

Dominican Republic

A large number of doves are flying over a square in Santo Domingo, Dominican Republic. In the foreground, a statue of Christopher Columbus stands on a pedestal. In the background, the Cathedral of Santo Domingo is visible. The scene is set in a brick-paved square with trees and street lamps.

Doves flying over main square with Columbus statue, Santo Domingo, Dominican Republic.
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“The greatest environmental challenge facing the city of Santo Domingo, the first in America, is to clean up the mighty river Ozama, to make it clean, pure and crystalline once again as it was five centuries ago when the colonial city was founded on its shores”

Urban Waters in the Dominican Republic

Rafael Osiris de León

Summary

In the Dominican Republic, towns are expanding, due to population growth exacerbated by the lack of employment opportunities and basic services in rural areas, which forces a sector of rural communities to move to urban areas. Likewise, many inhabitants of neighboring Haiti migrate to the Dominican Republic in search of better living conditions. Both those from rural areas and Haiti, unable to afford to live in urban areas with basic services, settle on the banks of rivers and streams in makeshift shacks, without potable water and basic sanitation, their waste ending up in the adjacent rivers and streams, from which they obtain water that has already been contaminated. We have thereby degraded virtually all our urban water and multiplied waterborne diseases, which mainly affect the poor, who are unable to afford the high cost of treated and purified water.

The periphery of the capital, Santo Domingo, with a population of roughly 3.5 million, concentrated in approximately 350 square kilometers, has grown rapidly, polluting the Ozama, Isabela and Haina rivers, while the lack of an adequate sewerage service has led citizens to dispose of their sewage through vertical filter wells that discharge directly into groundwater, subsequently extracted through adjacent wells to supplement the precarious and intermittent drinking water service. Our cisterns thereby combine drinking water, supplied by pipelines, with raw water directly extracted from the contaminated subsoil, which should be unacceptable in an organized society committed to health and basic sanitation.

The severe problem of urban water pollution has been compounded by an extraordinary drought not seen in the country since the mid-1990s. This drought has caused a severe drinking water crisis, which has forced the water authorities to ration flows for irrigation and prioritize the scarce water available for human consumption. This crisis has been so severe that it has led to inter-municipal conflicts over access to the limited amount of water available.

This should lead the country to redefine its public policies on drinking water and basic sanitation to begin solving old problems accumulated in these two major health-related issues, so that we establish a deadline of not more than 12 years to provide the city of Santo Domingo with adequate sewage service with wastewater treatment plants, relocate poor families living precariously on the banks of rivers and streams, fix leaks in drinking water pipelines, and obtain new sources of water harvesting, all of which must be complemented by new legislation that prioritizes investments in drinking water and sanitation and obliges all new residential projects to be provided with sewage services and treatment plants, while encouraging international agencies and local entrepreneurs to play a more active role in these solutions.

1. Introduction

In the Dominican Republic, as in most Latin American countries, urban waters are synonymous with rivers and streams contaminated by direct discharges from neighboring slums that lack sewers and refuse collection services. Likewise, they have

not been connected to the drinking water system nor have they been properly trained to preserve water and ensure basic sanitation. Most urban industries lack wastewater treatment plants, thereby turning the urban rivers of Santo Domingo and the country's major cities into the main recipients of the organic and chemical discharges that damage the quality of the water intended for consumption by the growing population.

The city of Santo Domingo was founded just over 500 years ago, on the banks of the mighty Ozama River, with its crystalline waters, which served as a permanent supply source for drinking water. In the five centuries that have elapsed since its founding, the city has grown westward, northward and then eastward, encompassing a large portion of the banks of the Ozama River and its northwestern tributary, the Isabela River and the west Haina river, now severely polluted by urbanization and industry.

However, the growth experienced by the city of Santo Domingo during the second half of the 20th century led to a swift process of exploiting the groundwater available in the coralline limestone aquifer on which the city was built. This aquifer, whose most effective intake extends E-W for about 1,200 square kilometers, receives an annual net

Photo 1. The Ozama River and its overcrowded buildings make it one of the most polluted urban rivers. Osiris de León.



recharge of approximately 1,200 million cubic meters of water, as well as the direct vertical discharge of almost 90% of the sewage supplied by nearly 3.5 million people who contribute about 7,000 tons per day of excrement, as a result of which this major aquifer, the largest net recharging aquifer in the country, is now severely polluted as are the rivers surrounding the city.

In the Dominican Republic, towns are continuously expanding due to natural population growth, and the fact that the lack of employment opportunities and basic services in rural areas forces a large sector of the people living in rural communities to migrate to urban areas. Since many of them are unable to afford to live in urban segments with basic services, they settle on the banks of rivers and streams, in makeshift shacks, where there is no drinking water service or basic sanitation, and their waste ends up polluting the adjacent rivers and

streams, creating an increasingly serious problem.

Clear examples of this situation are published in the national press, such as what happens in the eastern town of Hato Mayor, where the community's refuse, industrial waste and excreta end up in the bed of the Maguá River, as published in the *Diario Libre* on July 28, 2014.

This situation has degraded our urban waters, both the surface and groundwater of the Eastern Coastal Plain, where the cities of Santo Domingo, Boca Chica, San Pedro de Macorís, La Romana, Higüey and the growing tourist area of Bávaro and Punta Cana are located. It requires urgent attention and a solution, especially since the lack of a regional aqueduct means that the overexploitation of groundwater in the tourist areas of Boca Chica and Bávaro has produced saline intrusion processes of 15 km and 4 km respectively.

But the most worrying thing is that the Dominican Republic has failed to adopt proper drinking water and basic sanitation policies, or invest in the construction of sewers, or wastewater treatment plants, meaning that the wealthiest residential areas in the capital lack sewerage, and all new buildings are allowed to construct vertical filter wells to discharge their waste into the groundwater we extract to supplement the insufficient flow rates received from the main intakes located on the outskirts of the city. There is a tendency to forget that the Santo Domingo aquifer lies on a bed of highly porous coral limestone where hydraulic conductivity is extremely high, and any organic or chemical contaminant spreads rapidly to its surroundings, but mostly from north to south, which is where the hydraulic slope descends seeking the level of the Caribbean Sea located on the south side.

This creates a Dantesque situation of extraordinary urban and industrial pollution, in both wealthy neighborhoods and slums. It is exacerbated by an outdated water supply network through which just over half the water is lost, either through leaks in the primary and secondary networks, or informal use, which is either unregistered or not paid for. Coupled with the lack of investment in new water intake works, this means that many sectors of the capital and broad sectors of large cities lack a permanent water supply, forcing many people to purchase tanker trucks for their water supplies, or to protest angrily in an attempt to be noticed by the

Maguá River Choked by Pollution

Diario Libre. Monday July 28, 2014

The Maguá River, which rises seven kilometers away from the farming community of El Manchado in the northern part of Hato Mayor, recorded a high degree of pollution, due to the industrial waste, fats and feces discharged by over a thousand latrines existing on either bank of this water source.

The once mighty river has become a municipal sewer due to the waste thrown into the water, which threatens to eliminate this major tributary.

The waters are covered in filth at source, because the council built a municipal dump a few meters from the start of the runoff that feeds into it.

In the city of Hato Mayor, the Maguá river is affected by the feces and urine discharged by hundreds of toilets, and the red meat waste from animals slaughtered in the municipal slaughterhouse, located about 200 meters from its banks.

The river also receives effluent from the main pipeline in the Hato Mayor sanitation system, which burst open, spilling feces into the waters of the dying river.

Tree felling on the banks of Maguá river has also signaled the death knell of this major local river.

Toxic waste has caused the death of fish, crabs, shrimp, turtles, guabina fish, tilapia and mountain mullet, which have vanished from its waters.

