Spring 5-1-2013

Water Governance in the Postcolonial Developing World

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Water Governance in the

Postcolonial Developing World

A Participatory Research Approach

in the Dominican Republic

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Spring 2013

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Abstract

Water is an essential part of life. However, the right to govern water as a resource is not shared equally by all members of our global community. Every location around the world has had a unique historical, political, and cultural relationship with water. Countries need to tailor their water regimes to the unique lived experiences of all their citizens, if they are to meet the right of all humans to affordable and accessible water. Governance structures must be transparent, inclusive, and holistic. This paper analyzes literature on international water governance, and addresses a local case of water governance in Cabarete, Dominican Republic, where a participatory research project proved to be a useful tool for educating local youth about water quality issues in their region.
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Introduction

Water is an essential resource. Whether we use it for cleaning, cooking, or drinking, it is certainly a critical part of our daily life. Yet, different cultures assign different values to water and each geographic location has its own unique relationship with water. For this reason, it is crucial to think critically about how we interact with water and how our day-to-day water use can affect the use of future generations. Academics, activists, and public agencies worldwide agree that providing clean and plentiful water, especially in times of climate change, has become a pressing issue. The World Health Organization and UNICEF (2006), calculate that 1.2 billion people have no access to safe drinking water and 2.4 billion do not have adequate sanitation services. Logically, high demand and low supply of water resources would prove to be a fatal situation. Water scarcity, though, is not simply a natural problem, considering that it has social, political, and historical roots. Who has access to good quality drinking water? Who must travel long distances to collect it? Who has a voice in how this resource is governed and distributed? This paper tries to answer these questions.

No “one-size-fits-all” answer can be found to water governance issues. Every place has its own particular geography; a unique history that has created a very specific local context, socially and politically. Therefore, when addressing issues of governance one must understand the complex and unpredictable nature of every location and its natural environment. The US Army Corps of Engineers
(2002) states that water scarcity is a major road block to economic and social progress. However, there are many different ways to frame the issue of water scarcity. This could be the reason why there is such difficulty unifying over issues of accessibility and water quality. Looking through a holistic lens at water governance issues, we can start to unravel the questions above, seek out answers, and try to make changes to resolve flaws in current structures.

Water governance has grounds in environmental justice, in human rights, neoliberalism, and in environmental ethics. The Dictionary of Human Geography (2009) defines governance as “the process of social and economic coordination, management and [control]” (p. 312). More specifically governance is the coordination of planning and organizing of public policy and projects done by state actors and non-state actors with collaboration, interdependence, and interaction between networks of people. There are two types of governance: good and bad. Good governance depends on transparent, collaborative, and inclusive planning and decision-making processes. Who has and does not have the right to use or withdraw water from a source? Who has the right to degrade the quality of water? Should anybody have that right?

There are many actors involved in water governance regimes and they can have very distinct ways of addressing the management of water resources. To put this idea in perspective in general terms, governments can enact laws to create a norm for water use and access. For instance, in Chile the dominion of water resources is
reserved for the State, and the use of water resources must be granted by the State. All the control and use of water resources is outlined in their Water Code Law created in 1981 (Código de aguas, 1981). Conversely, communities can claim water as a common resource available to all without the need to acquire formal permission. For example, in South Africa in the 1990s, civics and activists boycotted housing bonds to reclaim their right to the city (see Harvey, 2008). In the 2000s, this same population decommodified and “commoned” water resources by creating illegal reconnections to existing systems. They have seen limited political gains, but have essentially claimed water as a common resource (Bond, 2012). Nonprofit organizations that focus on human rights strive for the provision of technology and information to communities that lack appropriate resources. The Silliman Research Group is a nonprofit group at the University of Notre Dame that actively participates in collaborative projects in Benin, Africa. They work alongside local partners to build latrines and water wells, monitor water quality, and develop educational programs (Silliman et al, 2009). These actors are not mutually exclusive. They oftentimes interact and exchange information or are involved in decision-making processes together. However, they sometimes can and do act independently of each other without the representation of the others. Ultimately, governing water is inherently complex and multifaceted.

There are some fundamental challenges to addressing the distribution and access to water: lack of sound scientific evidence when modeling water quantities, differences in values and costs for individuals or institutions and for communities,
difficulty of calculating social costs to people and to the environment, and the
contested social right to alter the natural environment (Wescoat & White, 2003).
Often resource management has been addressed with a technocratic approach
utilizing engineering designs and a strict economic form of evaluation (cost-
benefit analysis), which downplays or outright ignores innumerable
environmental values like aesthetics and desire for intergenerational preservation
(Wescoat & White, 2003). Consequently, those most adversely impacted must
learn to adjust and adapt to an altered environment, despite their lack of voice
throughout the process of planning, construction, and management of water
projects. I argue that powerful, top-bottom\(^1\) institutions hinder good governance
as they oftentimes are exclusive.

Another relevant topic that I will discuss is the concept of a right to water and
water rights, as they are inherently different. A right to water implies that all
humans have an undeniable right to access clean and safe drinking water.
Materializing this right to water, though, proves to be troublesome. Contrarily,
water rights are institutionally written legal rights and are oftentimes the making
of territorial nations in the form of laws and property rights. It is critical that we
start viewing water through the lens of the former, a right to water, in order to
adjust the unequal institutional precedents that have been made by the latter,
water rights.

\(^1\) Top-bottom approaches to water governance refer to government-led initiatives run by a small
portion of the population that do not consult the population when making decisions, but rather
they follow a more command-and-control style of governance. Conversely, bottom-up, or
grassroots, approaches have more of an emphasis on people and their community and attempt to
transform a powerless population into a collective force to combat injustices.
This paper explores the literature on water governance in postcolonial contexts as it pertains to development and the right to water. In the latter section, a localized empirical case in the Dominican Republic will be discussed. A lack of ownership and knowledge has created a poor water governance regime in the Dominican Republic and I argue that empowering communities, especially youth, to claim ownership of their water resources is necessary to ensure use for future generations of Dominicans.

**Governance**

“[Governance is a] range of political, organizational, and administrative processes through which communities articulate their interests… input [is] absorbed… [and] decisions made and implemented.”

*Karen Bakker* [Sultana & Loftus (2012)]

In order to better understand issues of governance, it is necessary to understand the inherent power relations of a specific place (Laurie & Crespo, 2006). Water can be legally owned by the state, by individuals, or collectively; formally and informally. However, the politics of water access and distribution are multi-faceted. In some locations water is a privatized resource, but some scholars argue that the private sector of water is exclusive, elitist, and technocratic (Laurie & Crespo, 2006; Bakker, 2003; Prasad, 2006). In the 19th and early 20th centuries,
the United States and Great Britain began debating public versus private water management issues in their own unique industrialized contexts.

These two countries were facing issues of access to good quality drinking water in their growing cities. The United Kingdom’s Public Health Act of 1848 addressed sanitation and public water issues and asserted that access to water ought to be universal in order to maintain a productive work force in cities (Hamlin & Sheard, 1998). This report acknowledged the economic, social, and political benefits of providing clean drinking water, and as a result there was an increase in public works funding. Control by local governments and private capital without public participation became a model for industrializing countries (Prasad, 2006).

Rather than exclude the public, governance regimes should take a multi-actor approach by including stakeholders in open discussions about water resources (Stewart & Gray, 2009; Bruch et al, 2005). The politics of distribution and provision can create friction between all members of a society (Meehan, 2012). For example, in San Felipe, Mexico, some communities have created new spaces for self-representation and control of water resources by developing and managing rain harvesting projects (Meehan, 2012). This project created tension between the local community and state authorities. Why? Essentially, the State saw this as illegal use of State property (i.e. the rainfall). The state authorities must be holistic and see how local practices can impact larger waterscapes, while local control focuses strictly on small-scale volumes. In this case, the local
community got a “taste of autonomy,” but at the cost of creating conflict with the state authorities (Meehan, 2012).

Goulet (2005) discusses the problem of scale by claiming the need to promote legitimacy. He claims that there is legitimacy when individuals acknowledge that an authority has the right to govern them and that they must in turn obey stipulated rulings. Goulet (2005) terms this “ethical globalization.” Thus, ethics plays an important role in good governance practices. Small-scale and large scale actors oftentimes conflict due to increased uncertainty in a new globalized world (Mehta et al., 2001). Bywater (2012) explains the need for a multidimensional approach when considering the local-global nexus.

For example, in the 2004 case of Plachimada, India, protesters pushed out a Coca-Cola development project from the area because of irresponsible industrial practices that lead to depleted and polluted groundwater resources (Bywater, 2012). These protesters challenged unequal power relations and brought up an international discussion on the meaning of water. Ultimately, water is necessary for life. Some people consider it sacred and a human right; therefore, meanings that people attribute to their water resources must be recognized (Bywater, 2012). Public participation can be a step to addressing issues and conflicts surrounding good governance by creating practices and political processes that are more inclusive, accountable, and transparent.
Types

Governance structures come in a variety of forms. In fact, every location around the globe has a unique historical context that affects current political and social attitudes towards water management. Despite this complexity, some commonalities have been acknowledged for good governance practices. The following, provided by the World Commission on Dams, are some commonalities (The Report, 2000; Wescoat & White, 2003):

1. Gain public acceptance of decisions
2. Explore all options, including considering alternatives
3. Address current problems faced by local communities
4. Protect and restore riparian ecosystems
5. Recognize property entitlements
6. Ensure public trust
7. Create a constructive cooperation between the conflicting parties

This list implies changing current governance structures in places that face water-related problems and conflicts. To begin, societies and governments must acknowledge that communities are not homogenous units, but rather are unique and complex. Natural and human systems that comprise a “community“ are interconnected and interdependent for survival. These complex communities hold their own values and have unique experiences and relationships to water.

