3.18 Exercises

1. Compile some personal evidence and/or offer an introspective discussion sufficient to approximate your personal discount rate. Use this discount rate to reanalyze the conservation measure of table 3.1 assuming the shower head will successfully function for ten years. Present your computations and the resulting recommendation.

2. The local utility charges Sand City households $2.50 per thousand gallons of metered water. Analysts figure this rate omits 50¢ in natural water value, but city leaders are opposed to an efficient rate increase. As a band-aid, the city utility is contemplating a new rebate program for people who install permanent conservation fixtures in their homes. The purpose of the program is to promote conservation investments which would not occur otherwise. As a first step, subsidizing low gallon-per-flush (gpf) toilets is going to be tried. How big of a rebate per toilet is justifiable under the following assumptions?

- Each replaced toilet is expected to save thirty gallons per day.
- Whereas a toilet possesses a longer average life than 15 years, analysts expect all residential toilets to be low gpf in fifteen years, even without this program, because rising rates will eventually encourage everyone to make the conversion.
- There are no social costs for disposing of old toilets.
- Except for their water use, low gpf toilets have no other advantages or disadvantages.
- Sand City's discount rate is 5 percent.

3. Redraw figure 3.5 omitting w_b, w_a, and the shaded area. Suppose that a new water conservation technology is discovered, but it cannot be established quickly enough for use in period 0. Suppose that this technology will be widely applied in period 1, and this fact is known in period 0. What, if anything, happens to dynamically efficient water use in period 0, dynamically efficient water use in period 1, marginal user cost, and retail water price? Show all of these results, making appropriate modifications to your figure by shifting the proper curve(s). (Other scenarios can be quickly examined using figure 3.5 as a basic tool. They include modified population projections or irrigated crop prices, modified water processing costs due to changing energy or labor costs, and changes to the discount rate. Cool!)

4. Suppose the average market-implied return on U.S. Treasury bonds has been 4.9 percent during the past year while the rate of inflation was 1.4 percent. What real and nominal social discount rates are indicated by these data?

5. As analyst for a suburban utility, you face the following question(s) from upper management for which a 100-250 word memo from you is the appropriate response. “The city uses its prevailing bond rate (i.e., its cost of borrowing, currently 4.6%) when analyzing the attractiveness of new water infrastructure projects and upgrades. Now, the city is setting a target schedule of depletion for an aquifer that it relies on for 80% of its current water supply. Is the bond rate a reasonable discount rate for this purpose?”

6. A revolving loan fund has just been established by the state. Its purpose is to provide money for the conservation projects undertaken by irrigation districts. The state can borrow more cheaply than districts, so passing along this borrowing ability might lessen water use. Districts repayments will include the same interest paid by the state, and all repayments will be returned to the fund for additional projects. Loan applicants are expected to submit a properly computed BCR for their intended project. The state is currently issuing bonds at 3.5 percent (real) to initiate the revolving fund, and program managers are wondering what discount rate to tell districts to use in their computation of BCR. If managers wanted to use the opportunity cost of capital, what is its numerical value? Use the parameters given in note 5 while recognizing that this is a state policy instead of a national one.

7. How are the return flow results of chapter 2 (figure 2.12 and equation (2.35)) modified if return flow does not become available for reuse until the next period?

8. Make up a three-period "project" for periods 0-2 by selecting dollar amounts for project-caused costs and benefits in all three periods (six numbers). Make sure net benefits have a differing sign in the first and last periods. Display your selections in a three-column table (t, B_t, C_t). Use these values and a reasonable social discount rate to compute NPV, IRR, BCR, and ANB.

9. A group of people are exclusive users of an enclosed stock of stored water. Precipitation and other water supplies are absent in the desert where these people live. The group wishes to exploit their water for three periods, after which they will relocate. Their retail water demand is $w = 20 - p$ in every period. The total costs of converting natural water to retail water is $C = 24 + 0.5w^2$ in every period. There are no water conveyance or transformation losses of any kind. Because they possess twenty-two units of stored water, it is required that $w_0 + w_1 + w_2 \leq 22$. Use this information together with equations (3.15) to determine the optimal schedule of water use, and marginal user costs during the first period. The social discount rate is 50 percent. How long will the water last if dynamic efficiency is not the deciding criterion?

10. A manufacturer (M) can invest in a water conservation measure. If M installs this measure now for $100,000 and spends another $20,000 on a maintenance contractor who will bill M in one year's time, M will reduce its water use by 70 million gallons over the coming year. Its water supplier bills at the year's end and charges $2 per 1000 gallons. The conservation device will not function after one year's time. This is all the available information. Develop advice on the economic merit of this measure for M.

11. In an irrigation-intensive region of a developing nation, ground water from a single aquifer is the only available water. It is estimated that 100 units of water are available for the next 20 years. All wells are completed and have no further expenses. All pumping is done using electricity, and 100% of electricity costs for pumping is subsidized by the national government, rationalized by the desire to generate agricultural exports and to support the incomes of the many small landholders.

Regional water demand for water for the first decade is $w_1 = 60 – p$ and for the second decade it is $w_2 = 64 – p$. Given the policy conditions of no energy costs, we may assume that mc=0 for both periods. The period-to-period (decadal) discount rate is 50%.

a. Use an accurate graphical model to explain this situation. Develop and explain accurate numerical findings about the outcomes you expect from regional pumping behavior. Develop and explain accurate findings about the pumping behavior that you would advise.

b. Use your model again to qualitatively show the impact of the electricity subsidy on actual behavior. From a water use perspective, how well is the subsidy serving society?

12. Carefully draw a 2-period model of optimal water use that accurately corresponds to the information contained in the following statements of aggregate total benefits and total costs for a two period scenario (t=0, 1) with a discount rate of d=10%. Calculate equations for each relationship you draw.

$$B_0(w_0) = 40 + 50w_0 - 2w_0^2 \qquad B_1(w_1) = 44 + 50w_1 - 2w_1^2$$
$$C_0(w_0) = 10 + 5w_0 + 0.75w_0^2 \quad C_1(w_1) = 10 + 6w_1 + 0.75w_1^2$$

Summed water use over both periods cannot exceed W. [Hydrologic quantification of W is the subject of ongoing, uncompleted study.]
Will water use in period 0 have to be curtailed below the ordinary behavior of period 0 agents? Why/not? Explain using your graphic.