

# Planning for watershed development

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PLANNING is a process for deciding what to do and how to do it. It is particularly important in connection with watershed improvement. The problems of a watershed area are usually so tangled and so complex it is hard to know where to begin. Moreover, it is often the case that the solution of problems that seem obvious on first study may turn out to depend upon the solution of more fundamental problems when more careful investigations are made. It is not uncommon, for example, for a catchment area to present a need for terracing as a means of controlling surface flows of water, but for the terracing to be impossible until some means is found for rationalizing a highly fragmented pattern of land ownership. Similarly there are areas where the need for afforestation is obvious but where it is not possible for afforestation to succeed until some changes are made in customary grazing rights on the land.

It is also usually the case that one aspect of the development of a catchment area will depend on what is to be done elsewhere. The silt storage capacity to be designed into reservoirs will depend in part on the action to be taken to control erosion on the lands of the catchment area. Plans for the control of grazing are usually dependent upon the development of some alternative source of forage for the grazing animals. All of these aspects of watershed improvement are related and careful planning is necessary if the work is to lead to a successful result.

While watershed improvement work can produce spectacular results, it requires both money and time and, if these are not to be wasted, careful attention must be given to the planning of each project. It is tragic when 10 or 15 years' time is wasted because efforts have been made to produce a forest cover on lands not suited to the purpose; it is equally wasteful of resources when engineering structures are built, only to silt up quickly because not enough attention was given to erosion control work above them. It is doubly wasteful when time and money is put into land improvement works which are allowed to fall into decay because no plans were made for their maintenance. The costs of careful planning of watershed improvement programs is small in comparison with the great investments that must often be made from both public and private sources. Particularly in countries where investment capital is in very short supply it should not be wasted as a result of a lack of careful planning of projects.

Plans for watershed management have two purposes. They are first of all a means for obtaining approval for funds to be spent and work to be done. There is never enough money nor enough time for all of the work of improvement and choices must be made as between projects. These choices are best made through a comparison of the plans for the alternate projects. It is difficult to decide whether investments should be made in the improvement of one catchment or another without knowing what each project is likely to cost and what the results are going to be. This knowledge comes out of project plans and the better the planning which is done, the more reliable will be the information on costs and results. Moreover, the better the project planning,

the more confident will administrators be that the expenditures proposed will actually give the forecasted results. In most governments the process of approval for a project of work such as watershed improvement tends to be long and to involve the decisions of numerous people. A carefully prepared report on the project plan is a convenient device for simplifying and speeding the process of administrative approval.

A second purpose for a watershed project plan is to guide the work to be done. This is particularly important because most watersheds require a variety of kinds of action to be taken by many people, both private persons and officials of the government. Moreover it is often the case that responsibility for the work to be done by the government is divided among several bureaus or organizations. For example, there may be work for the Extension Service in advising farmers on cropping systems for arable land that will minimize soil erosion, the Forest Service may have afforestation work and fire protection facilities to build, an engineering service may be involved in the construction of dams. An agreed-on plan for the whole program of watershed improvement makes possible the necessary co-ordination among bureaus. It also serves as a means for making clear what can be done by the Government and what must be done by the private land users. A carefully prepared plan will also indicate the timetable for development, showing for example that certain land treatment measures for controlling erosion are to be installed before particular flood retarding reservoirs are built, thus precluding the possibility that the reservoirs may be quickly filled with soil materials washed from the uplands by destructive surface flows. The plan can also indicate the timing for developments that affect farmers' incomes so that to the extent possible the measures taken first will produce increases in income, thus making it easier for individuals to finance later parts of the necessary work.

### **Organization for watershed planning**

A bureau or department responsible for watershed improvement needs a subordinate organization for watershed planning. The nature of such an organization will, of course, depend upon many things. It will depend, for example, upon the scope of the watershed work to be undertaken. Also it will depend upon the nature of the program responsibilities of the government bureau. A watershed improvement program of a Forest Service with responsibility in public forest areas will be different from that of an organization to deal with the mixture of problems found in catchment areas where all kinds of land uses and private as well as public lands are found. Similarly, the planning needs and the organizations for project planning will be different.