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Community is in quotes because community is a contested and politically charged word. A community, in actuality, is malleable and complex. For this paper, community will be referring to an implied notion of solidarity and shared daily experiences among a group of people in a particular geographical space.
Decision-makers must acknowledge that each of these communities may hold valuable lay knowledge concerning the water resources in their area.

Therefore, public participation is crucial to good governance. Resisting historical marginalization and empowering local individuals to seek social and procedural changes is necessary for greater control and legitimacy in decision-making (Parker, 2006). In this same vein, the objectives and motivation of water management practices must be clear and the information must be accessible, rather than imposing outsiders’ “expert” knowledge on what they believe are communities’ wants and needs (Parker, 2006).

Deliberative democracy is one example of public participation. McCormick (2007) and Schmidt (2012) define deliberative democracy as politics justified through the exchange of ideas and knowledge in order to come to mutual agreements about policy recommendations. A deliberative democracy, in essence, is a participatory framework that includes sharing of local viewpoints and opening dialogue at global, regional, national, and local scales. When this approach is used, individuals and communities can become empowered and serve as important actors in water resource management. By applying contextual knowledge of place, these non-state actors become involved in the decision-making process and have greater input in the outcomes of policies and projects.
Deliberative democracy takes on an ethnographic approach, wherein local analysis is linked upwards to larger scales (Mehta et al., 2001). Wescoat and White (2003) address the importance of this cross-sectoral dialogue, and how it enhances the knowledge base on which policies are made and projects are planned, organized, and managed. Networking with local, watershed-level projects is essential to the effectiveness of deliberative democracy. If the focus is on a small scale\(^3\), then these networks of actors and stakeholders can assess actual need and begin developing appropriate governance regimes.

The argument that individuals and communities lack the expertise to influence and shape policy is short-sighted. Wescoat and White (2003) claim that involving such stakeholders in formal and informal meetings allows them to become a key part in forming management objectives and information sharing. Conversely, these stakeholders can benefit from science-based knowledge sharing. The exchange of information is necessary in order to create mutual understanding and holistic policies that both beneficiaries, governments, and other institutions can approve of.

Participatory research can be one alternative to command and control governance structures. McCormick (2007) describes participatory research as lay participation in expert decision-making that allows for local experience to be taken into account. This citizen-science alliance supports activism, changes the attitudes of

\(^3\) Small scale refers to individuals and their communities, whereas large scale refers to regions, nations, and the globe (depending on the context).
scientists and activists, and develops a new value structure for resources (McCormick, 2007). The aforementioned Silliman Research Group (SRG) is one example of a citizen-science alliance. SRG works alongside community partners from a local university, a national water organization, another nonprofit organization, and local teams in Benin. Together, these partners collect water quality data in order to monitor and maintain the wells, latrines, and the surrounding areas (Silliman et al, 2009). The SRG found that collaboration with multiple partners allowed the community to address local and regional groundwater quality issues.

Another alternative is participatory budgeting. Goulet (2005) argues that this type of state-society administration encourages interactive meetings. These meetings help educate and consult individuals and communities and members are democratically elected and decisions are voted upon with input from multiple stakeholders. Representatives are not paid; therefore, volunteers step forward and act on behalf of their community. If these representatives do not effectively speak for the people they represent, then they can be removed and replaced. In this fashion, the community can raise problems, spur discussion, and decide where funds are invested. These committees account for expenditures and can propose and carry out projects based on the interests and desires of the community. These examples of public participation sound ideal, but they could cause more power imbalances within a community. Despite this limitation, they are worth the effort to include local people in decision-making processes.
McCormick (2007) developed the following typology to explain the different types of collaboration between individuals and communities and experts:

<table>
<thead>
<tr>
<th>Lay/Expert Form</th>
<th>Direction of Knowledge Transfer</th>
<th>Changes in Knowledge and Discourse</th>
<th>Main Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher Educator</td>
<td>Top→Bottom</td>
<td>Expert language sharing</td>
<td>Researchers serve as educators of movement representatives or lay people</td>
</tr>
<tr>
<td>Researcher Activist</td>
<td>Top→Bottom</td>
<td>Construction of a new discourse outside of collaborative space</td>
<td>Researchers serve as movement leaders or political representatives</td>
</tr>
<tr>
<td>Citizen/Science Alliance</td>
<td>Bottom→Top</td>
<td>Discussion and deconstruction of official knowledge; Countering of expert and lay claims</td>
<td>Construct new research about the impacts of [development] or analyze existing environmental impact assessments performed by hired consultants</td>
</tr>
<tr>
<td>Collaborative Forum</td>
<td>Bi-directional</td>
<td>New, official codifications of knowledge</td>
<td>Lay people and experts construct official documentation of [development] projects</td>
</tr>
</tbody>
</table>

Figure 1: Typology of lay/expert collaboration. This typology can act as a blueprint for more participatory and deliberative development projects. (McCormick, 2007, p. 244)

There are many criticisms of this frame of thought. First, not everyone in a community has the same capacity to participate (Goult, 2005). In some postcolonial developing countries, such as India, women are often the care-takers of the home and family, while their husbands are the head decision-makers and control family finances. Therefore, women’s voices are not heard in the public

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4 McCormick (2007) refers to local knowledge and community knowledge as “lay” knowledge.
sphere considering that it is culturally unacceptable for them to speak out or to disobey their husbands (Panihari, 2004). Deliberative democracy, arguably, operates under Pareto optimum, in which outcomes and circumstances are ideal (Sultana, 18/10/2012).

Communities are not homogenous units (Clark, 2012) and in many cases there are unequal power relations inherent in hierarchical social institutions at many different scales. Therefore, as Wescoat and White (2003) argue, it is best not to romanticize cooperative local water and environmental governance. Participation can look promising in theory, but it takes long-term sustained political, economical, and technological intervention to be effective and efficient.

Moreover, it is naïve to assume that the same strategy used in one place can effectively be implemented everywhere. There is no such thing as a quick-fix for bad water governance practices, considering the lingering power structures and specific cultural, historical, and political contexts in postcolonial developing countries. However, deliberative democracy that promotes individual and community participation is an effective alternative to command and control politics. It can be considered and adapted to fit the unique needs of a particular location.
In 2002, the United Nations General Assembly declared the human right to safe and clean drinking water, and eight years later the Human Rights Council made the right to water legally binding. The right to water is an idealized effort with the best intentions; however, its materialization\(^6\) can be problematic (Schmidt, 2012). Many would agree that water is an inalienable right, considering without it we cannot and will not survive. Many international organizations have championed this cause, but are naïve in thinking that there is a quick and easy way to provide the world with fresh drinking water. Social and political factors cannot be overlooked. The question of governance is crucial to the discussion since a universal call for the human right to water might lack the geographical sensitivity necessary for decision-making. Moreover, in some cases there are no formal structures in place to actively and consistently provide water subsidies to poorer communities, so people must search out their own sources or pay outrageous amounts. More questions that need to be addressed are: How might water be provided and by whom? How can this universal right be translated on the ground?

Several factors are necessary in order to begin materializing a right to water. First, water needs to be available and accessible to communities when they need it.

\(^5\) A right to water should not be confused with water rights. They are inherently different concepts. A water right pertains to the legal right to a specified quantity of water for personal needs (Linton, 2012). A right to water is a social matter rather than a legal matter, in that water is seen as a cultural and social good.

\(^6\) Materialization of a right to water refers to the creation of on-the-ground practices and policies that provide people with clean, potable water.
Second, water needs to be provided in a way that is socially and culturally acceptable and appropriate. Finally, the provision of water needs to be affordable in the long-term and the short-term. For example, in Buenos Aires, Argentina, the company Suez was awarded a concession to provide water supply and sanitation services. In the contract, Suez was not required to supply poor barrios with connections, and as a result they charged US$600 to the poor users who wanted connections, which was unaffordable. Furthermore, Suez was permitted to decide whether users had to pay meters or not, which made the connections even more expensive over a longer period of time (Hall & Lobina, 2007). In the short-term small metered fees could seem affordable, but in the long-term purchasing water this way is costly.

There has been a global water justice movement in the past decade fighting for greater public reinvestment, accountability, and transparency (Sultana and Loftus, 2012). The movement is calling for a more water rights-conscious world in which states and individuals alike acknowledge the importance of providing quality drinking water to every person. This would require more monitoring and regulation of water resources. A more conscious world would certainly not solve deeper institutional and societal issues of power and control, but would alleviate the water stresses that face many individuals in areas of scarcity. For this reason, the value of water and individual and collective rights on local and regional scales needs to be articulated and thoroughly discussed.
There are inherent issues of power and control that need to be assessed when attempting to materialize the right to water. Linton (2012) found that community water management in Canada still has issues of exclusion, rather than equitable or democratic distribution. Linton argued that a continued active role of the state combined with community management could be more successful in creating better water governance in this particular context. An emphasis on community participation can potentially empower local actors to become invested in natural resources. In this way, people can change how they view water.

The separation people feel from the resource through the process of water production needs to be reversed. In other words, people should be knowledgeable of where the water was extracted and what political processes control its extraction. Linton (2012) continues to argue that the commoditization of water has created an accumulation of resources by dispossession. That is to say, private companies have accumulated resources, which effectively has altered people’s sense of ownership of these resources. Therefore, individuals and communities ought to repossess this ownership and restore proper governance structures. The next section will address water privatization.

