

# Creating a Clearinghouse of Knowledge-Based Resources on Public Acceptance of Water Reuse and Desalination

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## Abstract

The purpose of creating the Clearinghouse is to make informational resources about public acceptance for water reuse easily and readily available to decision-makers, managers, engineers, communication specialists, and others so that they can begin planning their public education and acceptance strategies in the early stages of developing water resources projects. The Clearinghouse project involved selecting, collecting, categorizing, assembling, and presenting a dynamic compendium that is up-to-date and can be kept up-to-date in the future as new resources become available in the public domain. The resulting compendium will make it unnecessary for agencies and others to conduct their own separate search of available literature on public acceptance issues and outreach programs for water reuse and desalination. It will also provide a compendium of resources for future research projects and will, in this manner, better utilize research funds. The information will be available to them via an interactive website that will be made available by the WateReuse Research Foundation where they can select from drop-down menus those choices that best represent their own particular circumstances and conditions. The most relevant reports, articles, and decision tools will be displayed within moments of accessing the Clearinghouse.

## Introduction

Only a small fraction of domestic wastewater is reclaimed for beneficial reuse in most arid and semi-arid regions of the world. Jordan and Israel are exception, reusing 95 and 75 percent of their wastewater resource, respectively. California recycles and reuses only about 11 percent of its municipal wastewater. Therefore, water reuse is a relatively new concept in many communities in the world, even though it has been practiced for more than a century in some regions and is a *de facto* phenomenon in nature and along river systems throughout the world. Potable reuse and desalination are expected to provide the most abundant future sources of new water supplies for the burgeoning populations of many communities worldwide. Yet, the seeming newness of the concept makes many people squeamish and

uncomfortable about completing the cycle in what might appear at first to be such an abrupt way (i.e., using engineered treatment rather than the natural cleansing phenomena).

Examples of failed and delayed water reuse projects due to misapprehension by the public abound. In nearly all cases, a poorly-informed and poorly-involved public raised serious objections to projects that—in their views—required them to be exposed to sewage, sewer water, poorly treated effluent, or pharmaceutical compounds and other chemicals. As a result of these failed and delayed projects, much has been learned by academics, public affairs professionals, water/wastewater professionals, and agencies dealing with water scarcity and the need for recycling. Fortunately, in more recent years, several water recycling projects, including potable reuse projects such as the 400 MLD (100 AFY) Groundwater Replenishment System (GWRS) in Orange County, California, have been successfully implemented. The GWRS included a budget of \$1.5 million dedicated to public outreach and education, resulting in virtually no opposition to the project. The predecessor project to GWRS, Water Factory 21 showed the treatment process through tours to the facility that also paved the way for GWRS.

GWRS and other successful water reuse projects have benefited from the lessons learned from the failed projects in previous decades. Also, they followed recommendations resulting from a knowledge base gathered from a wealth of published papers, reports, and monographs on the topic of public acceptance of water reuse. Ready availability and accessibility of information about public attitudes toward water reuse and desalination is now viewed to be crucial for the leaders of water resource agencies considering water reuse or desalination projects to be able to make the most appropriate resource decisions.

## Materials and Methods

Exhaustive literature searches, both traditional, and web-based, were conducted to compile a collection of papers, books, book chapters and other published and unpublished resources with a focus on public acceptance of water reuse and desalination from throughout the world. Peer reviewed and gray literature were equally sought and compiled. In particular, proceedings of conferences sponsored by major associations with an interest in water and wastewater were reviewed for relevant information. Also, scientific and technical search engines were used to unearth relevant literature from publications not normally known to publish material related to water reuse and desalination. Several colleagues active in the field were solicited for contributions from their own collections of resources.

As a result of these searches and solicitations, about 200 relevant resources were accessed, evaluated and most of them were catalogued. The bibliography at the last section of this paper lists the resource materials that were selected for inclusion in the Clearinghouse.

The categorization process involved placing each individual document (item) in a table row within the Microsoft Access database and give it specific groupings based on 29 specific criteria (in table columns within the database). The categories utilized for classification of the papers into the database are shown in Table 1.