There are, however, some general principles which are useful guides for the organization of watershed improvement planning groups, regardless of either the size of the project, or the nature of the technical problems involved. In the first place the planning organization needs to be an integral part of the organization responsible for taking the action. The planning group, if it is organizationally separate from any body responsible for actually making the planned improvements will find its plans being ignored rather than being acted upon, and the action organization on the other hand will probably find it difficult to make use of the plans made by the independent planning group because of the apparent lack of attention to the practical problems of getting the work done. Planning and action must go hand in hand. There should be, of course, some degree of specialization. Not every member of the staff should be involved both

in project planning and in project operations. The most satisfactory solution is usually found in having a relatively small planning team located in the operating organization where there is an easy communication between the planners and the project operations staff.

A second principle for guiding the structuring of a watershed planning organization is that the planning staff should include experts whose fields of interests cover all the aspects of watershed improvement that are involved in the areas under study. For example, a planning team for watershed improvement in the public forest may need to include only a hydrologist, forester and forest engineer. On the other hand a planning body required to deal with problems of arable and grazing lands as well as the forest, and with private land ownership as well as public lands, will need the skills of other kinds of experts. Such a planning body should have technical competence in grassland management, and in agronomy and in addition should have experts with training and experience in the economics of farm organization and in land tenure, and in other institutional arrangements under which rural people live and produce their incomes.

It will most usually be found that the most satisfactory planning organization personnel are those who have had some practical field experience in action-type programs and have supplemented this with special training in their technical fields. Both practical experience and advanced training are important.

For some special types of watershed improvement work the necessary project planning should be done by the staff set up to operate the project. This is particularly true for research work and for pilot schemes. In these cases the size of the total program is usually so small as to not justify a separate project planning organization. Moreover, in research watersheds and in pilot area projects, the special considerations of data collection and analysis and the intimate relations between the plans for the work and the results to be evaluated are such as to suggest that the necessary project planning should be entrusted to the project staff directly rather than to a separate planning organization.

### **Types of watershed plans**

It should not be necessary to go into any detailed discussion of engineering design as related to watershed improvement. The detailed design of structures for retaining water, for controlling erosion and for related purposes is adequately covered in many standard engineering texts. It is important, however, to note that equally detailed attention is justified to non-engineering aspects of watershed improvement projects. The careful detailed planning (design) of a program of afforestation for a particular watershed, or of an educational campaign to get land users to adopt erosion-retarding methods of crop cultivation is essential. Money and time are usually the most scarce resources in watershed improvement and these can be economized through carefully made designs, or work plans for each aspect of the improvement program. In engineering work a great deal of the time of highly skilled persons is devoted to careful planning of what is to be done. The same policy should be adopted for other features of watershed improvement work.

It is not easy to draw a line between planning and design, but some differentiation is useful. In the main, planning relates to the making of a decision as to what should be done, and designing is related to deciding how to do it. In engineering terms, design is usually understood to relate to

the detailed planning of structures as a guide for those who will construct them. The same could be extended to other aspects of a watershed improvement program, with the term " design " used to mean the planning of detailed features of the operating program. However, it is more common to use the term " work plan " in connection with aspects of water shed work other than structural designs. This term will be used in this way in the report.

There are many kinds of watershed plans, each having a special purpose. In general, the purpose which the plan is to serve determines the nature of the plan. For some purposes reconnaissance planning is quite sufficient, and for other purposes extremely detailed planning is required. Also, for some purpose the planning may relate to a single technical aspect of the development of a watershed while for other purposes it is necessary to have a comprehensive and integrated plan covering all the many aspects of a catchment's development.