*Privatization*

Capitalism is the dominating force behind globalization. Countries, like the United States, put hyper-faith in capitalism and in open markets. Can capitalist
policies solve global problems? Can they solve water governance problems?

Neoliberal policies have grown prevalent in recent decades, encouraging deregulation and laissez-faire politics towards environmental regulations. Privatization of water resources, as a result, has come out of this changing political atmosphere.

Bakker (2003) calls water a merit good, meaning that it is a good necessary for production and reproduction. In the 20th century, countries in both the developed and developing world increased state spending and strictly regulated the private sector. In developing countries this strategy failed because of the inability of many local authorities to recover maintenance costs and revenues from users of existing water supply systems. As a result, public control lacked technical innovations for conservation, over-extracted water resources, and underinvestment in water infrastructure (Bakker, 2003). Could a private system that focuses on individual consumers be a better option than a public system that prioritizes the collective? Similarly, is water supply a human right provided by the public sector or a human need provided by the private sector? Supply as a human right implies that it is the duty of the government to ensure that all citizens have access to quality drinking water and a human need implies that any private entity can collect water, assign it an economic value, and sell it to make a profit.

These factors encourage a privatized water market, especially when a public works system has failed to be efficient (Prasad, 2006). It could be argued that the public sector does not have the proper resources to manage water resources, whereas the private sector can be innovative, receptive, and offer quicker results (Hall & Lobina, 2007; Prasad 2006; Bakker, 2003). In a market-based world, corporate strategies for water supply can seem appealing, but they are flawed and create even more vulnerability in populations.

Hall and Lobina (2007) criticize the argued virtues of the private sector’s better efficiency, financial capacity and proactive management. They argue that privatization in many cases has proven to be overly optimistic and unsustainable. In the case of the private company, Suez, in La Paz, Bolivia, individuals were

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⁷ Neoliberalism, as defined by the Dictionary of Human Geography (2009), is a societal/economic structure that is organized according to self-regulating markets and is void of strong political intervention and regulation.
only given water services based on their ability to pay. Therefore, the people who lacked the financial means to purchase water were unable to benefit from Suez’s services. Similarly, in Colombia, Suez had no contractual obligation to provide for people in “unofficial settlements,” thus more people went without access (Hall & Lobina, 2007). Corruption, neglect, and the ability to pull out of unprofitable locations can leave people and communities vulnerable and no better off than before the companies intervened.

Bakker (2003) acknowledges that rural and urban areas face different technical and institutional challenges. In a post-colonial developing context, the majority of the wealthy population migrates to cities and a pattern of dominance is created, what Bakker calls “urban primacy.” In other words, there is a higher population of wealthy and influential people in the major cities. For this reason, public services are disproportionately spent on providing access to urban dwellers rather than to rural areas. In this scenario, the urban citizen has more political power compared to his or her rural counterpart. This is a self-perpetuating cycle, expanding the gap between those who are connected and those who are not, considering that the urban elites often become the state elites that govern and manage state institutions. This cycle can be reversed, but it requires a change in the collective conscience of the population.

This transition of water governance over time from communal ownership to private ownership has transformed how water is governed. As water is privatized,
it is no longer governed or managed by local stakeholders, but rather by large national or international third party actors. This change is problematic because it is difficult to understand unique lived experiences at such large scales. Many places avoid changing this privatized structure because the responsibility of investing, regulating, and maintaining public water service is complex and has failed in the past.

There are no easy answers to issues of accessibility, but alternatives to the all-public or all-private sector management of resources should be considered and studied further. Systems that encourage public-private partnerships, while including local stakeholders in any decision-making processes and in water resource management could prove to be an effective and efficient alternative. It is crucial to understand that water functions as a social and cultural good with, in some cases, economic value; therefore, it cannot simply have a technical fix (Linton, 2012; Bakker, 2012; & Sultana & Loftus, 2012). People need to have the right to be involved in water-related decisions.

Commoning

Bakker (2003) argues that local involvement and investment in common resources is the most effective alternative to free trade and deregulation with respect to water-related problems. In this case, governments can still own legal rights to water and can define resource boundaries, sanctions, rules, and
regulations (Mehta, 2007; Gordon, 1954; Mehta et al., 2001). This institutionalization of common property rights creates a divide between formal and informal institutions (Mehta et al., 2001).

It is difficult for formal institutions to create policies that account for how people locally value their water resources. For example, in Cuenca, Ecuador, the Andean indigenous worldview is that rivers are sacred and operate through a mutual relationship based on respect between man and nature (Francisco Lojano, personal communication). Similarly, the First Nations people have a different worldview on water than the citizens of Canada (Linton, 2012). Western ideology of “owning” water resources falls outside of this indigenous belief system. Essentially, water resources used by indigenous populations need to be developed with their input to achieve the best success.

The concept of water as a common good shared and governed collectively has been suggested as an alternative to top-down, command-and-control rule of water resources. The term “commoning” has been used frequently (Bond, 2012; Clark, 2012; Bustamante et al., 2012; Perera, 2012) to describe this community-run right to water. Clark (2012) argues that community participation is crucial to creating mechanisms for protecting and realizing the aforementioned right to water. Similarly, Schmidt (2012) claims that society ought to return to a collective and communal basis of water law and that it is imperative to decentralize the entire network of human institutions in a way that ultimately respects all vital flows of
water. This alternative can be considered more humanitarian because it allows a community to govern the water resources according to their unique social and cultural norms, rather than having “outsiders” interfere and decide what is best for them. Commonly owned and governed water resources may be an ideal and romantic concept, but it is imperative to consider this alternative.

Commoning brings up issues of citizenship and autonomy. As a citizen, it is imperative to use resources without jeopardizing the ability of others to use the same resource. Infringement upon the “rights” of others would be considered unlawful if the government has legally asserted that all citizens have a right to water. All forms of government domination cannot be entirely eliminated in exchange for a pure local autonomy. Why?

Hardin’s (1968) Tragedy of the Commons has been widely-read and cited by academics. He argues that it is human nature to maximize individual utility; therefore, a community is a sum of individuals who constantly try to maximize on the resources available to them. He gives the following example to clarify his assertion: if multiple farm owners are given one pasture where their livestock can graze, collectively, the farmers will overgraze the pasture. Why? Each individual farmer wants his or her livestock to be fed and grown for consumption or for sale. In order to make sure the livestock receives enough food to grow, the farmer will ultimately overgraze the pasture because he or she is trying to maximize on his or her own utility, rather than that of the community. Therefore, the environmental
cost of overgrazing is born by the community, but the individuals responsible keep the benefits accrued from their overuse.

Empowering local stakeholders to become involved in common resources could be the most effective alternative to current harmful, exploitative, non-inclusive governance structures. Governments could relinquish some of their power to local communities by giving local entities more autonomy over their water resources (Bustamante et al., 2012). Conversely, local stakeholders must allow governments to hold power over the management of water on larger scales. Government-run water institutions are able to address water issues holistically by seeing how access in one area might affect access in another. Any water-related conflicts could be mediated by these institutions as an unbiased third party. In this scenario, communities are granted the right to participate in decision-making processes, while the government maintains peaceful relations between all parties involved.

Ethics

What is the most ethical way to manage resources? Schmidt (2012) addresses the need for solidarity across cultural and national lines to counter unjust profiteering and privatization. Therefore, the ethos of shared attitudes and values are relevant in the water ethics debate. Existence, Schmidt (2012) argues, is social; therefore, the right to water must be accepted by a group. With this in mind, how can a
healthy coexistence be established within a global economy and in development without a community losing its voice or identity?

Heyd (2004) argues that environmental ethic is expressed through a specific way of life and through daily practices. Therefore, governance must adopt appropriate attitudes and actions that are environmentally just and moral for a particular group of individuals. This must take precedence over profits.

Furthermore, there are problems with conventional modeling (Shrader-Frechette, 1990). Modeling is a common tool used by scientists to create simulations of real situations in order to predict future outcomes. Models used by scientists can have unreliable components, in which some parameters cannot be known with certainty. Scientific models account for some variables; however, they may not control for unknown historical precedents and uniqueness of specific places. Shrader-Frechette (1990) argues that in some situations even the best models might not be good enough for environmental policymaking. How can a model effectively account for all the complex parameters that affect social and environmental threads? Contrarily, how can policies be made if models are not used? Without models policymakers’ decisions would be subjective and irrational. Scientific models rely on the expertise of scientists; therefore, how can good governance be implemented when modern society relies heavily on the outcomes of scientific consultation? Development projects that consider alternatives and include local knowledge with scientific expertise are most ethical.
Mehta et al. (2001) describe the four types of other uncertainties. First, the environment is understood as being stable, but in reality it is variable and unpredictable, known as an ecological uncertainty. Second, when addressing livelihood uncertainties actors tend to focus on local, micro-level livelihoods, but ignore broader economical, ecological, and social processes. Third, knowledge uncertainties acknowledge that water has multiple meanings and people have different viewpoints and look at water through different lenses. Lastly, there are many political and social uncertainties dependent on political action and development intervention. Considering the uncertainty, it is important to have good governance strategies that are holistic, inclusive, and transparent.

