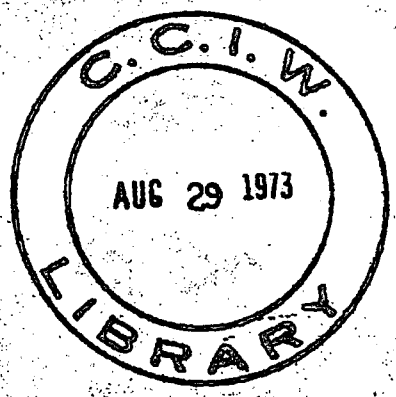
INLAND WATERS BRANCH

DEPARTMENT OF THE ENVIRONMENT



Proceedings of Planning Division Seminar

University of Waterloo, February 1971

COMPILED AND EDITED BY HARRY HILL

SOCIAL SCIENCE SERIES NO.7

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OTTAWA, CANADA, 1972

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Introduction

In February, 1971, R.C. Hodges, Chief, Planning Division, Department of Energy, Mines and Resources, called for a seminar on water resources planning. The objective of the seminar was to develop and share expertise in the varied discipline areas involved in water resources planning. A specific objective was to share experiences of personnel involved in the Saint John, Qu'Appelle and Okanagan studies. Several personnel involved in these studies as well as invited speakers were asked to introduce their areas to the seminar. A discussion by designated groups of seminar participants followed, wherein questions were developed for discussion by the speaker and the seminar as a whole.

The proceedings contained herein are the opening statements of the speakers.

The seminar was organized by Professor Harry Hill of the University of Waterloo with the able assistance of Peter Reynolds, Head, General Studies Section, Planning Division, Policy and Planning Branch, Department of Energy, Mines and Resources.

The seminar was held at the University of Waterloo and the seminar is indebted to the University for its hospitality.

The Role of Aquatic Ecology in Water Resources Planning

John Stockner

Through my involvement in the limnology programme, Okanagan Basin Agreement, my interest has been redirected from the more theoretical aspects of limnology into a more general water resource management approach to ecosystem analysis. We have a real task before us to monitor, to better understand and document what water resources we have available to us in Canada. Hopefully, answers will be forthcoming to enable more prudent management of our inland waters.

Five or ten years ago an ecologist would not have been invited to participate in a programme of this nature. I think it is time to digress for a moment and examine why the science of ecology, until recently, has been ignored. I guess there has been and always will be two basic attitudes prevalent when planning for future water use. There is what I call Group A, which for lack of a better term I'll call Technicrats. These people look at water as power or as a dilutant for wastes. Its value is often measured in terms of the ability to produce power or to assimilate wastes. There is another group, Group B, called the Preservationists or Conservationists. They look at water as a habitat, sustaining a very complex and interrelated biology. They look at water in terms of providing a habitat for waterfowl, a place to come to swim, to hunt and to fish. To them it has a great aesthetic value!

Up to about five or ten years ago, Group A generally had the greatest say, when planning the development of our water resource, and this was because since the early 40's there has been a constant push for an increase in the gross national product. Progress was synonymous with the positive growth of our economy. We need water for industry, power, etc. This was their argument, and until recently their ideas were generally accepted by a rather apathetic public. Ecologists have always spoken as a voice from the wilderness and often as a voice of dissent. It is no wonder that one of the most illuminating titles of a recent book on ecology is called "Ecology: The Subversive Science".

Why is it subversive? It is subversive because it seems to many that ecologists are against everything, concrete structures, dams, roads, pesticides, etc., and that their only concern appears to be for preservation of wilderness.

Well, fortunately, I can say that today, Group B, the Ecologists and Conservationists, are beginning to play a more important role in policy making. I repeat, ecology is coming to prominence now, because I think even the public is beginning to have an ecological conscience. I think it may be of interest to explore why President Nixon and Prime Minister Trudeau called the decade of the 70's, the Decade of Ecology or Environment. Why do we have in the Cabinet now a new Department of the Environment?

I think it is instructive to give an historical perspective to current events. I believe it all began about 1962 when Rachel Carson published her book entitled "Silent Spring". It was, as most of you know, a blunt attack on the pesticide industry and on the indiscriminate use of pesticides throughout the world. This was the first public outcry of an ecologist, and shortly following her book, came Udall's book "The Quiet Crisis", which again underscored the blatant misuse of our environment for the sake of "progress". Then came stories covering the "death" of Lake Erie which received considerable publicity. The result of these even led to a stirring of an ecological consciousness among the public. They asked, "What are we doing? ", "Can growth be synonymous with the good way of living? ". Then came the Torry Canyon oil spill, and other incidents, I could go on and on. I don't think one can pick up a paper today without reading something about pollution either, mercury, DDT, radioactive fallout, pesticides, or eutrophication. Stirrings of an ecological conscience are beginning to pervade all walks of life, and it is, indeed, this environmental awareness that has brought me here to address you today. Today's events have clearly shown the general public that the environment cannot tolerate indiscriminate misuse, maltreatment – the result of improper planning.

I think it is important to look at what we mean by ecology.

I've heard politicians use the word "ecology" as an adverb, adjective, pronoun, noun, etc. Because of improper understanding, there is among laymen and politicians a misuse of the word. I would like to briefly discuss what the science of ecology is about.

First, the science is not very old. It is about 60 years old, and most of the principles were laid down within the last 50 years. The word ecology comes from the Greek word, 'oikos', which means habitation or home. But the 'oikos' has a deeper philosophical meaning. The Greeks, I think, wanted to stress the integration of their very primitive domicile, bounded to earth, and the bondage with earth through all aspects of society. Thus, ecology is the study of the structure and function of nature.

There are ecologists who study the ecology of an individual plant or animal (autecology). The population ecologist studies populations in relation to community structure (synecology). The community ecologist is aware of discrete populations within the community, and communities are in turn the components of an ecosystem; the ecosystem representing the whole, e.g., the lake, the wood-lot, the Ocean, etc. All ecosystems are part of the biosphere.

By analogy I often think of ecology as a finely tuned piano or a very expensive and intricate Swiss watch. If you file off the gears of the Swiss watch, you begin to loose time or you begin to sense malfunction or imbalance. If you are playing a Bach concerto on a piano that is out of tune, you again soon realize there is something amiss.

Well, you must look at an ecosystem or the biosphere in the same way, it is an interrelated web of life, in fine balance with an inanimate environment. If an imbalance occurs through man's misuse the whole system is affected. For instance, the spray of DDT on a rose in a garden may have consequences felt in the wood-lot next door. It may have killed off the bird that in turn preyed on the pest you were ultimately trying to destroy. Thus, we must constantly think about the balance of nature, and not letting that balance tip to one side by our indiscriminate actions. I think this concept of balance will become clear as I go through some examples, where unfortunately the balance has been tipped to one side because of improper planning. It is about this gross imbalance, that has brought recent prophecy from ecologists.

Up to 5 years ago, most ecologists were locked in their ivory towers. Now we have people like Paul Ehrlich, Barry Commoner and Lamont Cole, speaking to clubs, to reporters, to television broadcasters about the problems of the environment. These people are upset. They realize that our own existence is at stake, and we must do something about it now! Commoner and Ehrlich agree that unless we do something now, we have only 20-30 years of time left. I think it is interesting this sudden catapulting of ecology onto the scene, into the papers, into the political arena.

In the remaining time I would like to outline very briefly:

(a) what a limnologist or aquatic ecologist does today, and

(b) what I see as the aquatic ecologist's role in water resource planning.

Briefly, limnology is the study of biological, physical and chemical aspects of fresh water, both lakes and streams. It's sister science is oceanography, which is of course, the study of the oceans. We are often called "fresh water oceanographers".

We generally adopt a holistic approach to lakes, which means looking at the total system, not at any single part. I too am interested in this holistic approach . . . one without compartmentalization, or without cross-walls. Therefore, I look on the land as well as in the water; I look at the lake sediment and the shorelines, and throughout the lake to try to understand the interconnections. Again, when you look upon a lake, think of the Swiss watch analogy, it will help you to understand the complexity of its workings.

In the examples to follow I will stress the importance of the ecosystem approach to planning; this means that when water resource development is contemplated, the ramifications on the surrounding environment must be considered an integral part of the study. I think that now is the time for ecologists to interact with hydrologists, planners, sociologists, economists and engineers, in bringing forth this ecosystem or holistic approach to basin planning – looking at the total plan, not just at single facets, or separate compartments.

It is time to examine how the limnologist has contributed to basic water resource planning.

I am going to draw on several examples that I myself have been involved in. A year and a half ago, I was called upon to assist in resource studies of an alternative diversion of the Churchill River in Manitoba. As you know, quite a controversy developed when Manitoba Hydro decided to flood Southern Indian Lake. The public objected and forced the provincial government to step in and hold public hearings. Millions of dollars were lost and the project is still not off the ground. Hydro has spent another million dollars on a study of the effects of Churchill River diversion on the natural resources.

Briefly, the Churchill River flows through northern Manitoba, forming a series of lakes that eventually flow into the Hudson Bay at Churchill. After the public hearings,

the attitude prevalent at the time was – 'Fine, we won't flood the lakes. We'll divert the river upstream and bring it down through the Burntwood River to the Nelson River. The Indians will not be affected and can live up there and continue to fish. The lake will remain at the same level, and we'll have the water for increased hydro power production and it will be the best of both worlds'.

My colleague and I grew very interested in this problem and asked the question: with upstream diversion will they have good fishing even if the lake is at the same level? We looked at the nutrient content of water flowing into Southern Indian Lake, and especially of those rivers coming in from the north that drained the Pre-Cambrian Shield. In other words, we looked at the entire system, and we said – 'what is it that makes Southern Indian Lake so much more productive than neighbouring lakes on the Shield? '. The answer was very simple. The constant source of nutrients from the Churchill watershed insured a high alkalinity, and a good source of nitrogen and phosphorus to the Churchill River system.

Now, what if you take 20,000 cfs from the Churchill River above the lake and divert it to the south? We did some simple calculations and estimated that the current lake resident time, that is, the time it takes the flow of the river to replace the volume of Southern Indian Lake, was nine months. We calculated the volume of the lake and the flows of the major rivers flowing into the lake, also their nutrient loads, and came to the startling conclusion that the productive capacity of Southern Indian Lake is to a large degree dependent upon the flow of the Churchill River. Diverting the Churchill River upstream, we postulated would markedly affect productivity, and even if the Indians remained on the lakeshore, in time they would witness a substantial decline in the fisheries. I think this is a good example of where aquatic ecologists have contributed something to water resource management. The diversion could have proceeded but 10 years from now people may have been crying, 'Why didn't you tell me about this possibility? '.

The second type of project that I think limnologists should have some positive input to, is in stream or lake impoundment. What happens to the late arriver when you impound water and flood shorelines?

First of all, it is obvious that it may upset the migration of anadromous fish. One should ask, what is the value of fish vs. the value to be gained by construction of a dam? It's a matter of political priorities vs. a conservationist's judgement! Fishways have in some places proven to be successful, but they are certainly not the ultimate solution.

The second factor to consider when constructing a dam is the ecological effects of flooding the shoreline. How will flooded timber, soil-water and wood-water interaction affect water quality? Water quality is a question that a lot of people are asking questions about. Their children can't swim in a lake, even though it looks clear. They wonder why. When water is impounded, water quality is affected. Again, I think an aquatic ecologist can contribute considerably here with his knowledge of water chemistry and the interaction of water with soil, wood and vegetation. On such projects he should be involved from the beginning.

I think the TVA situation in the United States is a very good example of where they did have people with ecological knowledge involved early in the planning process. These people made certain that the man-made lakes created behind dams would possess a good recreational value, and they have indeed, been successful in attaining their goal.

Eutrophication is another problem that in most instances can be associated with poor planning.

What can a limnologist contribute to Lake basin studies where eutrophication is a problem?

I'd like to cite Lake Washington in Seattle as an example. Lake Washington 100 years ago, was a clean, clear body of water. It sustained a productive salmon run through it and, was a classic example of a clear oligotrophic (nutrient-poor) lake. Suddenly men came to its shore, liked the looks of the lake, and built their homes around it. As the population increased, so did the productivity of the lake. The lake gradually deteriorated until one day in 1962 the lake turned brown and you could only see approximately 2 feet into the water. The city fathers went through the planning process and asked, "What can we do about this? ".

Dr. W.T. Edmondson, a limnologist at the University of Washington, who was asked to give his advice said: "Let's go back to the time when this lake was clean and clear and ask the question, what element led to the rapid acceleration of algal growth in the lake? " He suggested phosphate-phosphorus which, as it has turned out, was a correct assumption. His suggestion was taken and all sewage discharge was eliminated by diversion to Puget Sound. Now Lake Washington is rapidly recovering. People are again enjoying bathing, boating and fishing.

The second example of eutrophication is in the Okanagan Valley, B.C. A similar situation to Lake Washington existed here. People have always enjoyed the beauty of the Valley with its boundless recreational opportunities. In 1967/1968 an algal bloom occurred in Skaha and Osoyoos Lakes and people were alarmed. And suddenly millions of dollars were lost in the tourist trade because of algal nuisance conditions on the bathing beaches. Here is another classic eutrophication problem, close to home. Currently, the FRB are conducting bioassay

experiments, attempting to find out how effectively these waters can assimilate wastes. Hopefully, these results will enable us to determine what load of N and P these waters can assimilate without noticeable deterioration. For example, if someone were to say the population in the valley by the year 2020 will double over what it is today, and 4 more industries will locate there, I think with some confidence we could predict what sort of wastes the lakes could effectively assimilate. I think this is necessary and important information.

Unless I am misinformed, the comprehensive planning process is very much an interaction of interrelated disciplines and indeed, by definition is a holistic approach to water resource studies. It is this strong interaction with many disciplines on a personal basis that excites me!

I hope that through these examples, you have an appreciation for the type of knowledge the ecologist can bring to comprehension water resource planning studies.

I think you must include him in the formulation of policy and in the planning of future water resource studies. In the past, the ecologist as a dissenter was in the minority. Now, however, activists are carrying placards, not to ban the bomb or stop the war, but 'ecology for earth'. I think the public today definitely possesses an ecological consciousness and indeed, in one sense I consider that a testimony to my being invited to be here and address you today. Thank you.

The Impact of Water Resource Development on Environmental Ecology; the Studies Required to Predict these Impacts

R.S. "Bob" Dorney

I think John Stockner has put the issue pretty squarely into focus. So what I will try to do in this brief discussion is to look at water resources in a different perspective, look at it with a few more case examples in a local region, rather than jumping across the continent with examples drawn from different biological zones.

When we start to take an area apart, a piece of landscape apart, and look at it in functional terms, i.e., the elements of air, water, land, vegetation and animal life and how they interact, knowledge comes slowly. Waterloo County is a good example of the lack of knowledge which hampers water resource management decisions. For example, should the area go to tertiary treatment plants? Should the area build five dams? Should a pipeline replace ground water? There's no lack of specific and important questions and issues. The difficulty is in understanding what the various alternatives will mean in unexpected repercussions resulting from unforeseen interrelationships between environmental elements, such as the flow of surface streams and wells, or dams as modifiers or generators of pollution. The human element is equally important. What do the people want, what are they willing to pay, what are they willing to give up in terms of their personal freedom and financial wealth so as to achieve larger social goals?

For these reasons I believe the whole basis of land use management, and the accompanying understanding of the ecological interaction with this management has to be cast in terms of societal goals. In our planning school this is one of our prime foci – to try to look at the ecology of these man-manipulated systems from this point of view. This means accepting man as a prime part and prime modifier of the ecosystem.

Some of the work undertaken by my graduate students may be illustrative at this point. I rely on them very heavily, for all the analysis on which we base our regional studies. We have begun by first looking at regional history.

Paul Rump, one of our PhD. students, spent three years looking at the historical changes in water quality in the Grand River watershed. He went back to the early newspapers which are on microfilm, laboriously tried to discover what the issues of pollution and water quality were in the 1890's, and tried to compare them to the 1920's and to the present. He examined historical land use changes which started around 1820 (in this area), and then carried them forward into the 1970's to see where we have come and where we may be headed.

If you examine water quality in this way as a 150-year continuum rather than as a current issue, next it's quite apparent that we have not invented pollution in 1970. It began at the beginning of Caucasian settlement in Waterloo County and has continued to blow "hot" and "cold" ever since. Perhaps some quotes from Paul's paper, which he will present to the Canadian Association Geographers meeting to be held here this spring, may be illustrative. Some of the quotes I think are very interesting.

One for example is from Strickland in 1853, over 120 years ago, in which he speaks about the major streams in this area. He says, "These streams, the Grand River, the Conestoga River, the Speed River and the Nith River and their tributaries were well stocked with fish from 1800 to 1850". "Especially speckled trout were in abundance" . . . "These conditions appealed to the early settlers". After 1850, the trout disappeared. So even as early as 1850 water quality deterioration, as viewed from a fishing point of view, had taken place with the disappearance of speckled trout. This was only 30 years after settlement.

I will refer to this quote again in terms of our recent inventory of trout resources for Waterloo County.

"The Ontario Game and Fish Commission in 1892 reported that illegal and improper fishing, sawdust,

inefficient fish slides and the felling of shade trees were causing the fish to decline". This is in 1892, almost 80 years ago.

Some interesting anecdotes relate to water borne disease. Typhoid cases were recorded in most of the settlements of the Grand River watershed in the 1880's. In 1886 and up to 1892 anthrax killed cows in the Grand River. Although anthrax is a very rare veterinary disease today, in fact, it's practically gone, yet it was an important water pollution problem in the Grand River watershed, probably coming from foreign wool used by woolen factories in Guelph.

I think what Paul is demonstrating in his research is the point that water quality is not a new issue today; it was an issue as far back as 1850. We're not dealing with a new crisis, or dealing with a new situation. We're dealing with an on-going situation in which man is a principal actor, and has played an important role for over a century.

If we look at the changes in landscape in Southern Ontario between here and Lake Erie, analyses done by the Department of Municipal Affairs demonstrate that natural ecosystems now occupy something less than 1% of the landscape. If we include the semi-managed ecosystems, primarily forest-covered, we're talking about 8% or 9% of the landscape. The remaining 91% or 92% of the landscape is dominated by human activities: agricultural, urban, industrial and highways. For these reasons in Southern Ontario, the idea of "conservation" is in my opinion no longer viable. The issue is not conservation, but management. We should talk instead about managing the land for human activities, keeping in mind our goals, and utilizing all the human skills at our command. The era when we can let the landscape manage itself has been gone for at least 70-100 years. Stewardship belongs to us. We have the capability, hopefully, to face the issues, look at our goals, sort them out, and move ahead in directions which are meaningful in social terms and acceptable in environmental terms. We can find ways of producing human satisfaction, preserving the best parts of natural systems which can reduce our maintenance costs, provide us with a variety of natural products, and provide us with aesthetics in addition.