In 2000, the Cattlemen's Association of Hato Mayor, the United Nations Food and Agriculture Organization (FAO) and other national and international agencies announced the clean-up of the Maguá river, but the project was shelved, presumably due to lack of resources and the unwillingness of the government to address the pollution of this key water resource.

authorities responsible for managing the waters that should reach urban centers.

2. Water and the Problems Paused by Urbanization

Under normal conditions, the city of Santo Domingo, the capital of the country, with nearly 3.5 million people, receives about 410 million gallons of water every day, through the Santo Domingo Water and Sewerage Corporation (CAASD) of which 142 million gallons per day are obtained from surface sources in Isa, Mana, Duey, Guanaitos, Haina, Isabela and Barrera Salinidad Ozama, 138 million gallons per day are drawn from wells built by CAASD and 130 million gallons a day are provided by the western dam of Valdesia, indicating that the city of Santo Domingo is supplied in almost equal proportions by three sources: a group of surface rivers, an excellent aquifer on coralline limestone, and a large dam which, in addition to providing six cubic meters per second for the aqueduct, supplies 20 cubic meters per second for irrigation channels and 54MW of electrical power, although private wells may be contributing approximately 100 million gallons a day.

The city of Santiago de los Caballeros, the second largest city, with nearly 700,000 inhabitants, obtains 100% of its water from the Tavera and Bao dams, which supply about 125 million gallons per day, and virtually none from groundwater in view of the fact that Santiago is built on impermeable calcareous clays deposited on impermeable clay shales that do not constitute aquifers; the same way that the city of Moca, located east of Santiago, with nearly 100,000 inhabitants, is also supplied by the Tavera and Bao dams, which provide 20 million gallons a day, because since the city of Moca has no surface rivers, it has no significant local catchments, and as it is built on impermeable clays, it cannot rely on groundwater either.

The cities of Central Cibao, such as La Vega, with nearly 400,000 inhabitants; San Francisco de Macorís, with approximately 180,000 inhabitants; Bonao, with about 125,000 inhabitants; and Cotuí, with roughly 75,000 inhabitants, are supplied by

the surface waters of the Yuna, Masipetro, Maimón, Camú and Jima rivers and the Hatillo Dam, built on the Yuna River and the Rincón Dam, built on the Jima River, because in this area there is no significant exploitation of groundwater and aquifers are extremely limited and unproductive.

The Northwest Line aqueduct, which supplies the Monción Dam, built on the Mao river, supplies water to approximately 500,000 people in the northwest of the country, from Navarrete, Esperanza, Valverde Mao and Monción to Sabaneta, Villa Vásquez and Monte Cristi, showing that virtually the entire Cibao Valley relies on surface water stored in dams, polluted by urban expansion without sewerage, industrial liquid waste discharged directly into rivers and streams; landfills located on the banks of rivers and streams, agricultural activities using toxic chemicals, livestock activities that dump animal manure into adjacent streams and rivers; and acidic waters, laden with heavy metals from open pit mining operations on sulfurous mineral deposits, without proper government regulation.

The greatest exploitation of groundwater in the Dominican Republic is concentrated in the South, Southeast and Southwest regions, where there are extensive aquifers in recent coralline limestone, tertiary lithographic limestone and alluvial fans of coarse gravels and sands, with the largest underground exploitation being located in Santo Domingo (33% of daily supply), Boca Chica (100%), Punta Cana (100%), Bávaro (100%), San Pedro de Macorís and La Romana (partial delivery), especially the communities of Punta Cana and Bávaro that constitute the main tourist destination in the Caribbean region, where, due to the absence of surface water sources, hotels have been forced to resort to the widespread use of coastal aquifers of recent coralline limestone, and where at the same time, the overexploitation of groundwater has caused saltwater intrusion processes in Bávaro to advance 4 kilometers inland, and 15 kilometers inland in Boca Chica. Coupled with the pollution caused by the proliferation of filter wells that discharge residential and hotel wastewater into the aquifer, and landfills without protective waterproofing, this has seriously damaged groundwater throughout the area, endangering future supplies.

Table 1. Santo Domingo Aqueduct and Sewerage Corporation (CAASD). Monthly production of well fields in millions of gallons per month, 2009 (Source: Santo Domingo Water and Sewerage Corporation. CAASD)

Systems/Month	2009												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
LECHERIA	140.55	116.29	123.96	103.61	116.21	97.06	110.74	132.62	117.00	137.47	118.30	130.45	1444.26
SECTORAL	79.20	69.74	49.64	55.53	45.47	41.78	43.13	43.83	41.75	31.06	30.55	50.41	582.09
TOTAL NORTHWEST	219.75	186.03	173.60	159.14	161.68	138.84	153.87	1776.45	158.75	168.534	148.85	180.861	2026.36
CAFÉ WELL FIELD	41.27	37.96	42.57	37.56	41.31	38.12	32.38	35.50	35.22	37.44	38.66	38.91	456.90
LAS CAOABAS	116.80	125.85	137.12	108.55	115.36	129.14	133.04	59.07	0.00	0.00	0.00	0.00	924.93
SECTORAL SYSTEMS	186.64	173.45	177.45	157.38	163.49	166.54	162.53	164.87	155.28	160.84	140.67	158.83	1967.97
TOTAL NORTHWEST	344.71	337.26	357.14	303.49	320.16	333.8	327.95	259.44	190.50	198.28	179.33	197.74	3349.80
MATA-MAMON I AND II	151.22	110.63	175.35	203.95	197.80	180.03	168.60	164.30	143.34	167.33	145.15	120.16	1927.85
SABANA PERDIDA	181.71	167.82	171.17	162.32	177.31	185.96	187.19	181.96	138.81	131.63	170.83	169.55	2029.26
SECTORAL	340.18	290.05	338.57	308.33	501.07	518.27	499.09	481.26	429.22	484.28	412.38	532.50	5135.20
TOTAL NORTE	717.38	606.45	727.66	712.16	917.49	922.377	887.27	863.023	746.58	820.68	767.02	861.116	9549.21
LOS MAREÑOS	808.59	751.75	807.30	723.41	866.82	803.09	780.45	756.77	756.88	774.41	767.41	824.25	9421.13
EL NARANJO	192.13	152.41	156.78	166.57	192.67	166.89	182.15	147.98	137.08	151.43	145.88	176.09	1968.06
LA CATALINA	171.88	151.44	167.22	137.28	155.54	166.93	209.58	154.96	166.65	178.12	140.14	131.37	1931.11
LA JOYA	776.57	707.03	727.94	574.45	749.44	827.73	837.27	784.97	704.35	846.51	636.14	791.42	8763.82
LA CALETA	119.08	88.60	117.30	171.12	187.70	163.44	185.03	183.79	175.66	186.79	181.49	186.74	1946.71
BRUJUELA	600.19	542.82	594.76	569.15	597.36	570.86	586.55	562.47	504.44	505.70	480.63	512.69	6627.62
SECTORAL	16.88	13.60	15.59	13.74	12.42	19.59	17.50	16.13	18.74	15.20	19.64	19.12	198.15
TOTAL EAST	2685.32	2407.65	2586.89	2355.72	2762.95	2718.53	2798.53	2707.07	2463.80	2458.16	2371.33	2641.68	30856.63
TOTAL	3967.163	3537.392858	3845.292635	3530.51	4161.283	4113.547	4167.615	3905.983	3559.631	3645.654	3466.534	3881.397	45782.00219

Table 2. Santo Domingo Aqueduct and Sewerage Corporation (CAASD). Monthly production of well fields in millions of gallons per month, 2011 (Source: Santo Domingo Water and Sewerage Corporation. CAASD)