Our world is less predictable in its new global context (Mehta et al., 2001). Policies made by government officials at the regional and national levels can be detached from local realities on the ground (McCormick, 2007). Undermining all relationships at any scale is power and knowledge (Mosse, 1999). Whose voice is heard? Whose is not? It could be argued that development is a form of colonization of minds by institutions, in which the economically privileged develop the “underdeveloped”.

It can be argued that politicians make decisions according to their personal utilitarian views and maximize their own benefits while downplaying others. It is imperative that these actors take into account the

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8 Defined by colonial Western ideologies of “the developed” and the “underdeveloped.”
sociohydrological\textsuperscript{9} cycle and link the biophysical with the social processes that interact with it (Sultana, 1/11/2012). For example, in the case of the Maori indigenous people in New Zealand, for example, their spiritual and ancestral relationship with water is not taken into account in their national statutory water rights. Loss, exclusion, and the outright denial of rights has been the norm since the 1860s when the English Crown forcibly took Maori lands (Ruru, 2012). In 1991, the government passed the Resource Management Act which created national standards for control of water resources. The Maori would need a permit given by regional authorities to use local resources. The Maori tribes initiated court battles in the years that followed for their rights. Their perspectives were often overridden by public-works interests, such as irrigation and energy demands (Ruru, 2012). The conflicts between Western development culture and traditional indigenous ways of life can be uneven and unfair.

\section*{The Dominican Case: Context}

The Dominican Republic’s former president Juan Bosch describes the Dominican Republic as the imperial frontier (Wiarda & Kryzanek, 1982). The country has a long history of dependency on foreign powers and foreign capital to thrive. For centuries, the island nation was vulnerable to imperialistic tendencies of other nations. However, in recent decades the Dominican Republic has pushed for

\textsuperscript{9} The term sociohydrological cycle refers to the social (political, economic, historical, and cultural) conditions and the natural (hydrological, geological, biological, and chemical) conditions that constantly interact.
autonomy and the right to self-determine its future. Prasad (2006) claims that after colonialism and foreign interventions, developing countries resented any sort of foreign ownership. Consequently, nationalization of resources is commonly found in post-colonial states. In the case of the Dominican Republic this can be seen, considering that all water resources are under the control and regulation of the Dominican government. However, there is a lingering relationship of dependency between the Dominican Republic and developed nations, mainly the United States, which creates a complex system of water governance. The following sections will explore this complexity and alternatives to current water governance structures.

*Geography and Political History*

The Dominican Republic comprises the eastern two-thirds of the island of Hispaniola, neighboring Haiti. It is surrounded by the waters of the Gulf of Mexico and the Atlantic. According to the World Map of Koppen-Geiger Climate Classification (Rubel & Kottek, 2010), the Dominican Republic has an equatorial and fully humid climate. It has a wild and diverse landscape. The terrain is extremely variable and the country experiences severe hurricanes, periodic droughts, and annual flooding. The latter can prove problematic considering that poor drainage infrastructure and river control systems have substantial health implications.
According to the US Central Intelligence Agency, the Dominican Republic had a population of 10,088,598 in 2012 (The World Factbook, 2013). There is no indigenous population since the first conquistadors wiped out the native population through the use of guns, germs, and steel (see Diamond, 1999). Slaves were brought from Africa to work the land and the mixing of African and Spanish peoples created what is now the Dominican melting pot (Wiarda & Kryzanek, 1982). Despite their diverse and rich history, the colonial legacy of white domination remains entrenched in Dominican society. Therefore, there is a strong correlation between race and class in the Dominican Republic. The bloody reign of the dictator Rafael L. Trujillo mirrored this societal standard. He enforced an anti-Haitian policy of “whitening” the Dominican population, which entailed the massacre of tens of thousands of Haitians (Turits, 2002).

How does this relate to water governance? As mentioned in the first section of this paper, water governance is political and social in nature. For this reason, it is necessary to understand the unique historical and political geographies of a particular location, notably because these factors impact public and political attitudes towards how water resources are governed.

Wiarda and Kryzanek (1982) give a thorough historical and modern description of the Dominican Republic. The following paragraphs will summarize the rich political history of the Dominican Republic as explained by these authors. During Colonial times, the island was a favored location for Spanish trade, culture, and
administration in the New World. However, through the centuries it has experienced neglect, wars, repression, dictatorships, underdevelopment and foreign intervention. In 1492, Spain began its civilizing process in the New World. The first fifty years on the island were marked by great prosperity for Spain. During this time period, Spain had a highly centralized and state-dominated political authority. At the time, this was considered to be the ideal model for development in the New World and it was called the island’s “Golden Age.” Today, water is state-controlled, which reflects this colonial legacy.

Throughout the 16th, 17th, and 18th centuries, the Haitians, the French and the Spanish all fought for control of the island. In 1821, Dominicans declared their independence for the first time, but within weeks they were overtaken by Haitian troops. The opposition declared a second independence in 1844. In the following decades, the Dominican Republic was lead by corrupt leaders who were dependent on England, France, Spain and the United States, and became fractionalized and bankrupt. The Dominican people have become reliant on foreign nations to maintain political and economic stability, but this does not allow Dominicans to participate in decision-making processes. This lack of inclusion has created a politically apathetic society.

Years later, in 1906, the United States directly took control of the Dominican economy and used the money to repay the Dominican Republic’s debts. The United States modernized the Dominican land title system so that American sugar
firms could expand, which is a form of neocolonialism considering that the
decision-making process was mostly in the hands of the United States rather than
the Dominican people. The United States withdrew from the Dominican Republic
at the end of World War I (Wiarda & Kryzanek, 1982).

From 1930 to 1961, the country was ruled by the dictatorship of Trujillo. Under
his brutal and systematic repression, a culture of fear fell over the nation like an
unforgiving storm. Trujillo was a progressive leader who brought economic
prosperity to the Dominican Republic. He wrote many decrees and laws without
the word of the Dominican people (Wiarda & Kryzanek, 1982). This separation of
the Dominican people from the political sphere has excluded them from taking
part in water resource management and or in policy-making.

A civil war broke out in 1965. This revolution was significant in showing
Dominican drive for self-determinism, dignity, sovereignty, and national pride,
but proved that they had not overcome US dependency. Unemployment,
illiteracy, and poverty were high, the distribution of new wealth was inequitable,
and the social conditions for the poor worsened in the following decades (Wiarda
& Kryzanek, 1982). The Dominican Republic has faced problems of social
inequity and an overall lack of political voice, which has impacted how and who
participates in decision-making processes. Stewart and Gray (2009) argue that the
roots of water crises are poverty, unequal power relations, and problematic
management policies. Thus, the widened social gap has created an unequal water governance structure.

The Dominican Republic has had a long history of both foreign and national control, leaving little room for the Dominican people to claim the right to self-determination. This lack of power has lingering effects on every aspect of Dominican society, including how natural resources are governed. Command and control politics is what the country is most familiar with and is the common way of governing the Dominican people and the natural environment.

**Economy**

The Dominican Republic is rated 98th on the United Nation’s 2011 Human Development Index, lagging behind developed counties like the United States (ranked 4th), but ahead of developing countries like its neighbor Haiti (ranked 158th) (Human Development, 2011). Originally, the Dominican Republic had a cash crop economy: sugar. However, in the past century, the Dominican Republic has diversified its economy through various development programs such as mining, manufacturing, and tourism. In the 1980s, the government’s three big achievements were (1) the restoration of old Santo Domingo, (2) tourist development on the northern coast, and (3) mining programs in Bonao (Wiarda & Kryzanek, 1982). Today, it is known as a popular tourist destination, which has had both positive and negative reverberations throughout the country.
The new industries in the Dominican Republic have recreated a modern system of foreign control over the country’s economy. The government is reliant on foreign investments, resources, markets, and technology to develop. The United States is its principal consumer. Therefore, changes in American attitudes and interests have a strong impact on the Dominican economy. The largest firm in the latter half of the 20th century was a US company, Gulf & Western, which invested in sugar refineries, real estate, hotels and other development projects. Gulf & Western provided capital, jobs, and technical skills to Dominicans, but was known for being corrupt, expansionist, and having strong lobbying power. One Dominican describes Gulf & Western as being “a monster that will take whatever we [Dominicans] have” (Wiarda & Kryzanek, 1982, p. 78). These companies have a stronger political voice than the Dominican people, and have depleted and degraded water resource through wasteful and careless practices with little government regulation.

The services sector, such as tourism and construction, is the current fastest growing sector of the economy (Dominican Republic, 2004). In 1971, the Tourist Incentive Law was passed. This allowed the expropriation of land, and small landowners had little choice but to agree to hand over their land. In this same year, the Dominican Republic created INFRATUR, a government agency for tourist development. It used public funds to build airports, roads, new water systems, and bring electricity to more areas. The cities were modernized and in
seven years the number of tourists entering the country rose from 137,000 people to 460,000 people (Wiarda & Kryzanek, 1982). Land grabs and displacements for the sake of urban beautification were common. The Dominican tourist industry favored large TNCs, like Gulf & Western, which helped give the Dominican Republic international exposure (Freitag, 1996), but at a cost to the local communities’ autonomy.

The transformation of landscapes had positive and negative impacts. The local ecology, such as mangroves and fisheries, was transformed and there was mass destruction of marine life and ecosystems. Socially, there was little face-to-face interaction between the TNCs and the local communities, so as different regions developed it was not necessarily the local populations that benefited. Around tourist zones, land prices skyrocketed; consequently, farmers had to migrate to find affordable land. This migration compromised their subsistence livelihoods and communal solidarity was weakened because of tourists’ intrusion (Freitag, 1996).