### *River basin planning*

Watershed improvement and management is one of the important aspects of comprehensive river basin planning. Together with plans for the construction of main-river facilities for generation of electric power, storage of irrigation and flood waters, or to improve navigation, attention is needed on the plans for work needed on the watershed itself. In many parts of the world, to ignore the watershed is to invite disaster. Particularly in those areas where the soils are highly erosive, failure to plan for the control of erosion may result in the siltation of costly reservoirs long before the end of their planned economic life. It is unfortunately true that watershed planning is most often neglected in comprehensive river basin planning, or at most receives all too little attention. This is sometimes the case because the river channel structures are looked on as having a direct effect upon some major economic problem. They either provide an economic good such as electric power, or transportation, or irrigation water, or they minimize an economic loss such as flood damages. Watershed improvement, on the other hand, is often seen as being related only to the protection of the reservoirs themselves. In some cases it is possible to design into the reservoirs sufficient capacity for the storage of soil materials as to assure their useful life for a long period.

It is most often overlooked that the very work which is usually most necessary on the watershed for the protection of reservoirs is also of a nature which has a direct economic contribution to make. Practical soil conservation work is most often a form of improved land management which results in improving the productivity and usually the income from the land. In forests, in grazed areas and on arable lands this is found to be the case. The great possibilities for controlling erosion, and thus providing protection for reservoirs, is through getting private land users to adopt land management techniques which increase their incomes and, while doing so, preserve the soil resources in place, thus both sustaining the production of income and preserving the life of reservoirs. There are, of course, great areas in the world where the control of soil erosion is beyond the means of individual private land users, in these areas, to the extent they are in river basins where storage reservoirs are being planned and require that the designers of the dams and reservoirs include in their plans and cost estimates the necessary land treatment measures that must be undertaken at public expense.

As a minimum, the report of a comprehensive plan for a river basin area should have a special section on watershed improvement and management. Such a section should include a classification of the tributary catchments according to the nature and seriousness of the watershed conditions. It would be well for such a classification to be made from two points of view, from that of providing protection for structures to be built in the river channel, and from the point of view of increasing the economic welfare of the people on the land of the area. In the first instance the classification would highlight those areas where soil erosion control is most necessary in order to maintain the useful life of specific structures. A classification from the second point of view would highlight the areas where improved land management would make the greatest income contribution. A combining of both classifications would suggest the areas where the necessary reservoir protection could be expected to come from improved land management by private land users. It should also delineate the critical areas where public subsidy for land use improvements is needed in order to provide the needed reservoir protection.

The watershed improvement section of a river basin plan should also outline the various programs needed to get the necessary degree of land use improvement. It should cover afforestation, the management of grazing, and the use of arable lands. It should discuss necessary reforms in land tenure, desirable changes in legislation or government policy, adjustments needed in the organization of the Government's work, and should suggest lines for strengthening educational work among land users and other facilities of the Government such as agricultural credit and subsidy programs for aiding in improving the use of watershed lands.

#### *Watershed area work plans*

For purposes of this paper a watershed area work plan can be defined as one covering a catchment area which is to be the scene of a program of work. There is no useful measure of the size of such a watershed area. It can only be usefully defined as the area covered by a project work plan. In some cases where a very large project is envisaged the area may be several thousand hectares, in other cases it may be a watershed of very few hectares, perhaps only a half dozen farms. In any event, the significant feature of the area is that it is the subject of comprehensive planning, with the aim of indicating all of the various things to be done to achieve an improvement in the behavior of the stream that drains the area.

Because they are to serve as a basis for the developmental work, watershed area plans must be detailed and precise. They should indicate, by means of maps, tables, charts and text, exactly what is to be done, where it is to be done, by whom, how and when. This is discussed in some detail later in this article.

An important part of the planning report is the section on estimated costs. One purpose of the planning operation is to develop reliable estimates of the costs of the proposed work. In the course of the planning work various schemes may be planned and costed before one is selected as being most desirable from the point of view of technical feasibility and also relative costs. The reported cost estimates are useful in guiding decisions as to whether the planned work should be approved, and also in planning the financing of the scheme as between the Government and the land users most directly benefited.

