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NATIONAL RIVERS AUTHORITY
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WELSH REGION
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NRA

Guardians of the Water Environment
Diogelwyr Amgylchedd Dŵr

National Rivers Authority

Welsh Region

South West Division

The Development of a Portable Battery-powered
Telemetry System for use in Water Quality

Investigations

EAW/90/12

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ENVIRONMENT AGENCY



101990

CIRCULATION LIST

FULL REPORT

Regional Planning Manager.

Divisional Scientists (x3).

Regional Environmental and
Quality Manager.

Divisional Pollution Control
Managers (x3).

Regional Environmental
Appraisal Manager.

Senior Environmental Appraisal
Officers (x3).

Strategic Planning Manager.

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Manager.

Regional Fishery and
Conservation Officer.

Regional Environmental
Appraisal Scientist.

Introduction

In recent years developments in battery-powered microprocessors have provided a means of logging data produced by water quality monitoring instruments. Data loggers are capable of recording large volumes of data which can be subsequently transferred to a computer system for analysis. Continuous monitoring, employing data loggers, has revealed significant episodic water quality events in a variety of situations and is a valuable tool in understanding pollution influences on the aquatic environment. However, in certain applications, the delay, between the acquisition of data by the logger and its availability to the scientist, detracts from the value of continuous monitoring. The use of a telemetry system can eliminate this delay. The transmission of data to a manned location in more or less 'real-time' can be extremely useful by allowing officers to respond whilst an incident is in progress. There are a variety of options which might be taken in response to knowledge that a pollution incident is in progress, including a site inspection by a Pollution Control Officer, specialised manual spot sampling, formal sampling, advice to the polluter or, with some telemetry systems, the remote triggering of an automatic sampler. The use of telemetry systems would have a considerable deterrent effect on potential polluters especially if skillfully publicised. The aim of this desk study is to examine the range of telemetry systems available and select one system for field evaluation. Any other systems which might be preferable, in certain specialised applications, will also be highlighted.

Criteria

The following criteria were employed when considering the various telemetry systems which are available in order to ensure that an objective selection was made:-

1. Power supply - must be battery powered with a battery life of at least two weeks from an easily portable battery.

2. Portability - must be easily moved, ideally by one person.
3. Frequency of Transmission - data transmission every quarter of an hour may be required for some applications.
4. Aerial size - any aerial must be transportable, usable in real situations and ideally not attract vandals.
5. Independence - should be independent of any fixed structures or cables.
6. Range - must cover all of Welsh region from one location.
7. Ease of use - must be straightforward to operate.
8. Costs - these must be considered and comparisons made. .
9. Computer compatibility - data should be received in a form suitable for direct downloading to a computer system for storage and analysis.
10. Alarm capability - should have some facility to warn of data outside preset limits.
11. Two-way communication - ideally should allow remote triggering of an autosampler or other item of equipment.
12. Directionality of aerial - omnidirectional aerials can be mounted on a buoy or mobile unit but require more power than directional aerials.

Types of Telemetry Equipment

The telemetry equipment available can be divided into the following categories :-

1. VHF Radio (direct) - insufficient range, suitable for short range link to another system eg. from buoy mounted equipment.
2. UHF Radio (direct) - as above.
3. Microwave - not portable, not battery-powered.

4. Telephone PSTN - relies on BT lines which severely limits locations available.
5. Satellite systems - worthy of further consideration.
6. Cellular Telephone systems - as above.
7. Meteorburst system - as above.

The equipment indicated as worthy of further consideration is described in more detail below.

Satellite Systems

The only suitable satellite system currently available employs 'Meteosat' meteorological satellites to receive signals from the outstation and relay them to the users premises via a groundstation in West Germany. The satellite relays messages in the intervals between the transmission of weather forecasting images. It is necessary to employ satellites with geostationary orbits in order to have continuous communication. The ARGOS system, which has been developed for data collection and radio location, only allows infrequent data reception, with a delay of 2-4 hours, as it uses satellites with polar orbits. The Meteosat system has been used by some Water Authorities but has a number of drawbacks :-

1. Normally transmits infrequently (eg. twice daily) except in alarm situations.
2. The integrity of data is not guaranteed.
3. May be liable to costs from satellite operators in the future (currently free of charge to public utilities).
4. One-way communication only.

Systems under development are detailed in a report produced by 'Science Systems' under contract to Welsh Water (Science Systems 1988). They include :-

1. INMARSAT Standard 'C'.
2. PRODAT.
3. LOCSTAR.

INMARSAT Standard 'C' has recently come into operation and has some potential. However, it has been developed for message communication between ships, ocean-going craft and land stations and some further development work would be necessary before it could be used for data transmission. Because the charges are based on the number and size of messages it is also likely to be relatively expensive if used for frequent transmissions. The other systems are still under development.