*Table 1 Categories in which Each Item in the Clearinghouse is classified*

ID (assigned by the software)	Item Code (publisher's identification code or ISBN, as available)	Title
Author	Co-Author(s)	Author's Contact Email
Author's or Publisher's Contact Telephone Number	Reuse or Desalination?	Reuse Type
Nonpotable Reuse, Potable Reuse, Both, Neither	Direct Potable, Indirect Potable, Both, Neither	Country
State, Province	Year of Publication	Rigor (Scientific, Technical, Manual of Practice, Brochure, Fact Sheet, News Article, Guidance, Directory)
Content (Survey, Focus Group, Public Outreach, Guidelines, Literature Review, Report, Interview, Research Results)	Link to Site for Content	Comprehensiveness (Subjective Designation of Rankings: 5, 4, 3, 2,1)
Relevance (Subjective Designation of Rankings: Very High, High, Moderate, Low, Very Low)	Format 1 (Conference Proceeding, Brochure, Web-Based Directory, PowerPoint Presentation, Newspaper Article)	Format 2 (Conference Proceeding, Brochure, Web-Based Directory, PowerPoint Presentation, Newspaper Article)
Format 3 (Conference Proceeding, Brochure, Web-Based Directory, PowerPoint Presentation, Newspaper Article)	Citation (formal library citation of the resource)	Hard Copy Availability
On-Line Availability	Summary of Content	Link to Source
Keywords	Desalination Type (Membrane, Thermal, Both)	

Information was available for most of the categories above, and every item was categorized with respect to the most important criteria (e.g., title, author, reuse or desalination, type of reuse, direct or indirect potable reuse, type of desalination, year of publication, etc.) However, adequate information was not available for some of the other categories for every single item. Some of the fields lacking information include contact telephone numbers, Internet link to the item, and availability of the item in various formats. All of the fields with subjective criteria (rigor, content, comprehensiveness, and relevance) were filled with the professional judgment of the author. It is emphatically acknowledged that these particular criteria have no solid basis for their veracity, being the opinion of one individual.

Therefore, caution will be advised in using these categories for prioritization of the resources in the Clearinghouse by the general public.

## Results

Only two papers were classified as being desalination-related, in contrast to over 150 papers related to water reuse. About a dozen papers are included bearing no direct relevance to either water reuse nor desalination—they are included because of their direct relevance to issues of stigma, contagion, associative attitudes, and other related psychological influences on public attitude toward water resource issues. This relative paucity of literature about public acceptance issues regarding desalination probably reflects the fact that the public generally does not have an innate negative image about water extracted from the ocean. On the other extreme, there is much in the literature about the so-called “yuck factor”, reflecting the humanity’s atavistic revulsion and disgust toward anything associated with one’s own bodily wastes.

One of the striking findings from this project is the apparent lack of awareness of numerous researchers about similar work completed in prior years, even decades. Creation of this Clearinghouse should be of assistance to future researchers, so that the field can be moved forward in addition to repeatedly confirming previous findings.

Simply categorizing the research by type of reuse will be helpful only insofar as it aids in finding relevant items for a particular project. It is recognized that delineations between direct and indirect potable reuse are not always very sharply defined. Nor is such distinction necessarily conducive to better public image of potable water reuse.

Also, it should be pointed out that not all the research results are in agreement. Researchers typically do not use the same lexicon, and too many of them do not avoid stigmatizing language when referring to reclaimed/recycled water. One of the aspirations of the Clearinghouse project is to try to use a unified water reuse terminology so that future researchers will start from a common linguistic basis with words that define the water accurately—without implied negative connotations.

The result of the categorization process is a highly interactive “go-to” site (to be made available on the Internet by early 2014) for access to the most relevant and useful public acceptance, educational, and outreach material available to professionals and the general public alike. The user can read a summary of the content of each item and decide whether or not to acquire the full text of the item, in most cases by way of a direct URL link to the item itself. Examples of the type of statistical information that can be readily gleaned from the database are shown in the Table 2.