### *Community development plans*

Watershed improvement work is usually difficult because people live in the watershed area. It is not very difficult to plan and take action on the problems of a forested watershed where the land is all owned and controlled by the state and private persons neither live there nor have any rights to the use of the land. On the other hand, when private persons have rights to the use of watershed lands, their private interests as well as the public interest must always be taken into account. A most effective way of dealing with such problems is through community development schemes. Here the primary social groupings of people, the village or neighborhood, is used as the basis for some system of social or political organization. The objective of such work is to promote self-help on problems of land and water use and on other problems related to these. It is not often that the boundaries of a watershed coincide with that of a rural community grouping of people and thus the area for watershed planning and the area for community development planning are most often different. It is usually the case, however, that watershed areas selected for improvement projects cover the area of several rural communities, villages, or neighborhoods and thus there is often a possibility of encouraging the development of community improvement plans as a means for promoting land use and related improvements in a part of a catchment project area.

The planning of community development is primarily a means for organizing the action of private persons to make their contributions to the improvement of their community and the larger watershed area. The plan itself most often emphasises action on local problems, both community problems and individual farm problems. For example, a community improvement plan may include provisions for work on road improvement and on crop yield improvement. The road work may be planned as a co-operative undertaking in which every family provides labor or equipment. The crop improvement work may be strictly a matter for individual action.

Such community improvement work carried on as part of a watershed development project would of course place relatively heavy stress upon land use changes with desirable hydrologic consequences. These would include afforestation of privately-owned woodlands, control of grazing and fire in private or village forests, terracing and related water disposal systems, gully stabilization and other types of erosion control, improvement of vegetative cover on pastures, and other changes in land use that would have the effect of reducing soil losses and surface runoff.

### *Farm plans*

On privately held arable lands, and to some extent on grazing and forested lands as well, the basic element in the structure of planning for watershed improvement is the farm plan. Every land user has some sort of plan. Most often it is not written down, and usually it is not even thought of as being a " plan " or as being related to the operations of a whole farm. Most often it is only a collection of habits and customs which result in a pattern of decisions made by the farmer. Haphazard as it may be, however, this pattern of decision making determines how the land will be used. The problem of the watershed improvement technician is thus to develop some means for influencing this farm planning.

It is essential that watershed improvement work be built up from improvements in individual farm plans. The hydrologic behavior of a great watershed is in large part the result of the day-to-day actions of the hundreds or thousands of men who use the watershed's land for growing crops, grazing of animals, or production of wood. Changes in watershed conditions most often means changes in the operations of individual farms and this means changing the operating plans of these farmers.

These changes must be planned against the background of the economic and social objectives of the farmers. It is futile to suggest that a farmer adopt some soil and water conserving practice that will result in a lower income for his family. Similarly, realistic plans for watershed improvement must take account of the social standards and preferences of people. Values attached by people to land and water resources strongly influence the care given these resources. Similarly, values attached to animals often influence the extent of grazing.

The farm plans that are required for watershed improvement must be " whole-farm " plans. They must be related to land use and also to many other aspects of the operations of farms and the lives of farm families. Improvement of grazing land through reducing the number of grazing animals involves planning also for means at least to maintain the production of meat, milk, fibre or animal power. This may mean developing alternate sources of animal feed, or improving the quality of the grazing animals and these, if they are to be accomplished, must be planned in a workable manner. Similarly, a plan to improve the vegetative growth on grasslands by fertilizer use, and thus control surface runoff and erosion, raises the problem of some means for converting the grass into income to pay for the fertilizers required. Here again, planning of animal production enterprises becomes important. In any planning of changes in land use on farms, the proposed change must be thought through to the end of its effect upon the operation of the whole farm. This process of " thinking through " is what is meant by whole-farm planning.