The impacts of the service sectors were both beneficial and disadvantageous for water-related problems in the Dominican Republic. There was increased access to clean, potable drinking water and electricity, which improved the quality of life of many Dominicans. On the other hand, there were significant environmental costs, such as waste from hotels, travelers, and construction. This is counter-intuitive considering that a damaged environment could dissuade travelers from choosing
the Dominican Republic as their travel destination in the future, which would adversely impact the national economy. In the past two decades, precautions have been taken to combat environmental pollution and will be discussed further in the following sections.

*Urbanization*

Many Dominicans have left the countryside to settle and build careers in the four largest cities: Santo Domingo, Santiago, La Romana, and Bonao. Figure 2 below shows the dramatic increase in urban population between 1970 and 2000, as well as higher influxes of tourists and capital. Higher populations in the cities put more pressure on water and natural resources from rural areas. For this reason, there has been a higher demand on water for agricultural purposes and for providing water to urban residents (see Figure 3).

<table>
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<tbody>
<tr>
<td>Population (million people)</td>
<td>4.4</td>
<td>5.7</td>
<td>7</td>
<td>8.4</td>
</tr>
<tr>
<td>Rural population (million people)</td>
<td>2.6</td>
<td>2.8</td>
<td>2.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Urban population (million people)</td>
<td>1.8</td>
<td>2.9</td>
<td>4.1</td>
<td>5.5</td>
</tr>
<tr>
<td>GDP (USD 1995)</td>
<td>3.9</td>
<td>7.6</td>
<td>9.7</td>
<td>17.2</td>
</tr>
<tr>
<td>GDP per capita (USD 1995)</td>
<td>874</td>
<td>1327</td>
<td>1377</td>
<td>2055</td>
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<tr>
<td>Agriculture (value added, million USD 1995)</td>
<td>888</td>
<td>1523</td>
<td>1305</td>
<td>1917</td>
</tr>
<tr>
<td>Manufacturing (value added, million USD 1995)</td>
<td>708</td>
<td>1157</td>
<td>1750</td>
<td>2940</td>
</tr>
<tr>
<td>Tourism (millions of arrivals)</td>
<td>N/A*</td>
<td>0.4</td>
<td>1.3</td>
<td>3</td>
</tr>
<tr>
<td>Irrigation (thousand hectares)</td>
<td>125</td>
<td>165</td>
<td>225</td>
<td>269*</td>
</tr>
<tr>
<td>Fertilizer use (thousand tons)</td>
<td>38</td>
<td>52</td>
<td>92</td>
<td>94</td>
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<tr>
<td>Emissions CO2 (million tons)</td>
<td>3.1</td>
<td>6.4</td>
<td>9.4</td>
<td>20.2</td>
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*N/A = not available; Data refers to 1999

*Figure 2. Urban Migration*

*Source: Dominican Republic: Environmental Priorities and Strategic Options, 2004, p. 1.*
These major cities are connected to a public water works system. According to a Santo Domingo resident, the cost per month for this service is about ten US dollars (Luis Guzman, personal communication). However, rural areas must purchase water from local vendors. In the case study area of Cabarete, a small town on the northern coast, water is bought in five gallon jugs at five US dollars, and can be refilled for about one US dollar. Therefore, depending on the family size, the cost per month for water is between fifteen and twenty US dollars.

Bakker (2003) found that commercialization of the water sector disproportionately affects the poor, especially in developing countries. Similarly, she states that subsidies are only available for the “wealthier-than-average” portion of the population, and the poor must rely on private water vendors and, ultimately, pay higher prices. This generalization has been proven true in the Dominican case.
Politics of Dominican Water

“Democratic rule is not a system of governance with which the Dominicans have had long experience…”

Wiarda & Kryzanek, 1982, p. 106

All the water resources in the Dominican Republic, as of 2000, are property of the Dominican State. Title IV, Chapter III, Article 126 of the new Environment and Natural Resources Law, also known as Law 64, states that “All water resources in the country, without any exception, are property of the State… The right to private ownership of water and the right to purchase water does not exist” (translated by author). However, every Dominican has the right to use water resources, as long as it does not compromise the ability of others to obtain good quality water (Ley general, 2000). The ownership and control of water resources is completely reserved for the government.

In 2000, environmental degradation and the need to protect natural resources were top on the Dominican government’s agenda. Why? Considering that the tourism industry has boomed in recent decades (refer back to Figure 2), it is in the best interest of the Dominican economy to maintain and protect its natural resources, or else it will lose its main source of national income. In order to combat a strained natural resource base, including issues of poor water quality and scarcity, the Dominican government established an umbrella agency called the Secretariat
for the Environment and Natural Resources, under which all environmental institutions are organized (Dominican Republic, 2004). The responsibility over the resources is shared collectively between various agencies and sub-secretariats and some non-governmental organizations. The agencies include (but are not limited to): the Secretariat for Soil and Water, the Secretariat for Coastal and Marine Resources, the Secretariat for Environmental Management, and the National Institute of Water Resources (INDRHI) (US Army Corps, 2002; Dominican Republic, 2004).

These institutions are responsible for four main tasks: (1) environmental monitoring, (2) consolidating and integrating environmental institutions, (3) promoting environmental mainstreaming and building consensus, and (4) implementing necessary environmental policies and actual instruments for implementation (Dominican Republic, 2004). INDRHI has created a Water Culture Program to incorporate citizens in the decision-making processes regarding the use, conservation, protection distribution and management of water.

This program is five-fold: informing, educating, organizing society, writing new legislation, and developing new environmental programs (INDRHI, n.d.). These strategies, in theory, should help citizens learn more about Dominican water resources and give them a sense of ownership and power in how they are controlled, but in Cabarete the citizens appeared to lack ecological literacy. Furthermore, Law 200-04 and Decree 130-05 require the release of public
information to citizens. These two mandates have created greater transparency in water governance, but only for citizens that have access to appropriate technology and know what to search for. INDRHI has published various water-related reports outlining citizens’ rights, public finances, and public contract information for the public to access.

**Governance Structures in Cabarete**

Cabarete is located on the northern coast of the Dominican Republic in the province of Puerto Plata, bordering the Atlantic Ocean. There are small to moderate quantities of freshwater contained in the Yasica River (the closest flowing water source to the town) and the Bajabonico River. The rivers drain from the Cordillera Septentrional mountain range. Surface flows are greatest between April and October (US Army, 2002). According to the US Army Corps of Engineers (2002), all surface water should be considered contaminated and unfit to drink based on their water quality studies. Coffee is grown throughout the North Coast Basin, including areas surrounding Cabarete, due to the high precipitation in the area (US Army, 2002).

Pineapple and sugar cane are common crops grown in the region. However, fertilizers could be potential sources of surface water pollution. There are limited financial resources available to manage and treat the surface waters. Additionally, there is limited and sometimes no oversight or regulation of sewage runoff and
pollutants from agricultural runoff (US Army, 2002). The area has been developed for the tourist and agricultural sectors, but with neoliberal, laissez-faire politics of regulation and resource management.

The US Army Corps of Engineers’ (2002) water quality data is consistent with the data that were collected from the Yasica River on the 12th of July, 2011, by the author and a group of 23 Dominican youth. This participatory research project was proposed with support from the Capstone Reader (a university professor) and a nonprofit educational organization (The Dominican Republic Education and Mentoring Project). The DREAM Project (DREAM) is a US-based nonprofit organization providing quality educational experiences to underprivileged students through unique programming offered throughout the year in the Dominican Republic.

We developed a four-week pilot science module on the fundamentals of water potability and took 23 advanced students to three easily accessible sites on the Yasica River. We also sampled several less accessible sites to complete the data set from headwaters to mouth. This group, lead by the author and a science teacher from DREAM, tested the river water for the following water quality parameters: dissolved oxygen (related to contamination), specific conductance (measures total dissolved minerals, which can show the influence of sea water intrusion), pH (acidity) temperature, iron levels (related to contamination), and nitrate levels (related to contamination).
The objective of this project was three-fold. First, we hoped to develop a comprehensive environmental education module that focused on water quality and ecological literacy. We assumed, and were told by staff at DREAM, that the students had little knowledge of water-related problems in their area or in the world. Therefore, we hoped to share our “expert” knowledge and learn about how the students interact with and value their natural environment. Second, we hoped to sample surface waters of a local river to obtain concrete water quality data. We hoped that the field measures could be used to identify the sources of contamination. Lastly, the project was intended to empower the students to reevaluate how they interact with their natural environment and claim responsibility for protecting their natural resources.

**Methodology**

This participatory research project was an educational module meant to engage local youth in hands-on research of a local water resource. The project had four crucial parts: (1) preparatory lessons, (2) the field trip, (3) the follow-up lessons, and (4) the community presentation. The preparatory lessons introduced the students to map-reading and to the water quality test kits (see Appendices 1 and 2). The students were asked to hypothesize what they thought the levels of contamination were in the Yasica River, see Figure 4. Out of twenty-four students, most were unsure about whether the water was contaminated or clean.
The remaining students were split among thinking that the water was severely contaminated, slightly contaminated, or not contaminated.

![Figure 4 Student hypotheses of contamination levels in the Yasica River](image)

The excursion was done by boat down the Yasica River. The ride was prefaced by a local eco-tourist guide sharing information about the vegetation in the area. While in the boat, the students broke into three groups and each sampled three different sites. Each group was further divided into two groups and supervised separately. The students performed the tests, as practiced in classroom, and recorded the data. The boat ride ended at the mouth of the Yasica River, where the last sample was taken. There were six sample sites in total (see Appendix 3).

