# INFORMATION FOR POLICY: A SHORT NOTE ON THE BENEFITS OF CLEAN WATER AND THE TOTAL VALUE FRAMEWORK

JAMES D. CAUDILL

DEPARTMENT OF AGRICULTURAL ECONOMICS

MICHIGAN STATE UNIVERSITY

EAST LANSING, MI 48824

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## Introduction

One of the essential components in the groundwater policy evaluation process is the identification and measurement of benefits. The nature, distribution and magnitude of the benefits will depend on the extent of the increase in quality and more importantly, the specific use to which the groundwater will be put.

The potential impact of groundwater contamination on human health has been cited as a rationale for groundwater quality policies that focus on aquifer protection (Pye et al, 1983 and The Conservation Foundation, 1987). Consequently, groundwater policies have focused on decreasing or eliminating the introduction of contaminants into the groundwater system in order to ensure water of some given level of quality (Henderson et al, 1984).

This paper will focus on some specific policy implications of the use of the total value framework in the evaluation of alternative groundwater protection programs. The remainder of the paper will address the following three topics: (1) Specification of a total value framework for policy analysis, (2) the sources of value from groundwater use, and (3) policy implications.

Total Valuation of Improvements in Groundwater Quality

In the evaluation of policies to improve groundwater quality, the benefits must be accurately estimated. "Benefits" can be defined as the increase in use-value from improvements in groundwater quality. If one looks at a total value framework for valuing incremental changes in groundwater quality, the following components may be identified (adapted from Randall and Stoll, 1983):

1. Current-use Value: Value that is derived from a particular use in the current time period.
2. Discounted Option Price: Greatest certain payment an individual is willing to make in order to ensure groundwater quality of a given level is available for future use.
3. Existence Value: Willingness to pay (WTP) for the knowledge that groundwater of some given quality exists.

This can be stated in an alternative manner to incorporate the WTP concept as a value measure of policies to improve groundwater quality: The total value of a policy to increase groundwater quality from some level $Q_0$ to $Q_1$ is equal to the maximum incremental WTP of current-use consumers for increased water quality plus the maximum sure payment to ensure the future availability of groundwater of quality $Q_1$ plus the maximum WTP by non-users to ensure the existence of groundwater of quality $Q_1$.

## Sources of Value from Groundwater Use

To accurately estimate the benefits from improvements in groundwater quality, the alternative uses of groundwater need to be identified. This is important because the type of use or uses that are affected by changes in water quality will determine the value that is attached to groundwater protection policies. Sources of value from particular groundwater uses are identified in Figure 1. The degree to which these various uses are affected by a particular groundwater protection policy will determine, in part, both the magnitude and distribution of the benefits and costs associated with the implementation of the policy.

Groundwater used for different purposes will most likely have different values. For example, groundwater used for industrial purposes where large quantities are needed but relatively low quality is permissable is valued differently from groundwater used for human consumption where quantity is comparatively small but quality demanded is high.

## Policy Implications

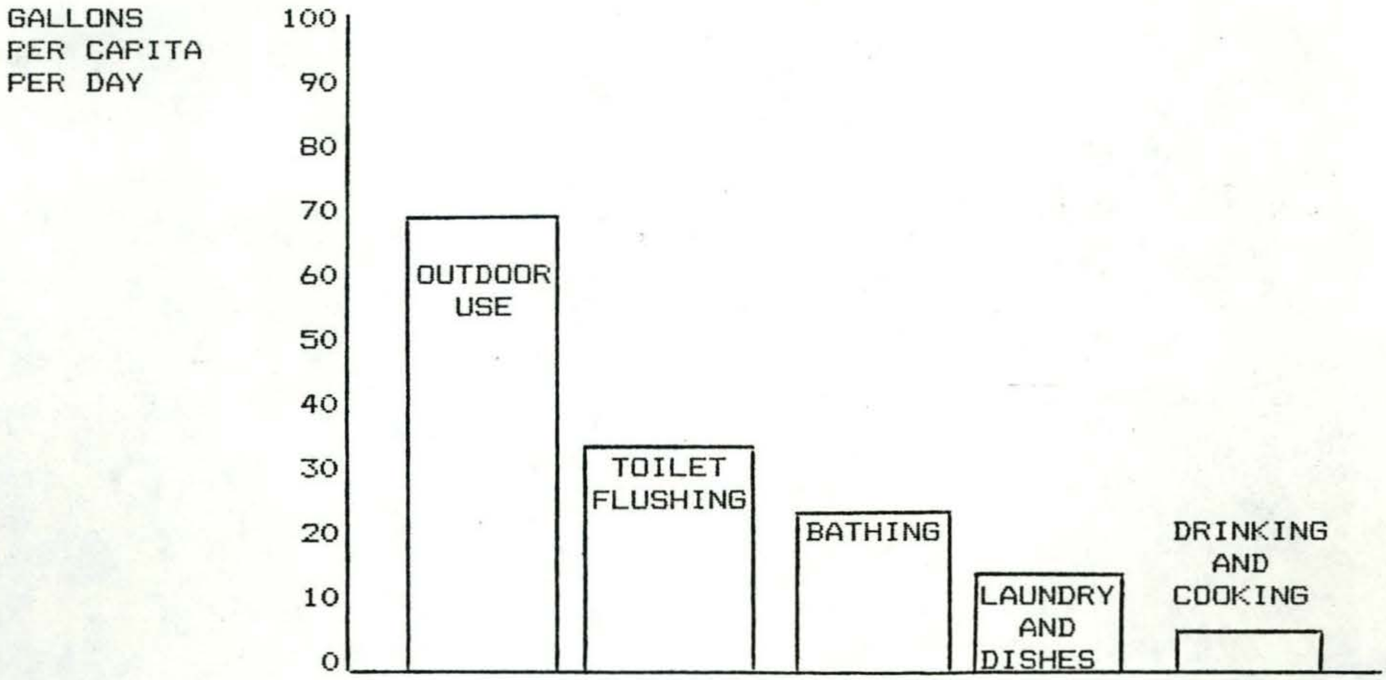
The relationship between the different uses of groundwater and the use of the total value framework for program evaluation has some potentially important policy implications. Concerning the nature of groundwater use, in general the amount of groundwater devoted to human consumption is a relatively small percentage of the total quantity used. Figure 2 shows the amount of water used for various residential purposes. The implication is that groundwater used for drinking and cooking may constitute a relatively small percentage of

