Water Supply Management in Virginia

NR 5884: Navigating the Social Complexities of Sustainability

Morgan McCarthy

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Problem Description

Unlike the arid regions in the Southwest, Virginia has historically been a water plentiful state. With rainfall averaging 43 inches per year (national average: 30.21 inches) and a total combined flow of 22.5 billion gallons per day in all freshwater streams, the Commonwealth has been able to meet and exceed water demands for its constituents [1]. Withdrawals from surface water (including rivers, streams, and reservoirs) and groundwater (aquifers) are the two sources that supply Virginia with the water needed to meet the full range of human and environmental purposes [2]. Of these two sources, surface water withdrawals make up the vast majority of water used in the state (~90%), with groundwater withdrawals being concentrated in eastern Virginia and from the coastal aquifer [1].

The drought of 1999-2002, however, sparked a major shift in water management perception for water planners in Virginia's Department of Environmental Quality's (VDEQ) Office of Water Supply. During this time, the Commonwealth experienced record low flows, leaving several public water systems on the brink of failure (less than 60 days of water supply capacity) [1]. Along with this unexpected drought, the VDEQ predicts a 32% increase in water demand from 2010-2040 (based on predicted population growth), while having gaps in data on ground and surface water withdrawals across various economic sectors. However, this prediction grossly overestimates how much water was actually withdrawn from recent years (Figure 1) [2]. This discrepancy and the unrefined nature of Virginia's water supply estimates ultimately frames the urgency for improving both water resource modeling and management.

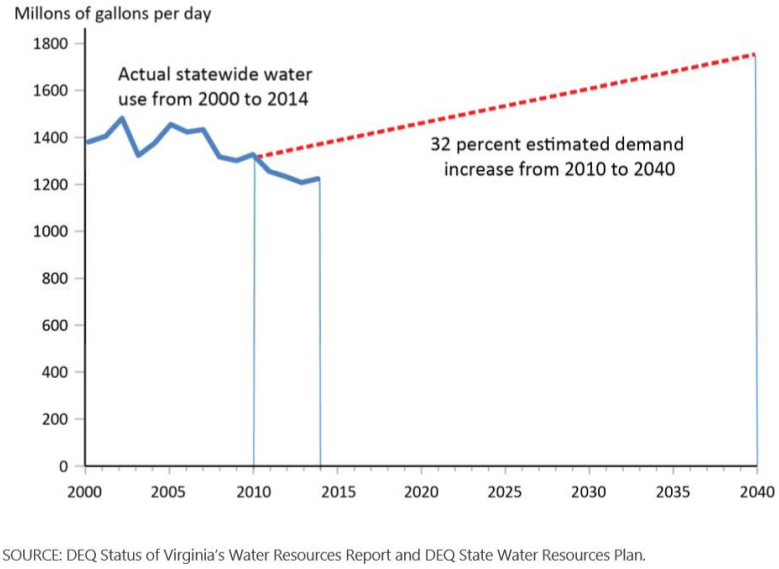

Figure 1: Statewide daily average water withdrawn from 2010-2015 vs. estimated demand based off of estimated population growth [2].

Stakeholders

Water in itself is a critical natural resource that is needed for a large range of human and environmental purposes. Because of this, there are many stakeholders, which makes this problem very wicked. The most relevant stakeholders include government entities, major economic sectors that use water for production (e.g., Industrial, Commercial, Agricultural, Mining, Energy, etc.), and citizens of Virginia.

Responsibility for managing water resources in Virginia is divided amongst the State Water Commission, the State Water Control Board, and the VDEQ Office of Water Supply. These three entities coordinate legislative activity, develop regulations, and implement water resource planning, respectively [2]. The Virginia DEQ (VDEQ) collects and analyzes surface and ground water usage data to understand the impact of permitted withdrawals on statewide supply [1]. They direct water supply management for the Commonwealth through three programs including groundwater characterization, water supply planning, and water withdrawal permitting [1].

Major water users in the economic sectors can be categorized into Energy, Industrial, Municipal, Commercial, and Agriculture/Irrigation facilities. In 2017, approximately 6.3 billion gallons per day (from 1,624 facilities) were reported as being withdrawn from surface and ground water sources across the entire state (Table 1) [1]. Of this, roughly 80% of the water withdrawn was used by energy producing facilities [1]. Of the remaining water, 6.54% was used for industrial purposes, 0.27% was allocated to commercial use, and 0.82% was used for agriculture and irrigation [1]. Therefore, municipal water, or water that is withdrawn to produce drinking water for households, accounted for 12.4% of the total water withdrawn [1].