The students had five follow-up lessons (see Appendix 6) borrowed from Project WET, including a discussion of the results from the water testing (see Appendix 4). The results are discussed in the following section. Lastly, the students reenacted their trip down the river for their peers, their family members, and other members of the community. They showed the community how they collected the samples and what the significance is of each water quality parameter (see Appendix 5).
**Results**

The project successfully introduced the students to the water chemistry of rivers. The students learned that health problems develop when water is contaminated and that fecal waste, agriculture, and other waste materials can all be sources of contamination, especially in the area that they live in (see Figure 5). The students learned how total dissolved solids and contaminant indicators, such as nitrate, increased from upriver sites to the mouth of the river. Total dissolved solids at Site 1, furthest upstream, were 159 part per million, and progressively increased to over 2000 parts per million at the mouth of Rio Yasica.

We concluded that this increase in dissolved solids could have been caused by a mixture of nutrient contamination from the local farms and salt water intrusion. Nitrate increased from less than 2.5 parts per million to 25 parts per million near the mouth. The students understood that high levels of nitrate can be an indicator of fecal or agricultural wastes in the water. Dissolved oxygen levels decreased from 8 parts per million to 5 parts per million, which can threaten the lives of species in the water that depend on oxygen for survival. pH levels remained constant between 7 and 8 showing no influence of significantly acidic or basic substances in the water. The iron levels were between 0 and 0.2, which indicates little to no iron pollution.
Our project introduced Dominican students, with easily accessible technology, to how water contamination can be caused by humans, poor water management practices, and naturally occurring phenomena. The project proved an engaging and effect teaching tool, particularly with this underprivileged, rural population. The students gained ecological literacy, were more aware of the impact they have on their natural environment, and how their surrounding environment impacts their health and wellness. Moreover, this participatory research experience successfully allowed local youth to become active participants in the data collection process, which ultimately allowed them to better understand their local water resources. This collaborative project is an example of McCormick’s (2007) typology “the Researcher Educator form of lay/expert collaboration” in practice.

One limitation of this project is that it was championed by a university student who could only spend a short amount of time in the host country. The project was only fully completed once and only one small group of Dominican students was
able to benefit from the knowledge sharing process and the technology. Fortunately, the lesson plans have been shared with local Dominican educators so that they can use the lessons in their classrooms year round.

Discussion

The quality of water in the Yasica River is poor and not potable. Local agricultural activities coupled with careless waste disposal and poor sewage and sanitation services seem to be the sources of surface water contamination in the area. The lack of enforcement of the Environment and Natural Resources Law (Law 64) has allowed a careless and poor water governance system in the Dominican Republic. Furthermore, the historical legacy of disempowerment and lack of knowledge sharing has created a population that is not ecologically literate and that lacks the power to influence the local water politics.

The public must be educated on the negative environmental impacts of wasteful and harmful practices at all scales: in the home, in the community, in the region, and in the nation. Individuals must dispose of garbage and other wastes responsibly. Communities must claim some responsibility and make sure that these wastes are sent to appropriate disposal sites. Communities can also work together in making sure that the local rivers are consistently cleaned and monitored for contaminants. Both regionally and nationally, water governing organizations should begin consulting with local stakeholders and creating open
dialogue on how they can collectively govern and monitor their water resources. Sewage and sanitation issues need to be addressed, while agriculture and tourism must account for the environmental goods and services that allow them to exist. If resources are degraded and over-extracted in the short-term, then these sectors will not be able to be sustained in the long-term.

The Dominican government ought to reevaluate how they address water governance in their country, especially in rural areas. Research and literature has shown that the public sewage and sanitation projects are not well managed or are completely absent in the Dominican Republic (Wiarda & Kryzanek, 1982; Dominican Republic, 2004; U.S. Army, 2002; Caribbean Land, 2007). The public ought to become more invested in the protection of their water resources. As stakeholders, they deserve a voice in how their local resources are governed. Thus, public participation should be an important component in future changes to water and natural resource legislation and to the water governance structures within multiple governing bodies.

Public participatory research is one way in which the Dominican government and organizations like the INDRHI can involve local stakeholders in the governance of their resources. Moreover, it creates an engaging educational activity for youth. However, the research must be replicable with the support and resources of the local community or an organization that can consistently provide resources. If possible, the research project should reach a greater portion of the population.
Potential solutions to highlight include involvement of low-income Dominicans in development proposals as beneficiaries by creating local representation in the planning process. The public’s concerns should be considered before any water management decisions are made. Cooperatives (i.e. farmer and fisher cooperatives) are another potential solution that could help tourist zones become more self-sustaining. Lastly, fees that tourists pay to enter the country and to participate in day-adventures can be used to develop environmental education programs and promote conservation efforts (McElroy, 2003).

**Conclusion**

Globalization has created unequal and unsustainable styles of governance. Post-colonial nations have developed their economies, lands, and natural resources at such high rates to keep up with the growing global economy. Ultimately, and unfortunately, this has had significant human and environmental costs. If we as global citizens want to ensure that current processes and practices do not harm natural resources for future generations, then we need to rethink and reevaluate how these resources are governed.

Problems of water *quality* and *quantity* should be addressed in tandem.

Contamination problems can have harmful impacts on human health. Immediately, observed risks of contamination ingestion include vomiting, headaches, and diarrhea. However, there are also subtle damages that occur in the
long-term. Such calculated future risks could be cancer, diabetes, or any number of immune deficiencies. Additionally, water scarcity in a region is an equally important factor to consider. Given these points, governance structures that can recognize and address problems of water quality and quantity will be most effective. As previously mentioned, water cycles through natural systems and social systems; thus, the value of science and societal and political institutions must be recognized.

Issues of water governance, who has the rights to water and who has the right to water, are complex and multifaceted. Therefore, solutions to these issues must also be complex and multifaceted. No matter what the scale, the importance of incorporating multiple actors and stakeholders in the discussion of how natural resources are governed cannot be overlooked. Private vs. public sector water provision debates need to be considered on a case-by-case basis, but public participation is crucial.

Changes in decision-making and governing structures must occur in administrative, organizational and political processes. Increasing public participation in each process can help post-colonial nations create more inclusive and holistic water and natural resource policies. McCormick’s (2007) typology of expert/lay collaborations is a useful tool for national, regional, and local environmental organizations and agencies when considering how to be more inclusive and transparent in decision-making processes.
It is paramount that the voices of the people who live and interact daily with their natural resources are considered when developing environmental policy and when making important environmental decisions. The unique lived experiences of a population are what form specific cultural and personal identities. Many post-colonial nations will need to reconsider how they value their natural resources; this may mean an overall change in the environmental ethics of a society. What is ethically correct or incorrect in a particular context? Societal and institutional changes are oftentimes gradual rather than immediate, so proponents of the change must be proactive and diligent in proposing and enacting environmental awareness campaigns. Furthermore, communities are not mutually exclusive from their natural resources. For this reason, natural and human systems ought to be seen as a single functioning community where the destruction of one could cause the demise of the other.

Participatory research projects can be a useful tool for community outreach. Stakeholders who become engaged in environment research can gain ecological literacy and can become empowered citizens invested in the natural resources of their community and their nation. There are many limitations to public participation in participatory research projects. These projects, though they may have positive intentions, may ultimately prove to be another way of forcing expert knowledge on the local populations. Furthermore, community members might not have to time, energy, or resources to become involved in political processes or
community-led initiatives. These are a few limitations that must be considered, but should not discourage post-colonial nations from attempting to be more inclusive. The importance of a variety of perspectives and knowledge is paramount in any context, especially in water governance.
Acknowledgements

I want to give a special thanks to Professor Donald Siegel for all his guidance and help in designing the environmental education module, not to mention for providing the water quality testing kits. Without his support the research project would not have come to fruition. Furthermore, I would like to thank Catherine DeLaura, Director of the DREAM Project, for her flexibility in allowing us to add this educational component to the science program. Without her and the rest of DREAM’s support this project would not have been feasible. Special thanks to Sarah Riggen, Rachel Ottaviano, and Denise Mitchell for helping plan the follow-up lessons and for their wonderful work in the classroom! I must praise all my Dominican students for their patience and eagerness to learn and participate in the project. They were a fantastic group to work with, and they are sorely missed. I would like to thank Jacob Bendix for all his patience, wisdom, and advice on writing this research paper. He has helped me create a well-thought out paper that I am very proud of. Another thank you to Henry Jankiewicz for helping me edit this paper. Lastly, a special thank you to my mother, Jari, for allowing me to spend countless hours at the kitchen table writing and listening to all my woes.
References


Appendix 1
Topographic map used to help students understand the spatial characteristics of the area, while teaching them the concepts of scale.
Appendix 2
(a) Hanna Tester used for measuring total dissolved solids, pH levels, and temperature. (b) The CHEMets Test Kits used for measuring dissolved oxygen, nitrate, and iron levels.
Appendix 3
Test site locations along the Yasica River. NOTE: Samples from sites 1 through 3 were collected and recorded by the author and another international teacher. Sites 4 through 6 were performed by the students.
Appendix 4
The test results from the field trip, as presented to the students in class.
Appendix 5
The Dominican students presenting their findings to their peers, their families, and members of the community.
Appendix 6
Lesson plans

DREAM project
DOMINICAN REPUBLIC EDUCATION AND MENTORING

Summer 2011 Science Lesson Plans

Written by Sarah Riggen

*These lessons were used at both DREAM campuses during the 2011 summer camp season. In addition, all teachers involved in teaching this curriculum (three Dominicans and three Americans) have taken a copy back to their schools and were eager to incorporate these lessons into their teaching for the school year.*

Resources used:
Project WET (Lessons 3–6)
Lawrence Hall of Science GEMS (Discovering Density) (Lesson 2)

ADVICE: Many lessons in these plans involve lab groups. Students must not complain about their lab groups. It takes all kinds of people to make the world work and the science room is not a place for being exclusive. Say something about this BEFORE announcing lab groups.
Lesson 1: Let's Draw Molecules

Objectives: Students will be able to draw water molecules and state their very small size.