### *Problem spot plans*

These are really parts of the work plans for watershed programs. They relate to the more critical areas in a watershed from the point of view of runoff and erosion and for the most part they cover the actions to be taken by the public agency concerned with watershed improvement. These may be extremely badly gullied areas where the necessary land use improvement is beyond the means either of individual land users, or of private persons co-operating in a village improvement scheme. The plans for such areas are usually concerned with engineering devices for soil stabilization plus such improvements in vegetative cover as afforestation or grass seeding. The plans for these areas often do not provide for any use of the area for a period of some years as their hydrologic improvement is so -important from the point of view of the entire catchment area that their rapid healing is more necessary than their use for such purposes as grazing, crop production, or wood production.

A most important aspect of problem spot planning is economic analysis. The remedial work on such areas is always expensive and great care must be taken to minimize the costs of the work. Where there is unemployed labor, work in such areas can often be planned as a contribution to the public welfare through providing employment. Still it is usually the case that great care must be taken not to " overinvest " in the improvement of these critical spots. In some cases, time can

be substituted for costly structures, and provisions for eliminating the cause of the difficulty, as for example, excessive numbers of grazing animals may in time give the desired results.

### **Data requirements for catchment area planning**

The kinds and amounts of data that are necessary for planning watershed improvement projects will depend in part upon the nature and purposes of the project. The special requirements of research work in small watersheds is discussed in another section. Where the scheme being planned is primarily a demonstration activity it may be necessary to collect somewhat more detailed information on the initial situation than would be required for a general project of watershed improvement. For this latter purpose the planning data needs seem to fall into the following categories:

1. meteorological information
2. hydrologic information
3. soils and land use data
4. economic and social information.

Enough information of these types must be collected so as to provide a basis for making an assessment of the present situation, developing a plan for correcting the existent watershed problems, preparing a forecast of the probable effects of the proposed works, and making some reliable estimates of the costs of the project.

#### *Meteorological information*

Emphasis should be placed on the collection of data on precipitation. This should include measurements of annual precipitation, its seasonal distribution, and the characteristic of typical storms such as duration, intensity of rainfall and the frequency of storms delivering various amounts of water. Information on temperature conditions is particularly useful where storm rainfall or runoff is associated with freezing temperatures.

#### *Hydrologic information*

Enough information on stream flow conditions must be collected so as to be able to construct hydrographs for storms of the size for which protection is to be planned. As a minimum there should be observations or estimates of rates of flow under a wide variety of storm conditions and for periods following storms. In addition, it is important that estimates be developed of the sediment load of the stream in question. Adequate information must be acquired to permit careful designing of structures particularly to provide adequate flood storage capacity for the " design storm ", to provide sufficient spillway capacity to assure the safety of each structure and to provide adequate silt storage so that each structure has an economically useful length of life.

#### *Soils and land use data*

A detailed soil survey is an essential for adequate planning of a small watershed project. The information which such a survey will provide will not only serve as a basis for assessing the



present situation, but is basic for planning land improvement activities such as afforestation, grass regeneration, terracing and other means for controlling surface runoff and Boil losses. A detailed soil survey provides most of the information for a determination of the erosion situation and the delineation of major silt producing areas. The information on soil types is essential in choosing species of grass or trees for planting on particular sites and such information is also useful in forecasting the possible changes in infiltration rates as a result of changes in vegetative cover conditions.

For purposes of planning and evaluating watershed improvement, a special type of land use classification is needed. This may best be described as a hydrologic efficiency classification and should be based on both soil characteristics and vegetative cover. The purpose of such a classification is to provide a means for estimating the hydrologic behavior of a watershed. On the basis of a set of site classifications an index for the entire watershed can be computed and this in turn can be correlated, through adjustment of the weighting values used, with data from the stream hydrograph. The correlated index will thus serve as a measure of the expected effects of land use changes on stream behavior. Progress in improvement of the watershed can also be measured by periodic re-surveys of soil, cover conditions in the watershed and recomputation of the watershed index<sup>2</sup>.

