PROBLEMS IN EVALUATING THE EFFECTS OF UPSTREAM TREATMENT

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(Transcribed from Wire Recorder)

I'd like to ask you gentlemen a question. You think of a watershed in your own home area, more than fifty square miles in area and less than a thousand, can you make a guess in your own mind how much sediment you think that could be kept on the ground or out of the stream channels as a result of a complete land management program on this watershed in your own area? This distinguished group does not include all the experts in this field, but it includes a good many of them. If anybody should have an answer to this question, there should be people in this room who could answer it. I imagine that if we were to tabulate our guesses with regard to watersheds with which we ourselves personally are acquainted, we would have wide divergence of opinion.

Let's go on and ask another question. Imagine a similar watershed, and let me ask what reduction in the annual flood you could obtain through a complete land management program? That ought to be easier, and I think that again, we would find considerable difference of opinion. If you have in the upstream watershed treatment a series of reservoirs, the computation of the effect of those reservoirs on, let us say, water stages downstream in the main channel, can be made by hydrologic procedures which are well known and well accepted. We would have no disagreement on choosing, for example, a value of X in the McCarthy flood routing formula. We could agree undoubtedly as to what value of Manning's N you would need to use in the computation of flow through any particular section. And we can make an estimate of the

stage in this section downstream, in this reach, if we have reasonable information obtained by ordinary engineering survey methods.

So, therefore, we are faced not with problems having to do with engineering estimates of the effect of reservoirs (except on sediment), but rather our problems lie in the field of trying to evaluate the effect of land management measures. That, gentlemen, is the basis actually for a great many of these controversies which exist in the field of flood control today.

We have some large progress visualized for major river basins in the United States. The Missouri Basin program alone, to say nothing of the program of the Corps of Engineers and Bureau of Reclamation, the upstream program which is visualized in the agriculture report on the Missouri Basin runs in the order of not millions, but in the order of billions. And we are not yet sure what this kind of a program is going to cost. The effects, gentlemen, of this money depends on the answer to such questions which we, as experts, supposedly, cannot give unequivical answers.

Now what is the reason for the situation which exists in the field today? We do not have very much information on this vital question which can be extrapolated to areas of this size. If you were to list the kind of information which we have available from relatively small plots and watersheds we have plenty. As a matter of fact, you could call within very small orders of magnitude, with very small chances of error let's say, you could forecast the result of changing the treatment on a small plot under certain kinds of conditions. But when you are having to extrapolate the results of plot experiments to visualize what is going to happen to a larger watershed, and I don't mean watersheds of great size, I'm restricting myself right now to watersheds of the type which are now being treated in the present

upstream Hope-Anderson program, we would have a very difficult time saying exactly what the answers are. It becomes easier when you increase the magnitude of the flood. The difficult problem is to decide what effect we can have on the annual flood. When you talk about a flood of really great proportion, such as the Kansas River flood of 1951, I think that the answers would come closer and closer together, those answers which we as individuals would put forth. We know that the effect diminishes with the size of flood.

What kinds of evidence do we have to answer questions of this kind? How many plots? How many watersheds? And of what sizes? We have in the Federal program of watershed investigations having to do with the effect of land treatment on runoff and erosion, plots numbering about 1,700 in the United States. Watersheds number about 560. The median size of these watersheds, gentlemen, is 2.5 acres, 2.5 acres is practically too small to put a farm operation on. More than that, the size distribution when you look at it in terms of a distribution graph is not too bad. Twenty per cent of the experimental watersheds from which our basic data are derived on this subject are larger than a hundred acres. That sounds pretty good, but very few of them of really larger magnitude have had enough of a complete program installed on them that we can actually get any kind of measurements which approximate what you would get under real conditions where you were trying to apply upstream treatment measures for the purpose of erosion reduction, flood reduction and, as the Soil Conservation Service says, water flow retardation.