There is another fundamental aspect of ecology and resource management shown in Table I, which demonstrates why we are beginning to perceive environmental pollution and why we cannot continue to rely on past resource management strategies to carry on through this century. Taken from DBS statistics, it shows the numbers of different professions in Ontario which affect the nature environment in one way or another. What I've done is take professions involved in producing environmental *change,* such as chemical engineering, civil engineering, architects, planners and economists. These groups combined make up

Table I Comparative Manpower in Various Professions in Ontario*

Professions Involved in Changing Natural Environments	Number
Engineers	19,729 (1961)
Architects	1,138 (1961)
Planners	365 (1970)
Economists	1,148 (1961)
TOTAL	22,380
Professions Involved in Conserving/Managing Natural Environments	
Foresters	586 (1970)**
Landscape Architects	76 (1970)
Fishery-Wildlife Biologists	200 (approx. 1969)
Ecologists	68 (1968)
TOTAL	929
Ratio between two groups 23:1	

* From DBS statistics and personal contact with professional societies.

** Many of the professional foresters are employed in northern Ontario in paper and pulp or lumbering work, and hence are not directly involved in the rapidly changing industrial-urban areas in southern Ontario.

about 22,000 professional men and women. If those professions which deal with management or measuring change such as foresters, landscape architects, fishery, and wildlife biologists, and the very elusive group "ecologists" (defined as those who subscribe to the journal Ecology) you come up with around 900 people. However, most of the foresters work in Northern Ontario in the lumber industry; there are less than 50 working in Southern Ontario. This results in some spatial inequalities in how these various professions are distributed since the engineers are primarily in the industrial and more urbanized south of the Province. Nonetheless, it is quite evident that there are at least 23 people professionally involved in the process of change compared to 1 individual who can somehow measure or direct that change. When some citizens talk about developing a meaningful role for ecologists in a technologically advanced society, I shudder to think what that means: there aren't that many ecologists. The societal odds are overwhelmingly allied to our preoccupation with technology and change to easily modify the present system along ecological lines.

Most of the schools in North America stopped training ecologists in the 1950's; biology went off on its molecular and physiological "kick", and has stayed there ever since. For this reason biologists have little experience with ecology and almost no background in the politics of resource management. Almost no biologists, ecologists or natural resource managers are in private "practice". So

there's a real imbalance in numbers not only between those professions involved in effecting change, and those involved in measuring change, but almost a total lack of ecologists or resource managers practicing their profession in the society other than as civil servants or academics. This lop-sided employment of ecologists and resource managers has fostered an ivory tower attitude amongst them at a sacrifice to the applied aspects of ecology which now seem to be such a critical need.

Another revealing truth is to look at the government (Table II) monies spent on natural resource management. Although it is hard, using the Canadian Gazette, to determine how much of the federal and provincial budgets are spent on natural resource sectors, I have estimated that they are – 1-½% and 4-½% respectively. It can be debated whether the museum budget for example should be added or not. In this case I have cut their budget in half, hoping that this proportion may relate to resource management.

Table II Ontario and Canadian Expenditures by Percentage of the Total Budget for Renewable Natural Resource Management and Research*

Ontario (1969-70)	4.6%
Federal (1968-69)	1.5%

*Source: The Canada Gazette, September 13, 1969.

Table III National Budgets by Percent Spent on Renewable Natural Resources, 1964 and 1965

Country	Percent of Total National Budget[1]
Argentina	2.7%[2]
Ecuador	1.3%
Honduras	1.25%
Colombia	<1.00%
USA	.6%
El Salvador	.5%[3]
Venezuela	.5%
Bolivia	.3%[4]
Costa Rica	.3%
Guatemala	.3%
Brasil	.2%
Peru	.1%
Panama	Proposed for 1966

[1]Data from Uruguay not included because of incomplete figures

[2]Calculated from national budget data of 1963, OEA Publ. America en Cifras 1963, Publ. 312-S-6221

[3]Calculated from National Budget data of 1962 in same publication as No. 2.

[4]Calculated from National budget data of 1961 in same publication as No. 2.

Table III is a comparison we did in the Organization of American States (OAS), of renewal natural resource budgets in the hemisphere (excluding Canada, Trinidad, Tobago and some of the other Caribbean countries). It is apparent that none of them spend much of their federal money on resource programmes. Some countries, like Panama, spent at that time nothing at all. At the time of our survey they had no resource programmes, no professional resources planners, no money. Although budgets vary from country to country, generally speaking, most governments in the hemisphere, and probably in fact most countries in the world, are spending little more than 1% of their federal or national budgets in renewable resource management. And only a very, very fractional part of that 1% goes into ecology – either academic or applied.

That brings up the point then. What is the image of an ecologist? What can he do? Who is he? Statistically, he doesn't exist. From a point of view of employment independent of government, he doesn't exist either. We're all either in academic ivory towers, because we can't make a living outside it, or we're in civil service because of the protection it affords. Wouldn't the societies resource interests be better served if ecologists became practitioners as well, working shoulder to shoulder with engineers, planners and economists, on impact studies, rather than having to adopt a devil's advocate role?

Few ecologists have ever tried to become private practitioners; they have never played a role in that world of change, and I don't believe easily are going to be enticed out of universities to play that role, since the whole focus of academic education in biology is centered around laboratory and theoretical work. Few individuals in Canadian Biology Departments are rising to the challenge of an environmental crisis of global proportions. Many more are criticizing those of us who do.

That leaves us in a kind of quandry, as I see it. Where is the manpower going to be found to do the resource management job needed, the impact analysis needed on the scale occasioned by the present crunch. Perhaps the best recourse, as I see it as an interim measure, is to retrain engineers, geographers and economists, in ecological concepts. Some may become ecologists through years of independent study and consulting. I think that this approach has some validity and practicality. Hopefully, biologists may get the message by 1980 and emerge from their cocoons into a world of change, debate, decision and policy so that their science can be adapted to respond to the resource management issues.

As a demonstration of using ecological analysis for regional planning purposes, our graduate class first wanted to get an overview of regional water quality. To do this, on no budget, we went out and talked to the game wardens.

We asked them to tell us where the speckled trout were (on the q.t.). It is amazing how much information can be gotten from experienced men using a map on the wall. We also relied on O.W.R.C. records of water quality, and we also based water quality on some geographical-spatial analyses. We classified water into high, medium and low quality in the county, which is about as fine a scale as is meaningful for planning use. Even on a 3-step scale there are likely a lot of overlaps between medium and high, and medium and low. Our conclusion was that approximately over half, and probably two-thirds of the county, now has deteriorated surface water quality from the 1820 base. Compared to Strickland's records of 1850 we have many aquatic systems barely supporting carp; we have some that are highly toxic from industrial waste and where cattle die if they drink from them. Only a few small sections of watersheds still are capable of supporting a speckled trout fishery.

What this demonstrates to me, as it did to my students, and to the Planning Board where we took this material, is that we're dealing with a highly man-modified system. We're not saying that it is wrong, or that it is good or bad. We're in fact not putting judgement values on it. We're just merely pointing out the fact that this is the status quo – that in 150 years about 2/3rds of the surface water has lost its original high quality, i.e., it is polluted. In taking this analysis to the County Planning Board, we get into some very interesting aspects of resource management. We found that in Waterloo County, for example, that water and air pollution are one of the chief goals perceived by politicians in the region. Now, if the politicians are correct in assessing environmental quality as a regional goal, then this begins to have some relevance, because we can say, "Fine, if water quality is a regional goal, that is where you are in 1970 and this is where you came from since 1850. The conclusion is inescapable that you are going to have to start to look at a higher level of management applied to the land and water to achieve these quality goals in a reasonable period of time, let's say 5 to 10 years".

We took our water quality analysis a step further and went out in the field and actually walked about one-half of these streams. Ray Smith, another graduate student, estimated the amount of eroding bank, erosion and the spatial interaction between agricultural land-use at the water-land interface. He got the approximate figure that we could rehabilitate almost all of the low quality surface water areas in this county for 2 million dollars. This figure would include erosion control, and reforestation of flood-plains. It wouldn't include the purchase price of land, or easements if these were needed.

So we have that handle, we have a dollar handle. We can go to the politicians, and we intend to do so very shortly, and the Planning Board and say, "Fine. This is your goal. This is the reality. We've lost a very useful aquatic ecosystem capable of supporting speckled trout in 1850 due to agricultural impact. We need high quality surface water in our tributaries to dilute waste in the Grand River. This is what it costs to put most of it back". And I think that's about as far as an ecologist can go. I think at that point it becomes a matter of political decision, if you will, by the elected officials. We can try to make the public and politicians aware of what is possible, what is feasible. We can compare public spending for example on our 40 million dollar freeway in this County with a 2 million dollar trout fishery and waste dilution system in our backyard. Perhaps we can sell streambank rehabilitation on the basis of developing a local recreation industry.

I believe that if we start to combine ecological analysis with political process and defined goals that we can start to reverse the historical trend of slow but steady environmental deterioration. I don't believe politicians are stupid; I do believe biologists and resource managers are naive, however, if they assume that through rhetoric and scholarly works that logic will prevail. Confrontation, no doubt, will still be necessary, appealing to the public for action when political channels are closed.

So this is as I see ecology today. A very, very small group of professionals, essentially unorganized, dealing with politicians, economists, sociologists and planners on issues of strategy and on professional terms. Whether or not we can train enough young people and retrain the old timers to move into this type of environmental management field I don't know. I hope that those young men and women who enjoy working with people and issues may find it challenging.

Some of the other studies we've been involved in as ecological consultants are listed in the outline. We've done impact studies which cause more immediate change on everything from subdivisions to zoo sites. Generally water resources are one aspect of site analysis and management. In our consulting work inside and outside of the university, we've found that for every dollar invested in "ecology" or environmental analysis, we've been able to save the developer, the corporation or the government about fifteen. What we've found is that ecology as an issue oriented science is a highly saleable profession. Some of the savings or potential savings, for example, are generated in this way. We have found developers who have tried to build schools on kettle peat-filled lakes, build homes on slopes with a high risk of slippage, or construct lakes leaving no aesthetic potential due to predicted low water quality. Analyses may indicate that a natural channel is gradually retreating from an eroded bank, hence channelization is not needed.

It's amazing sometimes what happens in private to public land transfers. We found very few Park Commissions will examine critically the 5% open space before it's deeded.

Waterloo has some beautiful dead elm swamps as parks as a result. These are the types of resource issues which very little field work can bring to light. When working with Planning Boards, e.g., we can say, "O.K. fine – if you want that as a park. But you're buying 50,000 mosquitos, a semi-aquatic ecosystem, and a soil base that won't take heavy human use". So ecologists as we see it can bring certain environmental knowledge to bear on land-use issues to planning boards, and developers. We feel impact studies for these reasons are vital before land-use decisions are made.

In summary then, can impact studies succeed? Economically, we feel they can justify the cost. However, they must have sufficient lead time. The question came up earlier, how much time do ecologist's need? We've done a fairly complete ecosystem analysis in two days, as long as the soils aren't frozen, and you can field a team of specialists on the weekend. You can take the geological part of an ecosystem apart and look at it, you can take the plant and sometimes the animal sector apart and look at it in two days at the right seasons of the year. But normally, that's a crash approach.

Usually, the time to do a reasonable analysis of an ecosystem is six months or twelve months, hopefully a full calendar year. This allows a group to study all the variables of temperature and season.

The question inevitably arises as to who should pay for ecological advice. Perhaps this is rather academic since it appears that ecosystem analysis and knowledge saves money. However, the existing professional engineers, architects, planners and economists presently are reluctant to invite ecologists to join a team and interact with a client. Since the society will be benefiting both now and in the future, some general legislative support to get the involvement started and some monetary support above the present ludicrous level ought to be forthcoming immediately. For example, CMHC through mortgage money, or the Federal Department of the Environment through its grants programs can do a great deal to ensure that adequate ecological studies and advice precede their investments. In this way both the private sector and the public sector can be prodded into a more thorough job of resource analysis and into accepting ecological advice.

The last point, who should decide land-use issues and set policy? Certainly not the ecologist. I'll leave it there.

Public Participation in the St. John River Basin Study- A Proposal for Action and Research

Desmond Connor

INTRODUCTION

This outline of the proposed program, by which the public will be provided with opportunities to participate in the process of planning the management of the Saint John River Basin, is prepared specifically for members of the Planning Committee. Questions, comments and suggestions are warmly invited.

BACKGROUND

The public participation program was originally conceived as a research project within the Resources Research Centre of the Department of Energy, Mines and Resources, in view of the provisions for public participation contained in the Canada Water Act. To enable the public to become constructively involved in a national program of basin planning, required detailed knowledge of just *how* this could be brought about effectively. While there are many theories and proposals, there was little validated research on which to base action plans securely.

Subsequently, several NATO countries (Belgium, France and the U.S.A.) became associated with Canada because their similar concerns were brought to light at a meeting of NATO's Committee on the Challenge of Modern Society.

This study could not be carried out in a vacuum, so a review of five basins was carried out. The Saint John River Basin appeared to offer a broad range of opportunities to test many aspects of public participation given its size, complexity, ethnic and occupational diversity, etc.

WHAT IS PUBLIC PARTICIPATION?

Let me be as specific as possible! For me, public participation in basin planning is:

- residents contributing facts and ideas to planners;
- planners listening to residents concerning their goals, ideals and fears;
- citizens finding early opportunities to make positive contributions;
- people understanding and choosing to support environmental quality through specific actions, e.g., allocating tax funds and improving water management practices;
- all the people affected (residents, planners, summer visitors, etc.) acquiring a broader shared understanding of the environment and its management;
- recognizing and adapting to the different goals, values, communication mechanisms and methods of decision making which vary across different human systems in a culturally complex basin;
- gathering data first by qualitative, unobtrusive methods and then using quantitative techniques as required;
- fostered through an administrative structure which is open, accepting, flexible and oriented to co-operation rather than to control;
- a contribution to the total planning process and its product – a sound plan accepted by most basin residents, other citizens affected and government officials so that it is implemented with maximum satisfaction.

Public participation *does not,* it seems to me, support:

- ignoring the potential contributions of residents;
- keeping planners and people apart and in the dark about each other;
- restricting citizens to formal hearings when most decisions are already essentially resolved;
- the "one best way" approach of traditional management theory;
- an initial reliance on survey research;
- an authoritarian management structure and

operating style in the project organization;

- independent action in dynamic ways unconnected or disruptive to the planning process and its product;
- one way communication.

More succinctly, the goals of the public participation program were formulated last summer as:

(a) Prepare for the acceptance and implementation of the final plan.

(b) Obtain constructive technical inputs from the resident population for the planners.

(c) To effectively integrate (b) above with specialized knowledge of the planners.

(d) To develop and evaluate techniques of generating public participation in water planning resource development according to the economic and social needs of the concerned population.

(e) To develop a model for further river basin planning to meet Canada's commitment to CCMS (Project Sheet, 1970-71 Departmental Estimates)

In short, the concerns different people have with environment, with participation and with planning have led this project to centre on an action research model of developing, demonstrating and evaluating the strategies and tactics which will most effectively and efficiently enable citizens to work with technical specialists in river basin planning.

WHY INVOLVE THE PUBLIC?

I believe it is necessary to bring about public participation to:

1. obtain information on basin phenomena which is not available through the usually recent official records, i.e., flood effects under certain conditions;
2. gain creative ideas for the solution of some aspects of environmental management and control, i.e., some residents have relevant technical skills and experience equal to that of paid staff, plus a high level of motivation towards their own environment;
3. respond to the high involvement which increasing numbers of citizens possess towards the preservation and management of the quality of their environment;
4. implement efficiently any managerial recommendations contained in the plan, e.g., new methods of agriculture, irrigation or domestic waste disposal. Recommendations developed co-operatively are likely to be accepted with a minimum requirement for legal action and enforced regulations;
5. discover the criteria which the residents believe are significant in evaluating alternative resource use;
6. find out the priorities and weights given by residents on the criteria they believe are significant;
7. provide a form of insurance on the investment involved by the plan, i.e., a rejected plan represents a close to zero return of the resources expended.

Comprehensive and complete examples of public participation in basin planning are difficult to identify at this time, although preliminary results from work in the Susquehanna River Basin Project are positive. A nationally experienced senior sociologist with the U.S. Department of the Interior recently said, "We just haven't done anything like this yet in the U.S.".

Experience in adult education, community development and related fields in Canada and abroad provide case material in support of both the goals and methods of public participation in basin planning. The absence of public participation is likely to lead to:

1. technically unsound plans, e.g., Arctic installations by engineers in one season, lacking inputs from local residents, proved unsound or ineffective in subsequent seasons;
2. plans which are misunderstood, misinterpreted and rejected by local residents, e.g., South Indian Lake.
3. services poorly used by local people, i.e., resistance to irrigated farming at Saskatchewan Dam;
4. decisions by "planners' preference" rather than "peoples' preference".

SOME ASSUMPTIONS

Before designing the research and program components proposed for this project, a number of assumptions were identified to provide the shared and visible frame of reference for subsequent design work. (Note = if you can see any more unidentified assumptions, valid or otherwise, I'd appreciate your sharing them with me.).

1. Treating the basin planning process as solely a matter of applying the results of biological and engineering studies is insufficient. Specifically, *citizens* can sometimes contribute technically sound planning suggestions and valuable information on the local area. In addition, an early and continuing involvement in the planning process has an educational effect on both citizens and planners, so that their joint product has a much greater probability of being accepted and implemented. On the other hand, where the public is ignored and kept ignorant, it frequently rejects the final study and its recommendations, i.e., the public always participates on

major issues, but often too little, too late and too negatively when given no clear and early alternatives.

2. A river basin can be treated as a single hydrologic system, but seldom as a single social and cultural system. There are typically a number of human systems in the basin, often with only slight relationships to each other. Human systems beyond the basin may affect it and its people very powerfully. Widely different values, goals, norms and attitudes should be expected towards water as a resource.

3. As a consequence of the above, no single approach, strategy or communication method is likely to reach all of a basin's population, but instead each socio-cultural system must be observed, studied and understood as an entity. In the process, certain mechanisms should become apparent which these people have used to work out the community's response to previous issues, e.g., the method and style by which educational, political, economic and other important decisions have been resolved through processes of information, exchange and decision making.

4. A qualitative approach to understanding the human systems in the basin has a greater probability of achieving more valid, reliable and dynamic data, with less static, than quantitative, survey-type approaches.

5. A good deal of useful data can be acquired about a basin from census publications and other reports of studies made in the area. Daily and weekly newspaper files are also valuable as unobtrusive sources.

6. Developing and increasing the size of the shared frame of reference of people in a basin will be a major factor in securing acceptance for the final plan and in subsequent public support for water quality management.

7. These assumptions are more likely to be fully tested if the basin is chosen for being large and culturally complex. (After applying 14 criteria specifying these two dimensions to five basins, the Saint John River Basin was selected).

8. The structure and style of organizational and institutional arrangements has direct implications for the effectiveness of the planning process and its public participation elements. A complex structure stressing control, close supervision and minimum delegation will be less flexible and less likely to respond creatively to challenges than a simpler one oriented more to trust, supportive supervision and lower level decision-making. The processes which characterize intergroup and intragroup behaviour are also critically important since they play a major part in determining whether the organization climate is positive or negative, e.g., methods of decision-making. Though structure and process are related, the consistent fostering of positive group processes can offset some of the negative effects of less appropriate organizational structures.

THE PROPOSED PROGRAM

Some 14 program activities have been developed in a sequence which is designed to achieve the objectives stated earlier.

