WATER, DEVELOPMENT AND ENVIRONMENT IN CUBA: A SECOND LOOK

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Nearly twenty years ago, at the 1993 Annual Conference of the Association for the Study of the Cuban Economy (ASCE), we presented a paper that looked at the interrelationship between water, development and environment in Cuba.[1] We elaborated on the topic and updated the information in Chapter 5, "Water and the Environment," of our book *Conquering Nature: The Environmental Legacy of Socialism in Cuba*, published in 2010.[2]

This paper takes a second look at these key relationships and examines the extent to which they may have evolved since our earlier work. The paper is divided into three parts. In the first part, we examine water availability and consumption in the island over the last three decades or so, with emphasis on the agriculture and population consumption sectors, the two leading water users during the period of our earlier work. In the second, we examine consumption patterns by international tourism, a sector of the economy that has gained in importance in the last two decades and whose customer base presents specific demands as well as environmental concerns. The third part presents conclusions and implications.

WATER AVAILABILITY AND CONSUMPTION IN CUBA

Water Availability

Surface Water: As a sub-tropical nation, Cuba receives an abundant amount of rainfall. Cuba's mean annual precipitation, according to long-term observations, amounts to 137.5 cm.[3] The abundant rainfall only partially translates into a steady supply of freshwater, however. Major seasonal and cyclical rainfall fluctuations and the country's geographic features give way to periods of overabundance of water followed by periods of water shortage. The frequency and intensity of hurricanes has a major bearing on seasonal and secular fluctuations in rainfall as they

[1] Sergio Díaz-Briquets and Jorge Pérez-López, "Water, Development and Environment in Cuba: A First Look," *Cuba in Transition*, volume 3 (1993).
[2] Díaz-Briquets and Pérez-López, *Conquering Nature: The Environmental Legacy of Socialism in Cuba* (Pittsburgh: University of Pittsburgh Press, 2010).
[3] Leví Marrero, *Geografía de Cuba*, 2nd Edition (New York: Minerva Books, 1970), p. 75

provide between 10% and 15% of annual rainfall, the volume varying from year to year and region to region.

The archipelago-nation experiences two well marked seasons, a rainy season (from May to October) and a dry season (from November to April). During the rainy season, when Cuba receives 80% of its annual rainfall, precipitation averages 140 to 150 cm, while during the dry season it averages 30 to 40 cm.[4] Annual rainfall fluctuations are equally substantial, with the volume of rainwater varying from year to year by as much as 30% to 40%. Regional fluctuations in mean precipitation are notable as well. Mean annual rainfall ranges from 300 cm in the mountainous region of Northeast Cuba, to under 60 cm in the semi-desert Southeastern coastal region found between the Sierra Maestra Mountain range and the Caribbean Sea. As a rule, rainfall tends to be more abundant in the Western and Central plain regions than in the Eastern plains, and most abundant of all in the mountain ranges. It has been estimated that, on average, Cuba has 38,139 billion cubic meters of potential water resources, 31,683 billion cubic meters as surface waters and the balance as subterranean sources. Of the combined volume, 63% or 23,988 billion cubic meters are deemed to be usable.[5]

Cuba's elongated and narrow shape, insular character, and extensive coastline (2,306 miles or 3,735 kilometers) accentuate the cycles of water overabundance and water scarcity. Most rivers flow from the center of the country to either the Northern or Southern coasts, with rainwater reaching the seas within at most a few hours.[6] Watersheds are geographically limited, the majority of rivers having a short course. The mean length of major Cuban rivers is only 58 miles (93 kilometers). The Cauto river, the country's longest and most voluminous, has a length of 228 miles (370 kilometers); the Sagua la Grande and Zaza run about 100 miles, with all other rivers having courses shorter than that. Eighty percent of the total flow of Cuban rivers occurs during the rainy season.[7] In the dry season, many of the rivers and hundreds of streams experience a severe or complete loss of water flow. In some parts of the country, the nature of the soils contributes to

[4] Marrero, *Geografía de Cuba*, Ibid.
[5] Instituto de Meteorología, *Variaciones y cambios del clima en Cuba* (La Habana: Instituto de Meteorología, 2001).
[6] "Report of Cuba," United Nations Water Conference, Mar del Plata, Argentina, 1977. In *Voluntad Hidraúlica*, 13:39, 1976, p. 59.
[7] Jorge Osterling, "The Society and Its Environment," in James D. Rudolph, editor, *Cuba: A Country Study*, Foreign Area Studies, American University (Washington, D.C.: U.S. Government Printing Office, 1985), p. 67.

rapid runoff due to their limited permeability. On the other hand, in low-lying coastal areas, flooding is a persistent problem.

Underground Water: The abundant annual rainfall contributes to the replenishment of the country's aquifers. Cuba is particularly rich in carbonate rocks, as they cover close to 70% of the country with a multitude of karst features. This abundance is however highly vulnerable as karstic soils are "highly susceptible to pollution, which may result in dramatic consequences for both the quality of karst water and the amount of water available."[8] Water capacity of the island's aquifers varies greatly, as does the quality of their waters.[9] The country's richest aquifers are (1) those running through the karstic soils of Western Cuba, from Pinar del Río province through Matanzas province and into the northern portion of Villa Clara province; and (2) those located in karstic soils extending through most of Sancti Spíritus and Ciego de Avila provinces and parts of Camagüey and Las Tunas provinces.