Materials: Diagram of the magic glasses; jar or glass with water; sheet paper or butcher paper; scrap paper (optional); index cards or post-its

Procedure

Do Now:

Where on Earth can you find water?

(oceans, rivers, ice, glaciers, animals, plants, soda, jugs, etc)

Introduction:

1) Hold up a glass of water. Ask students, "What is inside?" (Responses will likely be "water") Push students further, "But what makes up the water, does anyone know?" (Use if anyone answers up with water molecules...if not, say if they were describe a water molecule. If not, move on)

2) Introduce poster with magic glasses (keep right hand side covered at this point...only show the person with the glasses). Explain that if we had magic glasses to see very, very small (so clear that this isn't real), then when we looked very closely at water, it would look like this (at this point, show the rest of the poster).

3) Explain that every water molecule looks exactly the same and that all water is in lots of small little water molecules.

Student Practice

Distribute pieces of paper for students to draw individual water molecules (assign an appropriate amount...six, eight, twelve...whatever)...show students how to efficiently divide their paper to make evenly-sized molecules). For students who can handle it, label the parts of the water molecules oxygen and hydrogen.

Group Work:

1) Back table of students can then cut out their molecules and put them into scenes of their choice on butcher paper (e.g. fill in a big cup of waterfall or ocean or whatever). An alternative is to have students practice drawing just a few molecules in "students practice" and then have students draw the molecules directly onto the butcher/when paper.

2) Back group shares their design with the class. Have the presenter state where they think water molecules and what water molecules are composed of.

Portative Assessment:

Have students draw and label one water molecule on a post-it and stick it on the board as they line up.
Lesson 2: Dissolving Density

Subject: Exploration of water with varied amounts of dissolved salt; water can contain a lot of "salt" even if you can't see it.

Grade Level: 3rd and up

Objective: Students will be able to layer four different saltwater solutions in a straw by making observations about the way the different solutions interact with each other and writing predictions about where each solution belongs.

Materials:

For the class:
Four saltwater solutions (see chart)

<table>
<thead>
<tr>
<th>Color of Water</th>
<th>Water</th>
<th>Salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>1 gallon</td>
<td>0 oz</td>
</tr>
<tr>
<td>Yellow</td>
<td>1 gallon</td>
<td>8 oz</td>
</tr>
<tr>
<td>Red</td>
<td>1 gallon</td>
<td>16 oz</td>
</tr>
<tr>
<td>Green</td>
<td>1 gallon</td>
<td>32 oz</td>
</tr>
</tbody>
</table>

For each lab group:
Four small plastic cups
One small cup with regular, clear water (for dipping pipettes)

Pipette:
Ball of clay (1/2 ball size)
Clear straw (about 4" in length)

Paper
Colored pencils/markers for drawing predictions

Procedure:

Day 1:
Do Now:
If you could see water really really close up, what would you see? (water molecules) Draw a picture of one.

Introduction:

1) Ask students what the three states of matter are (or, if it needs to be more simple, what are the different forms that water comes in?). (solid, liquid, gas) Show a visual for each of these, associating the word with a sketch for each state of matter.

   SOLIDA
   [sketch of solid]
   "el sólido"

   LIQUIDA
   [sketch of liquid]
   "el líquido"

   GASEOSA
   [sketch of gas]
   "el gas"

2) Explain that water molecules are in ice, liquid water, and water vapor...the molecules are the same in each of these types of matter but they just have more energy. As they go along the progression.
**Kinaesthetic Activity:**

Do the molecule dance.

- Explain that each student represents a water molecule (you could have them each wear a picture of a water molecule if you like).
- Designate an area on the ground that is large enough to fit the class with a little room left over.
- When students are water molecules in ice (solid), they need to stick in one place and vibrate. Molecules in solids really do this. Even though we can't see it, molecules in solids do have energy and as a result, they vibrate, BUT they can't move around, which is why things that are solid have definite shape and volume. Students should be evenly spaced and in an organized pattern (rows of same kind).
- When students are water molecules in liquid water, they can flow around each other. BUT they cannot pass outside of the area you have designated. This is like molecules in liquids. They can flow all around each other, which is why liquids can fill any space, but they can't expand out of their original volume, which is why the students have to stay in the box.
- When students are water molecules in water vapor, they can move with more energy and go all around the room (in and out of the box). Gas molecules act like this. They have lots of energy and can travel anywhere they like (unless in a sealed container).
- Run through the dance, going from solid to liquid to gas and back down again...sell out that students are gaining energy as they go from solid to gas and losing energy as they go from gas to solid.

**Group Discussion:**

1. Is all water the same? (Pose this question to students and see what they say)
2. Discuss how purified water is supposed to be just water molecules but water from the sink, river, and ocean have additional molecules (use images to represent each type of water PLUS make one image of just water molecules and another with water and salt molecules)
3) Specifically show differences between salt water and just water. Begin with a model. Show a bottle filled with large gravel. Explain that each piece of gravel represents a water molecule. Ask students if any more water molecules can fit in the bottle (conclude that the answer is “no”). Then show another bottle with fine sand. Explain that each grain of sand represents a salt molecule. Pour the sand into the gravel and ask students which is heavier; just the rocks (water molecules) or the rocks and sand (water and salt molecules). Explain that salt molecules are able to fit in the spaces between water molecules, making the water heavier...also mention that the more packed molecules are, the more density they have.

4) Then do a demo with real water and salt. Have two jars of water. Add a bunch of salt to one (have a helper stir it in...pour in yellow food coloring too). Add blue or red coloring to the regular water...have a helper stir this. Ask students what they think will happen when the two liquids are poured together. If they think the regular water will sink, do a small sample to show them how the water mixes when you try to put the regular water on the bottom. Then very carefully pour the regular water on top (pour in line like you would a beer...sideways). Two layers should form. The bottom layer (the salt water) has more molecules packed in it so it is denser (it sinks)! (density = amount of molecules in a given volume, mass/volume)

Lab Info:
1) Explain that tomorrow they have a challenge. Each lab group (groups of two, three, or four students) will be given one straw apparatus, four different cups of water with different amounts of salt in them, a clear glass of water, and a pipette.
2) Students will need to figure out which colored water has the most salt and which has the least. Just as they saw in the intro, the water with more salt will stay below the water with less salt if they are put in the right order.
3) Have students set up their lab sheet (if you are able to, it is easier to just hand out a pre-prepared sheet) and decide which order of colors they’d like to try first.
4) Once students have a plan they can practice soaking up and siphoning out water from their pipettes.

Day 2:
5) Demonstrate the technique for filling the straw. Only 1 or 2 cm of liquid are necessary per color. They should squeeze the water into the straw carefully. If they do it too hard the colors will mix, even if the order is right. Stress the importance of waiting until the colored water goes. Close observations will help them to make more accurate predictions of how to successfully layer the colors.

Lab:
6) Students should record each round on the piece of paper they are given.
7) Students need to record their plan for color order before doing it. They should make a note of very part of the color that did lay and then move on to the next round. Students should share who gets to use the pipette.
8) Once students are successful, they need to write an explanation on their lab sheet as to why the water layered as it did. Which is the densest (the most packed with salt molecules)? Which is the least dense? — Formative Assessment

Advice: At first, only pass out the clear water and allow students to practice/explain the pipette and how to use them. Also, the clear water is for mixing the pipette between each colored water. They MUST do this or the water will get pretty mixed and be no good.
Lesson 3: Alma Bodies
Subjects: Water in living organisms
Grade Levels: 3rd and up

Objectives: Students will be able to explain that water is the main ingredient in living organisms.

Materials: butcher paper (to trace one student per class) or just use chalk on the ground; 1 box of raisin clusters, bunch of grapes, anyone eating cluster?

Procedure:
Do Now:
Put a couple of raisins and a couple of grapes on each table. Write down your observations of the two types of objects on your table. (You probably need to go over what an observation is first)

Introduction:
Show students the pictures and present the question: Two people are stranded in a desert. One person has a basket of food including canned meat, bread, cake, etc.—enough to last a month. The other has only a one-month's supply of water. Which of the two will survive longer? Have students share. Then clearly: We can go about a month without food but only about three days without water. The bodies of most living things are at least 50% water.

Activity:
1) Question: Do you think humans have water in their bodies? Have students guess how much of the body is water.
2) Depending on how much paper you have, you could trace one person per sheet [or use chalk on the ground]. Or do one student in the class. However you do it, have a student trace another student's body shape on paper. (We found it was best to model this with some students for the whole class and then have each group repeat the process.)
3) Refer to the students' guesses from earlier about how much water is in a human body. Circle the closest guess and share that 65-70% of our bodies are water! (FYI: with stuff dissolved in it)
4) Have students divide the traced shapes into 10 parts (this is a good time to talk about dividing the body into equal parts) and color 7 of them. If you did it on butcher paper cut it out for display (if it's worthy)
5) Extension: Have students calculate how many kilos of their weight is water (body weight x .7)
You can then calculate how many gallons of water (1 gallon = 3.8 kilo)

Water Songs (if time):
Emphasize that because so much of our body is water it is very important that we stay hydrated. You can choose a song to sing from the sheets of "agua Total".