What kind of instrumentation do we have on these experimental watersheds? Of recording rain gages, we have 1,042 over the period of experimentation. Standard rain gages, 987; a lot of records, gentlemen. Runoff

gages, 2,160; and what kinds of total record have we gotten from them? These, remember, are on the experimental watersheds in the Federal program. The station years of record from recording rain gages alone total over 11,000 station years. The standard rain gage records total over 12,000 station years, and the runoff records 18,000 station years. But where are the records? And this is one of the sad parts. And this is the thing that we are really faced with as engineers and administrators today. Only 30 per cent of the recording rain gage records have been tabulated by rain intensities. Until they're tabulated in rain intensities they are really simply masses of figures in the files, they are essentially unusable. Only 40 per cent of the runoff records collected from these experimental watersheds have even been tabulated by storms.

Therefore, we have before us an engineering job of considerable magnitude even to bring up-to-date the kinds of research information which we have already collected on small plots and watersheds to say nothing of watersheds and plots of such size that we can really extrapolate them into sizes of the kind with which we are actually going to have to deal.

We are faced in the problem of watershed research, with the kind of dilemma which has not yet been resolved. It is one of the kinds of problems on the basic nature which we as administrators, engineers and scientists have to face up to. The dilemma can be expressed in this form: If we say to Congress, "We need money to put our programs on the ground, we have not yet had enough money to really take an upstream program and treat an area and find out what goes on". At the same time we have to say to them, "We don't know what the effect of the upstream program is going to be". So we're trying to get money on one side by saying all we need to do is put it on the

ground because we know it's going to have a fine effect, on the other hand we cannot actually in detail demonstrate even to ourselves, to say nothing to report, which is going to be readable by congressmen exactly what this upstream program is really going to do in terms of flood reduction and sediment reduction. And that actually is the kind of decision which has been faced, I think, not too well by the administrators of some of our conservation organizations in their appeals to Congress where you have for example the head of a research part of an organization saying in a congressional hearing, "We really know enough now, we only have certain areas with which we have to explore, we really can start closing our research". The head of the organization will go to Congress and say, "Give us the money and we will do the job".

Now, what kinds of difficulties plague us in doing the job as we know it must be done. We have talked for years, and I don't think there is any man in this room who has not at one time expressed a view that we are short on the kind of basic data that we need for the evaluation of many kinds of programs, not only the effect of upstream programs, but it's come up again and again in the discussions that we have heard in this conference. The Colonel spoke about our inability to relate the stage of the lake to damages. So there is a whole problem, not only in the lakes which we have heard about, but in the flood control field of attempts to really relate the hydrologic and the economic aspects together. There is a great deal for research there.

But now, let's look merely at the engineering aspects of the problem. You can divide the kinds of experimentation with which we deal into essentially two kinds. There is a hydro-metric approach and a hydro-physical approach. The hydro-metric approach is the one which we ordinarily use where you have a pair of parallel plots, one of which is going to be

treated and another is going to remain as an untreated control and you actually then have specified, under constant conditions, a particular change, the results of which you are attempting to measure. The hydro-physical approach on the other hand is an attempt to analyze what happens to water under particular circumstances. In other words, you take out a certain part of the hydrologic cycle and infer what might be the effect of that change on the result that you are looking for. For example, you know when you have a timbered area you're going to lose a certain amount of water by interception. Therefore, you measure interception, you don't measure the effect of treated versus untreated, you simply measure interception and simply say the interception varies with the density and the stand of the timber in such and such a manner, therefore, if we improve the timber we are going to lose so much water by interception. That is the kind of approach which the word "hydro-physical" implies. The hydro-metric approach is a difficult one. On the other hand, it gives definitive answers. The hydro-physical one is very much more flexible. But you always are still making certain kinds of extrapolations. How are we doing with respect to trying to solve this problem at the present time, now that we have convinced ourselves and convinced the public that upstream programs can do something and we all intuitively know they can do something? How do we stand? Let's look at the sixty-five pilot plot watersheds. The Congress was quite clear in what they wanted done when they authorized the treatment of these sixty-five watersheds. They said this, Congressman Hope, who introduced the bill, made this statement in testifying for his bill. "One of the very important benefits to be derived from these projects will be the opportunity they will afford to study scientifically the actual affect of runoff, erosion, sedimentation and evaporation which will result from such watershed treatment". And he

