Desalination Technology in the US – Potentials for Economic Growth and Sustainable Water Supply

Jad Ziolkowska¹, Reuben Reyes²

¹ Dept. of Geography and Environmental Sustainability
² Oklahoma Climatological Survey

XVI World Water Congress
Cancun, Mexico
May, 29 – June, 3, 2017
What is desalination and why do we need it?

**Desalination** (desal) - process of removing salt particles and minerals from seawater or brackish groundwater

<table>
<thead>
<tr>
<th>Water source</th>
<th>Salinity TDS (mg/ l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seawater</td>
<td>15,000-50,000</td>
</tr>
<tr>
<td>Brackish water</td>
<td>1,500-15,000</td>
</tr>
<tr>
<td>River water</td>
<td>500-3,000</td>
</tr>
<tr>
<td>Pure water</td>
<td>&lt; 500</td>
</tr>
</tbody>
</table>

Source: AThirstyPlanet.com

Source: Victoriadesalplants.com
Desalination treatment process

GROUNDWATER DEVELOPMENT

Collection and Conveyance System

Well Field

BRACKISH WATER TREATMENT

Micro Filtration

Chemical Pre-treatment

Cartridge Filters

Energy Recovery Turbine

RO Membrane Array

Blending By-Pass

Post-treatment Chemicals

Degasifier

To Distribution System

CONCENTRATE MANAGEMENT AND DISPOSAL

Concentrate Disposal

DELIVERY OF POTABLE WATER

Treated Water Storage

SRWA

Southwest Regional Water Authority

The University of Oklahoma
Water desalination

Desalination capacity
Thousands of cubic metres per day

1320 MGD

United States

Saudi Arabia

1057

792

528

264


Note: only countries with more than 70,000 cubic metres per day are shown.
Global desalination market - costs and capacity

Source: Gasson (2013)
Global desalination market – water source

Source: Author’s calculations based on DesalData.com (2013)
Use of desalinated water in the world (2013)

Source: GWI Desal data (2013)
Desalination plant status (2013)

Source: Author's calculations based on DesalData.com (2013)
New desalination plants & capacity - US, 1970-2013

Source: Author’s calculations based on DesalData.com (2013)
Need for desalination

- Global water demand predicted to increase by 46% between 2000-2050 (UN, 2014; OECD, 2012)
- In Oklahoma, water demand is projected to increase by 33.3% in the next 50 years (OCWP, 2012)
- Water resources (surface water, groundwater, reuse water) will decrease by 10% in next 50 yrs (TWRI, 2011)
- Drought in the US (significant pressure on water resources)
- Brackish/seawater desalination could buffer the shortage
- Many open questions and impediments (desalination siting and economics)

Where are desalination plants located?
Research objective

- Develop interactive 5D and 6D geospatial models and a multi-dimensional analysis of desalination trends in the US
- Time span 1950-2013
- The models include a set of uniform variables for comparative analyses

<table>
<thead>
<tr>
<th>Category</th>
<th>Category variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant capacity (MGD*)</td>
<td>4.31 &lt; 73.21; 1.80 &lt; 4.31; 0.86 &lt; 1.80; 0.50 &lt; 0.86; 0.31 &lt; 0.50;</td>
</tr>
<tr>
<td></td>
<td>0.20 &lt; 0.31; 0.13 &lt; 0.20; 0.08 &lt; 0.13; 0.04 &lt; 0.08; 0.00 &lt; 0.04</td>
</tr>
<tr>
<td>Raw water type (TDS)</td>
<td>Brackish water or inland water (TDS** 3000 - &lt;20000)</td>
</tr>
<tr>
<td></td>
<td>Brine or concentrated seawater (TDS &gt; 50000)</td>
</tr>
<tr>
<td></td>
<td>Pure water or tap water (TDS &lt; 5000)</td>
</tr>
<tr>
<td></td>
<td>River water or low concentrated saline water (TDS 500 - &lt;3000)</td>
</tr>
<tr>
<td></td>
<td>Seawater (TDS 20000 - 50000)</td>
</tr>
<tr>
<td></td>
<td>Waste Water</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
</tr>
<tr>
<td>User category</td>
<td>Demonstration</td>
</tr>
<tr>
<td></td>
<td>Discharge</td>
</tr>
<tr>
<td></td>
<td>Industry (TDS &lt; 10)</td>
</tr>
<tr>
<td></td>
<td>Irrigation (TDS &lt; 1000)</td>
</tr>
<tr>
<td></td>
<td>Military purposes (TSD 10 - &lt;1000)</td>
</tr>
<tr>
<td></td>
<td>Municipalities as drinking water (TDS 10 - &lt;1000)</td>
</tr>
<tr>
<td></td>
<td>Power stations (TDS &lt; 10)</td>
</tr>
<tr>
<td></td>
<td>Tourist facilities as drinking water (TDS 10 - &lt;1000)</td>
</tr>
<tr>
<td></td>
<td>Water injection</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
</tr>
</tbody>
</table>
Graphical representation of the 6D model

- **Plant Status**
- **Raw Water Type**
- **Final User**
Methods and data

- Data set from Desaldata.com by the Global Water Intelligence (GWI, 2013) - 2,749 data entries for the US in 2013
- Data cleaning → 1,600 plants in the US with complete record specified for the models
- Google Fusion tables and Google Earth used for geocoding (lat long) with the Keyhole Markup Language (KML) applied in virtual globes
- C++ computing language used to create a 3D analysis space
- 6D model → 5D model + a function of three additional categories (plant status, raw water type, final user) that are a category in itself
Model access

Model website with explanation:


Open access model of desalination plants in the US:

http://www.hitechmex.org/US_desal/US_Desal.kmz
5D map of desalination plants in the US based on desalination capacity
5D view of desalination plants in the Los Angeles area based on the end consumer of desalinated water
5D map of desalination plants in the US based on the plant status category
Conclusions

- The models can be used as an educational and research tool to better analyze, present, and display water issues and developments of the desalination sector in the US.

- Geographical and spatio-temporal data analysis can help with designing policies and measures at the regional and national scale.

- Results can be viewed in ESRI ArcGIS, ArcGIS Explorer, ArcGIS Earth, NASA World Wind, Google Maps, Google Earth, Google Earth Pro, Chrome Google Earth Web, and CesiumGS.

- Models can be used on any computer system: Windows, Linux, Apple, and on smartphones: iPhone, iPad or Android.


Thank you

jziolkowska@ou.edu
New book on water resources
edited by
Dr. Jad Ziolkowska & Dr. Jeff Peterson

KEY FEATURES
• Provides a national and regional perspective through the use of country specific case study examples
• Includes a comparative analysis between the US and Europe, illustrating experiences in water management from two sides of the Atlantic
• Covers interdisciplinary topics related to water, such as agriculture and energy

International perspective on water scarcity problems and useful management methods and best practices in the US and Europe