Increased flooding in Caribbean countries such as Trinidad and Tobago can be linked to
development and behavioral practices that encourage erosion and the blocking of water
channels. Stormwater is the flow of water over the land after precipitation, and is a
major cause of water pollution and localized flooding in highly urbanized areas. Rain
that falls on impermeable surfaces such as driveways, roofs and car parks cannot enter
the ground for natural absorption and filtration by soil and plants. Water run-off across
surface structures, as opposed to soil infiltration, also prevents water from replenishing
aquifers needed to supply drinking water. As climate change intensifies, the problems of
flooding and fresh water scarcity are expected to intensify. To address these issues,
engineers such as Ewoud Heesterman, former President of the Association of
Professional Engineers of Trinidad and Tobago, recommend “educating the public and
involved professionals regarding options to control erosion and off-site movement of
sediment and to generally improve surface water quality” (Trinidad Express, 2015).

This paper addresses actions that have caused increased flooding in Trinidad,
demonstrating the effect of harmful practices by households and construction activity on
stormwater and flooding problems. The paper also includes a series of financing
mechanisms that can be used to fund water quality protection efforts. Approaches to
tackling stormwater and flooding problems are suggested in the paper. These solutions
involve public education on anti-pollution and impermeability of private yards for
citizens. For decision-makers, information is provided on finance, management and
policy mechanisms for programs to encourage green infrastructure from an Integrated
Water Resource Management (IWRM) perspective. The framework links drinking water
security to flooding, sanitation and water quality problems.
BACKGROUND

Trinidad and Tobago is a twin island republic located at the southern end of the chain of Caribbean islands. The larger island, Trinidad, is about 11 kilometers (7 miles) from South America. On a clear day, it is even possible to see an outline of the Venezuelan coast from the west side of Trinidad. Owing to the fact that Trinidad was once part of the South American mainland, its flora and fauna tend to be more diverse than other Caribbean islands. Due to the tropical latitude, the country has a rainfall average of 2,200 millimeters (86 inches) per year. The wet season is from June to November and there is a dry season from December to May. With such high rainfall levels and temperatures that range from 25 to 27°C (77 to 81°F), lush vegetation occurs in the undeveloped areas of Trinidad.

Lower estimates are that urbanization is occurring at a 3% rate of change on an annual basis (United Nations Population Fund, 2015). This urbanization is affecting ecosystems and the natural hydrology of the island of Trinidad. Flooding is becoming more frequent and widespread. When valuable freshwater takes the form of a destructive flood, the country also loses important groundwater recharge that later reduces public water supply. The basic water cycle that is taught in most primary schools shows these connections. Water management needs to consider all parts of the water cycle. The Global Water Partnership (GWP) has established a now widely accepted definition of the term “integrated water resource management” (IWRM). The definition is, “IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (Global Water Partnership, 2010).

PRACTICES THAT ENCOURAGE SOIL EROSION AND FLOODING

Trinidad is a relatively mountainous island within the Caribbean context. The Northern Range, with its highest mountain peak of El Cerro del Aripo reaching a height of 940 meters (3,084 feet), accounts for roughly a quarter of the island’s total land area. A large percentage of the island’s population occurs in the Northern Range and its foothills. The gravel sands that constitute the southern foothills of this mountain range are also popular quarry sites. The continued clearing of forests on the steeper mountain slopes for housing and agriculture causes soil erosion. Doctor Paul Hinds found that in particular, unplanned development in the Northern Range in areas such as Tunapuna is particularly blameworthy for blocking the natural path of water. He states that “unplanned hillside developments significantly compact the soil resulting in the alteration
of the hydrologic soil group classification and hence the relationship between infiltration and runoff (Hinds, 2015)." Incidentally, Trinidad may be the only Caribbean island with a written hillside development policy." The “Northern Range Hillside Development Policy” of 1989 was aimed at addressing the issues of environmental degradation in the Northern Range due to physical development. The consequential soil erosion from unplanned development leads to silting of rivers downstream in the central parts of the island. For example, the widespread flooding from 89mm (3.5 inches) of rainfall in Figure 1 from July, 2015 in areas such as Chaguanas is one effect of this soil erosion.