Systems/Month	2011												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
LECHERIA	98.060	76.950	90.480	80.610	83.220	107.280	116.900	113.460	108.310	122.630	121.400	109.800	1229.100
SECTORAL	33.768	28.289	28.314	12.873	15.244	14.880	10.084	13.319	18.896	27.108	26.046	29.896	260.717
TOTAL NORTHWEST	131.828	105.24	118.794	93.483	98.464	122.16	126.984	126.779	127.206	149.738	147.446	139.696	1489.817
CAFÉ WELL FIELD	131.828	105.24	118.794	93.483	98.464	122.15	126.984	126.779	127.206	149.738	147.446	139.696	1489.817
LAS CAOABAS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.000
SECTORAL SYSTEMS	182.140	165.290	184.260	166.790	174.210	176.430	175.053	163.780	139.980	181.800	172.874	161.197	2043.804
TOTAL SOUTHWEST	208.59	190.06	214.35	196.11	201.44	196.81	195.623	182.61	157	195.83	186.624	178.217	2303.263
MATA-MAMON I AND II	39.712	42.725	55.670	65.647	65.585	67.040	66.183	58.408	49.210	35.630	33.711	40.737	620.258
SABANA PERDIDA	173.929	159.965	182.252	167.156	146.635	143.132	133.524	133.138	125.093	147.088	148.672	152.127	1812.613
SABANA PERDIDA	64.578	60.876	68.223	59.843	34.104	38.664	32.290	30.690	29.111	35.395	34.770	38.798	527.342
SAN FELIPE	38.471	30.555	31.193	28.466	22.504	27.302	16.750	13.012	20.637	16.958	12.953	7.335	266.736
SECTORIALES	441.481	365.330	414.922	402.810	401.634	429.286	428.381	407.857	399.706	453.146	403.303	414.502	4962.358
TOTAL NORTE	717.38	606.45	727.66	712.16	917.49	922.377	887.27	863.023	746.58	820.68	767.02	861.116	7800.24
LOS MAREÑOS	485.230	482.420	571.300	619.050	508.180	476.070	494.680	476.460	458.360	219.910	285.100	281.090	5458.850
EL NARANJO	155.090	143.340	148.240	149.880	126.590	108.520	122.920	121.220	67.370	96.220	120.940	123.940	1484.170
LA CATALINA	134.990	135.460	161.480	164.480	153.300	172.300	212.780	146.590	138.820	174.620	166.540	179.680	1941.040
LA JOYA	541.370	581.640	710.880	598.590	525.750	567.420	499.300	450.560	564.860	512.900	420.230	351.470	6324.970
LA CALETA	151.160	170.750	183.880	169.930	169.650	135.690	158.040	98.160	85.510	172.740	173.150	176.140	1844.800
BRUJUELA	430.820	393.880	380.660	361.730	350.900	335.480	432.470	410.283	412.410	417.120	452.650	475.710	4853.413
SECTORAL	35.380	31.970	32.250	32.640	35.110	34.370	33.450	40.140	26.010	23.000	29.160	29.490	183.070
TOTAL EAST	2685.32	2407.65	2586.89	2355.72	2762.95	2718.53	2798.53	2707.07	2463.80	2458.16	2371.33	2641.68	22290.313
TOTAL	3967.163	3537.392858	3845.292635	3530.51	4161.283	4113.547	4167.615	3905.983	3559.631	3645.654	3466.534	3881.397	33946.97

Table 3. Santo Domingo Aqueduct and Sewerage Corporation (CAASD). Monthly production of well fields in millions of gallons per month, 2013 (Source: Santo Domingo Water and Sewerage Corporation. CAASD)

Systems/Month													2013
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
LECHERIA	105.410	98.60	123.810	112.019	108.800	108.160	108.800	104.010	95.270	70.510	88.870	130.030	1255.289
SECTORAL	26.480	28.340	30.856	17.156	29.880	20.270	15.372	17.352	23.642	20.848	26.560	21.004	277.529
TOTAL NORTHWEST	131.89	126.94	154.666	130.175	138.68	128.43	124.172	121.362	118.911	91.358	115.43	151.034	1533.048
CAFÉ WELL FIELD	35.630	31.910	35.000	31.680	35.160	34.890	35.440	34.150	30.660	29.730	20.020	35.130	398.400
LAS CAOBAS													
SECTORAL SYSTEMS	227.250	198.180	205.780	158.980	165.820	169.180	173.240	178.000	175.320	176.140	175.260	174.020	2176.170
TOTAL SOUTHWEST	262.88	230.09	240.78	190.66	200.98	203.07	280.68	212.25	205.98	205.87	204.28	209.15	2574.57
MATA-MAMON I	20.911	20.450	19.730	15.375	14.157	10.841	19.956	11.179	8.332	25.270	27.909	28.771	222.914
MATA-MAMON II	141.462	149.193	157.223	140.023	139.006	141.332	134.542	132.960	137.351	146.479	139.609	115.035	1674.215
SABANA PERDIDA	39.846	35.624	39.058	36.176	36.725	34.804	35.552	30.308	28.348	38.443	57.810	58.716	471.410
SAN FELIPE	26.774	24.019	26.077	22.675	25.868	23.702	21.940	25.114	16.735	22.435	19.003	20.407	274.779
SECTORAL	350.155	339.061	353.536	331.031	363.769	336.403	339.212	331.284	300.549	340.383	328.627	382.665	4096.675
TOTAL NORTH	644.925	596.88	624.451	548.862	592.1819	563.089	569.944	564.736	520.952	577.401	580.7	635.808	7019.0339
LOS MAREÑOS	532.410	395.410	532.480	440.330	427.420	313.280	378.380	377.110	398.920	427.950	319.420	254.920	4797.930
EL NARANJO	112.420	88.200	111.090	68.430	65.080	61.540	61.850	63.470	65.310	51.360	45.030	74.210	867.990
LA CATALINA	123.580	114.980	128.390	117.490	124.390	94.410	70.250	67.780	208.880	200.870	208.030	228.830	1687.880
LA JOYA	112.420	461.510	483.800	497.140	470.130	412.700	409.170	417.100	550.610	506.590	506.080	421.470	5604.480
LA CALETA	186.200	122.400	143.630	176.050	189.930	164.370	181.370	181.370	176.530	144.040	162.270	185.140	2013.300
BRUJUELA	364.690	331.780	332.090	325.460	294.930	248.140	267.120	268.340	313.050	295.040	260.500	318.430	3619.570
SECTORAL	31.950	31.250	34.650	31.310	32.910	30.940	30.171	30.140	33.910	32.280	31.860	33.935	385.306
TOTAL EAST	1819.4	1545.53	1766.13	1656.21	1604.79	1325.38	1398.311	1405.31	1747.14	1658.13	1533.19	1516.935	18076.456
TOTAL	2831.137	2489.787	27584	2504.075	2501.7979	2197.981	2276.037	2281.006	2580.763	2558.15	2428.759	2441.798	29845.8749

Table 4. Amount of water flowing daily into the city of Santo Domingo

Water supply sources for the aqueduct in the city of Santo Domingo can be divided into three groups:

1. Surface sources Isa, Mana, Duey, Guanaitos, Haina, Isabela, Barrera Salinidad: 142 million gallons/day= 35%.
2. CAASD Wells: 138 million gallons/day= 33%.
3. Valdesia Dam: 130 million gallons/day= 32%.

Source: CAASD

The following tables show the flows produced by the well fields built on the Eastern Coastal Plain, which supply the city of Santo Domingo.

2.1 Impacts of Urbanization on the Quantity and Quality of Water in the Dominican Republic

Urban growth in the Dominican Republic has severely impacted the quantity and quality of water available in major urban centers, to the extent that since the 1970s it was necessary to begin an extensive program for constructing dams, which now total approximately 34 and store about 2,500 million cubic meters of water, often a long way from

urban centers, where residential and industrial pollution is much lower than in urban areas. These dams supply water, since the direct intake from major urban areas near rivers was insufficient for the growing demand, especially during long periods of drought. This situation is exacerbated by the high levels of urban pollution due to the lack of sewerage, residential and industrial wastewater treatment plants, landfills to properly dispose of solid waste, and public policies to protect water sources, since although the waters are protected by environmental legislation 64-00, this protection is not enforced.