Start-up

This phase included the formulation of the general concept of the project, the acquisition of a field director and initial contacts with key personnel in relevant federal and provincial agencies. This followed the signing of a joint federal-provincial agreement in June under the Canada Water Act providing for a planning study of the basin to be completed in a period of 3 years and with a budget of $775,000. (Essentially completed by October 1,1970).

Team Building Process

A critical factor in the success of this program, though only partly within its influence, is the development and maintenance of an interdependent relationship between the members of the Public Participation Unit and the scientists, engineers, technicians and others who are co-workers in the total planning process.

Liaison with Joint Committees

Co-operation must pervade the working contacts of Board, Committee, Planning Office and contract staff from program start-up to conclusion; without it degrees of inefficiency descending to sterility are inevitable for both the total planning process and its public participation component.

Review of Experience

The basic concept is to have a research assistant review recent reports, articles and ongoing projects which included public participation in the planning process. This person can screen written documents and field observations for items relevant to our project, releasing field staff from a great deal of paper handling, yet reducing the risk that we will, unknowingly, re-invent the wheel. Workshops and other meetings may contribute to this activity.

Introduction and Orientation

The person responsible for directing the field work must have a thorough grasp of the people and character of the basin. A period of three months of cultural immersion is therefore scheduled in which he will become steeped in

the ways of the valley through personal field work and meetings with key people of all kinds. His growing understanding of the milieu will be tested by reviews with the program and research design consultant and other members of the planning group. He should then be able to identify, at least in a preliminary manner, some 5-8 systems salient for the project. These are likely to range from rural communities settled by French-speaking Acadians through urban complexes like the city of Saint John, to interest groups based on the pulp and paper industry and political system.

Compilation of Available Data

Another research assistant will assemble existing social, cultural and institutional information, drawing on reports, tables, charts, maps, aerial photographs, content analysis of newspapers, etc. This will include a card file on key resource persons in the Basin. For much of the statistical data, a recombination of county and census subdivisional units can provide data on a basin-wide basis. Territorial units can be distinguished by noting the boundaries drawn by political, religious and government agencies, together with trade centre information. After three months of intensive work, this activity should require only periodic updating.

Third Party Evaluation

Although ongoing evaluation will be an essential part of the program design, two researchers will spend about 5 days each per month providing a more detached kind of evaluation of design assumptions, program proposals and field performance. The results will be employed both to assist continuing program management and also as inputs to the final evaluative report of this project as a whole. The persons engaged must possess a high level of professional competence and field experience.

Field Staff

Following the initial introduction and orientation of the field director to the basin and its people, a field staff of 5-8 persons will be selected in accordance with the number and nature of the systems identified for planning purposes. Criteria and methods of recruitment, selection, hiring, orientation and training (pre-service and in-service) form important decision points. The skill level sought is that usually possessed by persons with a Master's degree in one of the social sciences and five years of field experience. A minimum of three months' lead-time will be required for recruitment, plus two weeks of pre-service training and orientation.

Field Data Collection

Initially, each field staff member will spend some three months using qualitative techniques (not questionnaires) to get to know and understand his/her socio-cultural system as thoroughly as possible. This will be a continuing activity in order to enlarge and update the information gathered initially.

In some cases, a rather immediate construction program may require a fore-shortened version of the fieldwork process. Film may be used to record information for future use.

Analysis, Strategies and Techniques

In this, the most creative phase of the program, the field staff will individually and collectively examine the characteristics of their populations, the core questions posed concerning the involvement of the public in the planning process and the variety of appropriate methods which may be employed.

Specifically, communication and exchange processes used in each system to deal with major issues in the recent past will be identified and assessed for their usefulness in dealing with water quality matters. Further, other methods used elsewhere will be reviewed to note any which seem appropriate for each specific group. New suggestions for examination will be derived from persons and projects uncovered by the Review of Experience, e.g., a series of workshops may be arranged featuring leaders of other projects. Original techniques which occur to the staff will be encouraged and tested by simulation or reality. This phase will last 1-3 months.

Mutual Education Phase

By using the various strategies and techniques generated in the foregoing process, the exchange of information and attitudes about water quality between the people in the valley (including the planning group as a system) will occur for a period of about one year. The objective will be to develop a larger shared frame of reference about water quality management across the entire basin as a necessary step toward planning and action. Relevant data will be sought from the public to supplement accumulated engineering and scientific information. The effectiveness of various communication strategies and techniques will be carefully and comparatively evaluated.

Public Response to Plan Elements

As the engineers and others develop alternative proposals for water quality management, the communication approaches identified as effective in the preceding phase will be used to enable the public to review and respond to these alternatives. In some cases, the alternatives may be between accepting a single proposal and doing nothing. About 1-3 months is estimated for this phase.

Public Response to Comprehensive Plan

The final plan is visualized as a series of weighted alternatives rather than a single package which must be accepted or rejected as a whole. Through a process of joint consultation between public and planners, the emerging calculus of costs and benefits (social and cultural as well as economic and political) will become clear to all involved. This phase may take 1-3 months.

Review and Evaluation

The final three months of the project will be devoted to assessing the learnings from the whole experience, drawing upon the accumulated insights and data of program staff, external evaluators and others.

THE CHARACTER OF THE PROCESS

This form of public participation is designed to operate in a cooperative, educational manner in a relatively unobtrusive way. It is *not* modelled on Saul Alinsky or "animation sociale" but a personal synthesis of applied anthropology and sociology developed through four years of field work and ten years of research and consultation. The focus is on developing constructive forms of communication and on fostering mutual education.

There can be no guarantee that people will not, as free citizens, take action on their own account if they do not feel that officials are getting on with the job. As a deputy minister from Ontario said recently at Banff: "If we don't involve them effectively, they'll trample on us". The danger of this happening is reduced, I believe, by this form of public participation.

ANTICIPATED RESULTS

Given such a program of public participation in the Saint John River Basin, we can anticipate:

1. an attitude of positive co-operation expressed by most citizens and local organizations towards the project;
2. a plan which incorporates the best thinking of the many technical and professional people who reside in the valley;
3. some creative approaches to solving environmental problems provided by local people, supplementing those of experienced project staff and consultants;
4. a positive approach by most people to accepting any new physical structures required;
5. a willingness to implement any recommended managerial practices by most citizens;
6. a more sophisticated understanding of the issues and the technical aspects of environmental management by an increasing number of people;
7. a clearer definition for themselves and their elected representatives of the criteria involved in environmental management decisions and the priorities held by the present residents at a given date;
8. a greater sense of shared responsibility for managing the environment;
9. a clearer understanding of social benefits and social costs to individuals and groups for each alternative plan.

CONCLUSION

This outline of the preliminary program and research design for public participation in the planning process on the Saint John River Basin is prepared to obtain your comments and suggestions. I look forward to acknowledging your assistance.

THE ST. JOHN RIVER BASIN

For those unfamiliar with the area, a brief sketch of the basin may be useful.

One of the largest and most historic rivers in Canada, the Saint John rises in Quebec and Maine and, through its 418 miles, drains most of the province of New Brunswick before reaching the Atlantic through the Bay of Fundy. One third of its watershed of 21,600 square miles lies in Maine where, for 80 miles, the river forms the international boundary between Canada and the United States. The lower 80 miles are tidal and navigable to the provincial capital, Fredericton.

The multiple use of the river is conveyed in a recent report:

"The river is presently developed for power generation to a total installed capacity of 550 megawatts on the main stream and major tributaries, a total domestic and commercial municipal water demand of 23 million gallons (Can.) per day was estimated for 1966 in the New Brunswick sector of the river basin together with a further 87 million gallons (Canadian) per day for industrial demands, plus some agricultural use. The basin supports a commercial fishery of $220,000 per annum and a significant sport fishery which contributes to the considerable recreational potential of the river. Pleasure boating and swimming are also important recreational activities in the basin, and below the Mactaquac Dam the river is used for commercial navigation. Many of the demand conflicts in the basin arise from extensive use of the river for municipal

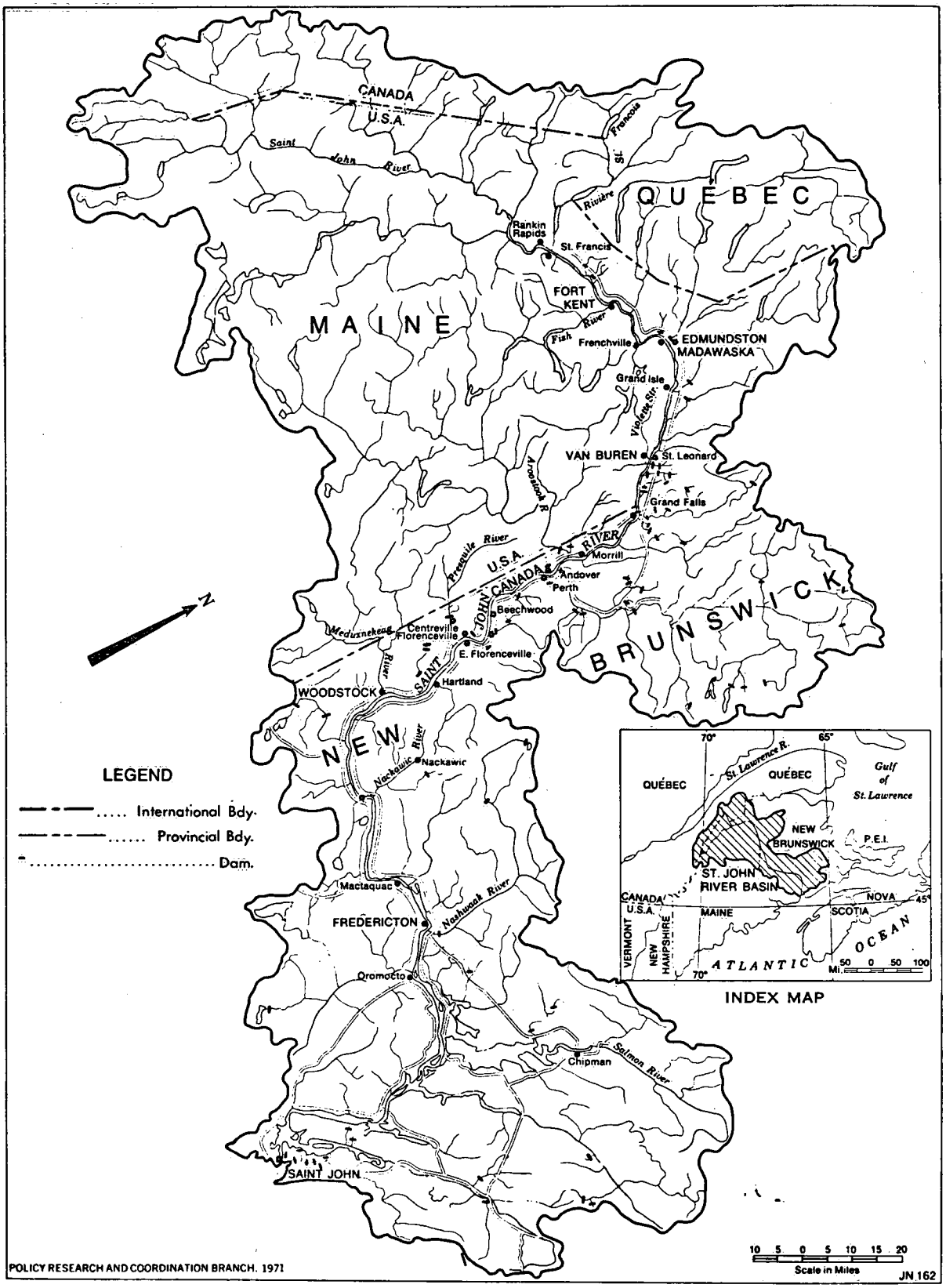

Figure 1. Saint John River Basin

and industrial waste disposal and it is estimated that an average of 774,000 lbs. of biochemical oxygen demand per day were discharged into the river in 1969. Most significant industrial waste discharges are of high organic content typical of the pulp and paper industry and the food processing industry, which in turn reflect the primary economic activities of the area; forestry and agriculture".[1]

There are 9 hydro-electric stations, 4 major pulp and/or paper mills, 7 agricultural processing plants and 3 large cities and towns on the river, in addition to the usual Appalachian pattern of scattered small communities based traditionally on subsistence farming and woods work. Commercial potato growing and mixed farming is now more common, expecially in the river valleys.

Some 300,000 people live in the basin, including about 200,000 in the New Brunswick portion of it. They include some Micmac and Malacite Indians and French-speaking Acadians who together form about half of the province's population, and a similar proportion of Anglo-Saxons made up of descendants of British settlers and the offspring of Loyalists who came north around 1783.

[1] Draft interim Progress Report, pp. 1-1, 1-2, August 25, 1970 (Internal Document).

Data Banks-Their Use in Water Resource Planning; Storage of All Types of Data, Economics of Data Storage, Problems of Retrieval

Sully Solomon

Data banks are systems of storing, developing and retrieving information. I shall emphasize two aspects: developing information and retrieving it.

Obviously in a data bank we do not store information just to have it there. We store it primarily because we want to increase the amount of information available and to make it possible to retrieve it in the form of useful information when needed.

By storing data in a data bank, and through the consequent processing and analysis of the data, a better understanding of the relationships between the variables is developed; and this provides an increase in the information available.

Just to give you a very simple example, if one has in a data bank analyzed and processed precipitation and runoff data, the situation that we often have of maps showing precipitation less than runoff would not occur.

A second, and very important reason for using data banks is the information explosion. We have more and more data. We have increasing means of collecting these data. And if we don't have some means to store, process and retrieve data, the collection of such data may be a waste of money.

A third reason is the fact that we have increased capability of treating data. Earlier, we were used to computing averages, extremes, and maybe occasionally, by time-consuming calculations, variances. Now we go much further to the use of time series, to cross correlation models, to simulation. It would be inconceivable to do these operations without data banks.

A fourth reason for using data banks which is quite important, especially in water resources, is that they allow the handling of areally distributed data. Data banks allow the user to work with segregated figures rather than with average values for the whole basin.

For example, it is possible to store data on the distribution of population in the river basin, and treat each area accordingly, instead of working with lump values.

A fifth reason is the fact that by getting the data in data banks, it is possible to get them updated and to assimilate new techniques into the analysis of the data on a continuous basis.

A sixth reason for using data banks is that they can be of use for checking accuracy of predictions. In most cases, nobody thinks of going back to see how accurate certain predictions included in various studies have been. This is too difficult; it represents a large amount of work and it is generally neglected. If the data is in a data bank it is possible to go back, see what was assumed and what was the accuracy of the prediction. This in turn, can be used for improving the prediction techniques and the related methods of analysis.

Now, the last, but not the least important reason for developing data banks is the fact that these can be made, and ought to be made, compatible with the new technology of data gathering. I have in mind the billions and billions of bits of information collected by satellites and used by various disciplines. These data can be fully used only by means of data banks.

Data banks can be used in many fields; in fundamental research, in geophysical and ecological sciences, in problems of inventory of resources and of development planning. They can be used for planning because the data banks can handle the large amount of information required for planning and design. Furthermore, data banks can also be helpful in the implementation of development and conservation plans.

Furthermore, an important application of data banks is in hydrologic regionalization and hydrometric network planning. An example is the work in the field of planning

the hydrometric network in Canada by the Department of the Environment. The hydrologic regionalization was based on multiple characterization of the region by different indexes related to data stored in the data bank. This made it quite easy to produce the required hydrologic regionalization.

Data banks have been developed by many organizations. Information Canada (D.B.S.) has a data bank. The Department of Transport recently has developed a data bank for meteorological data, but this data bank has for the time being only a station network character.

Other data banks are under development, also station network oriented. This means that they store and provide information only at a series of stations, and they do not estimate information at any other point of the area covered by the network.

Recently, a very interesting development in the area of data banks was conceived by the Geological Exploration Service of Quebec, which has a data bank which is also point (station) oriented but provides possibilities for areal extension (interpolation) of the information.

A very interesting data bank is that of the Canada Cartographic Information System (ARDA). From the storage-retrieval viewpoint it is the most sophisticated data bank which we have now in Canada. The ARDA data bank data is stored in a computer from which you can retrieve data on soils, soil capability, cover and all kinds of data related to the uses of soil at any desired point or for any arbitrarily selected area. Unfortunately, at this point it is still difficult for the public to obtain the required information from the data bank.

There is in addition, a preliminary hydro-meteorological data bank, which I will try to describe briefly later, and which has evolved from the Department of Energy, Mines and Resources work on network planning. This data bank is closely related to the data bank of the Inland Waters Branch (now of the Department of the Environment) on stream flows and the D.O.T. data bank for meteorological data and is supplementing them. As will be shown later, this data bank undertakes to estimate data for the whole area it covers.

What are the most stringent problems in the use of data banks? The main problem is the compatibility between the needs of the users and the capabilities of various data banks. For example, we in Water Resources would like to have data stored according to river basins, but we have data from the D.B.S. according to enumeration areas which in most cases have nothing to do with the river basins.

Also, a very significant problem is that of the compatibility between various data banks, e.g., the Information Canada (DBS) data bank and the preliminary hydro-meteorological data bank which is based on a square grid system and is compatible with the river basin as a data storage unit but not with the D.B.S. enumeration areas.

The other problem is the problem of accessibility. As I said, it is a fact that the ARDA Cartographic Information System has developed a very good data bank system, but it is still inaccessible to the public. The same thing applies to the preliminary hydro-meteorological data bank, which is in our opinion, very significant for water resources users and particularly for water resources planners, but there is still no organized way for someone who does a water resources management study to develop access to the data.

Another problem is that of cost. If the cost of using the data bank is very high, certainly it becomes prohibitive for most users. Costs can be reduced significantly if the number of users increases. As I mentioned earlier, data banks are used not only for storing data, but also for data synthesis. The errors of the synthesized data can also be estimated and then one can evaluate the "value" of the data bank as an information generator by comparing the costs of obtaining the data by synthesis with that of measurements. In many cases, data from data banks, including data from DOT or data from the Inland Waters Branch do not provide estimates of the errors involved and give the false impression of "error free" data.

A very important problem is the coordination of data banks. If all the information which now exists in the different data banks would be stored together in a coordinated manner, much more information could be made available due to the interrelationships between various types of data. A very simple example of a data bank which would put together various sources of information and could probably generate much more estimated information than each one separately, are the data on water quality, water quantity, and geology data banks. If these become coordinated, it would be much easier to estimate, for example, quality parameters in ungaged basins. It is hoped the new Department of the Environment will recognize the advantages which exist in combining the different data banks.

A particular problem may appear in using data banks which is very significant; it is the problem of confidentiality. There are many things which are considered rightly or wrongly as confidential and because of this it is difficult to use individual data such as those stored in the Information Canada Data Bank. This problem will have to be solved in some manner. I don't have a solution. But it's an important problem and I think the laws regarding the environment should be made in such a way that data affecting the environment should not be considered confidential.

I would like to say now a few words about the data

bank which constitutes the Preliminary Hydrometeorological Data Bank which was developed by the Department of the Environment and which has been the basis for the planning of the hydrometeorological network in most of Canada. This data bank has evolved from a study which was done three or four years ago for the Province of Newfoundland and which showed the advantage of developing data banks. This study was intended to provide a general inventory of water resources. We have developed a data bank in connection with this study which was then extended in the frame of successive studies to other areas and at present covers most of Canada, the only exception being Northern Ontario.

