



The economic value of groundwater in Obama



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ABSTRACT

Study region: Obama City has a population of 33,000 and is located in the central Wakasa district, in southwest Fukui Prefecture, Japan. Obama's groundwater resources are supported by the Kitagawa (38 km²) and Miniyamigawa (17 km²) river basins. Groundwater is used aboveground year round for commercial and domestic purposes and during winter months to melt snow. Submarine groundwater discharge along the coast supports a nearshore fishery in the region.

Study focus: Results from a choice-based analysis suggest that residents are willing to pay on average JPY 565 per month to maintain the drinking water function and aquatic resource function of groundwater in the Fukui region. However, the static approach is not appropriate for estimating the net present value of the resource, i.e., the discounted net benefit aggregated over time. We therefore develop and propose a dynamic framework capable of assessing tradeoffs between the various water uses as scarcity increases or decreases in the future.

New hydrological insights for the region: Marginal willingness to pay for water in Obama is currently low because freshwater is abundant. We expect that future optimal water extraction patterns will depend most on trends in energy costs, climate change and demand growth.

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1. Introduction

Worldwide, freshwater is important not only for direct consumption but also for its role in the production of a variety of goods and services. For example, water is used for cooling nuclear reactors and as an input for the production of energy via hydroelectric processes. Freshwater also is essential for the production of food, including crops and livestock. Recognizing these synergies and identifying tradeoffs are key components of water-energy-food (WEF) nexus research (Taniguchi et al., 2013; Loring et al., 2013; Giampietro et al., 2014). In this study, we focus on Obama City, Japan, where groundwater is used directly for domestic and commercial consumption and for melting snow. Stored groundwater also provides an indirect benefit: submarine groundwater discharge (SGD) from the aquifer supports the nearshore ecology, including a locally important fishery. Using this case study, we document some common challenges that arise when undertaking WEF research and outline an example of an integrated approach that combines multiple modes of analysis to overcome those obstacles.

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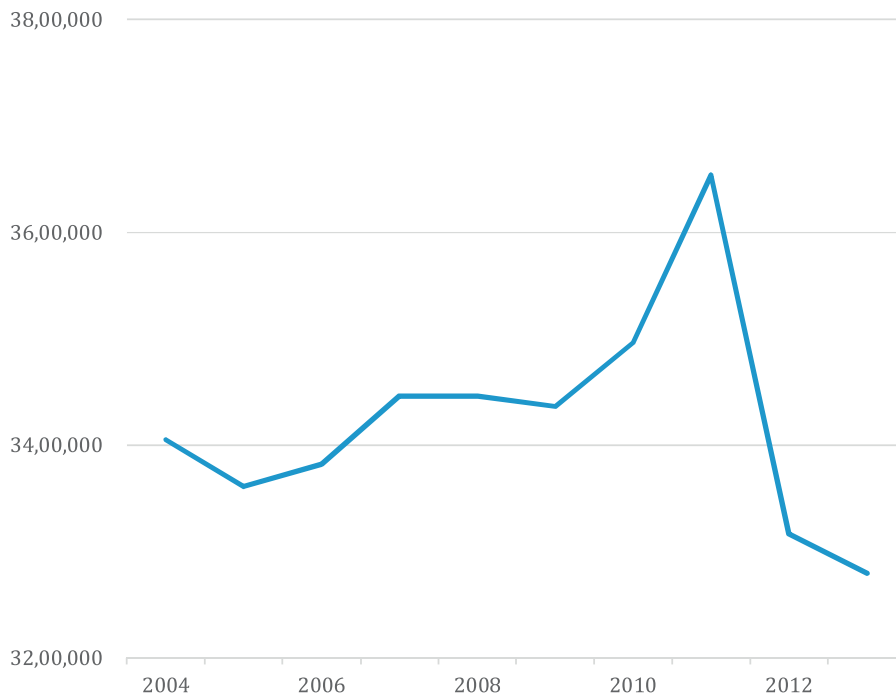


Fig. 1. Groundwater supplied in Obama (m³/year), 2004–2013.

1.1. Groundwater use in Obama

Obama City has a population of 33,000 and is located in the central Wakasa district, in southwest Fukui Prefecture, Japan. Obama is south of Wakasa Bay, which is included in the area's "Quasi-National Park". Fishing used to be the main industry in Obama, likely due, in part, to the fact that the mixture of cold and warm currents in Wakasa Bay provides fertile fishing grounds. In ancient times, Obama became known as "Miketsukuni," supplying food to the imperial court. More recently, the city's economy has shifted largely from fishing to tourism. Nevertheless, groundwater has always been an important resource for the Obama area, for domestic, municipal, industrial, and limited agricultural use, as well as having a cultural and historical significance. During the Omizu-okuri (Water Carrying) Festival, which is held on March 2nd every year, water is drawn from the Onyu River and presented to the principal image of the temple. This annual event dates back more than 1200 years.

There are two primary river basins supporting Obama's groundwater resources. The main Kitagawa river basin has an area of 38 km² and a thickness of 62 m. With a porosity of 0.3 the retention ability has been estimated at 700 million m³. The smaller Minamigawa river basin has an area of 17 km² and a thickness of 43 m. With a porosity of 0.3 the retention ability has been estimated at 200 million m³. Groundwater flux for both river basins was estimated using a standard water balance analysis (D. Tahara, personal communication). For the Kitagawa and Minamigawa river basins, flux is estimated to be between 31,225–108,305 m³/day and 16,657–17,491 m³/day respectively.

Groundwater in Obama is used for multiple purposes. The largest use is domestic and commercial, at approximately 15,300 m³/day. Another 4000 m³/day is used in winter months for melting snow. Obama City is currently pumping only a fraction of their total water resource. Fig. 1 shows the total annual groundwater supplied over the last decade, which after peaking in 2011 has recently been decreasing, possibly due to population decline. Fig. 2 illustrates the local population served by this same water resource, which also experienced a peak between 2010 and 2011 but has been declining since. Fig. 3 shows the distribution of municipal tap water pumping at various locations. The seasonal spikes correspond to increases in pumping during the winter months to meet snow-melting demands.

1.2. Relationship between the groundwater resource and nearshore ecology

SGD into the bay supports the nearshore ecology because freshwater flowing into the ocean affects the temperature and salinity of coastal waters, which in turn affects the growth and health of keystone species such as algae that fish and other sea creatures depend on for survival (Taniguchi et al., 2002). Since the flow of SGD depends on the volume of stored groundwater, decisions to extract groundwater for aboveground uses indirectly affect aquatic resources that may be important to residents for cultural, subsistence, or commercial reasons.

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