2.2 Main Sources of Water Pollution in Santo Domingo

Thousands of filter wells constructed illegally in the city of Santo Domingo to discharge the waste from residential toilets due to the lack of a proper sewerage system for the entire city; the thousands of poor people without basic services who live on the banks of the Ozama, Isabela and Haina rivers and the streams that are tributaries of these rivers; the thousands of industries that lack treatment plants for their effluents, and waste dumps on permeable materials are the main sources of pollution of surface and groundwater in Santo Domingo, which is not being effectively addressed by the authorities.

2.3 Overexploitation of Water in the Dominican Republic

The main case of over-exploitation of water in the Dominican Republic involves groundwater from the city of Santo Domingo, where 33% of the daily supply is obtained from groundwater sources; and the tourist resort of Boca Chica, where 100% of the water is groundwater, drawn mainly from the Brujuelas-Casuí well fields; and Punta Cana and Bávaro, the main tourist destination in the Caribbean region, where 100% of the water supplied to the hotel business is groundwater, due to the absence of surface water sources, a regional aqueduct or dams, all of which means that hotels have had to resort to the widespread use of coastal aquifers in recent coralline limestone, leading to an extraordinary overexploitation of the aquifer, which has already produced various processes of saline intrusion, which in Bávaro has advanced four kilometers inland, and 15 kilometers in Boca Chica, partially damaging this important porous coastal aquifer, despite which the authorities have yet to decide to build a regional aqueduct, supported by dams built on major rivers in the east area.

2.4 Water Sources and the Distribution of the Urban Population

Since the time of colonization, from 1492 onwards, the major urban population centers in the Dominican Republic have developed on the banks

of major rivers or nearby, in an attempt to be near drinking water sources. As urban areas have grown and urban water networks have extended laterally, many urban sectors have moved further away from rivers. It is now no longer as necessary to live near rivers as it was in the past, especially since many people have become aware of the dangers and risks involved. Since this is a tropical country, during periods of intense rains, storms and hurricanes, rivers may overflow and produce social disasters such as those experienced during Hurricane David and Storm Frederick in September 1979, Hurricane Georges in September 1998, the Jimaní Storm in May 2004, Storm Noel in October 2007 and Subtropical Storm Olga, in December 2007.

Nowadays, the Dominican middle and upper classes no longer need to live near rivers and streams to obtain access to safe drinking water, because dams and aqueducts are responsible for capturing and transporting water from tens of kilometers away. However, in marginalized human settlements, lack of economic resources forces very poor people to settle on the banks of rivers and streams in order to be able to gain access to water, even though it is not potable, which constitutes a social problem that the state should help resolve by relocating these people to other areas where they can have better living conditions.

2.5 Water Pollution in Informal Periurban Settlements

The most severe problems of urban water pollution and the resulting waterborne diseases affect informal settlements, which for decades have developed on the banks of the Ozama river, the Guajimía, Bonavides and Diablo ravines, and nearly 80 other ravines, mostly concentrated in the north and west parts of the city of Santo Domingo, where diseases such as cholera, gastroenteritis, amoebiasis, and frequent diarrhea have affected dozens of residents living on the periphery.

This situation occurs throughout the country, where extremely poor people settle on the banks of rivers, streams, and ravines, without having the basic services required to ensure their health.

Photo 3. View of marginalized housing on the banks of the mighty river Ozama in Santo Domingo, which has become a permanent source of organic bacterial contamination and large amounts of refuse. Photo Osiris de León

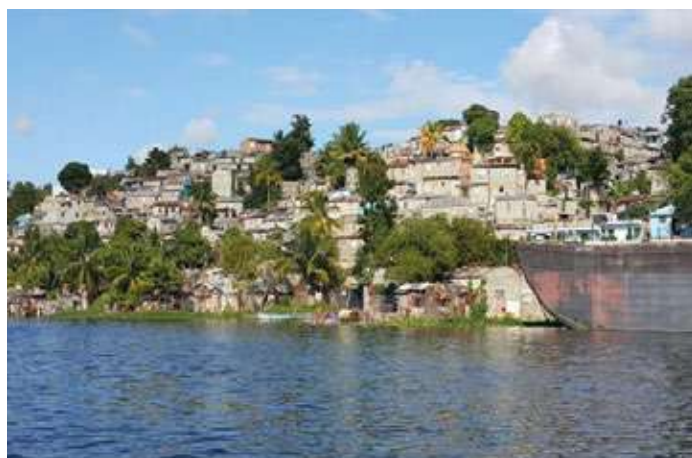


3. Water Supply in the Urban Areas of the Dominican Republic

In the Dominican Republic, according to data published by the Demographic and Health Survey (DHS) and the United Nations Development Program (UNDP), 92% of the urban population have access to water indoors or very near their homes (improved water sources). However, according to the Ministry of Public Health of the Dominican Republic, the actual percentage is lower and stands at 87%.

However, the quality and potability of water entering homes through pipes means that it is not completely safe to drink, because while it is true that water treatment plants for human consumption are generally handled correctly, in actual fact, water is often contaminated in the distribution pipes, meaning that people trust bottled drinking water more than tap water, since nowadays very few people in the Dominican Republic drink water from the tap.

Photo 4. View of extraordinary spread of housing on the banks of the Ozama River in Santo Domingo. Photo Osiris de León



According to the Social Policy report (2010) prepared by the United Nations Development Programme (UNDP), by 2015, the total number of urban households with improved water services is expected to be 92%, although the Millennium

Development Goal (MDGs) for 2015 is for 98.5% of the urban population to have access to water indoors or very close to their homes, and fewer than 2% of the urban population to lack water services indoors or very close to their homes, a goal that apparently will not be achieved, as the population has grown more quickly than the potable water supply.

The Table 5 shows the percentages of Dominican households with access to piped water inside or outside their dwelling.

The Table 6 shows the percentages of Dominican households without access to piped water inside or outside their dwelling, the aim being to reduce the latter.

On the basis of the statistical data produced by ENDESA and ENHOGAR, over the past 20 years, the percentage of households consuming bottled water rose from a mere 8.8% in 1991 to 64.3% in 2011, mainly in urban zones. This is due to the fact that many people distrust the quality and potability of wastewater supplied through the pipes in urban aqueducts. Since these pipelines do not operate continuously 24 hours a day, they often receive external contamination through damaged joints, major breakages, faulty connections, or adjacent sewer pipes.