Soil erosion was certainly not the only cause factor of the July 2015 floods. Plastic bottles and large quantities of Styrofoam littered the floodwaters, calling attention to the role that pollution plays in blocking drainage ways such as rivers (Figure 2). Enhanced solid waste management practices and public education on littering are needed to keep these materials out of the water channels.

Another substantial contributor to flooding and soil erosion is the concretizing of surfaces on the island. With its high rainfall levels and tropical climate, vegetation flourishes in Trinidad. The lawn in a residential front yard may need to be cut multiple times a month in order to maintain attractiveness, as well as for more practical reasons such as preventing mosquitoes and the diseases they carry (e.g. Dengue and Chikungunya). For these
reasons, more residents are electing to pave their yards. Paving could also represent a cultural or lifestyle shift within the country – schedules are becoming busier, leaving less time for cutting the grass, and it is possible that paving is almost a status symbol! When coupled with a growing population, private citizens’ preference for paving results in a dramatic increase in impervious area. Fewer opportunities for water to infiltrate the soil contribute to the classic “flashy hydrograph,” where, during a rainfall event, water reaches the river very quickly, causing riverine flooding by bank overflow. The problem feeds on itself, whereby such large volumes in the river over a short period of time can cause erosion within the river, leading to more siltation and flooding further downstream.

FRESH WATER SCARCITY

In addition to increasing siltation and pollution that impact water quality, human activity also negatively impacts fresh water quantity. Rapid runoff from impervious surfaces prevents infiltration into the soil, and as a result, reduces aquifer replenishment. Groundwater is a critical source of freshwater in the twin island republic, where the Water and Sewerage Authority (WASA) reports that groundwater accounts for twenty seven (27%) of its raw water (Govia, 2015). Even with Trinidad’s $US200,000,000 desalination plant, groundwater supply from aquifers have many advantages for the water distribution system. Perhaps foremost is that desalination is an expensive method of obtaining freshwater. Since its formation in 1999, the Desalination Company of Trinidad and Tobago (DESALCOTT) has had to increase the volume of water it produces over time (DESALCOTT, 2015).

APPROACHES TO ADDRESS WATER QUALITY AND QUANTITY PROBLEMS

PUBLIC EDUCATION

Public education that stresses the connection between increased flooding, deforestation, and pollution is essential to addressing water quality and quantity challenges. Damage and property loss caused by flooding tend to be tangible and salient to residents. The setting and format of the public education campaign also deserves some consideration. Of course there are the more formal education institutions that can instill conservation ideas into children, who will hopefully take the messages home in the short term and practice the ideas themselves as adults in the longer term. However, education campaigns should target adults for more immediate effect through forums such as meetings/workshops of religious and civic groups.
Activities such as beach or river cleanups have the dual benefit of directly removing pollutants from the environment as well as encouraging the participants (and even observers) to engage in more sustainable practices in the future.

POTENTIAL FINANCIAL IMPLICATIONS OF PUBLIC EDUCATION

In addition to the direct water quality benefits from improved public behavior, an important potential secondary effect is the public’s increased willingness to pay for the protection of water. In other words, if people understood better the value of good water quality, perhaps water customers may be open to paying a higher bill for water service. Going further, citizens may even be agreeable to paying a separate fee or tax, outside of the water bill, in order to protect water resources.

Furthermore, citizens who are better informed will seek more water quality-friendly options from commercial entities. For example, a yard owner who does not want to cut her grass as often, but does not want to pave the entire area either, may inquire about “grass blocks” in Figure 3. Commercial entities such as landscaping companies will then see a demand for such products or options and as the market economy works, supply will try to meet this demand. As such products or practices become more common with more homeowners employing them, it may lead to multiple commercial entities offering these products. This sets the stage for competition among the providers, which leads to better products and prices for consumers. Lower prices would also make the products accessible to greater segments of the population.