It consists basically of the following components:

(a) A space-time reference system;

(b) Data storage (including data screening);

(c) Data processing;

(d) Information transfer techniques;

(e) Information retrieval.

The space reference system consists of a geo-hydrologic reference system and a time coordinate system.

The geo-hydrologic reference system contains two elements: the first element is a square grid system and consists of a matrix of squares covering the area investigated and corresponding to the universal transverse Mercator reference system. Squares of 10 x 10 kilometers were used in most cases, the only exception being Southern Ontario where the size of the square was 5 x 5 kilometers. A possibility of combining a system of larger squares in areas with smooth terrain with squares of smaller sizes in areas where the terrain is more rugged could be included in the system and provide flexibility in application. This is now being investigated in British Columbia and Southern Ontario. The index number of the line and column of the square which is uniquely related to the UTM identification system gives the required indication on the location of each square, including its longitude and latitude. This part of the geo-hydrologic reference system indicates also if the square is located entirely inside the continental area, or partially on the sea.

The second element of the geo-hydrologic reference system consists of a technique of identifying the runoff path starting with the divide between basins and ending at the sea. This indicates in each area containing a divide between basins as to how many distinct basins are supplied by the runoff of the square considered and the corresponding areas and direction of flow with respect to the adjacent squares. For areas without divides, the "inflowing squares" and the square in which the outflow occurs is indicated. This permits establishing at any point of the area the drainage basin above it, the composition of squares and square subdivisions constituting it, the flow path of any additive to the water, etc.

The time coordinate system consists of an origin and referenced time intervals, both of which can be selected arbitrarily according to the requirements of the data bank. The referenced time intervals could be selected in most cases as being months, with possibilities of subdivisions into days, hours, etc.

Component (b), i.e., data storage, consists of physiographic and land cover (use) data stored in each square and meteorologic and hydrometric data stored in the squares in which the stations are located.

The physiographic and land cover (use) data stored at the present stage consists basically of the following records:

- Elevation of the southwest corner of the square;
- Percentage of square covered by forest, marshes, lakes, barren land, agricultural land, and sea;
- In some areas where the information is available, an index of soil permeability.

Meteorologic data stored are limited at present to the monthly temperature and precipitation time series at the stations located in the area.

Hydrologic data stored consist of the daily flows and sediment time series at the stations located in the study area.

Data checks are made using various techniques such as maps of physiographic data, screening by means of limits, screening by means of statistics of data (especially the coefficient of variation), graphical and analytical multiple regressions, multiple correlations between temperature and precipitation time series at various stations located in similar conditions. The latter techniques are also used to complete missing data where necessary. Completion of data is accepted only where this increases the information content of the data.

Component (c), i.e., data processing, contains three groups of operations:

The first group includes the computation of "derived" physiographic characteristics such as slopes, barrier heights, distance to the oceans and shield factors in the eight directions of the compass.[1] All these factors can be readily computed for each square from the physiographic data stored earlier.

The second group of processing operations contains the

[1] All these factors and their derivation are described in the paper and the use of a square-grid system for computer estimation of precipitation, temperature and runoff in sparsely gauged areas, ("Water Resources Res., Vol. 6, No. 5, Oct. 1968), except the shield factor. This is defined as the sum of all elevations which have to be ascended by a wind blowing from the sea shore located in the direction for which the shield factor is computed to reach the given square.

computation of statistics (means, ranges, moments of various orders, coefficients of variations and skew) of the distributions of the physiographic characteristics of various river basins. It is to be noted that such computations can be made automatically for any river basin at any point.

The third group of processing operations carries out the analysis of the meteorologic and hydrometric data and procures long term, annual, monthly and daily means, and other statistics of these values; namely regression coefficients of the monthly or daily correlations, between data at various stations, regression coefficients of autoregressive models and the statistics of the random components of these models, etc. Other features, not included yet such as determination of unit hydrograph and recession curves could be readily incorporated in the processing unit using existing programs.

The Information transfer techniques (Component d) contain statistical and deterministic models, based mainly on combined use of physiographic and climatologic, physiographic and hydrologic, or of all three groups of data, to produce estimated information for any point (square) or basin within the study area.

This data bank was used in conjunction with the available meteorologic and hydrologic data to develop a system of estimating such data at ungaged sites. The relation between error of estimate and station density was used further for assessing the various requirements of the hydrometric network planning. The same system was used for delineating hydrologic regions which indicate the areal variation in hydrologic conditions and consequently the desirable distribution of the hydrometric stations. These results were further used in conjunction with investment and operation costs of hydrometric stations for the optimization of the hydrometric network. It is conceivable that such optimization procedures could be applied to other similar networks.

This is just one illustration of the possible uses of data banks in water resources studies and one can readily conceive the wide range of other applications. Such applications have been already made in the water resources study of Newfoundland and Labrador for Atlantic Development Board, in a research study for the investigation of the effect of changes of land use patterns in the hydrologic conditions of the affected area, etc.

The large possibilities offered by data banks make it imperative that the Federal Government pays attention to some of the problems mentioned above, particularly coordination, accessibility and low cost for the user, to make it possible for the Canadian public to get all the benefits inherent in the reasonable application of the data bank technology.

Modelling, the Use of Data Banks. What Types of Models are Available? What Outcome Can We Expect from Modelling?

Harry Hill

I want to discuss modelling from a very broad point of view. Modelling may mean hydrologic modelling, water quality modelling, economic modelling, limnological modelling or a combination of these.

It may mean anything from a mental synthesis operation, to a slide rule or a desk calculating operation, to a very complicated computer operation. Or it may mean the solution of a set of equations.

A model may be stage versus discharge curve. Possibly, it's a sub-model if you're talking about water resource systems, but it is a model in itself. The definition of the stage versus discharge function is indeed a model, which may be used for predictive purposes.

Another type of model is a flow over a weir type of equation:

$$Q = CLH^{3/2}$$

where Q = flow of water; C = a coefficient; L = length of weir and H = head of water. Hydraulic engineers use this equation all the time.

The simplest type of water quantity models are straight book-keeping operations. How much goes in, how much stays and how much goes out?

In water quantity, estimation models are common. If a certain snow pack exists in the mountains, certain humidity, estimates of flow into a basin for the next month may be made; these are usually derived from regression equations.

Then of course, there are much more complicated water quantity models. There will be book-keeping aspects to it, there may be discharge equations inherent in the complicated model, there may be forecasting equations and routing equations (that is – what does a flood wave do when it goes down a river). The model will include functions for evaporation, ground water input, surface water input, and so on.

The common water quality models are simple nutrient balance models which are book-keeping models – how many nutrients go in, how many stay in, how many go out of a particular water body, or a particular watershed. Another type of model water quality people like to use are dissolved oxygen models, simply because dissolved oxygen has been set up in the past as a criteria of water management. The Streetor-Phelps equation is fairly well developed from the computer point of view, it describes a time function of dissolved oxygen. Put a substance with a B.O.D. (Biological Oxygen Demand) into a creek and as it flows downstream the dissolved oxygen will vary. There are reasons why the over simple Streetor-Phelps model doesn't work in many streams. There are models of conservative pollutants, which are book-keeping types of models.

Economic models are also used by the water resource planner. One of the most common to the economist is the input-output type of model. Using DBS data, relationships between different variables may be found and regression equations formulated to assist in the development of prediction models based on these statistical data.

Micro-economic models are of interest in water resources; a stage versus damage curve for flood control is one example. In Okanagan Lake, if the water level goes up two feet above normal, what's the damage? We should know. These functions must be described empirically. On the Fraser they are developed for each sub-region. They are very expensive functions to develop.

Limnologists use information and they model systems in a more subjective manner. The ecosystem is rarely defined mathematically; it is defined qualitatively, so that experience from other parts of the country and the world may be used in developing an appreciation for the system. If an input variable is changed something is going to happen

to the system. This type may be called subjective modelling.

Now, in order to model water resource systems, we have to put a lot of data together – data from the fields of water quantity, water quality, economics, limnology and possibly others. An "optimum system" is required. Of course, an optimum system is an unattainable ideal, which may only be approached. A watershed may have a couple of dams on it, a city that has flooding, and it may also have a wastewater assimilation problem. The problem may be – how should we set operation rules for the two dams in order to maximize the benefits to these peoples? This way of setting up the problem allows the planner to leave the tricky micro-economic problem of assigning values to water quality out of the modelling. A higher water quality standard may be planned for, but it will cost so much more money, in terms of flooding. When I think of water quality models, or modelling for a water quality problem, I always tend to think of this type of output, rather than defining a micro-economic function for pollution control.

How well does a model actually reflect what's happening in the real world? The degree of fit might be very good for an expensive model. If not very much money is allotted to modelling some of the "degree of fit" as I call it, with the real world is lost. A "reasonable" degree of fit is required. Sully Solomon's way of proving a model he described is to leave 30% of the data out, and then compare the estimated data with the real data by statistical means. I find that whether it's a physical model like the South Saskatchewan Dam Spillway or St. Lawrence River or a mathematical model, after the modellers use the models for a while they begin to believe in the model. An objective measure is required to find how good the fit really is.

The other issue is criteria. I've given you one situation where I stayed away from the criteria of water quality by just leaving it as a variable in the output. When designing a model the criteria to be used must be known. In terms of water quality, a very complicated criteria using dissolved oxygen, plus plant growth, plus animal growth, will probably result in a combined quantitative and qualitative model. It may be just too complicated in mathematical form, so qualitative types of models are used. But they must all fit together. (The quantitative output can be given to the limnologist and so on).

There are some questions which anybody may ask when he's thinking about a model; and I think these are – is a model wanted? Do we really need a model on the St. John River? A water quality model? And how do we find out if we really need one or not? And if so, how complicated should it be? If it's too complicated we might never get anything out of the thing. We may keep putting dollars into its development and not get any answers. And where should it run? Who should develop it? How much should it cost? If it's done a long way from where the integration of the output into the decision making process is going to occur, I believe there's less chance of the integration taking place. These are questions that I'd ask.

There may exist models within models, different types of models, different sophistication of models, and so on, and it is obvious to me that each job likely warrants a different model. Because the number of variables in a technical model are immense, one couldn't hope to build a universal model, certainly not with the computer size that we have now.

I'd like to end on a positive note on models; possibly I've been a little negative. There is a real use for models and this is in defining and illustrating the output from a complex system which can be simplified to the extent that the system may be represented mathematically. Models are used to test an array of possibilities; what would happen if I did this, this and this? By hand only a limited number of possibilities may be tested. By computer many, many possibilities may be tested.

Financial Arrangements - Flow of Money - Bookkeeping, Budgetary Constraints

Jacques Therrien

Unfortunately, I will not be able to talk specifically about your problems, because I know very little of them. The financial management of the F.R.E.D. Agreements will be the topic of my address.

We have basically three mechanisms developed in the Agreement for management purposes; the structure, the decision-making process and the financial management plan are integrated, or inter-related. The Committee structure of these Agreements are as follows. At the top we have the Federal-Provincial senior committee which we call a Joint Advisory Board. This board is usually composed of Deputy Ministers; Provincial and Federal. They usually meet two or three times a year. On the Federal side we usually have an ADM or a DM from our Department, and an ADM or a Director from the Department of Finance or Treasury Board and a representative from another Federal Department which is involved with the plan. It is very important to have Treasury Board personnel on this kind of Board. Usually, the other Federal Department represented is the Department of Manpower and Immigration, because Manpower and Immigration are usually involved with the F.R.E.D. Agreements. But it may be somebody from, let's say the Department of Transport, if the plan involves mostly transport. And on the Provincial side, equivalent representation exists. Usually a Deputy Minister of the Department responsible for the implementation of the plan, plus some representative from the Department of Finance, Provincial Department of Finance, and finally another DM represents the other Provincial Government interests.

Since the Board meets twice or three times a year at the most, it needs to delegate authority. Responsibility for the day to day management of the plan falls to the Management Group. In order to have this Management Group as effective as possible, it is usually composed of two men – one from our Department and one from the Province who is again responsible for the implementation of the plan. With a Committee of two, it is easy to meet, and they can have informal meetings. Consequently, they are in permanent, daily contact. They can take any day-to-day decision necessary to implement the plan. I will explain how the decision-making process is related to this Management Structure and their role in the Financial Management plan later.

This structure is quite definitely spelled out in the Agreement, in order that everybody knows the rules of the game before they start demanding who has the responsibility. But usually these people work with a Co-ordination Committee, we call it, and the name can vary from one place to another depending on the size of the agreement, the amount of money involved, and the area involved. We have at present a plan in Manitoba where there is a population of 50,000 people. We have on the other hand within the Gaspe a population of 325,000 people. So depending on the management of the plan and the money involved we may have under this Management Group a more or less complex series of Committees, Federal-Provincial Committees or Inter-Departmental Committees within the Federal or Provincial governments. We have a number of Federal-Provincial Committees for specific tasks.

But there is one thing clear in the Agreement and I think it's important to spell that out. All these structures of committees are responsible to the Management Group. Because the tendency is always to have people dream about a nice committee but for one reason or another, personality conflicts or other reasons, he wants to report directly to the Joint Advisory Board; and I don't think that's entirely satisfactory. But in 90% of the cases, people who are responsible for the particular management of the plan, also have responsibility for any committee working on the Agreement even if they involve people coming from other places. If a specialist is needed, for example – a planner – or a specialist of some kind, to work on a specific case within a committee, there exists a tendency for the specialist to come and try to be responsible to a member of the Joint Advisory Board rather than to the Management Group and that may create problems. But we try to spread the word that the Management Group are the only people who talk to the Joint Advisory Board. That may create

problems too, as far as the Department structure is concerned, because if you put a D.M. or an A.D.M. on the Joint Advisory Board and if you put a regional representative on the Management Group, there may be a whole line of responsibility going through a Director, and an Assistant Deputy Minister, and so on and so forth. The Management Group must report directly to the Joint Advisory Board.

Now, how does this structure work in the decision-making process? First of all, the FRED Agreement usually specifies the programme to be undertaken. And by programme, I don't know if you are familiar with the distinction between programme and project, but it's quite important in this decision-making structure. In the FRED Agreements, we have ten programmes: Agriculture, Forestry, Transport, Manpower training, and etc. Manpower training is entirely responsible to the Department of Manpower and Immigration, and all departments come into contact with the Department of Manpower and Immigration. But nevertheless, this is included in the Agreement to make sure that the activity of Manpower and Immigration are coordinated with the activity of the Provincial departments and the other Federal Departments. The manpower activity may be demanded by the Provincial Director under the Agreement, but financed jointly by our department. To take an example – what usually happens even if the Department of Manpower and Immigration is responsible for its own programme across Canada? The Department explains to the Board at every annual meeting what the Department of Manpower and Immigration wants to do in the region, how many people they want to train and how much money they want to spend in the region. This is the whole process of coordination of Federal and Provincial Activity, and within the Federal Government coordination within the departments acting in the region. I guess this example will be applicable to your own planning, because if I understand correctly you are in the business of River Basin Planning.

I mentioned that we have programmes, and the Agreements specify how much money over a certain period of time will be spent in each programme such as Agriculture. As an example, the objectives of the programme may be to reduce the number of farms from 10,000 to 3,000 farms in the area because we don't think there is room for more than 3,000 viable farms. It may be to reduce the number of people engaged in agriculture from 20,000 people to 6,000 or 7,000 people. So the difference between the two populations must be diverted to other activities. There is a certain amount of money for regrouping of farms, conversion of land use from farming to other purposes like forestry. There is a budget that comes in the Agreement for the programme of agriculture to implement the above objectives.

At the annual meeting, the Management Group presents the Joint Advisory Committee with specific projects with a budget attached to every project. The Board approves or changes or rejects the projects. But when they are approved by the Board, the Management Group takes the steps to implement this project within the implementation structure and within the budget schedule of each project. It may be a project implemented by the Federal Government, or it may be a project implemented by the Provincial Government but with the costs shared. The day to day decision to move money from one project to another within the same programme is taken by the Management Group. A Treasury Board representative on the Federal side and one on the Provincial side have a specific function on the Board. The reason we specify the financial management plan is we want to make sure that if we are delegating authority on the Federal side to the Joint Advisory Board through to the Management Group, we want to make sure that the Provincial Department is doing the same. In other words, there's no use having nice flexibility as far as the budget is concerned on the Federal side specifically when they share costs with the Province and the Province lacks flexibility.

Now what is this financial management plan? It provides two things. First of all it's a delegation of authority from one Treasury Board to another Treasury Board, of course, from the Provincial Treasury Board to the Joint Advisory Board within the envelope of the programme approved by the Treasury Board. The envelope of a programme is a statement expressing objectives and expressing a certain strategy. For example, a strategy in agriculture may be to solve the problem of unvaluable farms through consolidation to larger farms. That's the strategy and the objective may be to arrive at 3,000 farms rather than 10,000 farms over a ten year period. And within this envelope approved by the Treasury Board, the Joint Advisory Board can approve specific projects presented by the Management Group, with a specific budget attached to each project. And as long as the Joint Advisory Board remains within the envelope, financial, objective and strategy, as approved by the Treasury Board, he can approve specific projects on his own decisions. And then the Management Group in the course of the year can switch projects from one project to another project, if they see that one project is going slower than another project, and if they want to make minor adjustments to the projects. And, of course this implies that the Management Group know what's going on, because you can't switch projects if you are not up to date on a day to day basis. And I think basically we can achieve an up to the minute financial picture through a Management Information System which will tell you how much money you spend, let's say every three months. How much money you spend

on a project, and how much you expect to spend until the end of the year.

The best way to keep up to date is for the Management Group to have a direct contact with somebody responsible for each project, or if you have say thirty projects, then you name one person, whether it's a Provincial civil servant or a Federal civil servant to be responsible or in charge of this project. You ask him every month to report verbally or in writing (anyway at all) how much in his own opinion he did spend during the month and how many objectives he did reach.

Developing a Project Plan

Harry Hill

The jurisdictional characteristics of the Canadian scene have influenced the mechanism of negotiation in the development of Agreements to plan. There has developed a long process from a statement of need for a watershed plan to the signing of an agreement; this process will not be discussed in this paper. The Policy and Planning Branch has defined this process in a long diagram showing the steps involved. For the purpose of this paper it is sufficient to say there exists a negotiative procedure.

After the signing of the Agreement but before field staff begin to collect and analyze data a period of project development is required which will be documented here based on experience gained during development of the Okanagan, Qu'Appelle and Saint John project plans.

During the development of these Agreements a lot has been said about comprehensive planning. The comprehensiveness of the Agreements is important.

1) Different disciplines are involved in the definition of the problem. Different disciplines speak different languages, have different ethics, and recognize different problems and different solutions to a problem. In order to communicate in the solution of problems a rapport must be developed in order that basic questions may be discussed frankly.
2) Different government agencies are involved; these agencies are represented by different disciplines and represent different legislation. They deal with variables and programs which are the result of federal and provincial legislation. The jurisdictions represented are many and varied due to the comprehensive nature of the planning.
3) The external effects outside the watershed or area of agreement of planning decisions within the watershed must be documented and evaluated.
4) The public are involved in the solution of their own problems by agreement.
5) The planning is, by definition, planning for multi-objectives. The idea of multi-objective planning is not an easy one to comprehend, especially when the benefits and disbenefits of the plans cannot be quantified.