<sup>2</sup> See SEIGWORTH, K. J. and OLSON, E. F., " Infiltration changes resulting from forest protection and management ", *Journal of Soil and Water Conservation*, Vol. 12, No. 6, November, 1957. A system of this type is described as used by the Tennessee Valley Authority in the United States of America.

**TABLE 1. - A MODEL FOR A CLASSIFICATION OF LAND ACCORDING TO HYDROLOGIC EFFICIENCY**

Soil group Land cover group  
                   1                  2 3 4

| Soil group | Land cover group                                                                                                 |                                                                                                                                                                                                                       |                                                                                                                                                                                      |                                                                           |
|------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
|            | 1                                                                                                                | 2                                                                                                                                                                                                                     | 3                                                                                                                                                                                    | 4                                                                         |
| A          | Highly permeable soils of great depth covered with dense forest or tight sod of tall grasses<br><i>Index 100</i> | Highly permeable soils of great depth covered with medium to light forest with some surface litter, grasslands with unbroken sod of short grasses, cropland with solid cover of growing vegetation<br><i>Index 80</i> | Highly permeable soils of great depth of great depth covered with mutilated forest, overgrazed grasslands and crop lands with partial cover of growing vegetation<br><i>Index 40</i> | Highly permeable soil of great depth, essentially bare<br><i>Index 30</i> |
| B          | Fairly permeable soils, deep to medium in depth covered with dense forest or tight sod                           | Fairly permeable soils, deep to medium in depth covered with medium to light forest with some surface litter, grasslands                                                                                              | Fairly permeable soils, deep to medium in depth covered with mutilated forest overgrazed grasslands                                                                                  | Fairly permeable soils, deep to medium in depth, essentially bare         |

|   |                                                                                                                                          |                                                                                                                                                                                                                                               |                                                                                                                                                                                             |                                                                                                   |
|---|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
|   | of tall grasses<br><i>Index 80</i>                                                                                                       | with unbroken sod of short grasses, cropland with solid cover of growing vegetation<br><i>Index 60</i>                                                                                                                                        | and crop lands with partial cover of growing vegetation<br><i>Index 30</i>                                                                                                                  | <i>Index 20</i>                                                                                   |
| C | Soils of limited permeability and fairly shallow soils covered with dense forest or tight sod of tall grasses<br><i>Index 60</i>         | Soils of limited permeability and fairly shallow soils, covered with medium to light forest with some surface litter, grasslands with unbroken sod of short grasses, cropland with solid cover of growing vegetation<br><i>Index 40</i>       | Soils of limited permeability and fairly shallow soils covered with mutilated forest, overgrazed grasslands and cropland with solid cover of growing vegetation<br><i>Index 20</i>          | Soils of limited permeability and fairly shallow soils, essentially bare<br><i>Index 10</i>       |
| D | Soils highly resistant to infiltration and very shallow soils, covered with dense forest or tight sod of high grasses<br><i>Index 30</i> | Soils highly resistant to infiltration and very shallow soils, covered with medium to light forest with some surface litter, grassland with unbroken sod of short grasses, cropland with solid cover of growing vegetation<br><i>Index 20</i> | Soils highly resistant to infiltration and very shallow soils, covered with mutilated forest, overgrazed grasslands and croplands with solid cover of growing vegetation<br><i>Index 10</i> | Soils highly resistant to infiltration and very shallow soils, essentially bare<br><i>Index 0</i> |

A model of such a classification system is given above. The index numbers used are purely illustrative and appropriate numbers would have to be developed from research and investigations in each area where such a system is to be used.