Table 1: Gross reported water withdrawals (MGD) across Virginia in 2017 [1].

Sector	Water Withdrawn (MGD)	% Total Withdrawn
Energy	5047.15	79.95%
Industrial	413.1	6.54%
Municipal	782.9	12.4%
Commercial	17.5	0.27%
Agriculture/Irrigation	51.9	0.82%

Wickedness of Problem and Stakeholders

Monthly withdrawals (in MGM) are self-reported by users, which are submitted once a year to represent withdrawals from the previous calendar year. Reporting is required for users that exceed 10,000 gal/day on average, or agricultural users that exceed 1 MGM in a single month [1]. Approximately half of surface water users are exempt from permitting/reporting under these requirements and grandfathering [2]. A grandfather clause is a provision given by State governments that allow old rules to continue to apply to current situation while new rules will apply to future cases [2]. In this case, any user with an existing withdrawal before July 1, 1989, are exempt from permitting. Nevertheless, exempt water users are encouraged to voluntarily report their water withdrawals. Most choose not to, however, due to the fear of stricter permitting and withdrawing limit regulations. Collectively, in the year 2013, exempt surface water withdrawers accounted for an estimated 82% of the total surface water withdrawn statewide [2].

As for compliance with reporting requirements, the VDEQ does not have the authority to penalize a user that fails to report their withdrawal as reported. A lack of sufficient data ultimately makes it difficult for state planners to model existing and future water supply estimates. With the data that is available, water resource planning in Virginia is designed as a statewide partnership, which enables regional and local entities to identify their specific future water needs with support and oversight from the State. The first State Water Resources Plan (SWRP) was published in October 2015 and serves as the primary planning mechanism for Virginia sustainable water use through the year 2040 [3]. The plan was created by VDEQ staff and is intended to assist state and local policy makers to develop more informed water supply and management policies. It includes information regarding existing water use, sources of supply, population and water demand projections, anticipated deficits, potential new supply sources, and current efforts supporting efficient water use [3]. Approximately 48 plans from local and regional partners

were submitted and reviewed in 2014 for the creation of the first SWRP [2]. It is planned to be reviewed every five years to include updated water supply assessments and additional plans from collaborators.

Since this plan is the first of its kind, the Joint Legislative Audit and Review Commission (JLARC) was appointed to review its effectiveness in 2016. Among their analysis, they indicate that the state and local plans within the SWRP are not sufficient enough to fully inform stakeholders of the major sustainability problems in Virginia [2]. JLARC administered a survey to local water stakeholders, including municipalities, private water users, city and county administrators, and local economic developers, asking their opinion on the SWRP. Interestingly enough, of the 236 respondents, two-thirds of the stakeholders had either not read the plan or were not aware of it (Figure 2) [2]. A plan is only useful if it is being used to make decisions, and based on these responses, the SWRP has minimal value for the relevant stakeholders. For those that read the SWRP, they felt it improved their understanding of water use across Virginia, but was too vague and did not provide strategies or solutions to move towards sustainable water use. JLARC also notes that the VDEQ did not offer enough opportunities for stakeholders to provide feedback and input during the drafting process of the plan.

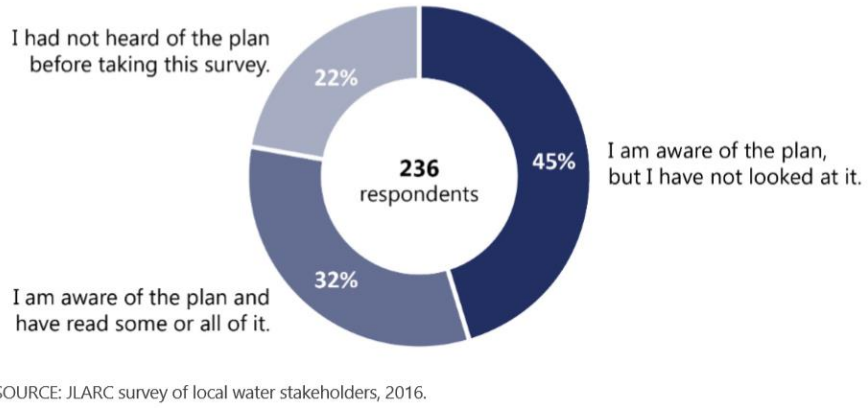

Figure 2: Results of JLARC's survey of local water stakeholders [2].