Figure 3. “Grass blocks” at a new development in Trinicity, Trinidad allow more infiltration into the soil than traditional concrete. Source: Stacey Isaac Berahzer
FINANCIAL INCENTIVES AND APPROACHES

TAX INCENTIVES

Apart from the demand for better water quality protection practices that an informed public can create, financial incentives can also improve water quality.

The fifteen percent “value added tax” that the country levies at the point of sale can be waived for products and installations that improve water quality. Whether this is done on a temporary or long term basis, it would encourage consumers to consider these more environmentally friendly options due to the lowered cost.

Another tax incentive that the government has already instituted in the area of renewable energy is a tax credit on solar water heaters. Since 2011, with the purchase of solar water heating equipment for household use, the individual is entitled to a tax credit of twenty-five percent of the cost of the solar water heating equipment up to a maximum of ten thousand dollars (maximum tax credit of $TT2,500.00) (Ministry of Energy and Energy Affairs, 2015). Lessons from this experience can inform a similar offer for water quality-related equipment.

The previous examples of tax incentives for residential customers can also be extrapolated to commercial entities, for example offering a similar tax incentive when a business owner elects to develop his property using stormwater-friendly practices. A savvy business person can even leverage such an investment to enhance his image to potential customers. Well informed customers are likely to patronize “green” businesses over competitors, all other factors being equal.

PUBLIC FINANCING

The government could install some of the most effective stormwater practices on public land. Financed directly through public funds, these sites can also serve as demonstration projects to teach citizens and developers more about water quality protection options. One example shown in Figure 4 comes from The Chaguaramas (not to be confused with the Chaguanaas) coastal area where a sign describes how a silt trap works on the very popular boardwalk area.
To encourage such best management practices on private lands, public funds can be used to provide grants to residents or commercial entities wishing to incorporate these features in their development. A new fund may be created for such a program, or money can be set aside from a related existing program, such as flood clean-up and home improvement grants. Grant funding could also be provided to do public outreach events, as well as test the effectiveness of existing technologies or develop new more appropriate local options.

Of course, allocating money to a cause such as watershed protection is different than actually generating the needed money. Taxes, fees and fines are mechanisms for actually generating this money. A higher tax on products that directly impact water quality represents an equitable way to generate these funds. Deciding on the appropriate products to tax could be contentious, but candidates could include fertilizers (for the additional nutrients that they add to water ways), and/or Styrofoam-intense products (because of the large amounts of this material found in Trinidadian flood events). In terms of fees, developers can be required to pay higher fees related to land disruption, especially when disturbing land with a steep gradient. Fines can be charged to those who violate the Hillside Development Policy or who disturb the river reserve (buffer) area. Local and national agencies should coordinate to set these fines at a level significant enough to discourage potential violators. Higher fines also have the advantage of generating more revenue when they are collected. Proper implementation of these rules and collection of these fines should be followed with a rigorous policy that restricts the revenue generated to use only for water quality-related efforts.

**PRIVATE FINANCING**

The most effective measures for treating stormwater occur close to where the rain falls. Larger, more regional detention ponds, for example, are often less effective at managing runoff and are arguably less attractive. Hence, while installation on public
land has merit, there is a need for private landowners to install these features locally too. Achieving the latter can be more challenging. One more direct way to incorporate private funds is to convince the private landowner (residential or commercial) to make the investment on their own property using their own funds. The education, tax and other financial incentives described earlier help make this case.

