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Supplementary Information for

The Low but Uncertain Measured Benefits of U.S. Water Quality Policy

David A. Keiser, Catherine L. Kling, and Joseph S. Shapiro

Corresponding Author: David A. Keiser
Email: dkeiser@iastate.edu

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Fig. S1

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Supplementary Information Text

Estimates of Spending on US Water Pollution Control Efforts

Figure 1 provides estimates of historic spending on US water pollution control programs. This includes spending that is strongly tied to Clean Water Act grants, Clean Water Act State Revolving Funds, and USDA conservation programs. This does not include spending by local governments outside of these programs or additional spending from federal agencies outside of these programs.

Municipal spending totals include:

- Capital expenditures tied to Clean Water Act federal grants. This includes federal grant dollars from 1960 to 2014. These data were obtained from USEPA through a Freedom of Information Act request. These data provide the federal grant amounts as well as local cost-share expenditures. See Keiser and Shapiro (2017) for details.

- Capital expenditures tied to Clean Water Act State Revolving Funds (CWSRF) from 1988 to 2014. These data were obtained from CWSRF financial reports dated 11/10/2015.[*] These totals include Clean Water State Revolving Funds assistance listed as Wastewater Treatment (Section 212). We also include funding listed under State Funded Clean Water Loan Programs that are separate from CWSRF. These additional State Funded Clean Water Loan Programs are not delineated by type of assistance and may include spending on nonpoint source programs in addition to wastewater treatment facilities. For 1988 to 1998, the State Funded Clean Water Loan Programs report an aggregate amount spent from 7/1/1987 to 6/30/1998. We divide this amount equally across these years. Total spending on State Funded Clean Water Loan Programs comprises approximately 8 percent of our estimate of total spending on municipal facilities outside of the federal grants program. We do not include funding listed under EPA Rural Community Hardship Grants or State Funded Clean Water Grant Programs as it is not clear if these grants are already captured in our EPA grants data. We also exclude spending listed as Estuary Assistance since examples include fish stocking efforts (not abatement efforts).

- Operations and Maintenance (O&M) costs. We follow Keiser and Shapiro (2017) and estimate O&M costs as a function of capital stock levels. Keiser and Shapiro (2017) describe how this ratio grew almost linearly from 3.7 percent in 1972 to 7.4 percent in 1996. We linearly extrapolate these values to years before 1972 and after 1996 to estimate O&M costs as a function of the current capital stock. We assume a lifetime of 25 years for capital expenditures.

[*] See https://www.epa.gov/cwsrf for more details (accessed March 12, 2018).

Industrial spending:

- Industrial spending totals reflect capital and operations and maintenance expenditures reported in the Pollution Abatement Costs and Expenditures (PACE) surveys from 1973 – 1986, 1988 – 1994, and 2005.

- To impute missing values, we perform the following calculations:

    - 1960 to 1972: We assume that spending in each year from 1960 to 1972 is a certain fraction of total industrial spending reported in 1973. We assume this fraction is equal to the same fraction of municipal spending for a given year relative to municipal spending in 1973. For example, the amount spent on municipal facilities in 1970 is equal to 56 percent of the total spent on municipal facilities in 1973. To impute industrial spending in 1970, we multiply 56 percent by the total amount spent by industrial facilities in 1973. We do not linearly interpolate spending in years prior to 1973 since the Clean Water Act was a significant departure from federal water pollution regulations in the 1960s.

    - 1987: We assume that spending in 1987 is equal to the average of spending by industrial facilities in 1986 and 1988.

    - 1995 to 2004 and 2006 to 2014: We linearly interpolate spending between 1994 and 2005. We assume spending remains at 2005 levels from 2006 to 2014.

Non-point source spending totals include:

- Soil and water conservation expenditures by USDA

    - 1960 to 2010: These totals reflect reported expenditures on soil and water conservation programs from 1960 to 2010 as reported by USDA-NRCS.[†] We include total assistance reported from all USDA agencies for both financial and technical assistance. This includes spending on programs such as Environmental Quality Incentives Program and the Conservation Reserve Program.