Fifty per cent of the Dominican urban population receive water through networks built

Table 5. Percentages of Dominican households with access to piped water inside or outside their dwelling

Zone	1996	2002	2007
Urban	97.0	90.7	91.9
Rural	56.0	63.8	73.3
Total	81.2	81.1	86.2

Sources: ENDESA surveys for 1996, 2002 and 2007 surveys, and UNDP 2010

Table 6. Percentages of Dominican households without access to piped water inside or outside their dwelling

Zone	Households without access in %					Growth effort	
	1996	2002	2007	2015		By trend	Necessary
				Expected by trend	Goal		
Urban	3	9.3	8.1	8.6	1.5	-0.72%	-19.00%
Rural	44	36.2	26.7	18.6	22	-4.40%	-2.40%
Total	18	18.9	13.8	11	9.4	-2.80%	-4.70%

Sources: ENDESA surveys for 1996, 2002 and 2007 surveys, and UNDP 2010

Table 7. Percentage distribution of drinking water sources in Dominican households

Source of supply	ENDESA 1991	ENDESA 1991	ENDESA 1991	ENHOGAR 2011
Indoor pipes	20.4	9.1	9.4	4.3
Outdoor pipes/in another dwelling or public tap	46.2	19.3	13.0	9.6
Well	3.6	2.5	2.0	1.5
Spring, river or stream	9.7	2.8	1.8	2.7
Rainwater	9.0	9.0	6.7	6.5
Tanker truck	1.1	2.0	0.6	1.7
Bottled water	8.8	55.0	55.7	64.3
Small truck	-	-	10.6	8.2
Other source	1.1	0.2	0.3	1.0
Doesn't know	-	0.1	-	0.0

ENDESA Surveys 1996, 2002 and 2007, ENHOGAR Survey 2011 and UNDP 2010

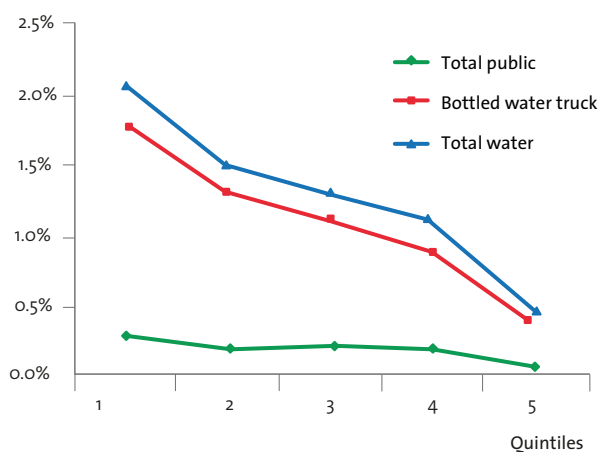
by the National Institute of Water and Sewerage (INAPA). This does not, however, include major cities such as Santo Domingo, a city that is home to 35% of the Dominican population, whose water services are provided by the Santo Domingo Aqueduct and Sewerage Corporation (CAASD), and includes Santiago, a city that comprises 8% of the Dominican population, whose water services are provided by the Santiago Aqueduct and Sewerage Corporation, while the remaining 7% is served by local water corporations.

This situation means that many middle-class households must assign between 2% and 3% of their income to purchasing bottled water, as the only means of drinking water, although bacteriological studies have often shown that many of the bottled waters sold in the Dominican Republic are contaminated with different types of bacteria, mostly fecal coliform bacteria due to the lack of permanent supervision of companies that sell bottled water.

3.1 The institutions that supply drinking water in the Dominican Republic

The National Institute of Drinking Water and Sewerage is the official institution responsible for supplying drinking water to most of the Dominican Republic (84.40%), followed by the Aqueduct and Sewerage Corporations that have local competences such as the Santo Domingo Aqueduct and Sewerage Corporation (CAASD), a public institution supplying drinking water to the 3.5 million inhabitants of the city of Santo Domingo, and the Santiago Aqueduct and Sewerage Corporation (CORAASAN), which provides the water

Figure 1. Monthly expenditure on water of Dominican households as a percentage of total income



Source: United Nations Development Program Office (UNDP 2010)

consumed by the nearly 700,000 inhabitants of the city of Santiago de los Caballeros, the second largest in the country, although in terms of geographic area, CORAASAN covers a larger area than CAASD albeit with a smaller population.

To meet the objectives of providing safe drinking water to the Dominicans, the National Institute of Drinking Water and Sewerage receives 74.08% of the budget assigned for the drinking water and sanitation sector, CAASD receives 21.07%, CORAASAN receives 3.88%, while the remaining local water and sanitation corporations receive less than 1% of that budget. These financial resources should be distributed more efficiently to match the actual scope of each institution.

Table 8. Percentage of Dominican territory covered by institutions that supply water and amount of aqueducts

Institution	Operational Jurisdiction Area		Number of Aqueducts
	Km ²	%	
National Institute of Drinking Water and Sewerage (INAPA)	41,083.90	84.40%	448
Santo Domingo Aqueduct and Sewerage Corporation (CAASD)	1,400.80	2.90%	15
Santiago Water and Sewerage Corporation (CORAASAN)	2,836.50	5.80%	4
Moca Water and Sewerage Corporation (CORAAOCA)	838.6	1.70%	6
Puerto Plata Water and Sewerage Corporation (CORAAPLATA)	1,856.90	3.80%	32
La Romana Water and Sewerage Corporation (CORAROM)	654	1.30%	8
Total	48,670.60	100%	513

Source: United Nations Development Programme Human Development Office (UNDP 2010) based on data supplied by the National Institute of Hydraulic Resources (INDRHI).

Table 9. Percentage of the Dominican population covered by institutions that supply water

Firm	Urban Area		Rural Zone		Totales		
	Male	Female	Male	Female	Male	Female	Total
CAASO	93%	94%	72%	73%	89%	89%	89%
CORAAMOCA	90%	92%	66%	67%	75%	77%	76%
CORAPP	91%	92%	62%	64%	76%	78%	77%
COAAROM	83%	83%	76%	75%	82%	83%	82%
CORAASAN	97%	97%	0%	0%	97%	97%	97%
INAPA	82%	83%	58%	60%	70%	72%	71%
Total	88%	89%	61%	63%	78%	80%	79%

Source: United Nations Development Programme Office (UNDP 2010)

3.2 Water Availability in the Dominican Republic

Although in general terms, except during the years of long droughts, Dominicans have sufficient volumes of water, the water supply map drawn up by the National Institute of Water Resources (INDRHI), although valid, fails to reflect the reality of water availability in the country, since the map was drawn on the basis of water availability per capita, and the areas of greatest total water availability, such as the city of Santo Domingo and the Cibao Valley, where the Ozama-Nizao, Yuna and Yaque irrigation zones are located, are the most heavily populated, while the areas with the lowest water availability, such as the Yaque del Sur irrigation zone, are the least populated.

The population is obviously more heavily concentrated in regions where there is greater water availability to meet their needs, including both urban and rural communities, since cities in central and east Cibao Valley, where there is greater water availability, have grown much more than cities in the West Cibao Valley cities and Neiba Valley, where water is scarce.

Given the challenges of climate change, it is essential for the Dominican Republic to continue constructing dams for water storage during periods of intense rainfall due to heavy rains, storms and hurricanes, which are typical of the Caribbean tropical summer, and for all that water to be available in times of drought, since in recent years, very few public funds have been invested in the construction of dams for water storage, while virtually nothing has been invested in the maintenance of the watersheds feeding the dams

or dredging to remove the sediment accumulated in the dam reservoirs. The demand for drinking and irrigation water is growing rapidly and these challenges must be addressed through appropriate public policies defined by experts in the field, leaving nothing to improvisation or chance.