Formative Assessment:
Have each student (or each group of students) draw a body on a 3/4 sheet of paper and color in how much of the body is water.
Lesson 4: Juegos de H2O

Subject: Introduction to water molecules
Grade Levels: 3rd and up

Objective: Students will be able to demonstrate adhesive and cohesive properties of water.

Materials:

<table>
<thead>
<tr>
<th>Juego 1:</th>
<th>Juego 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>two 6-oz cups; 100 1-cm pieces; bucket of water; pipettes</td>
<td>six 5-cm pieces; six pipettes; six cups of water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Juego 3:</th>
<th>Juego 4:</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 paperclips; three forks; aluminum pan filled halfway with water</td>
<td>ruler; three different types of paper towels; pitcher of water (without a top on it); stopwatch</td>
</tr>
</tbody>
</table>

Procedure:
1. Prior to play: Get counselors and co-teachers on board. Explain the mechanics of each station and have each adult pick one to be in charge of. At Juego 1, adult needs to make sure that the water level is exactly at the rim of the cup to start and that students don’t take the pieces. At Juego 2, adult needs to make sure students don’t take pieces. At Juego 4, adult needs to make sure students pick two of the three paper types and that they are hanging in the same length (for a fair test). They should time each round (1 minute) and help students measure how far up water absorbs. Another adult should man the scoreboard.

Do Now:
Look at the diagrams of molecules for liquid A and liquid B. When they are combined, which liquid will go on top and which will go on the bottom? Why?

Introduction:
1. Today (and probably next class too) is the Juegos de H2O in science!
2. Explain that in the Juegos de H2O, they will conduct a series of events to help them understand two properties of water called cohesion and adhesion.
3. Assign partner pairs for these games and have them sit together with one sheet per pair. Students should put their names on the worksheet.
4. Go from station to station briefly explaining the event without actually doing it full out. After you explain each station, have each student pair write its prediction on the worksheet.

Juegos de H2O:
1. Assign starting stations to each pair. After initial station, pairs can travel to any station.
2. After completing each game, pairs check in with the counselor and keep score on their paper.
3. Play Olympics here if you have it. Students go from station to station.
4. When the majority of pairs have completed the majority of stations, students get in seats.
5. Post the results and compare. Clap for winners of each game (you could have additional winners as well if you like, e.g., closest prediction, first to finish, best attitude).

Formative Assessment:
Define cohesion (water’s attraction to itself) and adhesion (water’s attraction to other materials) and have students point out examples of each. If they can sketch what they mean this might help.
Juego Uno:
Llena un vaso plástico con agua. Echa monedas en el vaso hasta que derrame. Cuenta las monedas que tiene el vaso. ¿Con cuántas monedas se va a derretir el agua? _____
Describe o dibuja como quedó el vaso cuando derramó el agua.

Número de monedas achatadas: _____

Juego Dos:
Usa una pipeta para echar gotas del agua sobre la moneda. Contar cuántas gotas queden encima del moneda hasta que derrame el agua.
¿Cuántas gotas del agua planas que puede quedar sobre la moneda? _____
Número de gotas: _____

Juego Tres:
¿Cuántas clips planas que puede flotar en el agua? _____
Con un tenedor, baja el clip con cuidado y saque el tenedor para que el clip se quede flotando. Dibuja o describe como quedó.

Número de clips flotando sobre el agua: _____

Juego Cuatro:
Recorta tiras de diferentes tipos de papel. ¿Qué papel va a absorber menos agua? Explica por qué.

En un lapiz, pega 2 tiras de papel diferentes. Introducir al agua para ver cual es más absorbente.
Altura para la primera toalla: _____
Altura para la segunda toalla: _____
Lesson 3: Draw in the Bucket

Subject: Water is a limited resource
Grade: Level: 3rd and up

Objective: Students will be able to explain why water is a limited resource.

Materials: 8.5 x 11" white paper with a circle drawn in the middle (1 per lab group); blue and green paper (1 of each per lab group that they will then need to cut into 100 pieces each); clear 1 L containers; small, clear 50 mL containers; small, clear (if possible) petri dish or container; metal bucket/vase; p/yeast; water

Procedure:
Do Now:
What is one reason that fresh water is important?

Introduction:
1) Review what a pie chart represents. Show one half filled in. "How much of the circle is colored in?" (half: 50%) Color in new different amounts and have students state how much of the 100% is represented.
2) In their lab groups, give students 8.5 x 11" piece of paper with a circle on it.
3) Give each group 100 pieces of blue paper and 100 pieces of green paper.
4) Groups need to decide how much of the planet they think is covered by water (blue = water and green = land). The total number of pieces they can use is 100. Example, if they think Earth has 50 pieces of water then they must also include 50 pieces of land.
5) Show the different predictions.
6) Explain that 71% of Earth's surface is water (71 pieces should have been blue). Show a globe and point out how much of it is blue. You can also show the Pacific Ocean side, where basically the whole view is blue. But, as we have discussed, not all of Earth's water is the same.
7) Have students adjust their estimates to show how much of the water on our planet can be used for drinking, cooking, cleaning. Blue = can be used, Green = can't be used

Activity:
1) Show the class a liter (1000 mL) of water and tell them it represents all water on Earth.
2) Ask where most of the water on Earth is located. (Ocean) Pour 50 mL of water into a small container. Tell students the water in the large container represents the oceans. Pour some salt into the container (you could label this too). The water in the small container is all fresh water on Earth.
3) Ask students what is at Earth's poles. Almost 80% of Earth's fresh water is frozen in ice caps and glaciers. Show a picture of glaciers/ice caps. Pour 6 mL of water into a small dish or container and put the rest in an ice cube tray (label it). The small dish represents non-frozen fresh water.
4) Use a pipet to remove a single drop of water. Explain that the water in the small dish represents water that is unavailable to us because it is too deep in the ground or contaminated.
5) Drop the drop in the pipette into a metal bucket/pan. Make sure students are quiet so that they can hear the drop. That drop represents all the clean, fresh water that is not polluted or otherwise unavailable.

6) Compared to the amount of water on our planet, how much is available for humans to use? (very little)

7) Refer back to their estimates of usable water from earlier (with the blue and green paper).

8) Have students explain their reasoning for their initial estimates. Do they think they are high or low?

9) In reality, a tiny corner of one piece of blue is all the potable water available (hold up a circle you have done and glued prior to class to show this). Water is a limited resource!

**Formative Assessment:**
What is a unit of water on Earth? Why is it a limited resource?

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**Lesson 6: Quiz**

**Subject:** Summative assessment of what students have learned

**Grade Levels:** 3rd and up

**Objective:** Students will be able to demonstrate their understanding of properties of water by completing a quiz.

**Materials:** Quiz

**Procedure:**
Take quiz.
Capstone Summary

Water is a vital part of our planet. It is the lifeblood that sustains all life forms. Without it the world would be a very different place. Nearly three-quarters of the entire planet is covered in water and our very bodies consist of about 60% water. Therefore, it is necessary that we understand our water resources and ensure their protection for future generations.

Unfortunately, water sources around the world have been degraded and depleted because of negative human and environmental impacts. Industrial waste and even residential waste from our own homes can make way into water resources. For this reason, water is a fragile resource that needs to be monitored and governed well. How, though, and by whom? These are very difficult questions to answer considering that there are so many factors that influence how water resources are managed.

First, every geographical location has a unique history. The politics of the past have lasting impacts on the politics, culture, and social structure of the present. Thus, when discussing water resource problems like lack of access or poor water quality, we must consider institutional and historical legacies that carry over into modern times. Second, every community and country value water differently. Some communities might value the spirituality of water, while another might consider solely the economic value. Similarly, should water be considered a
human right? If so, how can you translate this right into actual lived practices? In this same vein, should water be given an economic value? Or, should it be provided free to all? Lastly, we must consider the ethics of water management. How do people act daily with their local water resources? Are they involved in decision-making processes?

This paper analyzes the different types of governance, the right to water the privatization versus commoning debates, and environmental ethics. Above all, it is imperative that governing bodies tailor their water regimes to the unique lived experiences of all citizens. In order to accomplish this task, these governing bodies must have governance structures that are transparent, inclusive, and holistic. In other words, the policies in place must be accessible to citizens. Moreover, governing practices must include all people who have a stake in their local water resources. Ultimately, structures that involve all stakeholders and public agencies in decision-making processes are what create good governance practices.

The paper also analyzes a local empirical case study in the Dominican Republic. The unique and rich geography, politics, history, and economy of the Dominican Republic are reviewed and applied to a participatory research project done in Cabarete, Dominican Republic. The project was an environmental and educational module that introduced youth in Cabarete to water chemistry and the social and natural systems that impact their local water resources.
This project was an effective tool for creating ecological literacy in a population that has poor access to water quality testing kits. The students became active participants in research and data collection processes. This project is one example of public participation in water governance. I argue that public participation is essential in any governing processes, so that the wants and needs of the people are prioritized just as much as the wants and needs of the State. Water governance, in this sense, is an extremely multifaceted and complex topic that deserves further research and discussion.