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Evaluating economic efficiency of a water buyback program: The Klamath irrigation project

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ABSTRACT

Increasing scarcity of water resources in many regions is likely to give rise to disputes similar to those observed in the Klamath region of Oregon and California where irrigation water buyback programs have been implemented to reduce irrigation diversions with the purpose of securing required instream flow for aquatic habitat. In this study using a mathematical programming approach we compare a direct water buyback program with an indirect, land idling based, program for securing required amount of water. We show that land idling based programs can be costlier than direct water buyback programs. Compensation for water idling directly, unlike land idling based programs, ensures that marginal water units with the lowest derived demand values are removed from production first.

1. Introduction

Since the 1970s the focus of water management policies in the US has shifted from supply augmentation towards reallocation of existing supplies to meet competing demands (Chong and Sunding, 2006). Water acquisition and buyback programs are intended to reallocate existing water supplies among competing uses to correct under provision of public goods such as biodiversity and endangered species habitat. The Klamath Water Bank, California's Environmental Water Account, and Washington State's Walla Walla Mitigation Exchange are examples of programs that lease or buy water for environmental purposes. This paper evaluates the cost effectiveness of the 2010 Klamath Irrigation Project (KIP) water buyback program. The program solicited bids for idling land to reduce surface irrigation water diversions in accordance with the Endangered Species Act (ESA) mandate for aquatic habitat provision.

We demonstrate that an irrigation water buyback based on land idling bids, versus direct water idling,[1] requires expenditures in excess of the value of irrigation water in agricultural production. To illustrate this disparity, we first provide a

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[1] The use of the term "idle" in this paper should not be interpreted with a negative connotation of underutilized resource. We use the term "idle" to only reflect non-use of water and/or land in agricultural production. Benefits from land and water idling in terms of improvements to environmental quality are recognized.

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theoretical illustration of land versus water idling. Next, the derived demand for irrigation water in the Klamath Irrigation Project is empirically estimated. The derived demand is used to compare the observed expenditures in the 2010 water buyback program to the corresponding estimated derived value of irrigation water. The model is also used to compare the estimated expenditures from direct water idling to the estimated expenditures from a land idling based water buyback program. The analysis seeks to make two contributions to the water acquisition literature. First, our methodology illustrates a practical empirical framework that regulators can use to value irrigation water. Second, the disparity between actual 2010 buyback expenditures and the estimated marginal value product (MVP) of surface irrigation water is estimated. This difference can be attributed to the design of the water buyback program and/or to the premium necessary to induce participation in a water buyback auction (Burke, 2010; Burke et al., 2004).

The central argument of this paper is that, barring transaction costs including monitoring and enforcement, land idling buyback programs are costlier than paying directly for reductions in diversions of surface water. Land idling bids include opportunity costs of both land and water as inputs in production. In contrast, a water buyback program based exclusively on water idling avoids expenses associated with idling land as a factor of production. In addition, idling a parcel of land with its appurtenant water right idles water with high MVP as well as water with lower MVP. In contrast, a program which pays for water directly, rather than indirectly via land idling, ensures that water with the lowest marginal derived demand values is purchased first. Cost inefficiency results from the foregone value of removing land from production and the decreasing marginal productivity of irrigation water.

This study examines potential differences in expenditures on securing reductions in diversions not accounting for monitoring and enforcement costs. Monitoring and enforcement costs of land based idling programs are low. In contrast, direct water idling programs require investment in water meters, gauges, or other technologies.[2] Thus, if monitoring costs exceed the savings that may be realized by switching from land idling to direct water use reduction based programs, then direct water idling programs are not justified. While benefits of switching from land based idling to direct water idling during a water shortage in any given year may not exceed costs of monitoring, repeated water shortages requiring repeated buybacks may justify investments in monitoring infrastructure. Furthermore, monitoring infrastructure can provide benefits in addition to the facilitating monitoring and enforcement in water buyback programs.

The paper is structured as follows: Section 2 provides necessary background on the study area; Section 3 provides a theoretical illustration of land idling based vs. direct water buybacks; Section 4 describes the empirical approach; Section 5 discusses the data and data sources; Section 6 presents results and Section 7 provides discussion and concluding statements.

2. Study area and background

The Klamath Irrigation Project (KIP, Fig. 1), located on the Oregon/California border, was created in 1905 under the provisions of the 1902 Reclamation Act to provide irrigated agricultural land for homesteading (USBR, 2009; Hathaway and Welch, 2002). KIP includes approximately 200,000 acres of farmland with approximately 1400 individual farms and ranches which principally produce pasture, alfalfa, other hay, barley, wheat, oats, potatoes, and onions (USBR, 2005–2009). Surface water from Upper Klamath Lake, Clear Lake, and Gerber Reservoir is used to irrigate Project and non-Project land in the Klamath Basin, provide in-stream flows for endangered fish habitat, and water for two wildlife refuges. The Klamath Basin is home to 19 species of native fish, including the endangered Coho salmon and the Lost River and Shortnose suckers, which support tribal, sport, and commercial fisheries (Lewis et al., 2004). The decline of endangered fish species has been attributed to water management, water quality, loss of habitat, overfishing, and other causes (Lewis et al., 2004).

The U.S. Bureau of Reclamation (USBR) manages surface water deliveries to Project irrigators from water stored in Upper Klamath Lake, Gerber Reservoir, and Clear Lake Reservoir. Prior to releasing surface water for irrigation, USBR must comply with Endangered Species Act mandates in the Biological Opinions of U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). The USFWS' Biological Opinion recommends a minimum elevation for Upper Klamath Lake to protect the Lost River and Shortnose suckers. Similarly, NMFS' Biological Opinion recommends minimum in-stream flows in the Klamath River to protect endangered Coho salmon (Hathaway and Welch, 2002).

Water management in the Upper Klamath Basin has been contentious. Prior to 2001, irrigation curtailments during low flows were limited to low-priority Project water contracts (Markle and Cooperman, 2002). However, the severity of the 2001 drought necessitated the inclusion of high-priority water contracts in some areas of the Project. This curtailment attracted significant public attention, protests, and calls for annulment of the Endangered Species Act (Jaeger, 2004). The 2001–2002 surface water curtailment of KIP irrigators, as administered by the USBR, has been addressed by Braunsworth et al. (2002), Jaeger, (2004), Boehlert and Jaeger, (2010), and Adams and Cho, (1998). The curtailment resulted in estimated losses of $27 to $46 million in net revenue for KIP agricultural production (Jaeger, 2002; Jaeger, 2004). To alleviate the economic impact of irrigation curtailment, $35 to $37 million was paid in emergency government transfers (Jaeger, 2002). Drought induced high water temperatures and low in-stream flows along with irrigation withdrawals contributed to the 2002 die-off of an estimated 34,000 Chinook salmon (Guillen, 2003; Lewis et al., 2004) injuring tribal communities and commercial fisheries (Powers et al., 2005).

[2] Some technological progress has been made in remote sensing of consumptive water use. See for example Allen et al. (2007).