3.3 The Enormous Wastage of Water in the Dominican Republic

For decades it has been pointed out that in the Dominican Republic, about 60% of the water in primary networks is lost due to the obsolescence of the distribution system, malfunctions and the

INAPA: 60% of water lost through faults and citizens' misuse

El Día, July 31, 2014

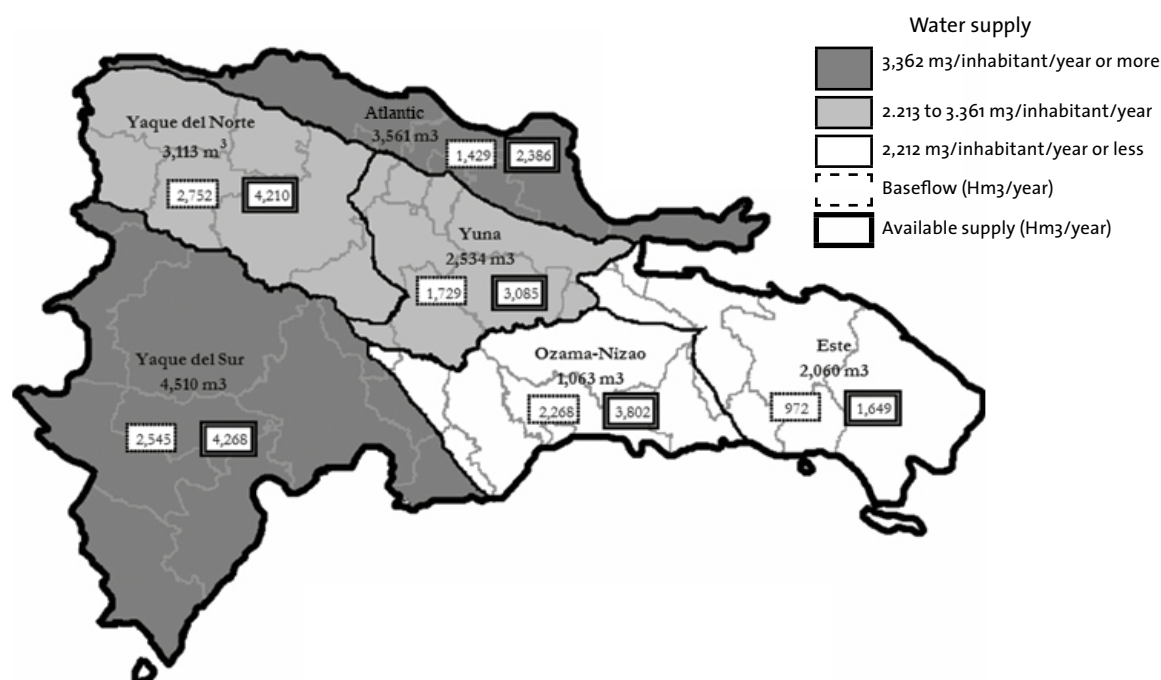
Throughout the country, it is estimated that nearly 60% of the water produced is lost due to faults and citizens' misuse, according to the National Drinking Water and Sewerage Institute (INAP).

Director of the institution Alberto Holguín said that of the 56 treatment plants existing in the country, 14 are in operation, while approximately 20 are under repair.

"We currently have an investment of \$150 million USD, with a program in which the government has already provided an advance payment of six billion pesos for sewerage in San Fernando, Villa Vásquez de Montecristi, San Cristobal, Azua and Neiba," he said.

He declared that 45% of the institution's investments are currently assigned for sewerage, whereas in 2012 only five percent were invested and in his view, attention should be paid to this aspect, while political and social leaders should be asked to allocate more resources to this issue.

Figure 1. Water supply in the Dominican Republic, according to the six different regions defined by the National Institute of Water Resources INDRHI



Source: PNUD, 2010.

inhabitants wasteful use of water in their homes, because since water costs very little, just \$ 0.14/cubic meter, and many do not pay, people waste it and place very little value on it. It is therefore necessary to launch a mass media education program for the population on proper water use, but also to establish a sliding scale of rates, whereby high consumption above the norm (250 liters per person per day) is penalized through extremely high rates.

3.4 Drought, Waste and Current Water Crisis in Santo Domingo

Not since the mid-90s had the cities of Santo Domingo and Santiago suffered a crisis as severe as the one in 2014, the result of a long drought that reduced water reserves in the Valdesia and Tavera Dams.

As a result of the severe drought in 2014, Director of the Santo Domingo Aqueduct and Sewerage Corporation (CAASD) Alejandro Montas said that the capital city was receiving 100 million gallons of water less than the normal rate of approximately 408 million gallons of water per day to supply about 3.5 million inhabitants of the capital. This shows

that greater Santo Domingo was receiving 25% less water, in addition to the 60% of water wasted due to the obsolete networks and damaged pipelines. Meanwhile, the population in the Capital continues to expand and demand more water, and given that the public is given insufficient education and guidance about the correct use of water, frequent crises in the water supply of large urban centers can be expected.

The severe drought of 2014 forced the government institutions administering the waters for human consumption and irrigation to change the administration of the water stored in the Valdesia Dam, from which six cubic meters per second must flow into the Santo Domingo Aqueduct and 12 cubic meters per second into the Marcos A. Cabral Aqueduct. Since the Valdesia Dam is now about 23 feet below its crown, the authorities have had to ration water for the Marcos A. Cabral canal and prioritize water for human consumption in the Santo Domingo aqueduct.

A similar situation occurred in the city of Santiago de los Caballeros, where the water supply was reduced by 30%, since for much of 2014, the

level of the two reservoirs in the Tavera and Bao dams, linked by a canal, was 18 meters below its crown, and eight meters below its critical level, significantly affecting everyday life in the country's second largest city.

Drought-driven Water Crisis Affects approximately 100 Inapa Aqueducts

Hoy, July 3, 2014

Approximately 100 (28%) of the 315 water drinking water systems administered by the National Institute of Water and Sewers (Inapa) in 29 of 32 provinces have been affected by the severe drought prevailing in the country in recent months.

A general report on the situation, provided by Inapa Director of Operations Nicolás Garrido Almonte says that there are aqueducts that are only serving 50% of the water delivered under normal circumstances.

Meanwhile, the National Water Observatory, which leads the National Institute of Water Resources (Indrhi) admits that farmers in the southern region have been affected by the rationalization of the water supply to this area three days after the drought affecting the Valdesia and Jigüey dams.

Critical Levels in Reservoirs Feeding the Gran Santo Domingo

Diario Libre, July 24, 2014

With the Jigüey Dam and the Valdesia Dam system, the two systems that contribute most to the Gran Santo Domingo water supply, with just 3% and 11% of their useful water supply capacity respectively, Director of the National Institute of Water Resources (Indrhi) Olgo Fernández, commended himself to God and the predicted rain for the weekend, hoping that the water crisis affecting the country would improve over the next few days.

"All we can do is ask God for rain," said Fernández, who explained that in the rest of the country, reservoir levels are at 34.84%. However, he emphasized the status of the systems serving Santo Domingo, San Cristóbal and Baní.

The national situation is "manageable" and irrigation and power generation activities can continue, together with human consumption, said Fernández, although concern over the intakes previously mentioned persists.

Director of the Santo Domingo Water and Sewerage Corporation of (CAASD), Alejandro Montas described current levels as "critical" and announced that if the crisis worsens, a strict water distribution plan has been prepared.

This worrying situation requires urgent government strategies to capture every drop of rain that falls on the country; together with the proper administration of all available flows in dams, irrigation canals and aqueducts networks; the reduction and subsequent elimination of all sources of contamination of surface and groundwater,

the optimization and proper use of urban water, the elimination of water leaks in networks and households, and payment of fair prices for water services for aqueducts and irrigation channels, because here we all believe that water should be free forever, despite the fact that it is the most important natural resource for life, and since water is free, no-one values it, since users do not value what is free.

INDRHI reports that, "all the country's Reservoirs are in a critical condition"

Diario Libre, July 31, 2014

All the country's reservoir systems are in critical condition," warned the National Institute of Water Resources (INDRHI), an organization that leads the Water Observatory, which evaluates the disposal of the country's liquid on a weekly basis, together with the short- and medium-term perspectives.

Olgo Fernández, the director of the institution, said that although the reservoirs that feed the provinces of Peravia, San Cristobal, Santo Domingo and the National District are in the most critical condition, "The country's other basins are also in a critical condition. They are at the red stage."

Fernández noted that, "When a basin is at the red stage, it is because it is below its normal level. Once this happens, it must be observed and operated on a schedule, as is done in the observatory." He said the Taveras reservoirs and Lower Angostura, "Must have their operating levels rescheduled, because they have fallen. Sabana Yegua's has too. And so has Sabaneta's, proving that the country is still affected by the stationary drought that hit us in recent months."