In adapting the classification system to the needs of a particular area some adjustments will be necessary in the definitions. It should be noted, however, that the essential feature of the system is that it is a two-way classification in which there is allowance for the compensating effects of soils and vegetative cover. A dense vegetation is to some extent a compensation for a soil of limited permeability and, on the other hand, the infiltration characteristics of the soil may offset to some extent the vegetative conditions. It is to be expected, however, that soil characteristics will be relatively unchanged over the life of a watershed improvement project while vegetative conditions may be substantially altered. Therefore, in making periodic reassessments of progress being made, it should be necessary only to collect new information on cover conditions which can be combined with the previously collected information on the soils. It will usually be found desirable to use some kind of reliable statistical sampling for these surveys.

*Economic and social information*

For purposes of watershed project planning a certain amount of economic and social data is essential. Some knowledge of the social structure of the area is important as a basis for planning means for enlisting full local co-operation in the work. In areas where settlement is organized on a village basis no special enquiry may be necessary to define the primary social groupings or to gain understanding of the leadership structure in the communities. On the other hand in areas of open settlement some effort at community delineation and leadership identification may be necessary. Standard sociological research techniques may be used for these purposes.

Considerable attention should also be given to collection of information on the organization of farming enterprises and to the economics of land use, whether for arable farming, grazing or forestry purposes. While it may not be feasible or necessary to make a comprehensive survey of every land holding in a watershed, it is essential to study the operations of a few farms typical of the area as to size and nature of farming. These studies should reveal the pattern of land use, the output of products and the cost and income position of the farm operator. Estimates should be made to reflect the effects on the farm of changes in land use such as would be made through the watershed program. Comparisons, particularly of the income estimates with data on present income situations for typical farms, will give useful indications of the probable attitude of individual farm operators toward making the land use adjustments required on their farms in the interests of watershed improvement.

Similar studies of private forest enterprises and of grazing operations would be equally valuable.

The data requirements for evaluation of the economic feasibility of a watershed improvement scheme will depend upon many things, but particularly upon the policy of the Government so far as such evaluations are concerned. In some countries procedures for such evaluations are prescribed in detail in either the authorizing legislation or in government policy directives. It should be noted that procedures developed for use in countries where there is a wealth of technical help and of technical data may be far too elaborate for use in less well-developed countries. Persons interested in the general problem of project evaluation will be well advised to study the special literature on that subject.

As a minimum for a watershed improvement project there should be a careful estimating of the public costs of the scheme and a description of the estimated effects of the work, both upon the behavior of the water of the catchment and also upon the income situation of persons using the watershed lands.

### **The planning process**

The process for making a watershed plan will vary, depending primarily upon the nature of the watershed development envisaged, and upon the extent to which local interests and local participation are involved. It will be affected also by the structure of the government services responsible for watershed improvement work. If all the technical services involved in watershed development are centered in a single bureau or agency of the government, the process of project planning will be much simpler than if several agencies are each responsible for a part of the work. For example, a department of mountain lands, responsible for all kinds of land development and management in mountain areas will find it easy to make catchment area

improvement plans. When responsibility for such lands is divided among various agencies such as a forest service, soil conservation service, community development service and animal production agency, the process for making integrated plans for development of watershed areas will be quite difficult.

This problem is most easily resolved in the legislative enactments authorizing watershed improvement work. In the law, the planning responsibility can be specified. An organization of government that is to carry on a great deal of watershed improvement work has need for a project planning staff. The size and composition of the planning organization will depend upon the amount of work to be done. Where -a very large program is envisaged, a central staff and field organization are required, but where the number of projects is to be small, a central staff may be in position to handle all the project planning work alone.

In general, the planning work may be divided into two lines of activities. These are preliminary studies, and project plans. In most cases the planning costs of a project are considerable and it is useful to make a reconnaissance, or preliminary study, of an area first, so as to have a basis for a decision as to whether to proceed with detailed planning. The reconnaissance study may be initiated at the request of interested land users, or at the direction of the head of the responsible agency. Usually a few weeks are required to collect some information on the nature and extent of the land use and water control problems and to develop some expert judgments of the feasibility of an improvement program. A very short report, describing the present situation, outlining the improvement program and making a first estimate of the costs of the work is prepared and submitted to the authorities, who can decide whether detailed project planning should be initiated. In some cases this kind of decision can be made by the head of the agency that is responsible for watershed improvement, but sometimes such decisions must be referred either to a ministerial level, or even higher in the case where several ministries are likely to be involved in the improvement work. In some countries the preliminary or reconnaissance report is the basis for public meetings in the catchment area for the purpose of assessing the extent of local interest in the proposed work, the extent of willingness on the part of landowners to make the necessary private investments required for land improvement, and the attitude of local persons toward any necessary control over land uses such as grazing and forest cutting.

