SNOW SURVEY TELEMETRY NETWORKS AND FUTURE PLANS[1/]

By

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The Soil Conservation Service in the U. S. Department of Agriculture has a number of legislative authorities for developing, managing, and using water resources. These programs illustrate the need for basic data covering a wide range of planning and operations. We will discuss primarily the water resources aspects. The important authorizations are--

1. Conservation Operation
2. Resource Conservation and Development including urban areas
3. Watershed Protection and Flood Prevention
4. River Basin Investigations

The conservation operations program involves primarily on farm land and water conservation work to efficiently use these resources and to preserve and improve the agricultural base of the Nation.

The resource conservation and development program not only concerns land and water but also takes a group, community, and agency approach to improve the economic and social well-being of rural and urban people and their environment. The areas selected to study and improve are not necessarily limited by watershed or political boundaries. This is mostly a "self help" program on the part of the people participating with some financial and technical assistance provided by state and Federal agencies. An RC&D area may be a part of a county, part of several counties, or one or more counties.

The watershed protection and flood prevention program is designed to provide conservation treatment on the land, reduce erosion and sedimentation, and control or reduce excessive stream flows to reduce flood and other damages. Fish and wildlife improvement, recreation, and municipal and industrial water supplies are also purposes permitted under the legislative acts. Structural measures, such as dams, improved channels, levees, and control structures are used extensively in this program. Treatment is confined to specific watersheds up to 400 square miles in size. A work plan is developed for each watershed concerned and submitted to the Congress for approval. Costs of structural measures to reduce flood damage are borne largely by the Federal Government.

Within the Department of Agriculture, the Soil Conservation Service has leadership in river basin activities. Three types of surveys are made.

Type I is a comprehensive framework study. This type of study is carried out under the auspices of the Water Resources Council to achieve the Administration's objective of making regional framework studies over the whole Nation and to formulate detailed plans for the subareas of these regions more quickly. The Nation has been divided into 20 regions. The framework studies will provide a general appraisal of overall water and related land resource development needs. Type II surveys are in greater detail than Type I. They define and evaluate projects in enough detail to serve as a basis for authorization or implementation. Type IV cooperative surveys are usually state-sponsored surveys of water and related land resources for all or a part of a state or a river basin in which one or more Federal agencies cooperate with the state or each other. The states need information about the agricultural, rural, and upstream aspects of water and related land resources in river basins wholly or partly within their boundaries.

Other Federal departments also have basic legislative authorities which concern water resources and management.

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In all of the programs and activities mentioned, the stated objectives depend on knowing water and land resources. For example, arid regions distribution and amount of streamflow are very important since about 70 percent of the water in many western stream systems comes from melting snow accumulated in high mountains. The amount and distribution vary greatly seasonally and annually. The obvious conclusion is that programs involving hundreds of millions of dollars of planning, design, construction, and operation costs require much knowledge of the water and land resources, both potential and developed.

There are major gaps in water resource and behavior knowledge, for example, knowledge needed to accurately predict storms, area and time of occurrence, precipitation amounts, evaporation, infiltration, sublimation, rate and amount of runoff, and stream hydrographs using varying time bases.

In most cases, works of improvement have to be planned, installed, and operated based on average figures, short records, transposed data, estimation of probable maximum events, and the like. Operating data generally are refined as specific needs arise and operations funds become available. More data are needed to predict time and magnitude of events.

The objective of the snow survey and water supply forecasting program is to accurately forecast volume, duration, and distribution of water from snow-fed streams to benefit all people. As we review the operation, we immediately see that practice is not up to potential for meeting the objective.

There are basic data gaps in the snow survey and water supply forecasting activity, particularly in the daily change in mountain precipitation amounts, total and residual accumulation, melt rates, and the relationship of these to downstream events and hydrographs. Snow on a mountain is water in storage for a period of time. This fortunately permits advanced study and planning. However, unpredictable forecast factors such as temperatures, wind movement, and post season rainfall have a pronounced effect on forecast accuracy. Studies are being made to determine the limits of these factors, which vary from watershed to watershed. This whole problem affects planning, designing, and operating works of improvement for basin and river systems.

The data used for once-a-month water supply forecasts serve a very important function to irrigators, and the economic returns are great. The manual observation and collection of high-mountain data on a monthly basis are not done often enough or comprehensively enough to fully realize the potential of these data for irrigation, water resource planning and development programs, or usual river and basin operating requirements. Nor is it possible to collect all the data needed by manual means. It can be concluded that a manually operated network partially satisfies only part of the water users. All users need more frequent and detailed information.

How do we satisfy the data needs of these groups? The technical approach is using electronic telemetry. The administrative requirements are more difficult. There are always administrative obstacles. These include basic legislative authority, budgets and availability of funds, cooperative working arrangements, duplication of effort, and special interest groups. Restrictive permits and exclusion of activities and installation in primitive and wilderness National Forest areas add to the problem of data collection in the West.