A less direct way to access private funds is through “sponsorship” programs such as the “Adopt a River” project in Trinidad. Started around 2013, it “is an initiative to involve communities and corporate entities in the improvement of watersheds throughout Trinidad and Tobago in a sustainable, holistic and coordinated manner” (Adopt a River, 2015). Programs such as these involve donations from private companies for items from garbage bags to food for volunteers. The hours provided by volunteers can also represented a significant investment. With proper tracking and documentation, a dollar value can be assigned to these hours that can be used to leverage further funds for watershed efforts. For example, some grant programs require matching funds and, in select cases, volunteer hours qualify for this match. An alternative is a commercial entity simply donating money to the efforts, based on the history of significant volunteer hours. A potential corporate donor is interested in impressing large numbers of people. If there is proper recognition for the donor via signs, media coverage etc., the watershed group stands a better chance of corporate funding. A corporation that is using water from a specific river may also be more easily convinced to adopt or provide funds for that particular river. Likewise, religious and civic groups are apt to support efforts in their local watershed. However, schools have shown the most interest in adopting rivers at this point.

PUBLIC PRIVATE PARTNERSHIP FINANCING OPPORTUNITIES

Public and private financing do not have to be mutually exclusive. The challenge of financing stormwater protection, especially on private property, is leading governments across the globe to consider Public Private Partnerships (P3s). The P3 mechanism is a co-operation between a public entity and private parties such as financiers, construction companies, individuals, and other businesses. A P3 arrangement can involve any combination of design, build, operate, maintain, finance, and transfer. More than very localized grass blocks in private yards, a P3 approach may have relevance in a more large scale effort such as a national river channel management program. Narinesingh points out that embankments, de-silting, and concretizing of river channels are currently the most common approaches to river management, but that other options should be considered (Narinesingh, 2014).
A related approach where public dollars can be used to ignite private financing mechanisms is the “loan loss reserve.” Under this scheme, the government establishes a fund with public dollars that serves as a pool from which private banks lending for water related projects can draw if their loans go into default. Investments that benefit from the initial credit support provided by the loan loss reserve would create a track record of repayment/performance for this type of project. Other financial institutions would therefore be better able to assess projects on a more specific, empirical basis.

To illustrate these concepts, we can look at the example of installing a rainwater harvesting system on a private home or commercial building. Rainwater harvesting is an old concept in the Caribbean, but is being re-propagated by entities such as Global Water Partnership – Caribbean. While the practice has many other benefits, for the purposes of this paper we will focus on the fact that collecting water off of a roof during a rain event delays the entry of that water into the river. This helps to reduce the flashiness of the hydrograph discussed earlier. Experts have developed fairly simple technology to improve safety and effectiveness of harvesting rainwater. However, adoption requires a financial investment by the user, perhaps in the form of a loan. Private banks may be unwilling to accept the risk involved in providing inaugural loans for this type of installation. However, if a government funded loan loss reserve is in place to help the banks mitigate default risks with the new type of loan, then banks may be more interested. Over time, once loans have been made and are being repaid, the private banks would have developed statistics on default rates etc. for rain water harvesting projects and may be willing to finance these types of projects without the government safety net.

CONCLUSION

Factors such as global warming and population growth are only expected to exacerbate flooding in Trinidad. Intervention needs to occur in order to alleviate the loss of property and disruption caused by these floods. Beginning with public education to address cultural attitudes to littering, pollution, and landscaping will go a long way to prevent future flooding. However, more informed consumers will also demand more water-sensitive products and services. The economic and financial systems are necessary for residential, as well as commercial customers, to finance these improved water quality practices. There is a tangible financial loss when crops are affected by flooding, as food shortages ensue and prices soar. One way or the other, the country is paying when it comes to flooding. Reserving some of these funds for “prevention” of flooding versus a “cure” after a flood event is worth consideration.
REFERENCES

Adopt a River, http://www.adoptarivertt.com, accessed on 07/20/15


Name: Stacey Isaac Berahzer

Biography:

1. Senior Project Director, Environmental Finance Center at the University of North Carolina (USA)

2. Graduate: Master of Public Administration, May 2005, University of North Carolina, Chapel Hill, (USA)

3. Environmental Scientist, RTI International (USA) - (June 2000 -December 2002)

4. Undergraduate: Bachelor of Science – Environmental Science major, Biology minor May 2002; Summa Cum Laude: GPA 3.97 North Carolina Central University, Durham, North Carolina (USA)