goes on to say that as a part of this program they are going to instrument these watersheds in an attempt to make measurements - attempt to evaluate the program. And what kind of evaluations are we making? Again we are on the horns of a dilemma. Did we inform Congress that you can't do research in a five year appropriation? Was Congress made acquainted with the fact that the hydro-metric approach requires, for adequate work, that you have some sort of control, control in time, a precalibration period, a parallel control? As a matter of fact, the Department of Agriculture has interpreted this legislation to mean that they can not use the money from the Hope-Anderson program to instrument untreated watersheds immediately parallel to the treated ones. Well, gentlemen, from the standpoint of attempting to do research, this is a grave restriction. And so we stand at the present time, with $5,000,000 per year, which must be spent over a period of five years to do a job which we have been talking about for twenty and we know that over the period of twenty years, we have been constantly plagued with lack of continuity, lack of adequate control, lack of adequate funds. And yet we find ourselves, in the legislation that everybody was hoping would get us what we wanted, with the same kind of problems which have plagued us for the past twenty years. As a matter of fact, at the present time you can consider that the sixty-five watersheds are essentially <u>not</u> evaluation programs. They are, in fact, merely a collection of certain kinds of basic data which have limited usefulness. And I say that with considerable care, because all of us are truly interested to the extent that we believe that the watershed program can be proven to be economically justified. And yet the thing that we are looking for, the actual evidence is missing. Take what Doctor Herbert said, early this morning. He listed a series of things which tend to indicate a direction of the kind of effects which an upstream program

might effect in Michigan. But he didn't give us a whole list of data, saying what we have proven by these experiments. We can't do that, gentlemen, we just don't have that kind of experimentation available. So we are faced at the present time with these deficiencies in the Hope-Anderson program for purposes of evaluation:

In the first place, the period is too short. The appropriation splits up money for only five years.

In the second place, we do not have any opportunity for a prior calibration period which we, as scientists, know is necessary if you are going to make real evaluations.

Third, we are prevented from having adequate parallel control.

And fourthly, we lack the means for making separate evaluations of the engineering aspects of these treatment programs from the land management ones.

And if we can't differentiate the two, except by a series of computations, again we are in considerable trouble. So what we do actually is we attempt to rationalize this dilemma and it turns out that out of the fifty-nine watersheds, which are now being treated, only seven will be completely instrumented. Was this what the congressman expected? I don't believe so. It's the best we can do with a rather bad situation.

Now where do we go from here? I think that this is the kind of thing that people who are interested enough to come to this kind of a conference might well do some serious thinking about. Research with Federal funds alone has not provided us with the kinds of data which we desire. It seems that one of the things we have not yet tried in sufficient detail is to get some sort of cooperative program with the states which would provide funds which last over a sufficient length of time and have the necessary

flexibility to get some answers to some of the questions that we know we must answer in programs of this magnitude. We need, more than that, to admit that there is a lack of knowledge. We should go to our legislatures and to the Congress and say, "Look, we cannot answer these questions, and the only way we can answer them is to get enough money to treat an area and then to get some measurements on that treated area." In other words, you can go out and you can change the land use of one acre on the university experimental farm, but what is necessary is to treat a 100 square mile watershed, owned by a large number of people, and that takes money. But why should we dodge this question? Why should we not admit that we simply don't know? Why could we not use this as an argument to try to persuade our legislatures and our Congress that in order to get the answers we must have the money to make the treatment on a large enough watershed? It seems to me that our philosophy in approaching our research problem leaves much to be desired. And furthermore, it seems to me, that among scientists at least we have reached the point where we need no longer merely to carry the torch about the necessity for upstream work, but it is time we sit down with our associates in all the various fields and sharpen our tools in order that we may answer some of the questions which now plague us in this field.