The constraints on the planners must be comprehended in order that a project may be developed which will satisfy the terms of the Agreement. Before the signing of the Agreement the drafts go between governments for modification. During the process a word is changed here and there which is very important to the author but may be less meaningful to others involved in the process. The author's objectives are implicitly stated in these changes. The final Agreement may read like so much motherhood to the casual reader. Therefore, the persons responsible for turning the Agreement into a project must discover the meaning of the Agreement as seen through the eyes of the many authors. In the development of the project there are other constraints:

1) There exists a reporting date for each Agreement. The time available is definite.
2) The governing set-up of Boards and Committees results in constraints. Senior, busy people must come together to make decisions. These people are of varied background, represent different interests, different jurisdictional limits, different programs, and they speak different discipline languages. Many steps are involved in order that the project may get under way and the Committee and Board must reach agreement on the decisions required. This involves working out jurisdictional conflict problems, developing a relationship of trust, and finding ways of making overall decisions.
3) There usually exist varying commitments on the part of the specialist civil servants at the time of project development. They may have been committed several months before the signing, however, other commitments may have pre-empted their interest during the negotiation time required for reaching agreement.
4) It is usual that time constraints do not allow long scientific studies to be carried out during the tenure of the Agreement. There is a tendency for scientists to think of obtaining new knowledge rather than of finding ways of using existing knowledge in planning decision making.
5) There exists a tendency to spend a lot of money on aspects of the problem where there already exists a great

deal of knowledge in relation to fields where little is known. The more we know about a problem, the more we would like to find out.

6) The budget constraints are spelled out in the Agreements. There may also be manpower constraints; especially in rapidly developing fields.

The development of a project plan becomes a complicated process due to the objectives and constraints outlined above. The process of developing a project plan will vary depending on the problem and the personnel involved. Some steps which I find to be useful are listed below.

1) Interview each associated agency, community and interested party in order to ascertain: the different agencies programmes which may be used in implementation of the plan, the legislative control over the various planning variables, the aspirations of the different interest groups, and the existing perceptions on the real meaning of the Agreement.

2) During the interviews determine the types of studies envisaged, the resources available for carrying out tasks, and details of any related studies existing or historic.

3) The project plan developers must get on-site knowledge of the study area. This is usually difficult to do because of the time constraint but it is an essential aspect.

4) Develop a framework of decision making.

5) Develop a comprehension of the required knowledge for decision making. This may be stated in terms of information objectives or in terms of groups of tasks.

6) A seminar at this stage is useful in bringing together knowledge of the process from a number of fields. Also, the personnel involved may work out the anticipated decision making process in a cooperative manner.

7) At this stage the relative importance of priority areas of study will emerge; the general budget priorities of ecological, economic evaluation and studies may be discussed.

8) A flow diagram of tasks showing the decision points, reporting dates, interconnection of tasks is required. At the same time, a description of tasks by name, objective, scope, reporting date and anticipated resources available for the job may be developed.

9) General budget figures may be developed at this stage. It is essential to develop relatively firm budgets for the first year. The remaining budgets should be left as loose as possible whilst fulfilling the objective of showing, as far as possible, the anticipated direction of the study.

10) The proposals for operation of the study office, book-keeping, and quality control must be developed at this stage.

11) Throughout the above processes as much communication as possible is required between Committees, Board, scientists, planners and so on in order to produce as acceptable a package as possible.

12) Present the agreed upon package to the Committee and Board for approval.

Upon the approval of the study authorities, the tasks may get underway. Also, at this time, a study director should be given the authority for directing the program as devised.

When the tasks are actually let to consultants, government departments or whatever, a complete understanding on the objectives of the task, interconnections with other tasks, other tasks required or giving information should be developed.

After a certain time, it's probably the study director's job to find out whether these tasks are meeting expectations, whether they are overspending or underspending. Also, it is his responsibility to make sure that synthesis tasks actually take place; that is, that people actually come together and synthesize information from several different tasks and a report on this synthesis is brought out. An example of this in the Okanagan is nutrient input to the lakes. The main synthesizers there are limnologists from the Freshwater Institute and the water quality people from the B.C. Pollution Control Branch. Now, these people live in different places, they talk different languages, they have different standards and so on, so that this task is a difficult one to do. After this information is all together the limnologist can say, "Well, you found out something about waste coming in here, we found out something about the life in the lake at this point; this indicates that there is some problem here which we haven't found yet, so we need more water quality data here. Or the indications are that all this water quality information on this side of the lake is enough for us. We have enough information there. We can cut off the water quality programme as far as we're concerned in developing a scenerio of the life of the lake". So these integration tasks are very important. I see these as some of the most difficult.

Finally, the project plan should be updated continually in some comprehensive way with everybody involved taking part in it. Busy people from different parts of the country must come together to take part in this process.

The Evaluation Process in Comprehensive River Basin Planning with Reference to the Okanagan Basin Study

Jon O'Riordon

Because some of the terminology used throughout this paper is placed in a context which may differ from that to which the reader is accustomed, it seems appropriate at the onset to present the definition of certain terms that appear frequently in the text.

Objective

A major policy goal set by the highest decision-making body in government. An objective has instrumental value because it leads to a higher valued goal, that of improving social welfare. The statement of objectives should include measurement parameters to indicate the degree to which they are achieved and to ensure that the objectives do not overlap. Examples of objectives include increased economic growth (regionally and/or nationally), improved environmental quality and an equitable distribution of opportunity.

Target

In this paper, the term target refers to a specific means of allocating resources to achieve one or more of the planned objectives. In the case of the Okanagan Study, targets will be expressed in terms of water management goals. For example, the planning objective of achieving economic growth in the Okanagan basin might be achieved through the target of supplying water in the region for agricultural needs to 2020. Similarly, the planning objective of improving environmental quality might be partially met by the target of providing water quality standards consistent with body-contact recreational sports.

Sub-Targets

Sub-targets relate targets to specified water resource demands in a study. For example, a sub-target related to the target of improving water quality might be to improve the water quality in a particular lake or reservoir to a specified water quality standard. Of course, the decision whether or not a sub-target should be achieved will depend upon a rigorous analysis of the benefits and costs associated with achieving this target.

Benefits

Benefits are defined as positive contributions to achieving objectives through meeting specified targets or sub-targets. When possible, the benefits associated with each target will be categorized into the multiple objectives. Because of the inter-linkage between objectives, aggregated or joint benefits will arise, which will require special consideration to avoid double-counting. When possible, aggregated benefits will be distinguished from separable benefits, as the latter can be fully attributed to a particular objective.

In the case of the agricultural water supply target, direct benefits associated with the economic growth objective could include increased or more efficient production of agricultural outputs, while indirect or secondary benefits might involve the benefits stemming from the location of a new fruit processing plant. In terms of the environmental quality objective, such factors as aesthetic appeal, due to landscape diversity or the psychic enjoyment of picking fresh fruit may be positively valued by the society and therefore accounted as benefits.

Costs

Costs are defined as negative contributions to objectives through meeting specified targets or sub-targets. Not only are there economic costs associated with actual monetary expenditures, but there may be environmental costs such as the loss of recreational experience and social well-being costs such as an increase in food risk for a certain community. Like benefits, joint costs may occur and must be treated with caution to avoid double-counting.

Project

A project refers to any alternative means for achieving a specified water resource target or sub-target. Thus, a project may refer to a structural alternative such as a new reservoir or canal or it may refer to a water management alternative such as metering and pricing water supplies or land use zoning. Because of their nature, projects are usually associated directly with sub-targets.

Comprehensive Plan

An array of water quantity and water quality projects which combined, form a complete comprehensive water management plan. Thus, while projects are designed to achieve targets and sub-targets, a comprehensive plan is designed to achieve the multiple objectives of the study.

INTRODUCTION

I would like to begin my talk by saying that I do not intend to cover the whole range of contributions that economists and sociologists make in comprehensive planning. Specifically, I intend to review the principles for evaluating alternative plans and to develop the concept of using an evaluation matrix in this evaluation process. I believe that the development of a sound framework for evaluation is one of the most important contributions that social scientists can make to the planning process.

At this point, I would like to emphasize that I am feeling my way in this matrix approach to evaluation and would genuinely appreciate constructive criticism about the approach both in this seminar and later on. I have written a paper on this subject (O'Riordan, 1970), which was presented to the Okanagan Basin Study Committee and with Committee permission, I would like to acknowledge at this time, the help and support of Mr. Jack Glenn, who is working in the Qu'Appelle Basin Study and who has also written a paper on the recent approaches to evaluation (Glenn, 1970).

Although this paper concentrates its attention on the evaluation process, it does attempt to review this evaluation process within the whole perspective of comprehensive basin planning. The paper begins by defining the scope of comprehensive basin planning through a review of the historical sequence of planning strategies. Then the complete planning process is briefly discussed to indicate the inter-relationships between its three major components – the evaluation process, basic planning activities and the institution structure. The main part of the paper examines in some detail each of the principal steps in the evaluation process, leading to a description of a conceptual model of the evaluation matrix. Finally, the implications of this evaluation matrix upon decision-making are discussed.

THE CONCEPT OF COMPREHENSIVE RIVER BASIN PLANNING

The concept of comprehensive river basin planning is perhaps best defined by reviewing the historical sequence of strategies in water resource development and planning. Four strategies have been identified (White, 1969). The first is *single-purpose* development and is exemplified by private schemes for irrigation water supply or the building of canals to improve inland navigable waterways. These projects were usually small in scale and localized in their impact upon the economic, social and physical environment.

The main purpose of this type of development was to promote economic growth. Scale economies were soon recognized by planners and led to larger scale projects which were multi-purpose in nature. Because of their size (and other reasons) such multi-purpose projects were undertaken at public expense and have their most notable examples in the T.V.A. development, which produced water power, water supply and recreation benefits. Although this strategy is classified as multi-purpose, it had essentially a single objective, that of increasing national and, in some cases, regional income. Economic efficiency criteria based on the technique of benefit-cost analysis were developed to evaluate projects and aid decision-making.

As readily available water resources were utilized, and new engineering techniques developed, planners devised more ambitious projects including large-scale diversions from one watershed to another. Such schemes produced major impacts on the economic and physical environment giving rise to a growing public concern for protection of the natural environment, particularly the ecosystems that were threatened by such large-scale interventions. The increasing costs of water resource development in both financial and environmental terms ushered in a third strategy of multiple means – multipurpose river basin planning (National Academy of Sciences, 1966). This strategy explicitly increased the range of alternatives to solve water supply problems, encouraging more efficient use of water through proper management as an alternative to large-scale diversion. For example, land use zoning or flood proofing of buildings were examined as alternatives to constructing dams or dykes; water metering was introduced to reduce demands, and waste treatment was encouraged instead of increasing water supplies to dilute wastes.

I would like to emphasize at this point that the main objective of all of these strategies I have mentioned so far is to develop and/or manage the water resource to stimulate economic growth. So essentially there was a single objective – economic development, which was realized by several purposes – supply for irrigation, industry, population growth, flood control, hydro power and navigation. But people were also becoming aware that water is an

important constituent of the environment – it is pleasing to look at, to swim in, to boat upon, to support valuable fish and wildlife resources. In addition, water can play a major role in community life and development as I think it does in the Okanagan Valley in British Columbia.

This awareness of the environmental role of water has required that the objectives of planning must be expanded to include environmental and social goals in addition to the traditional economic one. This has resulted in a fourth strategy, which I term *multiple objective – multiple means* or comprehensive planning and it is this strategy that we are developing in the Okanagan Study. Comprehensive planning represents a new strategy in water resource management in Canada, built upon the well-tested strategies of the past, but because it is new it requires fresh approaches to evaluation, to decision-making and to multi-agency co-operation. This paper outlines a broader, and, I believe, a more appropriate approach to evaluation of comprehensive plans than has been used in the past.

THE OKANAGAN BASIN STUDY

With this historical review in mind, I think that it is now pertinent to examine the Okanagan Agreement and check how it matches up to the strategy of multiple-objective, multiple-means planning. The Agreement explicitly states that there are at least two major objectives to the study:

> "... The purpose of the Agreement is to develop a comprehensive framework plan for the development and management of water resources for the *social betterment* and *economic growth* of the Okanagan Basin ...".

The Agreement also stresses that multiple means, i.e., a wide range of alternatives will be examined to meet these objectives, when it states that the study will:

> "... focus on the evaluation of economic, engineering, ecological, financial and organizational alternatives for water resource utilization ...".

Further, social values as well as economic values must be taken into account for the Agreement declares that the public will be involved in the planning process:

> "... to enable the comprehensive plan to be truly responsive to the wishes of the people for which it is designated ...".

Clearly then, the Agreement fits into the strategy of comprehensive planning. But, as a result, the broad scope of the study has its implications. Firstly, it costs more – up to $2 million can be spent for the planning phase of the study – which means that more money will be spent when we implement our plans. Secondly, the planning process is more complex, more disciplines are involved, and more work is required to integrate the results of the various components of the study.

Whereas planning in British Columbia used to be undertaken by engineers, in this study we have biologists, ecologists, economists, and sociologists as well as engineers working on the problem. Thirdly, the scope of the study may expand geographically. Should the planners indicate that water must be brought into the basin from another watershed, then we would be required to examine in detail all the economic, social and environmental repercussions of such a diversion before a decision could be made.

THE PLANNING PROCESS

To understand the comprehensive approach to the evaluation process, I must first place it in context of the overall planning process. The description of planning presented here is based upon the concept that planning is a process of social change (Bishop, 1970). There are basically three components to the planning process:

The Evaluation Process

The evaluation process is based upon a hierarchal structure of objectives from those of broad policy goals down to detailed water resource sub-targets.

Sequential Structure of Planning Activities

The sequential structure of planning activities represents the main planning activities and decisions throughout the planning period.

The Institutional Structure – The Planning Participants

The institutional structure identifies all the interest groups both in the three levels of government and the general public and indicates how the decision-makers interact at any point in the planning process.

The interaction of these three components can perhaps best be visualized with the aid of a three dimensional diagram (Figure 1). This figure is presented to indicate that planning is a highly dynamic process, which passes through a series of logically related steps (often repeating the cycle several times), and that at each step in the planning process a number of hierarchally related decisions must be made by the complex institutional structure.

When discussing the evaluation process, I recommend that the reader refer to Figure 1 so that he can understand how each step of the evaluation process interacts with the appropriate steps in the other two components of the planning process.

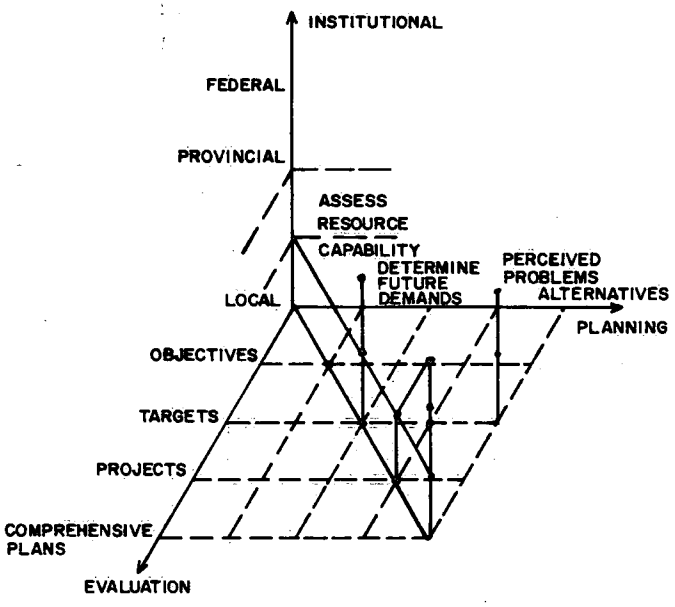

Figure 1. A Three-Dimensional Planning Space (after Bishop, 1970).

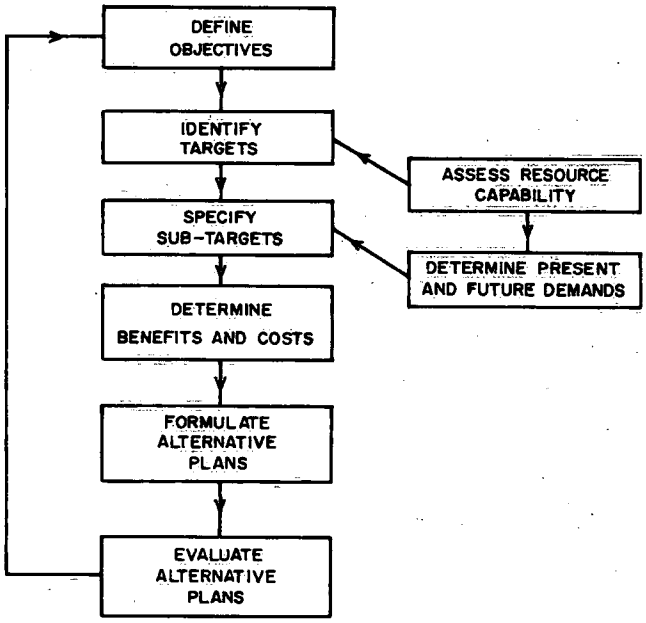

Figure 2. Simplified Evaluation Process

THE EVALUATION PROCESS

As is the case for all components of the planning process, the evaluation process can be stratified into a hierarchy according to the level of detail required at any particular point of time in the planning process. Each element in the process can be decomposed into various subjects down to the smallest element in the evaluation process which is called the sub-target, i.e., a specified water use for a particular location in the study region. A general hierarchal structure of the evaluation process with key linkages to elements of the other components is indicated in Figure 2. The diagram shows that objectives are decomposed into targets and then sub-targets where particular problems are studied and then the sub-targets (and related projects) are aggregated into integrated planning alternatives. The whole process should be reiterated for review and modification as time and money permit.

The remainder of this paper is devoted to a discussion of each of the hierarchal sequence of steps in the evaluation process as shown in Figure 2. The reader is asked to review the definition of terms at the beginning of this paper as many terms are used in a rather special context.

THE OBJECTIVES OF COMPREHENSIVE RIVER BASIN PLANNING

The commonly stated idealized goal in water resource planning is to maximize social welfare. Generally speaking, a person's welfare is increased if he is somehow better off as a result of some action than he was before. But the objective must be more precisely defined and include specific measurement criteria before the decision-maker can be certain he has achieved this ideal goal.

Until recently, welfare was usually measured in monetary terms and welfare was said to be increased if a person's net private consumption of goods and services was increased. Today, the values associated with welfare appear to have broadened to include 'the quality of life', as well as a more equitable distribution of opportunity. Therefore, we must be more explicit in our definition of social welfare if we are to include all relevant human values.

I have produced a hierarchal system of goals in Figure 3 to help define the relationship between the different levels of goals in comprehensive planning. The figure indicates that social welfare can be achieved by meeting a number of broad objectives. These objectives are major policy goals, set by the highest decision-making body in the government and are therefore instrumental for achieving the higher valued goal of improving social welfare. It is important that these objectives are explicitly defined and shown to be non-overlapping (though they may conflict) and that their definition includes measurement parameters to indicate how resource allocation decisions may achieve them.