He explained that this problem will not be solved, "Until it rains heavily, and the basins are filled with water and the soils are saturated, so that the rain can drain the dams. That is what we are hoping will happen in the next few days."

3.5 Rationing and the Higher Cost of Scarce Water

Society must understand that water is a vital natural resource, but a finite one, which is valued in an inverse proportion to its abundance, since those with very little water value it highly and waste very little, while those with plenty of water undervalue it and waste a great deal.

It should also be made quite clear that a major challenge of today's society is to address the imbalance between geometric population growth and the linear reduction of river flows. This imbalance is exacerbated when population growth does not go hand in hand with sanitation, and instead of building

proper sewage systems, what we do is discharge our domestic and industrial wastewater into urban ravines, streams and rivers wastewater, polluting the already diminished flow of our streams and making people sick.

People drink a great deal of water, but most people do not know where water comes from, let alone how much it costs to capture, purify and bring it to homes. They are not interested in knowing, because for many people these data are not important. This ignorance explains why people place very little value on the water in their homes, and simply say that the government is required to supply drinking water through networks that reach our homes, and that if the government fails to do so, then we will organize strikes, call the press, and exert pressure until we are provided with water, which will solve the problem.

Governments should consider the possibility of providing the first 150 liters of water free for every citizen, approximately 750 liters for the average household, after which any additional volume of water consumed should be charged at very high rates, as a means of forcing water use to be rationed and of reducing losses due to careless use. Sooner or later, this measure will be compulsory.

To give one example of curbing excess water use and wastage, the Municipal Water Department in Santa Cruz, California, decided that as of May 2014, water supplies should be rationed, giving each household a ceiling of 28,317 cubic meters of water per month, equivalent to 943 liters of water a day. Those who exceed this level must pay up to four times the monthly bill of about \$40 for permitted consumption levels.

3.6 Conflicts Over the Use of Scarce Water

In the Dominican Republic, there is an increasing gap between water demand and availability, and although it is true that since 1995 the Dominican Republic had not suffered such a severe drought as the one it experienced from December 2013 until winter 2014, it is also true that the sedimentation of most of the dams has reduced their water storage capacity, which, added to the lack of investment in the construction of new dams, and the large leaks in the aqueduct networks and the wastage in homes and irrigation canals, led the country to suffer one of the worst droughts in all history, which found almost all the population ill-prepared for dealing

with the situation, severely affecting major sectors of producers of food for local consumption and export. This affected the country's economy and the quality of life of many people, and today certain communities, including the province of Peravia, take to the streets demanding better water management, so as not to be affected again, which has turned into a conflict over water use.

Another example of conflicts over water used occurred in the community of Sabana Iglesia, adjacent to the Bao Dam, where a crowd of 300 people seized the operating station of the water supply system linking the Tavera and Bao dams to the Santiago and Moca aqueducts. Under normal conditions, this system provides approximately 125 million gallons per day to Santiago and about 25 million gallons per day to Moca, but nothing to Sabana Iglesia or Baitoa, the communities closest to both dams.

The crowd gathered there shut off the water flow to Santiago and Moca, claiming that if they, who are owners of those two dams, have no water, then Santiago and Moca cannot have water either, which is a serious sign of conflicts over water, which are likely to increase unless water management improves.

The newspaper clipping taken from the *El Caribe* newspaper, dated July 30, 2014, clearly shows one example of conflicts over water use in the Dominican Republic.

Crowd turns off valve, leaving Moca and Santiago without Water

El Caribe. July 30, 2014

A crowd demanding drinking water service for the town of Sabana Iglesia turned off the valve on the intake at the Tavera dam, depriving the Moca and Santiago communities of water.

Approximately 300 residents from Sabana Iglesia went to the intake, tied up the operator, and shut off the valve controlling the water supply to Santiago and Moca.

The Moca Aqueduct and Sewerage Corporation (Coramoca) reported that the city only receives 100 liters of water per second.

The water crisis in communities that receive very little water and on an intermittent basis was exacerbated, since most of them did not have time to stock up.

They suggest that the water supply should be administered by the Santiago Aqueduct and Sewerage Corporation (Coraasan) rather than Inapa, which is currently responsible.

3.7 Basic Sanitation and Urban Water Pollution in Santo Domingo

Santo Domingo, the capital, with a population of nearly 3.5 million people, concentrated in about 300 square kilometers, has grown rapidly as a result of migration from the countryside to the city. This growth has not been accompanied by the provision of basic sewerage, since the city is built on a terrace system of highly porous coralline limestone, which are the main aquifer in the country. They receive an annual net recharge of approximately 1,100 million cubic meters of rainwater, but in the absence of adequate sewerage, all new buildings, apartment blocks, industries, schools and hospitals, dispose of their sewage through vertical filter wells that discharge directly into the same groundwater we later extract through adjacent wells to supplement the precarious and intermittent water service. Our tanks therefore combine the drinking water supplied through pipes with the water we extract from the contaminated subsoil, and despite knowing that this groundwater is full of fecal coliform, we are forced to brush our teeth and bathe in the same water we previously discharged

through our toilets, which would be unacceptable in an organized society, committed to health and basic sanitation.

Just 5% of the population in the Dominican capital have proper sewerage. There is an urgent need for the Dominican government to make the necessary investment in modern sewerage for buildings that have already been constructed, which may involve an investment of approximately two billion USD. It also requires the establishment and implementation of strict legislation obliging the developers of new housing projects to provide their own sewerage and wastewater treatment plants, all of which must be strictly controlled by the Ministry of the Environment and the Ministry of Public Health as a means of solving the problem within a period of not more than 12 years, equivalent to three periods of government.

The newspaper clipping taken from the *La Información* newspaper, dated December 4, 2012, shows that the highest authority of the Santo Domingo Aqueduct and Sewerage Corporation (CAASD) admits that over 3 million people in Santo Domingo have a dysfunctional sewage service, and that only 5% of that population have sewerage.

CAASD presents Master Sewage Plan for Santo Domingo and its Province

La Información. December 4, 2012

Over three million inhabitants of Greater Santo Domingo have wastewater treatment service that does not function properly, according to a study presented by the Santo Domingo Aqueduct and Sewerage Corporation (CAASD).

During his presentation of the "Master Sewerage Plan for Santo Domingo and its Province" research project, Alejandro Montás reported that only five percent of that population has sewerage system coverage.

The CAASD director said that the study was conducted by the consulting firm Hazen and Sawyer, with funding from the Inter-American Development Bank (IDB).

The results showed that 95 percent of the population discharges its waste into the subsoil through filter wells, and through ravines and rivers that reach the Caribbean.

Montás stressed the importance of the study, adding that it is the first step that will allow the government to have a tool with viable solutions to facilitate decision-making to build a new sewerage and storm drain system.

He said that the Master Plan will allow Greater Santo Domingo to be cleaned up and help decontaminate the Ozama, Isabela and Haina rivers and the south shore on the Caribbean Sea.

4. Improved Sanitation Coverage and Millennium Development Goals

Improved sanitation, meaning the availability of a private toilet or latrine adjacent to the household, has grown significantly in the Dominican Republic from 69.8% urban coverage in 1996, to 84.5% urban coverage in 2007. By 2015, 91.5% of the urban population is expected to have improved sanitation.

The Tables 10 and 11 show that in 1996, 64.2% of the total Dominican population had improved sanitation coverage, which had risen to 80.3% by 2007.

These favorable results indicate that significant progress has been made in improved basic sanitation, since almost all people with some schooling realize the importance of having a suitable place to properly dispose of personal and household organic waste.

4.1 Although the Problem is global, Each Country Must Find its Own Solutions

The World Health Organization (WHO), through its Department of Public Health and Environment, presented its latest global statistics on progress in access to drinking water and basic sanitation, stating that nearly 2.5 billion people worldwide lack access to basic sanitation facilities, indicating that a third of the world population has serious problems with the final disposal of its contaminating excreta, the main cause of surface and groundwater pollution worldwide.