Cellular Radio Systems

Telemetry systems using the cellular telephone network for data transmission are now becoming available. By employing this network of radio relay stations they allow deployment anywhere that there is adequate cellular telephone coverage. This includes most of the South Wales coastal area but not the mountainous areas of Mid or North Wales or some coastal areas of West Wales. Data at the outstation is recorded over the short term by a data logger. A master station, consisting of an IBM compatible computer, can be programmed to automatically dial-up the outstation and interrogate it. Data is transmitted in a compressed form so that the actual connection time is short. There is, however, a standing charge of approximately £300 per outstation per annum to cover the cellphone charge before any calls are made. In some areas of Britain, particularly near large cities, where there are no topographical problems with cellular telephone coverage, the system is overloaded at certain times of day and there would consequently be a delay in receiving data.

Meteorburst

'Meteorburst' is a telemetry system which relies on the reflection of VHF radio signals from the trails of meteorites as they enter the atmosphere 60 miles above the earth's surface. The system consists of a

master station, which transmits a cone-shaped pattern of coded radio signals away from the earth, and a number of outstations. When a meteorite enters the atmosphere, within the cone, the radio signal is reflected from the ionised particles, which are produced as the material of the meteorite burns up, back to the Earth's surface at a point dependant on the location of the meteorite. The reflected signal returns to the Earth over a relatively small 'footprint' of 3 to 4 square miles. If an outstation is within this footprint then it will recognise the coded signal and transmit a reply, establishing a communication link. The transmission of data occurs in compressed 'packets' to take advantage of the short-lived meteor trails. Data integrity is ensured by means of memory stacks at the outstation and the master station and by the two-way communication capability which allows 'handshaking'. Correct receipt of a coded signal, incorporated into each packet of data, confirms successful transmission of that packet and allows data to be cleared from the appropriate stack at the outstation. Any error in the receipt of this signal will prevent the clearance of the appropriate data from the message stack and the data packet will be retransmitted. Data from the outstation, received at the master station, is relayed to the users premises by the same method by which it reaches the master station. Data received at the users premises is stored and displayed on an IBM compatible computer. The system was developed by the defence industry in North America and one of the first units deployed in the UK was used at Llyn Brianne in mid-Wales, by WRc in conjunction with Welsh Water, to monitor the performance of a mobile aluminium monitor used in acidification studies.

Performance against criteria

	Meteosat Satellite	Cellphone System	Meteorburst System
Power Supply	12 volt	12 volt	12 volt
Portability	OK	OK	OK
Transmission Frequency	Low 2/day + alarms	OK but expensive	OK
Aerial Size	small	very small	large-2m Yagi
Independence	OK	OK	OK
Range	All of UK	Some problems	All of UK
Ease of use	OK	OK	OK
Costs (1 master, 1 out)	£13,000	£2000-2500 +£300 per annum	£1260 +£2400 p.a.
Computer compatibility	OK	OK	OK
Alarm capability	yes	yes	yes
Two-way Communication	no	yes	yes
Directionality of aerial	optional	omnidirectional	directional

Conclusions

The Meteosat system was discounted for the following reasons:-

1. One-way communication only.
2. Integrity of data not assured.
3. Possibility of satellite costs being imposed.
4. The low frequency of data transmission.

The cellular telephone system was eliminated for the following reasons:-

1. The poor coverage in some areas of the UK.
2. The cost of obtaining frequent data.
3. The unreliability of the system near large cities.

However because of the small size of the outstation aerial and the portability of the system it could be considered for certain applications where vandalism of a prominent aerial may be a serious risk.

The Meteorburst system was selected for evaluation in spite of the following shortcomings :-

1. The size of the aerial.
2. The directionality of the aerial

A Meteorburst system has therefore been leased and will be evaluated in a series of real situations reflecting the possible scope of application of such technology.

Further development of the satellite systems mentioned, in particular INMARSAT Standard 'C' and PRODAT, should be watched

carefully as they may become superior to the systems currently available.

References

1. Science Systems(1988), " A Study of Recent Developments in Satellite Communication and their Application to Telemetry and Control " Consultant's Report to Welsh Water Authority.

REPORT FEED BACK SHEET

The purpose of this form is to provide information which will enable the EAU to improve its service and help to ensure that resources are used appropriately. Comments are welcomed from any reader of the report. Please photocopy this page and return the completed form to the appropriate Senior Environmental Appraisal Officer/Scientist.

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LIST ANY OMISSIONS IN THE FIELDWORK UNDERTAKEN _____

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ARE THE CONCLUSIONS VALID? _____

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