FIGURE 1. SOURCES OF VALUE FROM GROUNDWATER.

1. RESIDENTIAL USE
    - A. CONSUMPTION
    - B. DOMESTIC
2. AGRICULTURE
    - A. IRRIGATION
    - B. LIVESTOCK WATERING
3. INDUSTRIAL USE
    - A. INDUSTRIAL PRODUCTION
    - B. COOLING OF PIPES AND CONDENSERS
4. WASTE ASSIMILATION
    - A. HOUSEHOLD CHEMICAL USE
    - B. TOXIC AND HAZARDOUS WASTES
    - C. URBAN RUN-OFF
    - D. ROAD SALT
    - E. AGRICULTURAL CHEMICAL USE
5. EXISTENCE VALUE
    - A. KNOWLEDGE OF EXISTENCE OF CLEAN GROUNDWATER
    - B. ECOLOGICAL USE
        1. HYDROLOGIC CYCLE
        2. FOOD CHAIN
        3. PLANT AND WILDLIFE HABITAT

SOURCE: SOLLEY ET AL, 1984, PYE ET AL, 1983 AND RANDALL AND STOLL, 1984.

FIGURE 2. COMPONENTS OF RESIDENTIAL WATER USE.




SOURCE: GIBBONS, 1986, P. 8.