The total lack of basic sanitation services is directly related to the spread of diseases such as cholera, diarrhea, dysentery, hepatitis A and typhoid, whose treatment costs and indirect costs due to absenteeism far outweigh the cost of installing sewerage, which is why each of the countries affected by this problem must make the necessary investment to ensure that the entire population is gradually provided with basic sanitation services.

In this order of ideas, the WHO admits that Ecuador, Honduras and Paraguay have made significant investments to improve public access to sanitation facilities, whereby they have achieved 25% more coverage since the early 1990s. However, Bolivia and Haiti are still the countries in Latin America and the Caribbean with the lowest rates of access to health care systems, meaning that international organizations must prioritize investments and

loans to expand sanitation coverage, and that national and local governments must do the same, to eliminate the bad practice of defecation in the open air. In the book of Deuteronomy 23:13, the fifth book of the Old Testament, written some 3,500 years ago, it clearly states that, "You shall have a stick with your weapons and when you sit down outside, you shall dig a hole with it, and turn back and cover up your excrement," indicating that for more than three millennia, people have known that excreta left outdoors pollute the environment.

The WHO states that Latin America and the Caribbean have the highest rate of potable water in developing regions, achieving 94% coverage of water services. Nevertheless, there are a total of 748 million people worldwide without access to safe water, in other words, 10% of the world population lack water services, and it should be a priority for rich countries to help poor countries to concentrate investments in projects that increase potable water services.

In terms of access to basic sanitation and drinking water for human consumption, the WHO states that the most notable progress in Latin American since 1990 corresponds to Paraguay with 33% and 35% respectively; Honduras with 30% and 26%; Guatemala with 28% and 29%; Mexico with 21% and 19%; Colombia with 18% and 16%; Chile with 18%

Table 10. Percentage of Dominican households with access to improved sanitation inside or outside the dwelling

Zone	1996	2002	2007
Urban	69.8	78.2	84.5
Rural	53.3	68.9	70.8
Total	64.2	74.9	80.3

According to the ENDESA 1996, 2002 and 2007 surveys and UNDP 2010

Table 11. Millennium Development Goals for 2015 in terms of improved sanitation, and expected results as a percentage of the population without access to improved sanitation

Zone	Households without access in %					Growth effort	
	1996	2002	2007	2015		By trend	Necessary
				Expected by trend	Goal		
Urban	30.2	21.8	15.51	9.5	15.1	-5.88%	-0.33%
Rural	44.7	31.1	29.2	21.4	22.3	-3.80%	-31.10%
Total	35.8	25.1	19.7	12.7	17.9	5.29%	-1.19%

Sources: ENDESA Surveys 1996, 2002 and 2007 and UNDP 2010.

and 15% respectively, while the Dominican Republic improved by just 17% and 9%, respectively, making it the country that achieved the least in this group.

The WHO report shows that over the past 22 years, a third of the world population (2.3 billion people) gained access to clean water suitable for human consumption, while two billion people achieved basic sanitation, reflecting substantial progress, which although insufficient, demonstrates a commitment to finding solutions to these two major social problems.

In terms of drinking water, in the early 1990s, 95% of urban residents had access to the supply of this basic service, whereas only 62% of rural residents had water service. However, 22 years later, these percentages had risen to 96% in urban areas and 82% in rural areas, showing that rural areas have achieved greater progress than urban areas, although urban areas still have more net coverage.

5. Climate Change and its Potential Effects on the Dominican Republic

Since the Dominican Republic is a tropical island territory, it usually benefits from the meteorological phenomena that occur in the period between May and December of each year, mainly heavy rains, tropical waves, tropical depressions, tropical storms and hurricanes, which contribute heavy rains that increase the flow of rivers and streams that supply dams, irrigation canals and aqueducts. However, the obvious effects of climate change, which have significantly reduced the amount of water vapor in the Atlantic Ocean, have reduced the meteorological phenomena that pass very close to the Dominican Republic in an east-west direction, which has dramatically reduced

rainfall, causing severe droughts that affect dams, aqueducts, irrigation canals, agriculture, livestock and the Dominican economy in general.

In 2014, very few meteorological phenomena occurred in the Atlantic Ocean, and the few that did had very little hydrological importance for the Dominican Republic, making 2014 one of the driest years the country has seen in recent decades.

In order to mitigate these potential impacts on the Dominican economy, it is necessary to adopt public policies aimed at increasing investment in research and the construction of new dams for multiple uses. A policy for reforesting watersheds and a permanent cleanup plan for removing the sediment from all the reservoirs across the country are also required.

6. Greater State Investment in Drinking Water and Basic Sanitation

The Dominican Republic urgently requires greater state investment to provide drinking water and basic sanitation for the growing population, since the population of just over 10 million is growing in a swift, disorderly fashion. This problem is compounded by the growing Haitian migration, pressured by international organizations which understand that the Dominican Republic offers better living conditions for some of the neighboring Haitian population, which increases the pressure on drinking water and the need for more basic sanitation.

Given that the state admits that it lacks the financial resources to address the problem of sanitation, we have prepared a preliminary draft law to enable the Dominican government and the private sector to partner to build sectoral sewerage and the respective wastewater treatment plants.

Contributors

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7. Conclusions

1. Santo Domingo, the Dominican capital, which usually receives about 400 million gallons of water daily, has seen a 25% reduction of these volumes as a result of the long drought that lasted from November 2013 to July 2014, creating an acute drinking water shortage for the city's 3.5 million inhabitants.
2. The severity of the drinking water crisis in the city of Santo Domingo has required a reduction of the supply of irrigation water in the Marcos A. Cabral canal, where irrigation has been reduced from seven to just one day a week. Although this is an appropriate measure since the first use of water should be for human consumption, it is equally true that it affects food production for the population, and worsens the living conditions of many of those whose livelihood is agriculture.
3. The drinking water crisis has caused worrying inter-municipal conflicts, since people living in the vicinity of the Tavera and Bao dams, understand, quite rightly, that they should be taken into account in the distribution of these waters, which have always belonged to them. However, due to the water shortage, these waters are now being prioritized for important, distant urban centers, while those in the immediate vicinity are dying of thirst.
4. The flow of urban waters in Santo Domingo, Santiago and other cities in the country, is becoming increasingly reduced and contaminated by direct discharges from inhabitants who lack basic sanitation, and untreated discharges from industries near rivers and streams, which paints a worrying picture for the present and future of urban water in Santo Domingo.
5. The growth of the Dominican population, coupled with the increasing migration of Haitians seeking better living conditions, puts pressure on the already precarious drinking water and basic sanitation services, compounding the problem.
6. According to the World Health Organization, as regards access to basic sanitation and drinking water services, over the past 22 years the Dominican Republic has only achieved an improvement of 17% and 9% respectively, well below countries such as Paraguay, Honduras and Guatemala.
7. Whereas in major cities in the Dominican Republic, particularly Santo Domingo and Santiago, water is scarce, due to a lengthy drought, communities around Lake Enriquillo have been inundated by extraordinary floods for seven consecutive years, while the state has failed to devise a solution to take advantage of these waters.

8. Recommendations

The Dominican government must urgently make major economic investments to ensure full drinking water and basic sanitation services. The international community and the Dominican business sector must make financial contributions to help solve this serious problem, which is becoming increasingly complex.

The city of Santo Domingo, which has grown without proper sewerage, requires a two-billion-dollar investment for the construction of a modern sewerage system, which should be begun as soon as possible and completed in no more than 12 years.

It is necessary to enact a law requiring the next three governments, lasting four years each, to prioritize investment in drinking water and basic sanitation, with particular emphasis on investments guaranteeing that the entire capital city is provided with the necessary sewerage.