The terms social betterment and economic growth used in the Okanagan Agreement are examples of broad objectives. However, they are ambiguously stated and although

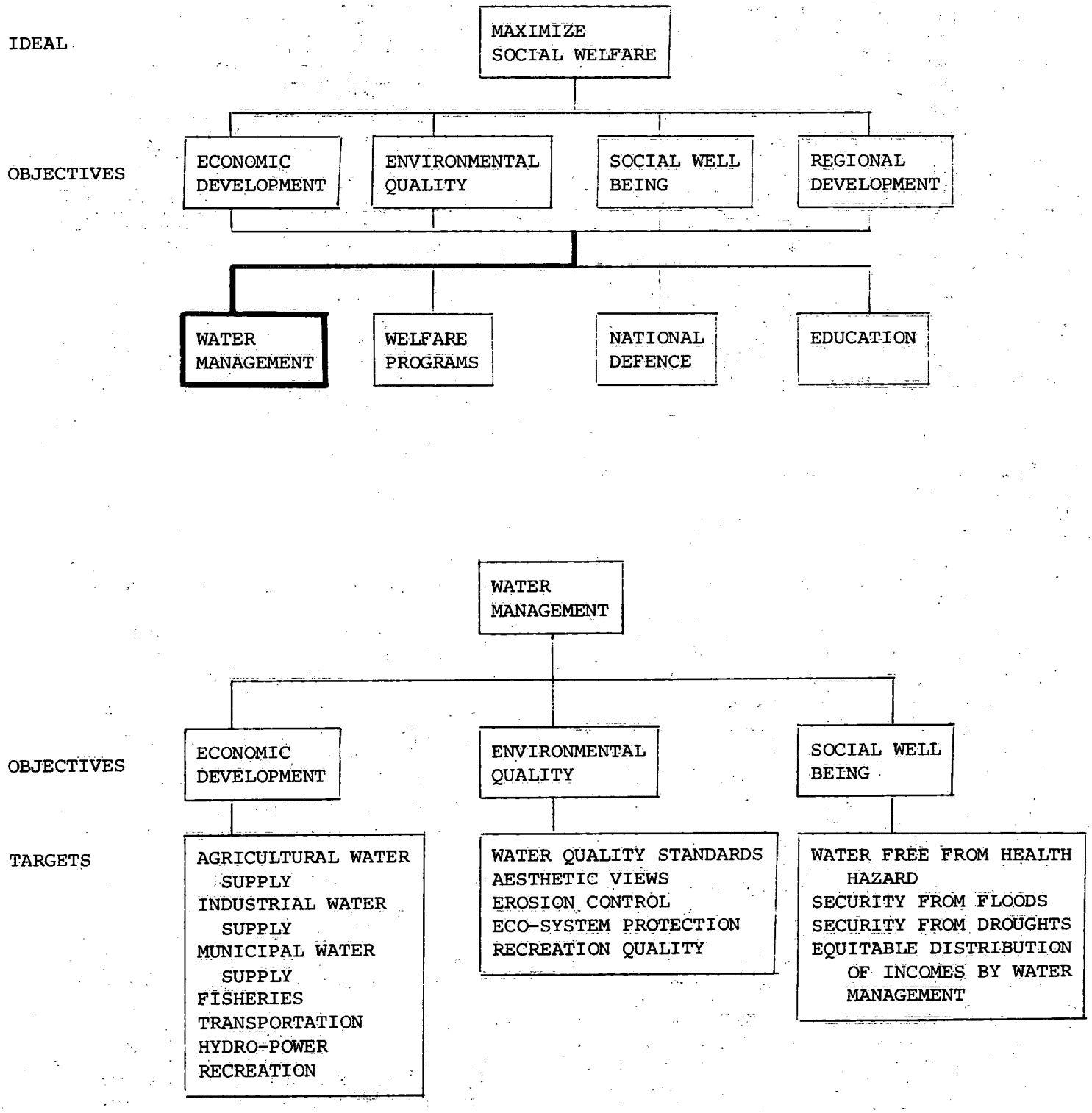

Figure 3. Goals and Objectives

the decision-makers at the policy level of the Federal and Provincial governments[1] should ultimately be responsible for more precise definitions, it is perhaps the role of us planners to recommend such definitions to the Consultative Board. In this context, I have identified three objectives for the Okanagan Study and define them accordingly.

1. To increase economic development in the Okanagan and surrounding regions as measured by its net regional income, i.e., that net value of incomes, goods and services. The geographic boundaries of the region will be drawn wide enough to encompass all significant project effects.
2. To enhance environmental quality by management, preservation and improvement of certain natural and cultural resources and ecological systems. A social preference index net of costs required to produce a specified level of environmental quality will be developed as a measurement parameter.
3. To enhance social well-being by creating a more equitable distribution of opportunity as measured by net per capita incomes, employment and population densities, and by contributing to security of life, health and property.

There are a large number of economic and social measures that can be chosen to achieve one or more of these broad objectives and thereby the ultimate goal of improving social welfare in the Okanagan; for example, grants for industrial expansion, manpower retraining centres, and subsidies for the agricultural industry. It is important to understand that water resource management is only one means of allocating resources to achieve these objectives. Ideally, comprehensive regional planning should examine a wide range of these social and economic means to achieve improved social welfare and allocate resources so that the marginal value of benefits (in terms of net social welfare) is the same for all social and economic programmes.

In fact, only water resource management was specified in the Agreement and therefore all targets are specified in water resource management terms.

IDENTIFICATION OF WATER RESOURCE TARGETS

The next step in the evaluation process is to specify how water resource management measures can achieve the previously stated multiple objectives. For this purpose, water resource management means or *targets* must be defined and again the definitions should include measurement parameters that are compatible with those of the broad objectives so that the decision-maker can evaluate the degree to which these objectives have been achieved. Although each water resource management target is primarily conceived as a means of achieving one or other of the multiple objectives, any target could also contribute to other objectives. For example, the target of increasing water supply to increase the net value of agricultural production in the Okanagan obviously contributes to the economic development objective, but also may contribute to environmental quality through the preservation of green spaces (diversification of landscapes) and to the social well-being objective through maintaining employment and therefore incomes to family farmers.

It is important to understand at this time that the merit of achieving the water resource targets listed below should be evaluated in terms of all of the multiple objectives. Under the more traditional benefit-cost analysis, targets were evaluated simply in economic terms, i.e., whether they contributed to an increase in net regional (or national) income, and decisions were based upon the performance criterion of maximizing net benefits.

Under multiple-objective planning, each target should be evaluated in terms of economic growth, environmental quality and social well-being and decisions will have to be based upon a complicated trade-off performance criteria which hopefully will maximize net social welfare (see section on decision-making).

Listed below is a preliminary statement of water resource management targets, all of which are explicitly or implicitly stated in the Okanagan Agreement.

1. To meet agricultural water supply needs in the Okanagan basin to the year 2020.
2. To meet domestic and municipal water supply needs in the Okanagan basin to the year 2020.
3. To meet industrial water supply needs in the Okanagan basin to the year 2020.
4. To provide adequate water quantity and water quality to satisfy water-oriented recreational demands for the Okanagan basin to the year 2020.
5. To provide all communities and individuals in the Okanagan basin with adequate protection from floods to the year 2020.
6. To provide adequate lake and river levels in the Okanagan basin to support water based transportation.
7. To preserve, protect, manage and enhance fishery and wildlife resources in the Okanagan basin to meet the commercial sport and aesthetic demands of the people in the basin.
8. To preserve, protect and enhance natural and cultural landscapes in the Okanagan to meet the aesthetic demands of the people in the basin.

[1] In the Okanagan Study, the policy level is represented by the Canada-B.C. Consultative Board

9. To provide optimum water quality standards in the Okanagan basin to meet the needs and desires of the people in the basin.
10. To prevent and protect against water induced erosion in the Okanagan basin to the year 2020.

In effect then, water resource targets represent all relevant uses of water resources in the Okanagan basin which may ultimately contribute to the achievement of the multiple objectives. Thus, targets should not be identified until the Consultative Board has agreed to a set of precisely stated, non-overlapping multiple objectives. I see it as a function of the strategic level of decision making, represented by the Okanagan Study Committee to decide upon targets and for them to obtain feedback on these targets from the local agencies and organized groups in the Okanagan.

SPECIFIED SUB-TARGETS AND WATER REQUIREMENTS

As defined at the beginning of this paper, sub-targets are specified elements of targets and are usually related to spatial components of the water resource system. Figure 2 indicates that an array of sub-targets can only be specified once economic growth studies and other demand studies have been completed and the capability of the existing resource base to meet these demands has been assessed. For example, there may well be a need to improve water quality in the Okanagan basin, but that need will likely vary from one lake to another and therefore specified water quality sub-targets may have to be established to look at each component of the water resource.

Each sub-target must contain specified water quantity and water quality criteria and an appropriate time dimension. Possible qualitative examples of the associated water quantity, water quality, time and space requirements are indicated in Table 1. In the case of many targets such as irrigation, recreation and fish and wildlife management, important related land requirements should also be specified. Of course, the physical criteria outlined in Table 1 only represent part of the evaluation process, for each sub-target would also be evaluated in terms of the multiple objectives to enable trade-offs to be determined when conflicts for scarce resources occur. The crucial step of evaluating sub-targets in terms of the multiple objectives leads me to a discussion of the concept of benefits and costs, dealt with in the following section.

IDENTIFICATION OF BENEFITS AND COSTS

Once the sub-targets have been specified in terms of water requirements, projects can be devised under the plan-

Table 1 Examples of Water Quantity, Water Quality, Space and Time Dimensions Associated with Water Resource Targets

Target	Water Quantity Requirements	Water Quality Requirements	Spatial Requirements	Time Requirements
Agricultural Water Supply	acre feet	appropriate water quality standard	Sub-basin	Monthly irrigation season
Industrial Water Supply	acre feet	appropriate water quality standard	Sub-basin	Monthly all year
Domestic & Municipal Water supply	acre feet	appropriate water quality standard	Sub-basin	All year
Recreation	lake levels, stream flows	appropriate water quality standard	Major basins Sub-basin	Monthly all year
Flood Control	lake levels, stream flows	N/A	Sub-basin	Daily all year
Navigation	lake levels, stream flows	N/A	Sub-basin	Daily all year
Fish & Wildlife	lake levels, stream flows	appropriate water quality standard	Sub-basin	Daily all year
Erosion Control	lake levels, stream flows	Sediment loads	Sub-basin	Monthly all year
Water Quality	lake levels, stream flows	appropriate for all uses	Sub-basin	Daily all year
Scenic Aesthetics	lake levels, stream flows, related land resources.	appropriate water quality for aesthetic demands	Sub-basin	Daily all year

ning component wherever the existing water (and related land) resource cannot meet these requirements. As defined earlier, projects represent any water resource management means, either structural or non-structural to meet a sub-target.

Associated with each project are a number of benefits and costs each expressed in terms of one or more of the multiple objectives. The important concept of benefits and costs in comprehensive planning is that they have meaning only when they clearly relate to the multiple objectives. Benefits are defined as positive contributions to the attainment of objectives and costs are defined as negative contributions to specified objectives.

Thus, there can be economic development benefits and costs, environmental quality benefits and costs and social well-being benefits and costs.

Using the example of an agricultural water supply target and its sub-target of supply X acre feet of Y water quality to the Mission Creek sub-basin in the Okanagan, several possible projects may be conceived to meet this demand. For each project, economic benefits may be identified as the net value of agricultural production returned to the additional water supply. In addition, the sub-target will create a number of acres of irrigated landscape, which might be valued by the local public as environmental benefits. On the other hand, if the water in Mission Creek was able to support a sport fishery should no diversion for irrigation take place, the loss of this fishery must be accounted as an environmental cost and as such weighed against the economic benefits (and other benefits) accruing to irrigation development. Examples of benefits and costs (expressed in qualitative terms at this stage) for possible targets are shown in Table 2.

From the example quoted previously, it should be realized that not all of the consequences of alternative projects will be quantified in economic terms, but that there will be other consequences associated with the

Table 2 Examples of Benefits and Costs Associated with Water Resource Targets

Target	Economic Growth	Environmental Quality	Social Well-Being
Agricultural Water Supply	Increased or more efficient production of agricultural output; secondary benefits.	landscape diversity; fruit picking experience; ecosystem management	diversified economy; family farm income; rural development; stabilization of incomes
Industrial Water Supply	Increased or more efficient industrial output; secondary benefits	water quality deterioration; aesthetic benefits or costs	benefits accruing to identified disadvantaged groups
Municipal Water Supply	Service to increased population; land value enhancement	lawn sprinkling; golf courses; open spaces; urban parks; water quality deterioration	urban crowding; health and sanitation costs.
Recreation	Expenditure impact on regional economy; land value enhancement	aesthetics of recreation enjoyment expansion of recreational choice; overcrowding of facilities	increased opportunity for identified disadvantaged groups
Flood Control and Management	Reduction of flood damage to existing and future facilities; land value enhancement; secondary benefits; economic opportunity costs	erosion control; aesthetic value of land-zoning; impacts upon ecosystems	increased feeling of security; stabilization of incomes and opportunity
Navigation	More efficient transportation of goods	impact on ecosystems	
Power	Market value of power supplies	aesthetic impacts; impacts on ecosystem	stabilization of incomes of certain groups
Fishery & Wildlife Protection and/or Management	Expenditures of recreationists; commercial value of fishery and wildlife resource; more efficient resource productivity; economic opportunity costs	aesthetic value of hunting and fishing; wilderness values; landscape diversity	increased recreational opportunity for certain disadvantaged groups; more diversified economy; optional values
Erosion Control	Improved resource productivity; land enhancement	water quality improvement; aesthetic impacts. landscape diversity.	
Preservation or Enhancement of Aesthetic Landscapes	Economic opportunity costs; costs foregone; recreational expenditures	aesthetic enhancement; wilderness values; landscape diversity	'option' values
Water Quality Standards	Economic opportunity costs; increased resource productivity	aesthetic impacts, increased choice of water uses	health hazard control increased opportunity for 'latent' recreational demand for certain groups

environmental and social well-being objectives that are often referred to as intangible, non-quantifiable, aesthetic or social impacts. To date, these benefits and costs have rarely been explicitly included in decision-making because they have not been quantified in monetary terms and therefore have not appeared in the benefit-cost analysis. Indeed, in many cases, it seems inappropriate to quantify such intangibles in monetary terms. Therefore, traditional benefit-cost analysis has not been able to weight all the pertinent information in decision-making and while it may maximize economic returns in resource investment decision, it does not necessarily maximize net social welfare.

Depending upon the definition of the objective, benefits and costs may be expressed in one of the following categories:

1. benefits and costs that are ordinarily valued on the market and can be expressed in monetary terms.
2. benefits and costs that are not valued on the market but can be expressed in quantitative units, e.g., physical units (number of fish) or social units (employment opportunities).
3. benefits and costs that cannot easily be quantified and are expressed by qualitative description or a social preference index.

Obviously, in a comprehensive analysis of the effects of water resources development, some basis must be established for evaluating and communicating to the decision-maker both the monetary and non-monetary consequences of alternative projects and ultimately of alternative comprehensive plans. To establish this, four important aspects of the problem should be considered. These are (a) the quantification and separation of monetary and non-monetary consequences measured in terms of the multiple objectives; (b) the viewpoint of the decision-makers; (c) the interpersonal distribution of benefits and costs and (d) the time period of analysis.

(a) *Quantification* – If alternatives are to be compared in a rational manner, their relative advantages and disadvantages must be quantified. As has been stated before, the units for quantification should be stated in the multiple objectives and impacts of each alternative should be measured and evaluated in these units wherever possible. This paper does not detail how the environmental and social well-being units should be defined, but Bishop (1970) has developed a scheme of 'factor profiles' which enable the monetary and non-monetary consequences to be weighted against each other and to allow trade-offs between alternatives.

(b) *Viewpoint* – The spatial viewpoint from which project and comprehensive plan impacts are evaluated is of fundamental importance, especially as the comprehensive river basin agreements undertaken under the Canada Water Act involve both federal and provincial governments. The viewpoint for evaluating the positive (benefits) and negative (costs) impacts of water resource plans may well differ between the regional, provincial and federal levels of government. For example, if, as the direct result of augmenting the supply of water into the Okanagan Valley, a pulp mill was to locate in the basin, then from a regional viewpoint, the economic and social benefits and costs to the regional economy stemming from the mill should be attributable to the increased water supply. If however, the mill would have located elsewhere in British Columbia, then from a Provincial viewpoint, no benefits or costs accrue to the Okanagan as the decision of the mill to locate in the Okanagan simply becomes a re-allocation of resources within the Province. Similarly, from a national viewpoint, if the alternative location of a mill would occur elsewhere in Canada, then again the decision to locate in British Columbia represents only a re-allocation of resources.

The problem of viewpoint may also be important at a regional level as the Okanagan Basin Agreement explicitly states that the evaluation of alternatives will be expanded to cover impacts on neighbouring areas. Thus, if improved water quality stimulates the recreation potential of the Okanagan basin and captures a demand that would otherwise have moved to the Shuswap watershed, then these recreational opportunities foregone in the Shuswap should be included as a cost in the evaluation matrix.

It is also likely that as the viewpoint adopted in the analysis broadens, some of the secondary effects tend to cancel each other out. For example, secondary benefits accruing to increased agricultural production such as an expansion in fruit-processing industry may be a re-allocation of resources that may otherwise have located in the Niagara Peninsula in Ontario. Generally speaking, as the spatial scope of the analysis increases, evaluation of plans tends to rest more directly with primary benefits and costs and is less concerned with secondary effects.

(c) *Inter-Personal Distribution of Benefits and Costs* – The distribution of benefits and costs from any project and the redistribution of opportunities are important considerations, especially because the multiple objective function explicitly identifies these impacts in terms of per capita net income, employment and other opportunities. Not only should these redistribution effects be identified and quantified, however, but the decision-makers must measure what value society places upon the distribution of gains and losses. This principle emphasizes the importance of a broadly based institutional structure interacting on decision-making. If the analysis were to be restricted only to the local level, Okanagan residents will obviously prefer any plan that increases their welfare at the expense of other regions. Thus, this approach will represent the weighting placed on redistribution of opportunity by Okanagan

residents, but not by all British Columbians or by all Canadians. Obviously, provincial and federal decision-makers will have to provide their own weightings from their respective viewpoints before a decision can be made.

(d) *The Time Period* – When analysing the alternatives the distribution of benefits and costs over time should also be taken into account (O'Riordan, 1970). An appropriate discount rate must be determined and applied to all benefits and costs, though changes in the relative value of outputs should be given special consideration. The time period of analysis should be carefully chosen to avoid biasing unduly either short or long term effects.

It is worth mentioning here that both the spatial viewpoint and time period of horizon will drastically affect the analysis in selecting and evaluating the benefits and costs of alternative plans. Both of these variables need to be clearly specified before the variables are quantified, and probably a complete evaluation will require sensitivity analysis in which a number of analyses are performed for each plan using different viewpoints and planning horizons.

EVALUATION OF ALTERNATIVE PLANS

Once a number of projects have been identified and their impacts on the water resource and social system of the Okanagan assessed, the institutional agencies should aggregate a number of projects into a comprehensive plan that represents an integration of water management and development alternatives to achieve the multiple objectives. At this point, an evaluation matrix, based on the goal-achievement matrix developed by Hill (1967) is proposed as the necessary tool to implement comprehensive evaluation analysis of alternatives.