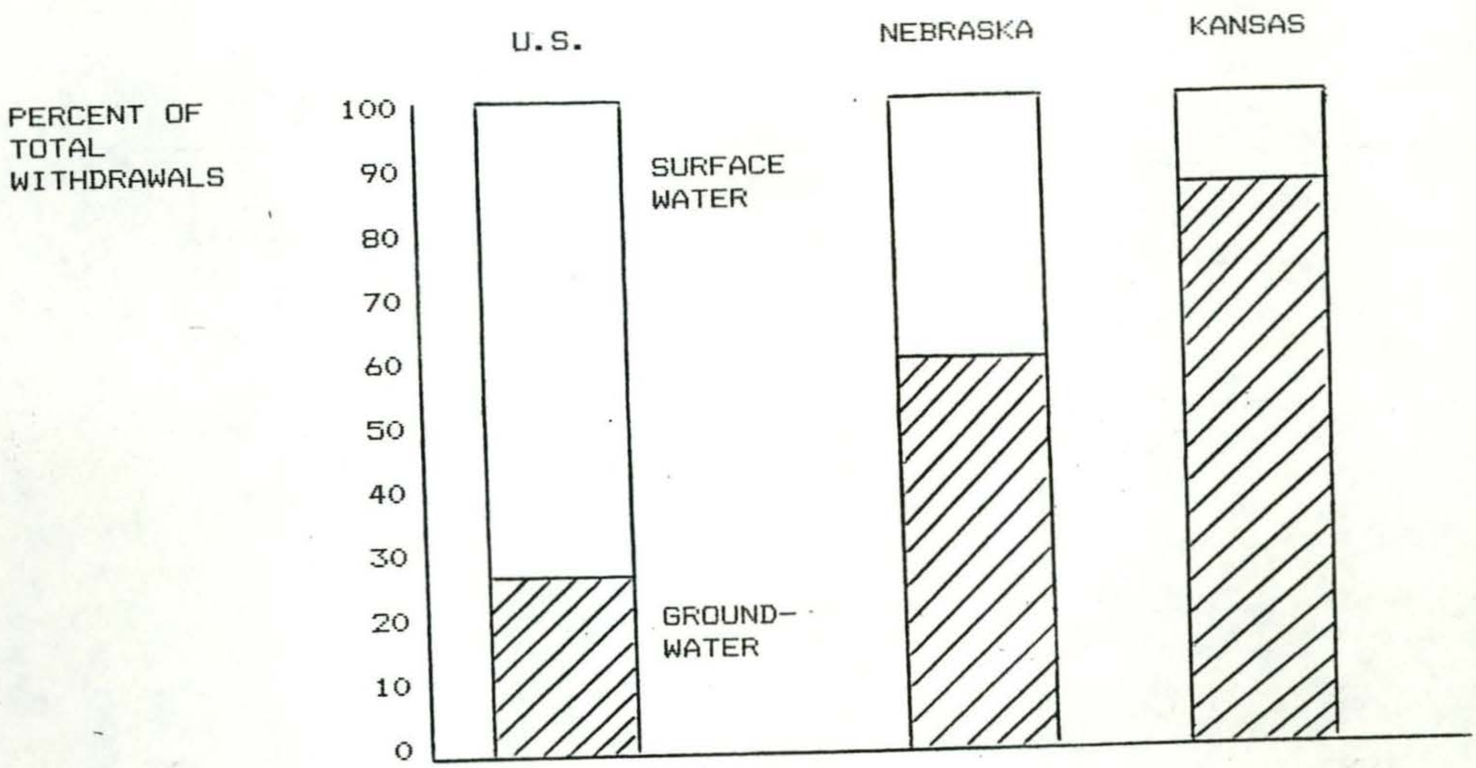
total groundwater pumped from a particular aquifer.

Aside from individual use of groundwater, the nature of aggregate groundwater use will have important policy implications. This is important in two respects: (1) the importance of groundwater as a freshwater source and (2) the relative magnitude of withdrawals for different purposes. Figure 3 looks at total freshwater withdrawals in the U.S. in terms of the percent of the total amount contributed by groundwater and surface water. Approximately three-fourths of the total consisted of surface water and one-fourth groundwater. For comparison, two states are shown, Nebraska and Kansas, that have expressed concern over potential contamination problems from agricultural chemical use (The Conservation Foundation, 1987).

Figure 4 shows in a broad sense what the groundwater is used for. A substantial portion of withdrawals in the U.S. are for agricultural irrigation, while the vast majority of groundwater withdrawals in the two states are for irrigation.

