Effects of a changing water supply in Imperial Valley, California and its implications for the Salton Sea

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Introduction

The Salton Sea is a terminal, saline lake in southern California that relies on agricultural return flows from the Imperial Valley for its water supply. In 2003, the implementation of the Quantification Settlement Agreement (QSA) limited inflow to the Imperial Valley, potentially reducing return flows to the Salton Sea. The QSA's Salton Sea Mitigation attempted to alleviate consequences of the reductions, but its effectiveness has not been fully assessed on a hydrologic level. In this study, we used a mixed methods approach to analyze changes in the Imperial Valley since QSA enactment and examine their implications for the Salton Sea.

Research Questions

1. How did inflow to the Imperial Valley and outflow to the Salton Sea change over the years since QSA enactment?
2. Did Imperial Valley agricultural water productivity increase, decrease, or stay the same after the QSA was implemented?
3. According to key informants, how has the QSA affected the Salton Sea?

Methods

- Inflow to the Imperial Valley and outflow to the Salton Sea were calculated from USGS stream gage data using a simple water balance equation (Figure 1)
- Time series of inflow, outflow, and total consumptive water use were plotted and normalized to visualize and compare hydrologic trends
- Water productivity of the Imperial Valley was determined by dividing gross agricultural value by total consumptive water use. Data was normalized to a 2003 base year to mark the beginning of the QSA
- Preliminary semi-structured interviews were conducted with key informants to identify effects of the QSA on the Imperial Valley and Salton Sea

Results

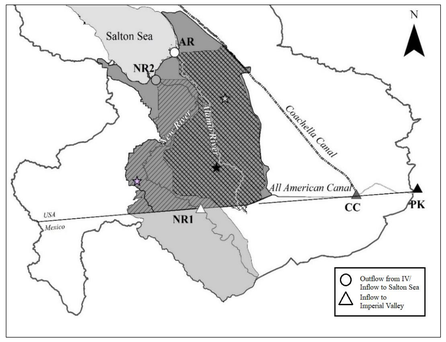

Figure 1: Map showing inflows to the Imperial Valley and outflow to the Salton Sea (adapted from Salinas, 2017).

Annual Imperial Valley Water Productivity ($/Acre Foot)			
1995	484.81	2007	490.77
1996	436.40	2008	611.87
1997	468.36	2009	564.24
1998	481.95	2010	638.90
1999	451.78	2011	653.36
2000	379.63	2012	668.38
2001	414.30	2013	794.04
2002	475.75	2014	662.94
2003	432.73	2015	680.59
2004	501.40	2016	720.82
2005	532.22	2017	677.26
2006	502.82	2018	700.48

Figure 2: Annual water productivity in the Imperial Valley, calculated by dividing gross agricultural value by total consumptive water use. The year 2003 is highlighted to indicate the beginning of QSA programs.

"The QSA is exacerbating Salton Sea problems…it's not causing them, it's not the root of all evil, but it is definitely exacerbating it from an environmental standpoint."

"The biggest single change is the Salton Sea…the elevation's dropped eight and a half feet from when the QSA was signed, 25,000 acres of Salton Sea lake bed have been exposed...these are significant changes. Fish are largely absent back in the Salton Sea. The salinity of the Salton Sea increased by probably 25% or even 30%., so it's a very different ecosystem than it was 15 years ago."

Figure 3: Responses from key informant semi-structured interviews regarding relationships between the QSA and environmental change at the Salton Sea.

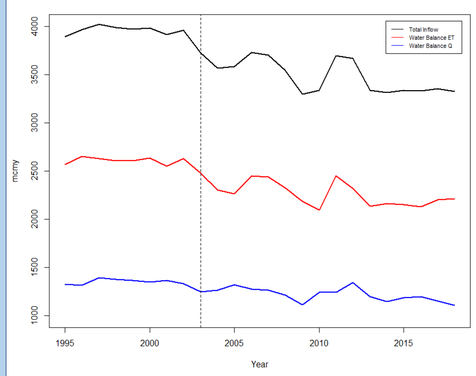

Figure 4: Annual time series plot of the Valley-wide water balance. The year 2003 is marked to visualize the start of the QSA.

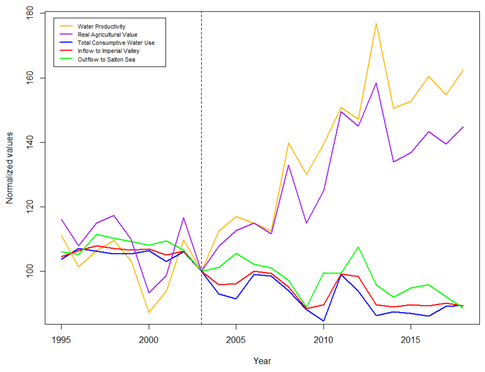

Figure 5: Annual time series plots of inflow to the Imperial Valley, outflow to the Salton Sea, total consumptive water use, real agricultural value, and water productivity. Time series normalized based on values from the year 2003, the year the QSA took effect.

Discussion

Despite the Valley's decrease in water supply from reduced canal inflow, annual water productivity in the Imperial Valley increased since the QSA took effect (Figure 4). Total consumptive water use, calculated by subtracting total outflow from total inflow, also showed a decreasing trend (Figure 5). The inverse relationship between water productivity and water use could imply increased water use efficiency within Imperial Valley agricultural systems.

However, the time series plots confirm an overall decrease in outflow to the Salton Sea following the QSA's enactment, likely connected to decreased canal inflow to the Imperial Valley. Key informants implied that decreased outflows to the Salton Sea have and will continue to increase salinity and exposed lake bed (Figure 3). Other studies on the health of the Salton Sea also reported secondary effects of the decrease, including rapid degradation of fish and migratory bird habitat and worsened air quality (Cohen & Hyun, 2006; Cohen, 2014).

Future research will include GIS and remote sensing analysis of agricultural transitions in the Imperial Valley followed by more interviews with purposively-identified key informants.

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