A conceptual model of an evaluation matrix for one alternative plan is now presented (Table 3). To develop the model, the following information is required:

1. A set of function objectives $O_1, O_2, O_3, \ldots O_i$
2. An agreed system of weights for each objective $W_1, W_2, W_3, \ldots W_i$ (see section on decision-making)
3. A set of targets and complementary water resources needs to achieve the objectives $T_1, T_2, T_3, \ldots T_n$.
4. A set of sub-targets to achieve each target

   $T_{11}, T_{12}, \ldots T_{ij}; T_{21}, T_{22}, T_{2m} \ldots T_{il}, T_{i2}, \ldots T_{in}$
5. A set of water resource projects to achieve one or more sub-targets. $(P_{111}, P_{112}, \ldots P_{ijk})$, etc.
6. A complete account of benefits and costs measured in terms of the achievement of a target for each objective $(B_{111}, B_{112}, \ldots B_{ijk}); (C_{111}, \ldots, C_{ijk})$.
7. In some cases, benefits and costs may be represented by expected values or a range of values to account for risk and uncertainty.
8. The incidence of benefits and costs on each relevant group in the community and the relative weight attached to each group.

In the table, a vector of targets (T_n) is established to achieve all of the multiple objectives to be attained by water resource management. For example, one such target, say T_1, might be to meet demand for agricultural water supply in the Okanagan basin to the year 2020.

There may be a number of sub-targets (T_{ij}) to meet sub-basin requirements for T_1, such as the development of agricultural water supply in the Mission Creek watershed to meet future agricultural water demands in that watershed.

For each sub-target, T_{1j}, there may be a number of alternative methods of supplying the water, both structural solutions (reservoirs, groundwater wells) and for managerial solutions (pricing of water, water licence transfers). These alternative methods are represented by a vector of projects (P_{11k}) for target T_{11} and vector (P_{121}) for target T_{12} and so on. Associated with each project are benefits and costs, which may be defined in monetary, other quantitative units or in qualitative terms as appropriate. The vector (B_{11k}) represents the benefits associated with projects (P_{11k}) required to meet sub-target T_{11} and the vector (C_{11k}) represents the costs associated with implementing these projects.

The external and/or joint benefits and costs associated with any project that directly or indirectly affect values associated with other objectives are also noted in the evaluation matrix. In the example described above, T_{11} was defined as the need to supply agricultural water in the Mission Creek sub-basin, $P_{111}, P_{112}, \ldots, P_{11k}$ are various storage reservoirs and groundwater wells that could be developed to supply the water; $B_{111}, B_{112}, \ldots, B_{11k}$ are benefits due to increased or more efficient agricultural production, $C_{111}, C_{112}, \ldots, C_{11k}$ are the costs of constructing and operating the reservoirs or wells and C_{2111} is the external cost resulting from the fact that project P_{111} destroys a potential sports fishing resource.

All direct and indirect social costs and benefits are recorded according to relevant objective. A dash in a cell implies that no cost or benefit is related to that objective if the associated project is implemented. The major advantage of this accounting system is that all effects – internal and external – are explicitly shown according to their appropriate objective. Although for certain objectives all benefits and costs might be in the same units and therefore can be summed and compared, in most cases the benefits and costs will be in different units which will make a grand benefit-cost summation impossible.

Table 3 General Evaluation Matrix

Plan A

	Objective O_1 Rel. Wt. W_1				O_2 W_2				O_i W_i			
Target	Sub-Target	Project	Ben.	Costs	Sub-Target	Project	Ben.	Costs	Sub-Target	Project	Ben.	Costs
T_1	T_{11}	P_{111}	B_{111}	C_{111}		B_{2111}	C_{2111}				–	C_{i111}
		P_{112}	B_{112}	C_{112}		–	–				–	–
		.	.	.								
		.	.	.								
		.	.	.								
	T_{12}	P_{121}	B_{121}	C_{121}		–	–				B_{i121}	–
		P_{122}	B_{122}	C_{122}		B_{2122}	–				–	–
		.	.	.								
		.	.	.								
		.	.	.								
	T_{1j}	P_{1j1}	B_{1j1}	C_{1j1}		–	C_{21j1}					
		P_{1j2}	B_{1j2}	C_{1j2}		–	–				–	–
		.	.	.								
		.	.	.								
		P_{1jk}	B_{1jk}	C_{1jk}		B_{21jk}	–				–	C_{i1jk}
T_2			–	–	T_{21}	P_{211}	B_{211}	C_{211}			B_{i211}	–
			B_{1212}	–		P_{212}	B_{212}	C_{212}				C_{i212}
					.	.	.					
					.	.	.					
			–	C_{1221}	T_{22}	P_{221}	B_{221}	C_{221}			–	
			–	C_{1222}		P_{222}	B_{222}	C_{222}			B_{i222}	–
					T_{2m}	P_{2m1}	B_{2m1}	C_{2m1}			–	–
			$B_{12m\ell}$			$P_{2m\ell}$	$B_{2m\ell}$	$C_{2m\ell}$			–	$C_{i2m\ell}$
T_1			–	C_{1i11}			–	–	T_{i1}	P_{i11}	B_{i11}	C_{i11}
			–	C_{1i12}			–	–	.	P_{i12}	B_{i12}	C_{i12}
									.			
									.	.	.	.
			–	–			–	C_{2in1}	T_{in}	P_{in1}	B_{in1}	C_{in1}
							B_{2in2}			P_{in2}	B_{in2}	C_{in2}
										.	.	.
				C_{1inp}			–	–		P_{inp}	B_{inp}	

An evaluation matrix such as the one shown conceptually in Table 3 should be prepared for each alternative plan. Because the measurement units of benefits and costs in each cell will be similar, it should be possible to directly compare and therefore, rank these alternative plans.

DECISION-MAKING IN MULTIPLE OBJECTIVE PLANNING

The application of the evaluation matrix approach in comprehensive planning has a number of important implications on the institutional component of the planning process, the most important being the need to develop a new strategy for decision-making. In the past, under cost-effectiveness and benefit-cost analysis, decision-making was effected by the choice of the least costly alternative or by the largest benefit-cost ratio and few additional factors were taken into consideration. Even under the most elaborate economic analysis undertaken for multi-purpose planning, decision-makers were asked to compare and 'trade-off' between different outputs (irrigation, flood-control, etc.), all of which were expressed in the same unit, namely dollars.

This concept of multiple-objective planning complicates the decision-making process because economic benefits expressed in monetary terms have to be compared

and weighed against social and environmental benefits which are not necessarily expressed in monetary values. Thus the key to plan evaluation is to devise a rational weighting system so that all objectives can be compared simultaneously. In addition, the decision-making strategy should also accommodate incremental analysis whereby the decision-maker can assess the impact of marginal adjustments in project size or resource use. In like manner, provision should be made in the evaluation of each major alternative plan to assess the contribution of each individual project to the achievement of objectives on a sequential or incremental basis. In this way, various contributions of projects could be examined to determine which combination will make the largest contribution to net social welfare.

Theoretical trade-off functions have been developed by some economists (Marglin, 1967; Major, 1970), but in practice it is doubtful whether these can actually be established. Furthermore, because decision-making will involve both senior levels of government, the local levels of government and the public itself, it seems inappropriate to attempt to devise complex trade-off functions. A more practical strategy, based on the theory of games, appears to be more appropriate whereby each participant in the decision-making process develops his own weighting system and then approaches the other participants with a bargaining position. In the likely event that the different levels of government will present different weighting functions, a process of bargaining should be initiated to resolve this initial conflict, based on the principle that all sides may have to give ground in order to gain ground.

Gains are made incrementally and realized only slowly with the objective of the game to achieve what is desirable by seeking consensus between all parties (Chevalier, 1969).

This approach to decision-making is relatively untried in basin planning and will require a great deal of commitment and understanding on the part of the decision-makers as well as a strong linkage with the public through a well-organized public participation programme before it will be effective.

CONCLUSION

Social welfare is defined in this paper as a combination of economic, environmental and social objectives. The traditional concept of benefit-cost analysis based upon the superiority of the market place under competitive conditions as a dominant measure of value will not be a suitable performance criterion to achieve maximum social welfare. It is most likely to approximate the achievement of maximum economic welfare for those projects whose outputs have well-defined benefits and costs subject to monetary evaluation, but it appears likely to be an inefficient resource allocation tool for those projects where environmental and social well-being objectives are explicitly stated.

Because society has a definable welfare function when its values can be expressed according to the market mechanism (real or simulated), benefits and costs will be quantified in monetary terms wherever possible. But it is recognized that society does not have a clearly defined welfare function for certain environmental quality and other social values, as indicated by conflicts over local recreational and environmental issues.

The professional analyst has no right to dictate these values, but instead must attempt to determine more accurately society's well-being and environmental preferences and values. Optimum social welfare can be achieved through successive trade-offs between the three broad objectives according to economic, social and political criteria.

The evaluation and decision-making process is complex, but that is in keeping with the concept of comprehensive planning. While the approach chosen in this paper does not result in a single number outcome, as in the case of the more traditional benefit-cost analysis, it is more responsible to the complexity of the consequences of comprehensive river basin planning.

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The Interface Between Regional Planning and Water Resources Planning

Len Gertler

At the time of the National Pollution Conference, I joined a group of geographers, political scientists and Planners to produce a position paper on the policy and administrative aspects of the pollution problem. A major preoccupation was to overcome fragmentation – fragmentation of effort, of finance, responsibility, authority and programmes. We called for the co-operation of municipalities, industries, and organizations on a watershed basis. We asked the governments to provide the statutory framework and regional structures to induce and sustain an effective process of resource planning and pollution control. I think that would also not be a bad summation of the main thrust of that national conference.

Now last summer, while many of us were out of town on vacation, the Trudeau government with several strokes of the pen, signed a series of agreements setting up a number of river basin Boards, each charged with the optimum management of water resources, with the maintenance of a proper ecological balance, with the formulation of a water quality plan, and with the preparation of a comprehensive plan for the optimum development of the entire basin. Now that's pretty heady stuff.

In thinking about the discussion that is before us this afternoon, I've tried to put myself in your boots at this time, as the group of men and women who have to turn the brave new words into brave new worlds. We all know that legislation and agreements are one thing, but getting the show on the road is quite another. Where do we start?

One of the difficulties is that you have very few precedents, very few models to work from. I don't think that would be overstating the case. In this connection, you might be interested in knowing that the pioneer River Basin Program in North America, TVA, has recently been voluminously reported by its first moving force and most creative Chairman David Lilienthal, in his recently published journals. And although the time and the circumstances were different, I think you might find some of the observations on the TVA early days, those days of the early 30's, as not entirely irrelevant; and I'd like to give you just a few selected excerpts from those journals.

The first is from his entry of September 1935, two years after he had joined the Board of the Authority. And he states the following: "I am constantly impressed with the difficulties of administration as we go along in this job. The difficulties seem to be inherent in any large scale undertaking, and they're probably accentuated in any enterprise that has elements of novelty, and elements of pioneering. This problem of whether we can organize community activities or even industrial activities so as to make them work is a central problem of the TVA job. In fact, it may be that when we are further along, we will conclude the chief problem we are tackling is whether the people can so organize themselves to perform some of the functions which we are trying to perform, some of which are usually associated with private enterprise, such as electricity and fertilizer operations, and the dam building, and some which are usually regarded as purely public, such as forestry, soil conservation and the rest. One of the temptations of the expert organizer, the professional executive, is to confuse an organization chart and an organization. These two things are distinctly different. It is a very great trick to devise a very effective organization chart, that is to have machinery indicating what division is under what head, and devising administrative mechanisms, but the effectiveness of any organization chart depends on human factors to such a large extent that a good many people begin to think that effective organization is about 90% personnel – 90% dependent upon the kind of men and women you get".

"The Tennessee Valley Authority is one of the most extensive problems of organization and administration, because of the great diversity of jobs we have on hand. Most important perhaps of all, the cohesive force, the motivating driving force behind this kind of organization, is a new kind of force in many ways and doesn't have the simplicity of the profit-motive by which one can appraise the results of work of a vast organization".

And then an entry in 1939, which looks back on his first six years of operation of TVA – "I've been sitting here speculating on what aspect of what I've been doing would interest you most". (This is in the form of a letter). "It is difficult. The kind of job, friends and foes, that most people think of first almost exclusively, is what I have done in establishing the public power programme and putting some big tremors in the most brazen crowds in the country, the utility industry". (You might recall his rather prodigious battles with the utility interests led by the late Wendell Wilke that he's referring to). "That has been exciting, and it does have importance and permanence. But the undertaking that means the most to me is quite another chapter.

As everyone knows, economically and socially, the south is the underdog of the country. I recited some of the figures of income per person or family, expenditures for public health and education, and so on. It is so much worse than anyone expects. How can TVA help change the income level – not only of the section, but of the low income groups? How can we help to increase the income which remains in the hands of great masses of miserable people, most of them darn good stuff too. Speed was important for the sands were running pretty low in parts of the region. Besides only in a period of sweeping reform or emergency psychology could the job be started. The first step seemed to me to revive morale. To hammer home the basic primary need of increased income by demonstrations – as many demonstrations as possible, but always ones that the average man who had to carry the job ahead could see and understand". (Then he refers to demonstrations in power, he says –) "I used to make speeches in front of country crowds with a lot of farm machinery gadgets, grinders for feed, brooders, etc. set up on a big table in front of me, and work these into the talk indicating how much some particular farmer somewhere had added to his net income when he had these machines. Well it was undignified as hell, like an Indian root doctor. But those farmers listened to every darn word and came up afterward and handled the gadgets, and watched the electric motor grind feed, and so on. And then a co-operative would be formed and the power lines would reach them . . .".

And then finally, the final selection which is again a retrospective one in 1942 in which he relates a luncheon he had with President Roosevelt to whom he reported directly, he first of all refers to Roosevelt saying, he had while he was governor of the State of New York, initiated a comprehensive planning effort, and Lilienthal goes on ". . . mention of his work in New York on the planning idea, gave me the opportunity of saying something to him that I had long wanted to. Occasionally people will ask, where did the regional planning idea of TVA come from? We know that Muscle Shoals and Senator Norris account for the power part of TVA, but what about planning and how come? What you have said about you beginning the land use study idea in New York suggests the answer I give. The regional planning idea of the TVA is a direct output of the experience and thinking of Governor Franklin D. Roosevelt".

And then finally "In the early year of the TVA I used to count the days and energy spent on legislative facts, conferring with member of Congress, as wasted. Indeed, I had a certain resentment about that whole business. At the outset I had too great an interest in persuading or mollifying, as the case may be, the demanding member of Congress. This had a tendency to obscure their function and what makes them act as they do. Then I came to see in the political field, it is the army that you have to be concerned with and not the generals. That if the people affected can understand what you are doing and approve it, the generals, the congressmen, do not present a serious problem. And as a matter of fact, if the people approve firmly of what you are doing, there's no problem of conflict at all. Quite the contrary".

I gave you these as a few representative samples of what you can disinter from the TVA experience during its formative years, for your own formative years.

The interesting thing that I found about this account, was the emphasis of those first years on institution building, on the establishment of the organization's philosophy, its struggle for position – between the private power interests on the one side, and the sometimes too zealously centralizing federal power in Washington on the other – the establishment of administrative and planning structures and processes, the working out of relationships with the states, the municipalities, and the Congress, and the building up of a broad base of support in the region. If there is anything in this experience, then there may be a lot more to your various terms of reference than the preparation of short and long term water resources plans, as difficult and as confounding as that assignment can be.

In fact the question is raised whether the idea, the very idea of a relatively short agreement of three years is consistent with the essential nature of your task.

I'm tempted to say in response to our discussion topic, the interface between regional planning and water resources planning, that the latter is simply a special aspect of regional planning. For the basin defines the region, and planning as a methodology is characterized as being policy-oriented, comprehensive, and concerned with the future. Basin planning is certainly all these things. There are, as I see it, about eight fundamental analyses associated with the research phase of regional planning: the resource analysis, the demographic, landscape, ecological economic, social, engineering and political. The fundamental questions that interest you, which are spelled out in your terms of reference, suggest that you will be concerned with each of

these in your research programme. You can't estimate water demand without a study of the change in growth and the economic structure of your region. Water demand is sensitive to differences in socio-economic structure. You have already quite extensively explored today, your relationship with ecological studies. The existing political and social structure and patterns will affect both the perception of and response to your programmes, and so on.

Recently we had the pleasure of hearing a talk on this campus by one of your colleagues, Roy Tinney, in which he drew out the implications of the Canada Water Act, and I think it is quite clear from that presentation that as far as broad methodology is concerned, that planning approaches are already operational in your thinking if not in your practice. He outlined a hierarchal system moving from the general social welfare goal to functional objectives through specific water resource targets. In concept this is very much a goals-achievement framework, which is one of the more effective ways to think of and organize the planning process.

I have set out here a very simplified picture of the planning process (Fig. 1).

I propose to briefly go over some of the major elements of the process, and try to think of it in terms of the field of water resources and how in fact it might be useful as a line of thought in attacking your problems.

The chart is made up of letters. V is for values which are the basic individual and societal values. For example, we might in that category, refer to the drive for biological survival.

G is for goals. These are thought of as idealized end states expressed in terms of real world processes and conditions. Such a goal may be the improvement of water quality, removing hazards to health and barriers to enjoyment.