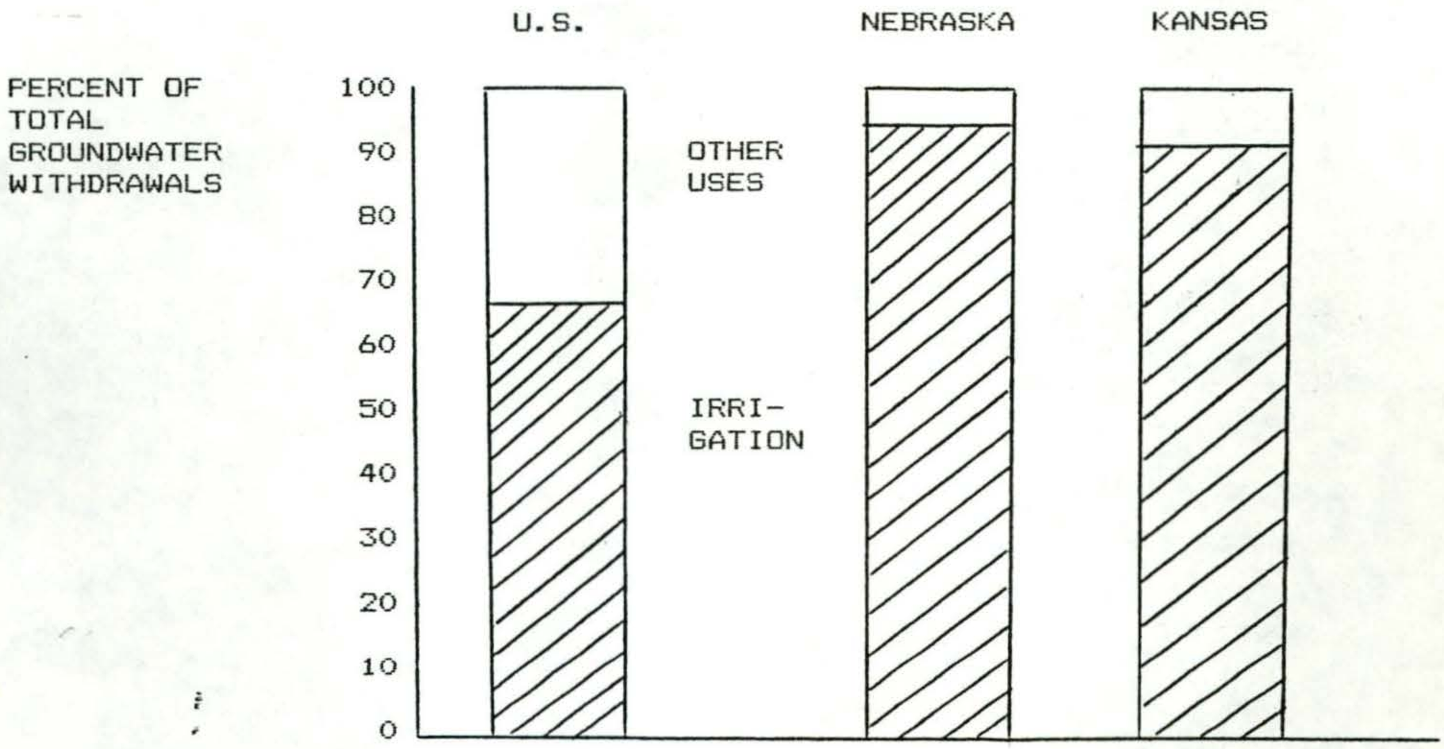
If the primary concern is human health, the objective of a policy is clean water for drinking and cooking. Consequently, if clean water per se is the sole concern, substitutes for groundwater may be available. Some examples include: (1) bottled water, (2) finding alternative water supplies, (3) increased reliance on municipal treatment for publicly supplied water, (4) increased point of use treatment (home filtration systems) and (5) moving from the area. The point is not to argue for a particular type of groundwater substitute but simply to point out that such substitutes frequently exist.

FIGURE 3. FRESH WATER WITHDRAWALS BY SOURCE, 1980.




SOURCE: SOLLEY ET AL, 1984.

FIGURE 4. GROUNDWATER WITHDRAWALS FOR IRRIGATION AS PERCENTAGE OF TOTAL GROUNDWATER WITHDRAWALS.




SOURCE: SOLLEY ET AL, 1984.

Concerning benefit estimates, if the maximum WTP approach is taken to ascertain the benefits of groundwater quality improvements, the current-use and option price valuations will be limited by the availability of these substitutes. The valuation that is being made is the maximum WTP for improvements in groundwater quality given the availability of substitutes. This is quite different from the valuation of a policy where there are no feasible alternatives available. Consequently, the cost of substitutes will set an upper bound for current-use and option price values.

On the other hand, substitutes may not exist for existence value from clean groundwater. In this situation, clean groundwater takes on value because of its uniqueness as clean groundwater. If individuals attach a large value to existence value, then the resulting increase in benefits from the policy may be considerable. People may attach a value to clean groundwater simply for the sake of clean groundwater and not simply because of the potential for use.

The ecological impacts of groundwater might also be a component of existence value because of its unique role in the hydrologic cycle and in affecting the ecology of a particular area. The fact that contaminated groundwater can adversely affect wildlife habitats may result in individuals placing a high value on clean groundwater even though they may never visit or use, in any sense, the habitat in question.

Alternatively, people may not especially care about the quality of water in the aquifer, but only care about the quality of water as it comes out of the faucet. If health is the sole concern, it may, under certain circumstances, be economically inefficient to insist on a high water quality standard for a particular aquifer ("inefficient" is used here to mean that some given objective such as clean drinking water can be achieved at less cost by alternative policies).

There are several reasons why this may be so. Exposure to groundwater contamination is not continuous or constant as it is, for example, with air pollution. One is only exposed when it is drawn out of the aquifer and consumed in some fashion. Risk of exposure to contaminants can be reduced or eliminated by the use of available substitutes. As a result, broad-based policies to reduce agricultural chemical use to ensure a relatively high level of quality may result in costs greater than benefits. In situations that are characterized by a relatively small percentage of groundwater being used for human consumption and with a number of substitutes available, a more appropriate policy from an economic perspective <u>might</u> consist of centralized or point of use water treatment or increased reliance on bottled water.

Research efforts to both increase knowledge about the use-values derived from groundwater and ascertain how these values are affected by improvements in quality will be especially helpful in contributing to a more effective analysis of groundwater protection policies.

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