheless, use of advanced hydrological instruments has been attempted in scattered cases such as in the Yamuna Flood Forecasting System by CWC and Automatic Weather Stations installed in some locations in the country. This, however, has not induced the users at large to change over to modern instrumentation. Unfortunately, the advances and modernisation of hydrological measuring instruments in India has been caught in a vicious circle of demand, and supply that is since there is no demand, there is no supply.

4. CONCLUDING REMARKS

4.1 Development process of improvement, advancement and of new techniques is a continuous process with short obsolescence periods. Hydrological instrumentation has been equally affected in this regard. However, unfortunately in India, awareness among the users is lacking in this regard. The situation needs drastic change. The following steps are needed to improve the situation:

i) draw awareness programmes for users about advances in hydrological instrumentation through periodical workshops and training courses involving on-site practices of hydrometry.

ii) dissemination of information amongst the users, institutions and organisations engaged in hydrological instrumentation. It should also include seeking consultancy of institutions that have developed adequate expertise in the field.

iii) users to provide for, specify and insist on updated modern instrumentation for their hydrological observation programmes.

iv) undertake vendor development activities to ensure timely supply and after-sales-service. Training at the vendor's premises on repairs and maintenance be included in the supply contract wherever possible.

v) national standards need to be updated more frequently then the obsolescene period and they be framed to be resilient to accommodate advancements at any point of time. Quoting these standards during purchases be resorted to with knowledge and should not close doors to advanced instruments.