    - 2011 to 2014: We assume annual expenditures equal annual expenditures in 2010. Claasen (2014) shows USDA annual average conservation

[†] These data were obtained at the following USDA website: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/about/history/?cid=stelprdb1044451 (our version of these data were downloaded on April 15, 2016).

expenditures for 2008 to 2013 were slightly greater than annual average conservation expenditures for 2003 to 2007.[‡]

- Nonpoint source funding from Clean Water Act Section 319 funds.
    - We separately include funds listed as Nonpoint Source Assistance from the CWSRF financial reports described above.

Counts of U.S. EPA Economic Analyses by Year

Figure 2 provides counts of USEPA economic analyses by year. To conduct this count, we include all analyses performed by the Office of Water and analyses with titles that include major keywords for water quality policy such as water, wastewater, and sewage. This database is now housed at the USEPA library in Washington, DC. For details on this database see: https://www.epa.gov/environmental-economics/environmental-economics-reports (our version of the database was downloaded September 20, 2016).

- Our count of analyses that pertain to water analyses include those where the EPA Office name includes "water" or where the title of the analysis includes one of the following words: water, wastewater, effluent, wellhead, drinking, pretreatment, well, nonpoint pollution from agriculture, 316, disinfectant byproduct, disinfection byproduct, disinfection, meat and poultry, marine, npdes, spill, total maximum daily load, sewage, underground, wetland, pcb.

- Our count of analyses that pertain to air pollution include those where the EPA Office name includes "air" or where the title of the analysis includes one of the following words: air, vehicle, road, nox, gasoline, combustion, ozone, emission, acid rain, truck, energy, engine, fuel, naaqs, neshap, skies, so2, no2, boiler, creosote, coke oven, visibility, methane, vapor, mercury, coal.

[‡] https://www.ers.usda.gov/amber-waves/2014/may/2014-farm-act-continues-most-previous-trends-in-conservation/ (accessed March 12, 2018).

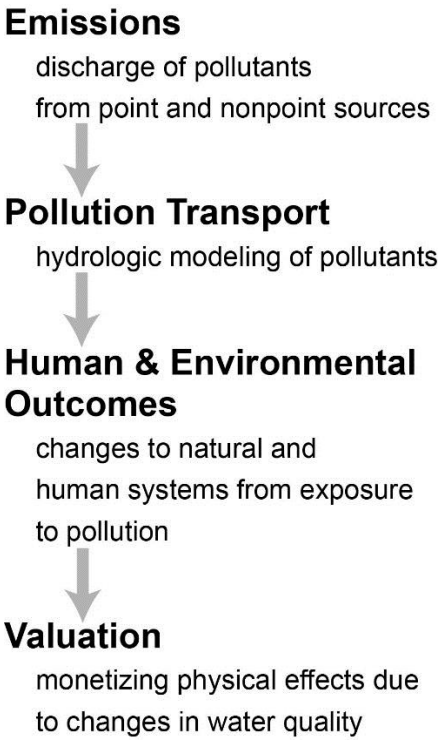

Fig. S1. This figure provides a conceptual diagram for an integrated assessment model (IAM) of water pollution. First, the IAM uses data listing emissions of pollution from a point or non-point source. For example, it may have data on BOD loads for all industrial plants. Second, it tracks the flow of pollution from an emissions source through dispersal in a river network. For example, this step could model emissions flow from a wastewater treatment plant or agricultural field through a watershed or specific river. Next, the IAM models changes in human and environmental outcomes from pollution exposure. For example, this step could model changes in disease incidence, changes in the frequency of harmful algal blooms, changes in the number of recreational trips to a waterbody, etc. The last piece of the IAM calculates changes in the economic value of the changes in human and environmental outcomes.