Without the active cooperation and collaboration between stakeholders, the VDEQ cannot create informed supply management plans for the state of Virginia. Thankfully, there are several social science theories that can help navigate the relationships between the relevant stakeholders to help the commonwealth effectively manage the commonwealth's water and move towards sustainable water use.

Relevant Social Science Theories

Due to the large number of relevant stakeholders, there are multiple social theories (Table 2) that can be used to understand the complexity of statewide water management. Table 3 identifies relevant stakeholders, their interests and potential theories that may provide insight.

Table 2: Social Theories presented in Marc Stern's Social Science Theory for Environmental Sustainability [4].

Social Theory	Concept
Trust Theory	What is trust, how does it come about, why is it so frequently lacking, and what can we do about it?
Diffusion Theory	How do innovations become adopted and how do they spread?
Co-orientation Model	How can we better understand others' viewpoints such that we can improve our chances of working toward common understandings of problems and collaboration?
Collective Impact	What do we know about tested strategies for building a coalition to solve large-scale societal issues?

Table 3: Relevant Stakeholders involved in Water Management and Planning in the State of Virginia.

Stakeholder	Interests	Relevant Theory
State Water Commission	— Study all aspects of water supply and allocation problems — Coordinate legislative recommendations	**Collective Impact[4]**
State Water Control Board	— Develop policy, plans, and programs for conserving and developing state water resources — Create regulations for issuing surface and ground water withdrawal permits — Designate management areas	**Collective Impact[4]**
VDEQ – Office of Water Supply	— Conduct state water resource planning — Allocate, evaluate, interpret surface and groundwater resources — Administer withdrawal permits — Wants more users to report withdrawals	**Co-Orientation Model[4]** **Collective Impact[4]**
Major Water Users	— Maximize profit — Decrease costs	**Diffusion Theory[4]**
Exempt Water Users	— Access to plentiful potable water — Less strict permitting regulations	**Trust Theory[4]**

Trust Theory[4]

Working from the bottom up, **Trust Theory[4]** can be used between the Department of Environmental Quality and exempt water users (< 10,000 gal/day or grand-fathered). Trust theory is centered on identifying areas where trust is lacking and being able to develop trust depending on the situation (whether it's before or after crisis/mistakes). In terms of trust in this problem, there has been a noted stigma between minor/exempt water users and government entities. Water users want to be able to use as much water as they want without limitations or fees, and exempt users don't want to report their water use in fear of stricter policies and permitting requirements.

Therefore, the Department of Environmental Quality (the trustor) can develop *systems-based trust* with exempt water users statewide (trustees). This type of trust depends on a mutual perception of what is fair, transparent, and consistent in terms of procedures and regulations [4]. Since the State Water Control Board maintains authority over permitting requirements, they can hold panels and educational seminars regarding statewide water use. Since the State Water Resources Plan is only relevant to regional and local policy makers, it would be useful to educate the general public about the current assessments of water supply, the gaps in data, and importance of cooperative action. During these panels, the exempt users can

also express their sources of distrust, so that all stakeholders can identify places of miscommunication and opportunities for clarification. Including the trustees in the conversation can decrease perceived risk and hopefully lead to an increase of exempt users reporting their water use.

Diffusion Theory[4]

Unlike exempt water users, the focus for major water users is to maximize profit, increase productivity, while decreasing the costs of resources. With ever-developing and omnipresent technologies and innovations, there are ways to decrease water use (or at least consumptive water use) for major production facilities. **Diffusion Theory[4]** focuses on how innovations are spread and adopted in efforts to change the behavior of a group/entity/stakeholder. As stated before, JLARC notes surveyed stakeholders do not believe Virginia's State Water Supply Plan adequately presents actionable strategies to move towards sustainable water use. This is an opportunity for the government entities in Virginia to work with major water users across the state (e.g. Energy and Industrial facilities) to incorporate sustainable technology that use water more efficiently.

Adoption decisions of newer technology/methods will depend on who and how they are presented to the major facilities. Typically, the first adopters are highly educated with deep connections in both their community and the outside world [4]. Therefore, facilities located in highly populated and educated areas should be the primary focus when first implementing the diffusion theory. There are several energy facilities in the Richmond area that are on the "smaller" side and have started incorporating biomass alongside fossil fuels to produce energy [1]. Focusing on facilities that have already showed sustainability initiatives will act as good *Innovators* and *Early Adopters* [4].