Next, O for objectives. Objectives are thought of as being quite specific, in conformance with the goals, and obtainable with explicit programmes, programmes that might be appropriate for each objective. For example, working from the general goal of improving water quality, the first objective might be, if you are concerned with an area where the dominant industry is pulp and paper, to reduce chemical pollutants to a level compatible with water based recreation. The second objective might be to improve

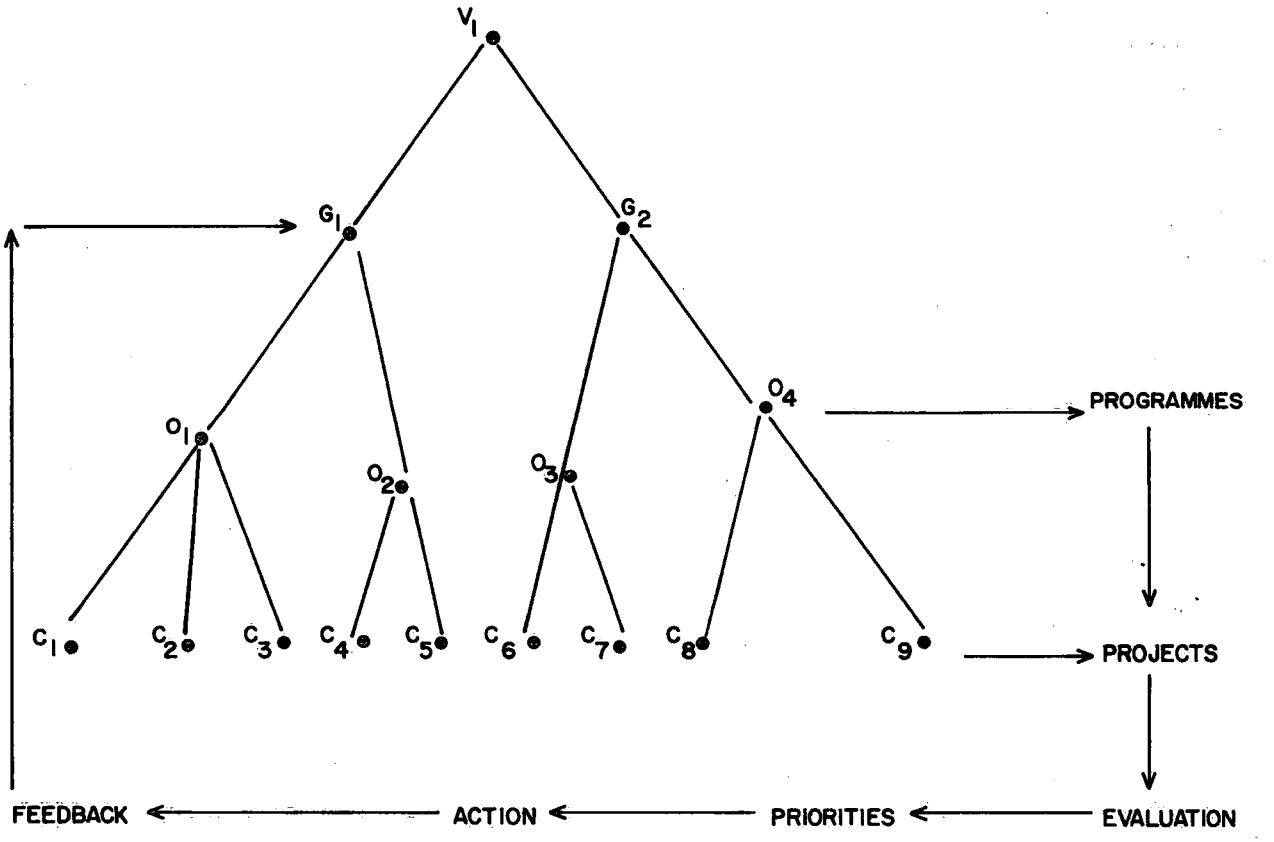

Figure 1. The Planning Process

sewage treatment up to a level compatible with water based recreation. The second objective might be to improve sewage treatment up to a definite performance level. The third might be to change the industrial zoning pattern with a view to reducing the amount of discharge to the river within a prescribed distance from downstream settlements. And these things then would be expressed in appropriate *programmes.*

Then bearing the same kind of functional relationship to *objectives* would be a number of *criteria* which are explicit operational definitions arising from particular objectives and forming the basis both for design and evaluation of *projects.* These projects would be related to the kinds of programmes and objectives that I cited. One project in an area of pulp and paper would be to apply the type of criteria the Chairman of O.W.R.C. was talking about the other night, let's say of reducing chloride to a certain number of milligrams per litre, and the same with the other chemicals, or designing or building a tertiary treatment plant that has x gallons of treatment capacity, or removing specific offending industrial uses from industrial zones along the shoreline. These are the kind of criteria that would form the basis of a number of projects.

The projects then would be evaluated by the best standard method that we have available, e.g., cost-benefit analysis, goals achievement account, and other ways; and priorities will be set and action taken. This is the kind of simplified process that I suggest may be appropriate.

In your programmes and certainly in the legislation there is a great deal of emphasis on public involvement which would suggest a concern with the feedback phase as an integral part of the planning process. So that what you really have is a circular process moving from goals, objectives, criteria–setting out the terms of strategy, to the programmes and projects, selection of one of them as a plan, and then to implementation of the Plan, the feedback of the experiences after implementation, its appraisal, the revision of goals, and the continuation of the process.

This kind of goals-achievement model is of course only one of numerous models that can be found in the growing body of planning theory. They range all the way from the incrementalism of Lindbolm in plans evolving through a slow process of cautious incremental changes, to systems models, such as PPBS, which I understand is rapidly becoming the gospel of the central planners in Ottawa, and the advocacy model of Davidoff and others, and the models of the activities all around the world.

Well, I won't carry the discussion of the conceptual aspects of Planning any further, because it strikes me that at this present time, it is not the fundamental concern in this stage of river basin planning in Canada. Much more critical is the relationship between basin planning to the basic development and planning policies and to the administrative structures in your respective provincial jurisdictions.

This has both a spatial and organizational dimension.

The fact is that the important units of association that cumulatively relate in the most fundamental way to the demand supply equation of water are often not coterminous within the basin boundaries. These may be towns, cities, urban centres regions, planning regions, economic regions, the various special purpose units, and so on. But these areas often form the critical centres around which future patterns of growth will gravitate, and so it becomes of some importance that they be reckoned with in your kind of operation.

The river basin Boards to play the roles of integrating both studies and policies of all water related agencies, must establish effective working relationships with such agencies.

I can give you an example from my own experience in connection with the Mactaquac Regional Development Plan. At that time when I was with a consultant firm, I had the dubious honour of being the head office supervisor of that Project. And what was most striking in that project was the crucialness of a land compensation policy and therefore of our relationship with the New Brunswick Power Commission. Some of you may know very well, better than I do, those of you who are from New Brunswick, what the structure of that project was. The power development was conducted by the New Brunswick Power Commission and development planning was the responsibility of an inter-departmental ARDA Committee. And on that committee of course, we had the General Manager of the New Brunswick Power Commission, and appointees from Agriculture, Lands and Forests, and other relevant departments. The point is this, that the experience in the St. Lawrence Valley had clearly illustrated to us as consultants the close connection between compensation policy, relocation, settlement, reorganization of services, and the regrouping of regional services into a suitable urban structure in the region between Fredericton and Woodstock. And it seemed to us crucial, that at an early stage in the process that the landowners be given clear options concerning the form of compensation, as they were in the case of the St. Lawrence Seaway case. I don't make a habit of throwing bouquets at the Government of Ontario, but they seemed to move with a very sure foot in that case because at a crucial time they were able to offer to the people who were in the communities that would be flooded out, a clear and unequivocal choice. Ontario Hydro, the agency that administered the programme, was able to say, "Do you want compensation in the form of money, or do you want an equivalent in the terms of a specific community? " By determining this and offering them very real and very specific alternatives, they were able to co-ordinate compensation, resettlement and new com-

munity development with a high degree of effectiveness. It seemed highly necessary to do this in the Mactaquac case. The flooding associated with the headpond not only directly affected about 1,000 families, but it disrupted the entire pattern of communities and services that had grown up along major highway and railway routes. There was a need for an orderly re-grouping of these features and resettlement was an integral part of such a strategy. But the seaway type of policy was not implemented in the Mactaquac region. It is an instructive lesson in Political Science that the policy was adopted by the responsible ARDA Committee, which included the general manager of the Power Commission in its membership, but when it got down, or shall I say got up, depending on your point of view, to the operational level of the Power Commission, this kind of subtle process didn't work at all. The owners were simply offered various financial settlements and therefore the process of resettlement and so on became a very tenuous one. And some of you may know the new community of Nackawic was established with some boost from the Federal-Provincial Agreement, but the original "new community" role is not quite fulfilled. This is partly the result of the kind of miscarriage I have described.

Well this demonstrates to me the crucialness of the relationships that you must have with various agencies that are established in the various river basin jurisdictions, and this relationship deserves a great deal of attention. This kind of co-ordination becomes the most important water resources – regional planning interface that confronts us at this time.

Now in conclusion, I would like to leave you with four questions which I think might pertain to all of your river basin bodies.

What are the agencies in your province which could have a significant impact on your work? Do you have any built-in and sustained contact with them? What are the opportunities of within existing arrangements to obtain the necessary liaison? What are the barriers? What innovations, if any, would you like to see in the present administrative structure or planning process to achieve a more effective interface with regional planning and other agencies?

Discussion of a Basin Planning Project - Sask.-Nelson. Comments on Aspects of Study. Practical Problems on Doing Basin Planning

Fred Durrant

When Harry Hill asked me to speak to this group, he suggested that my role would be to describe the practical problems that are encountered when you stop talking about a planning project and start doing it. I was pleased to accept his invitation because I think that credibility of plans and planners will improve when emphasis is placed on practical problems and less on theory.

Having such a conviction is one thing, but writing about it is another. I don't think any sermon should exceed 20 minutes in length, yet the subject could be a symposium in itself.

So, I have tried to develop just two major points, with a little interpolation, we can go on from there in the discussion period. Firstly, "What is the function of a planning group? " Secondly, "What should a planning group do to carry out this function? ".

WHAT IS THE FUNCTION OF A PLANNING GROUP

Before suggesting what this function is, let me say what it is not. A planner does not make decisions. If the principle of representation in government is to mean anything, it is essential that the representatives of the people understand what people want, what people need (what people will vote for, perhaps) and make decisions from time to time as to how the resources of the region or nation will be directed to meet those needs. The people who do this are not planners, they are a special group who are sensitive to the value systems of the day and who are able to take *properly packaged* information and make decisions that are "right with God". The words "maximum", "minimum", "optimum", "flexibility", "integrated", "preclude", whatever you like, have little to do with the decisions of this group. They have developed the ability to sense what is needed, to absorb what has been studied and to make decisions.

If you can accept this, the function of a planning group becomes a little more clear and I think I can break it down in three sub-functions.

Firstly, the planning group must phrase the problem in soluble terms. Secondly, the planning group must gather and process information needed to solve the problem. Thirdly, the planning group must present the results of its work to management in such a way that those results are understood and good decisions can be made. I would like to expand a little on each of these sub-functions.

PHRASING THE PROBLEM

A few years ago, I rode the plains in a Ford-V8, giving farmers and communities advice on how to solve their water problems. Usually, the local people were not clear on what their water problem was. The simplest example is the farmer who wants a dam at a certain location because one beautiful summer day he had a vision that a dam at that point would be a useful thing. Let us say that he needed water for household and stock-watering purposes, it might be that the dam-site he had chosen was a good solution. On the other hand, there may have been several alternative solutions which were not only lower in cost but would provide additional benefits to the farmer. An important part of my work was to explain all of this to the farmer until we reached a joint definition of what his problem really was. Only then could we proceed to reasonable solutions. The real problem was that he needed water, not a dam.

And so with planning, look carefully at your terms of reference, make sure that both you and management have the same understanding of the problem. Detect and delete statements of the problem which are really pre-conceived solutions.

GATHERING AND PROCESS INFORMATION

Sometimes I think the world is divided into two kinds of people. One kind says "We know everything", and the other kind says "We don't know anything". The first kind likes to make decisions after a two-minute calculation on the back of a cigarette box. The second kind of person never has enough data – no matter how hard you try to satisfy him. He is congenitally incapable of making a decision. Somehow or other, a good planner has to strike a compromise.

Once you have defined the problem and someone has told you the amount of time and money that is available for your study, this will set the scope and schedule of your information gathering program and set the amount of effort you can devote to processing it. Just how you go about setting limits on this process is something I will speak on later. For now, it is sufficient to say that a planner, having worked with management to define the problem, must make all information gathering relevant to that definition, must complete the presentation of results on time and must stay within the budget.

PRESENTATION OF RESULTS

The planner may have a fabulous grasp of the problem and his study may show *to himself* beyond a shadow of a doubt what the consequences of various actions will be. But, if management has no understanding of how the study was done, the planner's cleverness is of no consequence, in fact it is worse than of being of no consequence, he may actually generate hostility on the part of management toward the planning group. It is of the utmost importance that the results of any study or investigation are shaped and moulded into something that management can understand and which management can see as relevant to the decisions that they must make.

PLANNING STEPS

The planning group must first prepare a budget, a schedule, a description of work to be done and arrange for management to incorporate their suggestions in all three. The total amount of money available will already have been specified by management, but details on how this is to be spent should be worked out and presented to them to ensure mutual understanding of the relative importance of various aspects of the work.

The preparation of a schedule is absolutely essential if work is to be done on time. Schedules have many fancy names these days, but the main thing is that you illustrate to management that you have some concept of what work is to be done and more important, you must demonstrate to them that you can complete work according to the deadlines mutually agreed upon.

A description of the work ensures that you and management have a similar understanding of some of the more detailed aspects of the study. This step is also necessary if some of your work is to be done by outside contractors or even by specialists of your own staff. Most of the points I will mention now are related to budget, schedule and work descriptions.

It is necessary to arrange to report progress to management at agreed upon intervals. These reports are not to be detailed, but they should be carefully written so that the lay reader gets a clear understanding of what has actually been done in comparison to what remains to be done.

Parallel with investigation progress, one must keep track of financial progress and compare one with the other. One thing management can always understand is the difference between the dollars you started with and the dollars you have at any given time. This is their measure of the amount of effort and resources they have committed to the work, and since it is their money, they are entitled to know how expenditures match up with investigation progress.

One aspect of this periodic reporting is the enforcement of contracts or study arrangements with outside firms or even with your own staff. Consultants and sometimes government agencies, have the most wonderful excuses for adding two or three months to their study schedule or 50% to their study budget. But if you keep good records of their progress and financial expenditures, it should be possible to anticipate requests of this type and nip them in the bud.

Everyone who is given an assignment if he is a good man, will feel that his part of the study is the most important part. He will feel that his field is more important than any other and he will feel that his solutions should be researched more thoroughly than any other. Patience, argument, discussion, resolution of difficulties by creatively redefining the problem, all have a part in riding herd on this kind of problem.

The schedule should incorporate ample time for feedback. If there are recognizable stages of achievements in the study, there should be an opportunity at each one of these to consult with management and gain their approval before the next step proceeds. This "feedback" time is particularly important during the report drafting process. It would be a major error to draft a report completely (and hence do all the necessary supporting work) without having management involved throughout the process. You would be inviting criticism by management – in fact it would almost ensure it.

And finally, I would like to repeat that you must do all of the foregoing in such a way that it is all relevant to the problem and all within the budget.

EXAMPLES FROM OUR STUDY

The objective of our study was contained in a report prepared in December, 1964, by the Saskatchewan-Nelson Technical Advisory Committee and submitted to the Ministers. Without going into the historical background it is sufficient to quote this sentence from the report:

> "The Study Board shall give no consideration to the most beneficial use of water, relative rights of provinces to waters of interprovincial streams, allocations of project costs, and other like matters which are not directly associated with a strictly physical appraisal of the water resources of the basin".

At the outset, we had to answer the question "How do you undertake a basin study without considering the uses which may be made of water? " and we had to answer that question in a meaningful way. The Study staff prepared several papers on this subject incorporating changes from time to time until management was reasonably happy with the approach. This was actually a definition of objectives.

Several outside observers commented, some of them strongly, that a study of water supply only was of no value in the planning process. Therefore, one important aspect in the evolution of a problem definition was to figure out what kind of a planning sequence or framework would have a place for a study such as ours.

It was necessary to begin our investigations before our definition of the problem was complete. On the one hand, we knew how much money we would have and it was not too difficult to guesstimate how much of it would be used for project investigations and how much must be used for studies by the Study office. On the other hand, we did not know which projects were to be investigated, nor how many were to be investigated. Until we had decided this, we could not divide the number of projects into the available money in order to arrive at investigation standards.

The Study office put together a list of the projects which might be "competitive" in supplying water to various parts of the prairies. We drew on our own knowledge and the knowledge of others regarding projects for which investigations were already complete. We leaned heavily on our familiarity with the prairie area in guessing at the kinds of projects which would be needed. We did some very hasty cost breakdowns for typical investigations, then we prepared a list of projects. We discussed the list of projects with our E.A.G. (and subsequently, the Board) and reached agreement for the first year's investigations. It was understood that the balance of the investigation program would be subject to revisions by the E.A.G. and the Board, as we all learned.

These project investigations were begun almost immediately by 4 different agencies under contract with the Board. It was necessary for the Board staff to move quickly to develop investigation and costing standards so that the work prepared by all parties would be comparable. These standards were developed with the co-operation and participation of the agencies, and this, of course, made them acceptable.

With the problem defined and the investigation program started, the Study staff had an opportunity to do a little budgeting and scheduling. This activity revealed a most interesting point, namely, if a study as described in 1964 is done during the period 1968-72, the inroads of inflation require that the budget be increased by more than 50%. These facts were made known to the Board in October, 1968, about six months after the study had started. There was a most violent reaction to the suggestion that the budget be increased; it was necessary to reduce the quality of the investigations for a number of projects which appeared to be a long way in the future. In other words, we stuck to the budget by accepting original investigation standards for some of our work but by lowering the standards for some parts of our work.

During this six-month period, we carried out another interesting exercise, and that was to do the entire study in miniature. We prepared cost figures in a few days for some 80 projects. We prepared some very rough flow data and we used some very simplified reservoir operation programs and we carried out a flow-cost analysis for about 12 project combinations. Using the results of this, we prepared an interim report to the Board which outlined the study procedures we thought we might use and illustrated the kinds of results that might be obtained. The Board made some very good suggestions to amend our proposals and we, of course, had been forced to do a lot of thinking. The most important development of this exercise was that everyone involved with the study gained a clearer picture of what was to be done.

I would like to mention an example of the kind of feedback we got from this activity. We were using some multi-colored graphs – beautiful things – to show how much the supply of water would be increased to various parts of the prairies by the various project combinations in our interim report. The Alberta Member of the E.A.G. was quick to point out that none of our illustrations increased the supply to Southern Alberta. After thinking about this for a few moments, we confessed that we didn't have any projects with this capability. The result of this, of course, was that changes were made to the list of projects to be investigated.

Not all of the important study decisions were made during the first six months. A great many have been made since. Each time a major issue arises, the appropriate members of our staff arrange to meet with their counterparts in the provincial and federal agencies to discuss possible solutions. Once a solution appears to be jelling, we bring the matter to an E.A.G. Meeting. Here, the proposed solution – quite likely amended – will be agreed to (or at least understood) by the engineering representatives of our management. If it is a matter that involves policy or money, it is taken to the Board for final discussion and approval. This process must be followed in a most positive fashion. If we take shortcuts in the interest of speed, we risk losing the understanding and support of the study management. Their understanding and support will be our most valuable asset at final report time.

In order to keep all of our contracting agencies honest, we meet with them periodically to discuss study progress. We also require that their accounting staff report expenditures to us on a monthly basis. We watch study and financial progress very closely. On some occasions, it has been apparent that an investigation budget may be too large or too small or the time budget may not be correct. We are aware of this at an early date and have plenty of lead time in which to do rescheduling and to adjust budgets. This puts you in the position of working with someone to develop a mutually satisfactory solution. It is preferable to the role of a heartless accountant who demands delivery of goods exactly as per original contract.

An important aspect of study management is to make sure that all of your study staff knows what's going on. Most of the important decisions in our office are made at meetings of the senior staff or perhaps the entire staff. There are several reasons for doing this, the principle one being that the decisions of an *informed* group are usually better than individual ones.

There is another gimmick used in our office which helps to keep people up-to-date. The file copies of all correspondence leaving the office are placed each day in a daily correspondence file folder which is then circulated to all staff. This avoids the possibility of anyone ever saying "You didn't tell me". Everyone has the responsibility of keeping himself or herself up-to-date.

SUMMARY

Together with management, we have attempted to phrase our problem in soluble terms. Together with management, we have reached an understanding of how much information we will gather, and in general terms how we will process that information. And finally, right now, we are working with management on ways and means of presenting the final results of our studies one year before our report reaches final drafting stage.

Perhaps it can all be summarized in one sentence. The function of planning is to serve management – not to tell them what to do.