*Table 2 Examples of Numbers of Items under Each Categorical Selection*

<b>Total Number of Items in the Clearinghouse as of 5/31/2013</b>	<b>292</b>
Water Reuse	222
Desalination	49
Both Water Reuse and Desalination	17
Graywater	3
Neither (Specifically) Water Reuse or Desalination	18
Nonpotable Reuse	100
Both Potable and Nonpotable	77
Potable Reuse	65
Direct Potable	6
Indirect Potable	54
Both Direct and Indirect Potable	51
Scientific Items	51
Technical Items	76
Manuals of Practice	5
Guidelines	71
Surveys	82
Literature Reviews	13
Reports	19
Papers	130
Conference Proceedings	79
Items with International Applicability (Minimum Count*)	25
Items from USA	170
Items from California	100
Items from Arizona	5
Items from Florida	3
Items from Australia	56
Items from Europe	19
Items from Jordan	3
Items from Singapore	4
Items from South Africa	2

\* Many published papers may be considered international in scope and relevance. However, for the purposes of this Clearinghouse project, only those with multi-national teams of researchers, or with databases from more than one country were tagged as “international”. Conversely, most of the papers coded “international” originated in the United States, usually in collaboration with one or another country’s researchers.

An interesting outcome of creating the Clearinghouse is the emergence of patterns of evolution of public attitudes literature over the past several decades, as shown in Figures 1, 2, and 3. Such literature began to appear in the early 1970s, coincident with increasing levels of interest in water reclamation

and reuse—especially in California. There is a clear boost in the rise of interest in (all types of water reuse) public acceptance during the late 1990s and 2000s with a sharp drop-off in the early 2010s—especially shown in Figure 3. Public acceptance related to *potable* reuse has received increasing levels of researchers’ attention over the recent decades as technology for potable reuse has made big strides and as demand for new sources of water has placed greater emphasis on exploitation and reuse of this resource.

Another interesting pattern is the distribution of literature by country of origin. While the United States leads the world in this field, Australia also played a significant part in contributing to the public acceptance literature—coincident with the decade-long drought that persisted on the continent in the late 1990s and most of the 2000s.