Experts in mechanical, environmental, and civil engineering in the Department of Environmental Quality can work with these facilities personally to help implement and test the effectiveness of the new technology/method/innovation (*trialability*). An economic analysis of the proposed innovation should also be performed. This will accumulate case studies that can be perceived as *relative advantages* for switching to increased sustainable water use. Results from the case studies can then be used for mass communication through different channels, including media, politicians, and public officials. This will simultaneously foster *compatibility*, that shows social norms favor sustainability without the risk of losing money and productivity [4].

The State Water Commission, who is charge of coordinating legislative recommendations, can then frame the appeal of using water efficient technology. If incentives (like tax breaks) and the case studies from the *Innovators* and *Early Adopters* are presented to other major facilities across the State, their perceived risk of adoption may diminish. Once larger and more influential facilities (like Dominion Energy) start adopting sustainable techniques, they can act as a *central node* to influence others to become more sustainable. Most importantly, the VDEQ can publish the cost/benefit results from participating facilities into the State Water Resources Plan. This will provide transparent actionable strategies for other water users to use as well.

Co-Orientation Model[4]

Since JLARC reports that over two-thirds of surveyed stakeholders did not review the SWRP, there is an obvious gap in communication (Figure 2) [2]. The **Co-Orientation Model[4]** can be used to first assess the *agreement*, *accuracy*, and *congruency* among stakeholders and their views on water use in the State of Virginia [4]. The survey can ask for their opinions on the current SWRP, how water availability impacts their economic development, and whether they believe if water supply is a concern. This will initially set the grounds for each involved stakeholder.

A third party board, like the State Water Control Board, can then evaluate the surveys and indicate areas of *dissensus*, *true consensus*, *false consensus*, and *false conflict*. Once this is completed, the concepts and logic of water use can be mapped to show all stakeholders the where everyone stands and their key assumptions. The VDEQ can then use these results to improve their communication technique to water users and address any and all dissensus. Knowing the assumptions and opinions of the stakeholders, the VDEQ can offer more opportunities for them to give specific feedback about the current SWRP and express their specific needs for their facility, locality, town, etc. This input can then be used to create more informed local and regional water supply management plans for the SWRP.

Collective Impact[4]

It is safe to assume that water use in Virginia will not become sustainable within the next 1-3 years. Systemic change can often take decades to be implemented. In the case of sustainable water, it will take a long time to acquire appropriate funding and phase out the older practices and technologies. Therefore, this will need to be a *Collective Impact* initiative, involving all relevant stakeholders. In congruence with the *Co-Orientation Model*, the government entities can communicate with water users across Virginia to establish a *common agenda* to move towards sustainable water use. With this common agenda, universal measuring metrics will be established so that water use is comparable. Thankfully, reporting units are defined and required by the VDEQ when water users report their monthly withdrawals [1].

With *continuous communication* and reassessments (*adaptive management*) of each stakeholder's opinion on sustainable water use, the government entities can provide guidance for the water users to perform *mutually reinforcing activities*. These activities will be different for each stakeholder depending on the facility and economic sector. For agricultural/irrigation facilities, their reinforcing activity may be using more efficient irrigation techniques; while energy facilities may be switching to once-through cooling to decrease evaporation. *Backbone support organizations* will be needed to facilitate the continuous communication between the government and other stakeholders, remind everyone of the common vision, help build public support, advance policy, and accrue funding [4]. The backbone here could be the State Water Control Board, which is comprised of seven Virginian citizens. An entity of this size can communicate efficiently amongst themselves as well to other stakeholders as well. Ultimately, this will be a complex and adaptive process; but these social theories are a great stepping stone towards sustainability.

Conclusion

Although it has been perceived that water supply in Virginia is not a concern, recent droughts and gaps in data have sparked an urgency for improved water resource management. The disconnect and miscommunication between water users and the government entities directing water resource legislation, regulations, and implementation needs to be addressed so that policy and decision makers can create more informed water supply management plans and strategies. Social theories including the *Trust Theory*, *Diffusion Theory*, *Co-Orientation Model*, and *Collective Impact* can be used to improve the relationship and communication between water users and the VDEQ. By diminishing the perceived risk of reporting water withdrawals and implementing more sustainable water use practices, water users, both large and small, can report their water use and provide feedback to the VDEQ to create more informed water resource models and management plans. An adaptive and transparent relationship between all stakeholders can foster a collective impact, to make sure the State of Virginia stays a water plentiful state for many years to come.

References

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