The preparation of a detailed development plan for a catchment area may take several months. If no detailed soils survey is available for the area, it should be made. Similarly, engineering surveys of various kinds must be made if appropriate data are not available. For example, rainfall and runoff data must be collected, engineering studies of the stream channel should be made, sites for structures tentatively located and necessary foundation examinations made. Sites for channel improvements should also be located and the nature of these improvements outlined. Similarly, the necessary land use survey should be made, both as a basis for planning the land use changes and to establish a benchmark for measuring future progress of the program.

With all these data in hand, the program of watershed improvement can be worked out. Sufficient design work should be done on the engineering features of the project to permit development of reliable cost estimates. Plans for land use changes should be made in sufficient detail to indicate the specific nature of the adjustments to be made and the procedures and techniques to be used in making the changes. For example, the afforestation plan should specify

the areas to be planted, species to be used, number of trees required, planting dates, site preparation work to be done, provisions to be made for prevention of grazing or burning of plantations, and an estimate of the costs of the work. For land use improvements on privately operated farm lands the plan should specify the nature of the work to be undertaken in each land use class, the actions to be taken by the government agency or agencies, the contributions to be made by private land users, the procedure to be followed in planning the work on individual farms, the nature of agreements to be made between the government and the individual land users, the financial contributions to be made by the government, and a schedule or timetable for the work over the entire catchment area.

When the planning report has been drafted by the field team it should be reviewed by the responsible senior officials of the agency or agencies that will carry out the development program. For watershed areas in which there is any amount of land in private use, the final project plan should reflect the views of responsible local leaders. The implementation of the plan will be made easier if such persons have an opportunity to participate in the project planning. In some cases, considerable effort is usefully devoted to encouraging contributions to project planning by local persons in order to generate a feeling that the project is essentially a local effort and not something being imposed upon by a distant government. For this purpose a local watershed improvement association is often useful. In other cases a local project advisory committee may be used. In still others the informal advice of a few local leaders may be sought.

The process of final approval of watershed development plans should involve some sort of review by all the public agencies with responsibilities for aspects of land and water development in the area. Attention should be given to the design of a system of clearance of planning reports that will minimize the loss of time and at the same time give all interested parties an opportunity to comment.

### **Selected references**

DE VADYA, A. J. " *Soil conservation planning in the Damodar valley.*" *See* United Nations.

UNITED NATIONS. *Manual of River Basin Planning*, Flood Control Series No. 7, 79 p. New York, 1955.

UNITED NATIONS. " *Soil conservation planning in the Damodar valley* ", *Proceedings of the Regional Technical Conference in Flood Control in Asia and the Far East, Bangkok*, 56-59, New York, 1952.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE. *Economics Guide for Watershed Protection and Flood Prevention*, Washington, D.C., 19.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE. *Hydrology Guide for Use in Watershed Planning*, Washington, D.C., 1957.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE. *Watershed Protection Handbook*, Washington, D.C., 1957.

UNITED STATES, NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION. *Land Cover in Relation to Water Control and Utilization in the Upper French Broad River Watershed*. Bulletin 339, 70 p. 1943.

WETZEL, JOHN H. " Planning and operating watershed projects ", *The Challenge of our Watersheds* (ed. Blackmore, J. and Holscher, C. E.) 130-139. Soil Conservation Society of India, Hazaribagh, Bihar, India, 1957.