Figure 1 Number of Papers by Type of Reuse—Potable, Nonpotable, and Both

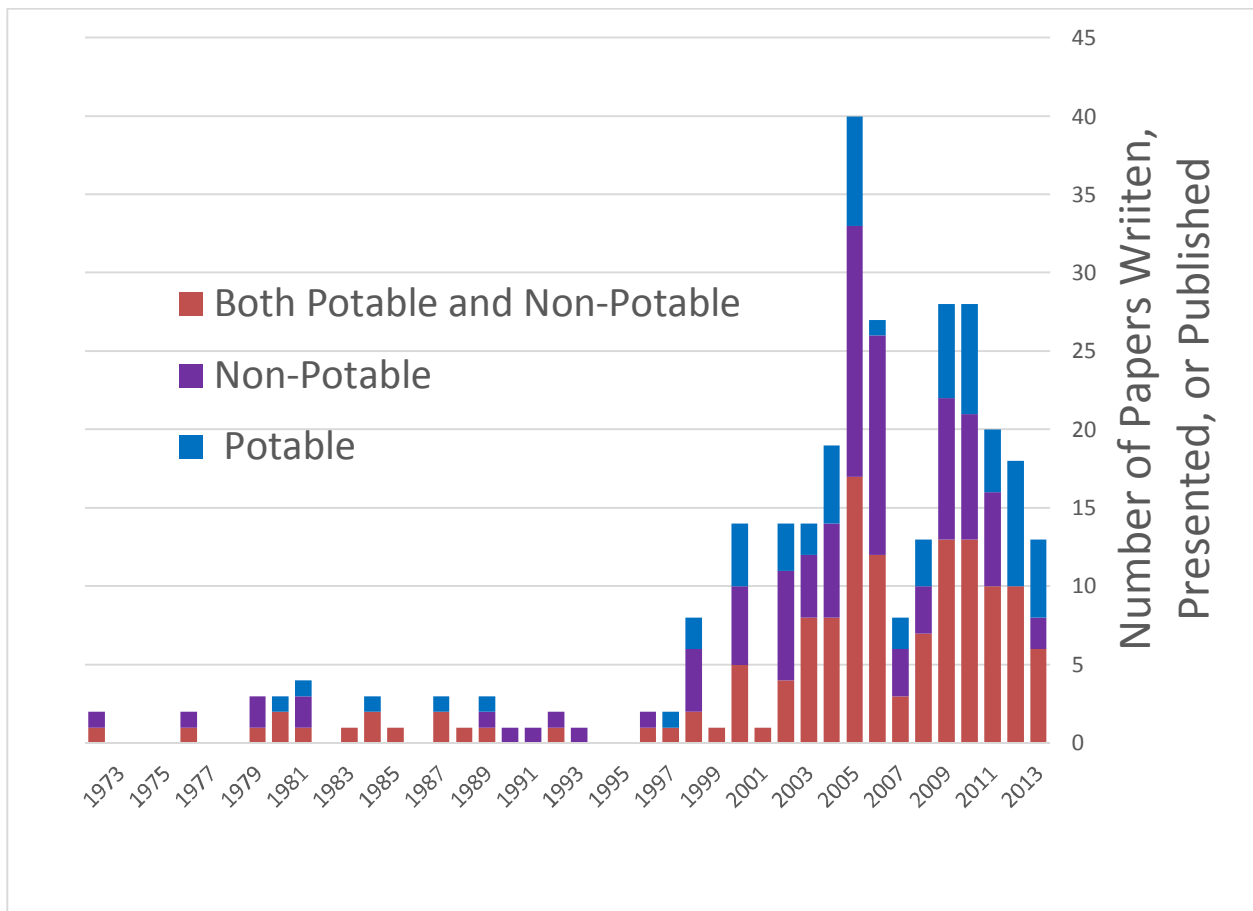


Figure 2 Number of Potable-Reuse Related Papers by Type of Potable Reuse, Direct, Indirect, and Both

