Towards SWIM Narratives for Sustainable Water Management

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SemSci 2018: Enabling Open Semantic Science
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Water Sustainability in the US Southwest

• **Research Fields:** Economy, Hydrology, Climatology, Computer, Environmental, Earth Science, and Civil Engineering.

• **User Roles:** Farmers, Policy Makers, Citizens, Academics

• **Regions:** New Mexico, Texas, Chihuahua (MX)

• **Institutions:** UTEP, NMSU, UNM, UACJ, MTU, TAMU

Source: middleriogrande.org
Sustainable Water through Integrated Modelling Framework (SWIM)

- **Expose** water sustainability models on the Web.
- Clearly identify the sources and processes used for data **manipulation** for model consumption.
- **Describe** the science behind the models.
Sustainable Water through Integrated Modelling Framework (SWIM)

Source: middleriogrande.org
Scientific results hard to understand

Semantics behind the data

<table>
<thead>
<tr>
<th>Year</th>
<th>Use Location</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>LCMI_u_f</td>
<td>$872.46</td>
</tr>
<tr>
<td>1996</td>
<td>LCMI_u_f</td>
<td>$889.95</td>
</tr>
<tr>
<td>1997</td>
<td>LCMI_u_f</td>
<td>$906.75</td>
</tr>
<tr>
<td>1998</td>
<td>LCMI_u_f</td>
<td>$924.47</td>
</tr>
<tr>
<td>1999</td>
<td>LCMI_u_f</td>
<td>$942.35</td>
</tr>
<tr>
<td>2000</td>
<td>LCMI_u_f</td>
<td>$961.10</td>
</tr>
<tr>
<td>2001</td>
<td>LCMI_u_f</td>
<td>$979.88</td>
</tr>
</tbody>
</table>

Units: USD/AF  
avg: 1230.3341

Source: middleriogrande.org
SWIM narratives

Customizable human-readable data explanations

*Inspired by Yolanda Gil and Daniel Garijo (2017) [1].

Source: middlerio grande.org
Urban Price follows a upward trend with a 65.528% increase of Urban Price by the end year with a peak volume of 1444.0 USD/AF in 2021 and the lowest volume of 872.36 USD/AF in 1995.

**Units:** USD/AF

*Source: middlerio grande.org*
## Narrative components

<table>
<thead>
<tr>
<th>Language</th>
<th>Spanish and English</th>
</tr>
</thead>
<tbody>
<tr>
<td>User role</td>
<td>Farmers, policy makers, water administrators</td>
</tr>
<tr>
<td>Focus area</td>
<td>Urban, environmental</td>
</tr>
<tr>
<td>Geographical region</td>
<td>El Paso, Texas; Las Cruces, New Mexico; Ciudad Juarez, Mexico</td>
</tr>
<tr>
<td>Model element</td>
<td>Model inputs, model outputs, and scenarios</td>
</tr>
<tr>
<td>User scenario</td>
<td>Model run document</td>
</tr>
</tbody>
</table>
SWIM narrative generation

Preprocessing
- Get user scenario
- Get narrative template

Processing
- Narrative assembly

SWIM UI
- Narrative Request

SWIM-NLNG

mongoDB
Preprocessing

{"varLabel": "Surface Water Storage", "varName": "water_stocks",
"varDescription": "Reservoir water storage", "varUnit": "KAF/yr",
"varValue": [{"res": "Store_res_s", "t": "1996", "value": 2061.5},
{"res": "Store_res_s", "t": "1997", "value": 2213.49}...]

Excerpt of an executed scenario serialized as JSON using SWIM’s data model. The response contains metadata and result values for the output variable “water stocks.”

Q1. List<Narrative> outputNarrative = mDataStore.createQuery(Narrative.class).filter("element.name", varName).asList();

R1. ~element_label follows a ~adjective_trend trend with a ~percent ~adjective_behaviour by the end year ~constant_year with a peak volume of ~maxValue ~element_unit in ~maxYear and lowest volume of ~minValue ~element_unit in ~minYear.

Query to retrieve narrative template for an output variable and result.
Narratives

Global Average Values
Model outputs compared with outputs from the historical period of 1995-2015

→ Average Total Inflows
Average annual total inflows in thousands of acre feet

Current Run: 466.9 - Historical Run: 582.86

Water Supply outcome causes a 20% reduction in average inflows to Elephant Butte in comparison to the historical period (1995-2015). Historical averages were 582 KAF/yr and the selected scenario results in 466 KAF/yr average annual inflow.

Units: KAF/yr

Water Stocks
Reservoir water storage

Project Storage:
Store_res_s = Caballo/Elephant Butte

Surface Water Storage follows a downward trend with a 75% reduction by the end year 2033 with a peak volume of 2213 KAF in 1997 and lowest volume of 541 KAF in 2033.

Units: KAF/yr

Summary narrative (a) and single output narrative (b)
Current results (1)

- **Specification** of the narrative components.
- One narrative template document per model element (scenario, input or output).
- In-house **ontology** for SWIM specific terms.
- Semantically annotated **narrative schema** formatted in JSON-LD.
Current results (2)

- **Stand-alone web service**: Natural Language Narrative Generator (NLNG).
- **Data interpretations** through the ingest of individual model elements (single value or time series), target user metadata and baseline model runs.
- Narrative addition to **SWIM UI**.
Future work

Extension of narrative templates for **different roles**.

**Generalization** of SWIM narratives.

**Evaluation** with stakeholders and scientific team.

Expose SWIM's annotated data as **knowledge graphs**, e.g., Cayley.

**Predefined user preferences** through Machine Learning algorithms.
International, Interdisciplinary Research Team

Bill Hargrove
Soil and Water Management

Josiah Heyman
Anthropologist

Deana Pennington
Geoscientist

Alex Mayer
Civil Engineering

Frank Ward
Economist

Dave Gutzler
Climate Change

Sarah Sayles
Water Science and Management

Alfredo Granados
Soil Science and Agronomy

Luis Garnica
Software Engineering
Availability

Project Website:
http://purl.org/swim

SWIM-NLNG Service:
http://purl.org/swim/services/nlng

SWIM Vocabulary (JSON-LD):
http://purl.org/swim/vocab

SWIM Terms (OWL):
http://purl.org/swim/terms

Backend Source Code:
https://github.com/iLink-CyberShARE/SWIM-NLNG
Acknowledgements

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References

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