Arizona’s Use of R for TMDL Automation

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Environmental Program Manager
Arizona's Current Parameter Impairment Status

- 289 Impaired Parameters
- 137 of those Parameters Have a TMDL
- 152 Impaired parameters don’t have a TMDL
Auditor General Report Findings

- Department has not developed some TMDLs
- Department has not tracked due dates
- Department has not reviewed existing TMDLs to identify needed changes
The Team!

Source ID & Sampling Team
- Valeria Botanegra: Data Analyst
- Environmental Scientist
- Zee White: Data Analyst
- Environmental Scientist
- Rebecca Trott: IAMS Specialist
- Environmental Technician
- Meghan Smart: Environmental Senior Scientist
- Community Science Coordinator

ADEQ Lab
- Josh Goodfellow: Lab Manager
- Environmental Technician

Sampling and Source Identification Unit
- "We Identify Impaired Waterbodies"

TMDL Team
- Audrey Ridge: TMDL Project Manager
- Hydrologist
- Kelli Johnson: Data Analyst
- Environmental Scientist
- Grant Weinham: Subject Matter Expert
- Associate Environmental Science Specialist

Photo Credit: Lear Miller 2016
Sampling and Source Identification Unit

“We Identify Impaired Waterbodies”

The Team

Source ID & Sampling Team
- Valeria Bocanegra
  Data Analyst
  Environmental Scientist
- Rebecca Truitt
  HABS Specialist
  Environmental Technician
- Meghan Smart
  Environmental Senior Scientist
  Community Science Coordinator
- Zac White
  Data Analyst
  Environmental Scientist
- Josh Goodfellow
  Lab Manager
  Environmental Technician

Community Science/Arizona Water Watch
- Meghan Smart
  Environmental Senior Scientist
  Community Science Coordinator

ADEQ Lab
- Josh Goodfellow
  Lab Manager
  Environmental Technician
- Kali Johnson
  Data Analyst
  Environmental Scientist
- Zac White
  Data Analyst
  Environmental Scientist
- Valeria Bocanegra
  Data Analyst
  Environmental Scientist

TMDL Team
- Mikayla Baker
  SSI Unit Manager
  Environmental Program Manager
- Audrey Ridge
  TMDL Project Manager
  Hydrogeologist
- Grant Weinkam
  Subject Matter Expert
  Associate Environmental Science Specialist

Photo Credit: Lear Miller 2016
Where Do We Start?

- There are 67 impairments out of 152 that are **high priority** based on Arizona Administrative Code R18-11-606
Arizona’s TMDL Priority Application

Developed by: Jason Jones

Welcome!

This application helps users assign priorities for Total Maximum Daily Loads (TMDLs) in Arizona. TMDLs are basically a pollution budget for impaired waters so a waterbody can meet standards. Waterbody and parameter combinations will be used in this application because this is what has been traditionally reported to EPA for the impaired waters list. For example, Three R Canyon, which has a waterbody ID (WBID) of 15050301-588B is impaired for nickel and selenium.

How this Application Works

This interactive document was created using an R markdown document with shiny. R is a free opensource software platform for data science. R markdown generates the document and shiny makes it interactive. The user does not need to know anything about R but it is important to know that the code and logic behind this application is fully transparent and can be reproduced by anyone with the appropriate permissions (see the Sources tab).

Code was written that gathers the data needed for the metrics that make up the TMDL priority index (Figure 1). This application does not run that code directly as there are database, google spreadsheet and network permissions that are needed. A file is produced when the code is run that is used by this application. Code for the app is located at 3:\WQ\Surface Water Section\TMDL\TMDL Prioritization.

1 – Sources

- World Wide Web
  - WIA and Suesis Rivers
- Water Quality Database
  - Outstanding Antizona Waters
  - Priority Uses/Flow Regime
  - Watershed Area
- Google Sheets
  - 4 Years Impaired
  - Bi-Parameter
- Excel
  - WIU
- R Tools
  - # Impairments
- GIS
  - Permits

Figure 1. Application architecture

https://azdeq.shinyapps.io/tmdl_priority/
Weights determine how much influence each metric has when creating the index. Default values have been chosen but these can be adjusted by moving individual sliders. Overall weights should equal 1. Weights should be assigned based on agency priority. Human judgement is needed to pick what is important. The application is meant to help make the calculations fast and transparent but does not decide what is important for the user (although defaults are suggested).

Weight must equal a total of 1
Metric_1 = \frac{x_1 - \min(x)}{\max(x) - \min(x)} \omega t_x

Index = \sum_{i=1}^{n} Metric_i

Index Breakdown
This stacked bar chart shows how each metric contributes to the overall index score. Hover over the bars to see the waterbody, category, raw value and the metric value. See the 'Metrics & Sources' tab for additional information on each metric such as units.

Select How Many Waters You Would Like to Explore
Load Duration Curves for E. Coli

**Inputs:**
- Gage for flow = 09504500
- Start Date = 1970-01-01
- End Date = 2022-12-31
- CharacteristicName = Escherichia coli
- MonitoringLocations for data = multiple monitoring locations from water quality portal

![Graph showing load duration curves for E. Coli](image-url)
Questions?

TMDL
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R Code
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