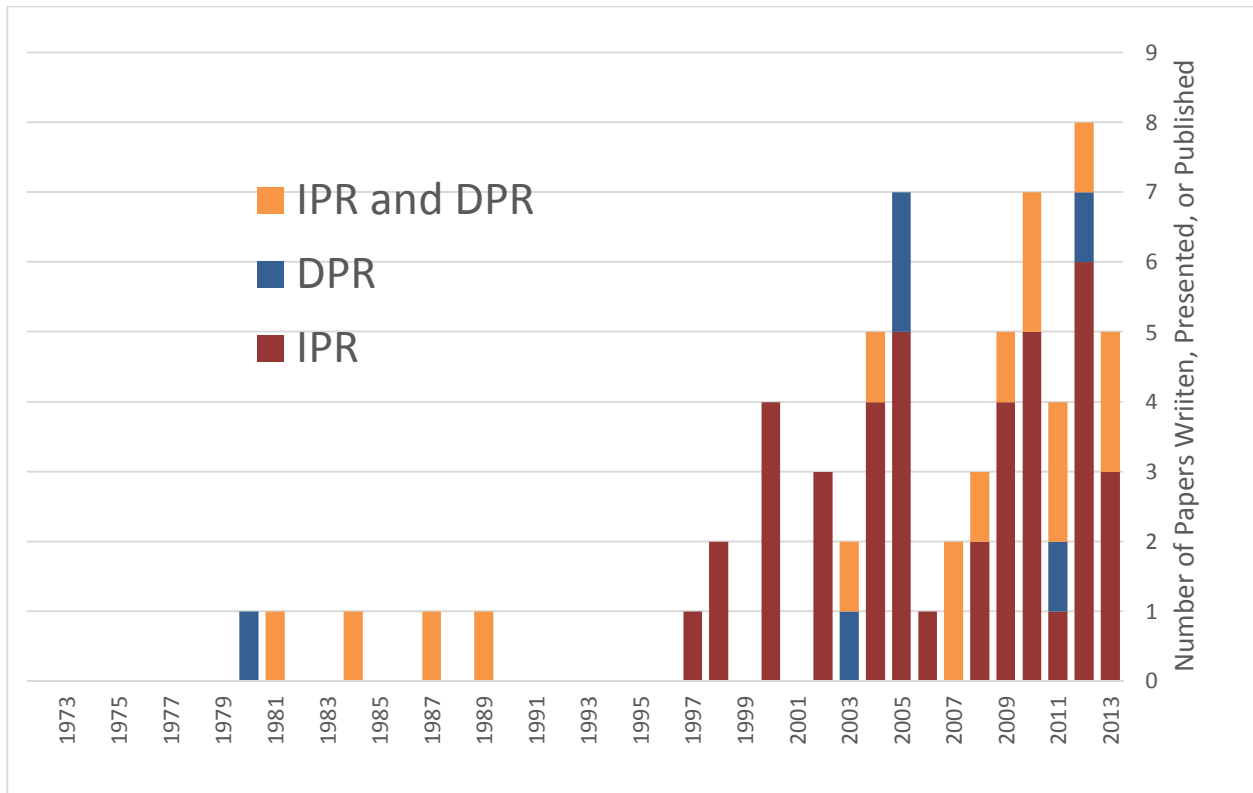
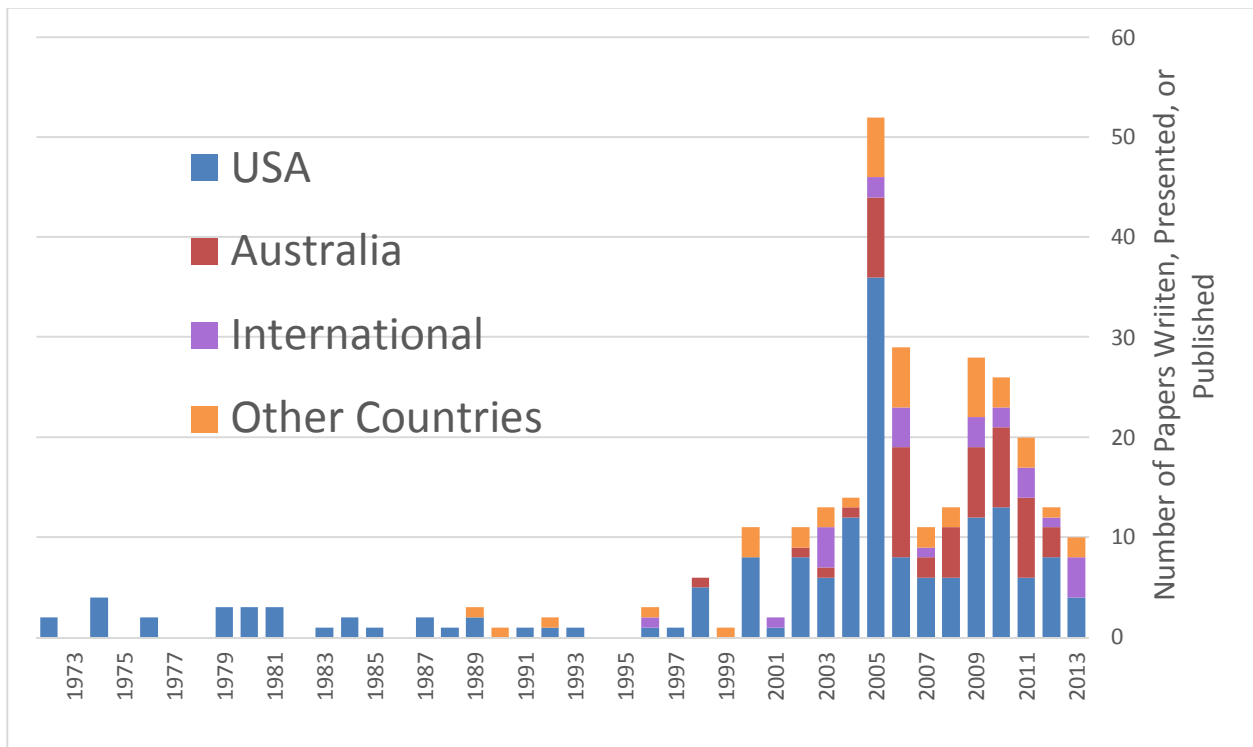


Figure 3 Number of Papers by Year and Country of Origin



## Discussion and Conclusions

The knowledge-based Clearinghouse of public acceptance resources for water reuse and desalination professionals is a work in progress. As additional resources come to light and as new papers, books and other publications are created and placed in the public domain, they will be added to the Clearinghouse on a continuous basis, enlarging the database and enriching its content. By the time the Clearinghouse is placed on the website of WateReuse Association and made available to the public, the number of resources will be considerably higher, and the mix of categories shown in Table 2 and Figures 1, 2, and 3 will have changed, albeit marginally.

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