An ideal telemetry system would account for total precipitation, distribution, and depletions on a "real time" basis for the total water-producing areas and their subwatersheds. Also, knowledge is needed to predict these same factors accurately for a future period. A scientist must prescribe the parameters to be collected, the frequency of sampling, and the distribution of stations or areal coverage before telemetry systems are designed and installed. The legislative authority and administrative policy must be compatible to achieve the overall objective.

We can only guess what data collection technique will be used 10, 30, or 50 years from now. Will all atmospheric and land data be collected by one agency and stored in one massive data bank or will collection be segmented? Will land stations be used or will satellites scan the earth surface and the atmosphere and transmit data to computer centers? Will there be a combination of these techniques or new techniques not now known? Technical ability is already available to accomplish much. Economic feasibility, practicability, total costs, fragmentation of legislative and administrative authority, and lack of national and international objectives govern to a large extent the kind and volume of basic data which will be collected as time goes on.

Getting back to the present condition of activities, planning, research, and operations agencies in water resources each need basic data to carry out their legislative and administrative responsibilities. The same basic hydrologic and climatic data may be used by a number of agencies. The composition, analysis, and application of these data generally are different.

Considering that basic data are needed now, how should they be obtained? Should the agencies wait until further research, development, and tests have been made using satellites or until research finds a new approach? Will these approaches be too costly compared to alternatives? Should an attempt be made to have one agency collect and analyze all basic data? Will radio frequencies be available to handle all needed installations?

Enough prototype equipment and operating experience are already available to give partial answers to these questions. There is little question that telemetry can be used to meet at least part of the added data needs. For example, when dealing with the origin, amount, distribution, quality, and use of water resources in a given area or region, a definite approach can be taken to collect information needed for specific purposes. If the purpose and specific data needs are stated, a data collection system can be designed and operated as required. For instance, just what do we want a high elevation mountain telemetry system to do? Stated simply--to tell what's happening at the data site. The system should be as simple as possible and provide no more information than is needed and can be used. Usually six- or eight-channel capability from each data site provides all the information needed for water supply forecast purposes using present forecast procedures. Special study or purpose sites may require more.

The electronic telemetry system should obtain and record information automatically on a preset time interval. The recorded information should be in such form that it can be processed by ADP techniques and retrieved from storage. The big problem is to obtain, at a reasonable cost, hardware that is completely reliable and that operates unattended for nine months or longer at high-elevation data sites. This problem can be handled.

The Soil Conservation Service has been developing sensoring devices and operating various kinds of electronic telemetry equipment for several years. This experience is being put to good use in planning future installations and expansion of its basic snow course network. Experience already gained indicates some approaches which will prove to be troublesome. The invitation-to-bid procedures used by Federal agencies usually mean that different contractors and equipment are used if a network is installed in segments over a period of years. Thus, compatability of equipment and components may be difficult or impractical to obtain. Different modes of transmission and readout are also inherent with this approach.

Selecting a repeater site is very important not only from a transmission standpoint but also from the standpoint of its accessibility in winter. Iceloads on antenna, extremely cold temperatures, and malfunctioning equipment can be everyday problems. A positive maintenance plan is a must. Modular construction of equipment is desirable since winter field repair at repeater and data sites generally cannot be done. The ability to field test and exchange individual components such as the receiver, transmitter, or power supply greatly eases the maintenance problem.

Developing specifications and issuing invitations to bid, can be simplified by stating performance requirements rather than setting detailed specifications for parts and components. The degree of accuracy, reliability and type of readout, number of channels, length of service without attention, and compatibility with existing network equipment are the kinds of performance requirements that can be specified.

Based on comparative costs, simplicity of operations, and flexibility and ease of receiving and processing data, it appears that the land system approach is now preferable for collecting mountain hydrologic data--at least until it has been demonstrated that there is a simpler and more economical approach. Using land base stations, repeaters, and data site stations is a relatively economical and practical approach for obtaining information by electronic telemetry. In measuring data at mountain sites, a practical and intermediate step in going from manual to telemetry measurement is installing "onsite" continuous recorders. These relatively inexpensive installations serve a number of purposes. The continuous record of parameters provides a basis for post-analysis of forecast estimates, relative weighting of the data site with respect to other data sites, and refining site selection for installing telemetry equipment. A disadvantage is the necessity of manually processing and analyzing chart data. The questions "how many stations?" and "how much data?" can be answered from analysis and results of data collected from initial segments of a network operated for specific purposes.

It follows that the electronic telemetry network will grow along with specific needs and funds available. It also follows that as data collection methods are perfected, systems will be upgraded to take advantage of improvements.

The Bureau of the Budget is holding a tight ceiling on expenditure of funds and personnel. Highest priorities for funds and people are going to new agencies and departments administering programs for civil rights, health, education, welfare, housing, environment, and pollution control. Thus, the past few years have been lean ones in trying to upgrade and expand the high-mountain data-collection program. This trend is likely to continue. This means that greater effort will be required and different approaches will have to be tried if we expect to keep pace with technology and demand for more precise mountain hydrologic data.