CHAPTER 18

DROUGHT AND WATER SUPPLY: CONCLUDING COMMENTS

This study has moved from observation of a natural event to the construction and application of a model for investment planning. Accordingly, it seems natural to arrange our concluding comments in two categories: first, the significance of our findings about the experience of Massachusetts water-supply systems during the 1962–66 drought; and second, the significance of our effort to go beyond the drought into the area of policy prescription. Broadly speaking, the results of our study of the drought itself indicate that this was a very severe and correspondingly rare event on the physical scale, but one with a surprisingly small economic impact on municipal water supply systems and their customers. On the significance of our generalization from these observations, we feel that our planning model and rules of thumb point the way to potentially significant savings but that there are notable obstacles to their use (beyond the obvious problems of data-gathering and computation).

SUMMARY OF FINDINGS

More specifically, we may summarize our findings on the recent drought as follows:

Recurrence Frequency. As measured by our pooled rainfall record (a rough average experience for the state) the drought, as a 4-year event, had a recurrence frequency of about 1/150, i.e., it was roughly the 150-year drought. It was considerably more severe than the drought used to define "safe yield," that of 1900–1911, which had a recurrence frequency of about 0.03, or was roughly the 30-year event.

Physical Impact on Water Systems. In the sample of cities (26) for which we were able both to predict and observe the physical stress created by the drought, we observed no annual water shortages of greater than 30 percent.[1] On the other hand, a reasonable model of the physical impact of the drought projected shortages of over 50 percent for several towns. In general, those cities for which very large shortages were projected were observed to have smaller-than-projected shortages. A number of systems for which no shortages were projected actually suffered significant shortages.

In explanation, it was suggested that shortages could be created for a relatively adequate system by a system manager who wished to hedge against worse conditions ahead through conservation today. At the other end of the scale, it seemed likely that potentially hard-hit systems might find, in extremis, that their actual water availability was greater than that indicated by their safe yield. This would be a natural result of the pressures on consulting engineers for "safety" of supply.

Reactions in the Short Run. Our data indicated that in the short run, when faced with a potential shortage, municipalities find it most desirable to cut back water use through restrictions, especially on lawn-sprinkling and car-washing. Restrictions were placed on industrial and commercial uses by fewer municipalities; those that did introduce such restrictions were generally facing larger shortages than those that restricted only domestic uses. The most frequently used restriction on commercial and industrial use was one requiring that air-conditioning cooling water be recirculated. No efforts were made to ration water through higher prices on such price-elastic uses as lawn-sprinkling.

Those systems which were in a position to do so obtained additional supplies by sinking new wells, improving old ones, by tapping recreational lakes, or by purchasing water from a more adequate system.

Economic Impact. We observed that after correction for future investment returns and for certain other considerations, the economic impact of drought was small in absolute terms. The fully corrected annual "loss" figures, at a 20 percent discount rate and local accounting stance, for our sample cities in the last year of the drought (self-suppliers as well as municipal system customers) ranged from $5.46 per capita in Braintree (with a 10 percent shortage), to $5.33 in Pittsfield (14 percent shortage), to $13.05 in Fitchburg (22 percent shortage). After removing the influence of self-supplied users, these figures became, respectively: $5.42 in Braintree, $4.53 in Pittsfield, and $11.07 in Fitchburg. Changing the interest rate to 8 percent and the accounting stance to a national one changes the loss picture substantially. Indeed, before separation of self-supplied users,

[1] The reader will recall that observed shortages are measured after correction for emergency supplies provided, so that actual consumption might equal projected demand when we "observe a shortage."

Fitchburg had an aggregate *net gain* under these assumptions of $26.05. This reflected almost entirely the profitability of certain recirculation investments undertaken by Fitchburg industrial firms.

INVESTMENT PLANNING LESSONS OF THE OBSERVED EXPERIENCE

Based on our study of the drought, we constructed expected drought-loss functions which we then used in an investment-planning model. The computational results from this model were in turn used to construct sample handbook tables for the use of practical planners, tables which answered the questions of how much safe yield to add and when to add it. This method is capable of refinement and complication to a degree limited only by the time and money devoted to additional research. In particular, alternatives to system expansion could be included in considering the optimal path for system adequacy over the planning horizon. By refining the present treatment of climatic variation, it would be possible to take account of the seasonal nature of shortages and resulting losses. The ultimate refinement would be to introduce demand and price considerations, to do away with the assumption of given constant prices and hence of equivalent gross benefit streams for all plans.

But is it, after all, realistic to expect the acceptance of a planning criterion which explicitly incorporates a positive failure rate or average annual loss from water shortage? We found that the municipal water system planning process is significantly constrained, not only by the familiar local governmental constraints of lack of money and susceptibility to special interests but by the public's attitude toward water and water supply. This attitude stresses the "specialness" of water and discourages rational pricing and informed discussion of shortages.

Our fundamental conclusion is that significant savings could be effected in system design if account were taken of the real nature of the loss functions from water shortage. The present implicit assumption is that loss functions rise essentially vertically from zero shortage. Such is not the case. Indeed, if more flexibility in the application of short-run measures such as restrictions were politically feasible, it might be possible to take advantage of slack in the adoption of water-saving technology by industry significantly to reduce the real impact of drought. Even in the absence of this opportunity, however, system shortages do not mean disaster, and perhaps if more effort were made to spell out beforehand the consequences of various "failure" levels, public acceptance could be won for more rational planning. In short, "drought" need not constitute, as it now does, a convenient natural cloak for hiding past planning failures or garbing for public acclaim plans for building expensive monuments to the "right" to cheap water.