Aquifer recharge hinges exclusively on rainy season rainfall. Of the 165 aquifers evaluated as of 2001, 86 store 77% of the total volume of subterranean water, 70 of which are open to the sea and already contaminated by seawater intrusions. By 1990, 2,000 square kilometers were affected, accounting for between 5% and 10% of available water. Some aquifers were so impacted by marine intrusions that currently are of only limited utility.[10]

Karstic aquifers can also become easily contaminated by ground-based pollutants, such as human and industrial effluents, especially those that lack surface areas capable of containing their filtration.[11] Contaminants spread swiftly in karstic aquifers since they allow underground waters to be rapidly displaced. This feature of karstic soils is of considerable concern in Cuba since, as noted, many of the country's principal aquifers are located along coastal areas prone to salt intrusions. In coastal regions of Southwest Cuba, the Zapata Swamp, and the Northern coast of Sancti Spíritus and Ciego de Avila provinces, the mineral content of aquifers is so high that the water is not suitable for human or agricultural use.

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[8] Leslie Molerio León and Mario Parise, "Managing environmental problems in Cuban karstic aquifers," 2009, *Environmental Geology* 58:275.
[9] Academia de Ciencias de Cuba/Academia de Ciencias de la URSS, *Atlas Nacional de Cuba* (La Habana, 1970), pp. 22-23.
[10] Instituto de Meteorología, Ibid., 31-32.
[11] Antonio R. Magaz, "Urbanización y karst en La Habana," *Cuba Geográfica*, 2021, No. 8-9, 12.

Pérez and Solo-Gabriele have written the following with respect to Cuba's water availability and consumption:[12]

> The total safe yield (i.e., the flow that could be withdrawn annually without depleting the resource) for the island as reported by the Cuban Government was estimated at 6.5 billion cubic meters [of water] per year, of which 63.5% was said to be groundwater. …Water extraction was expected to reach 5.2 billion cubic meters per year in 1980. Scaling this number upwards to reflect the population growth between 1980 and 2008 … suggests that water extractions may have reached a value of 6.2 billion cubic meters per year. That is, the water demand for the island is nearing its maximum safe yield supply. Problems associated with saltwater intrusion are likely to continue. Meeting the needs of the population will require additional water storage facilities in localized areas where the demand is the greatest. Additional alternatives could include various water conservation measures, and eventually the reclamation of highly treated wastewater for selective uses.

Water Consumption

AQUASTAT, the Global Information System on Water and Agriculture of the United Nations Food and Agriculture Organization (FAO), distinguishes withdrawals of freshwater for three uses: (1) agricultural, including irrigation, livestock, and aquaculture; (2) municipal, including domestic; and (3) and industrial.[13] At a global level, the withdrawal ratios are 69% agricultural, 12% municipal and 19% industrial. These numbers, the FAO clarifies, are biased strongly by the few countries which have very high-water withdrawals; averaging the ratios of each individual country, "for any given country" these ratios are 59%, 23% and 18% respectively. Official Cuban statistics on water sources, water use, and surface under irrigation from 2016 to 2020, are shown in Table 1. According to 2020 figures, of the 6,668 million cubic meters available, 53.1% were allocated to agriculture and fisheries (68% of which used for irrigation); 22.9% to human consumption, and the balance to other economic activities. Desalinated and reused water

[12] Armando I. Pérez and Helena Solo-Gabriele, "Cuba's Water and Wastewater Sector: Environmental Literature, Institutional and Economic Issues and Future Work," *Cuba in Transition*, Volume 18 (2008).
[13] AQUASTAT: FAO's Global Information System on Water and Agriculture, https://www.fao.org/aquastat/en/overview/methodology/water-usecv

Table 1. Sources and Uses of Potable Water and Land Use Areas for Some Water Intensive Crops, Selected Years

	1990	2016	2017	2018	2019	2020	2021
Water Use (millions of cubic meters)							
Surface potable water use		3,355	3,877	4,411	4,303	4,296	
Subterranean potable water use		2,634	2,784	2,973	2,773	2,372	
Selected potable water uses							
Human consumption		1,592	1,605	1,614	1,587	1,525	
Agriculture and fisheries		3,394	3,420	4,108	3,755	3,539	
irrigation		2,903	3,204	2,858	2,549	2,403	
Other economic activities		907	1,547	1,575	1,653	1,527	
Desalinated water		20	20	20	20	21	
Reused water		9	10	10	10	12	
Losses during distribution		1,016	1,079	1,093	1,195	1,132	
Agriculture Surface Area (hectares)							
Sugarcane harvested area	1,452,200	314,400	392,900	393,000	348,000		
Permanent citrus plantations			19,700	19,400	18,400	18,500	10,700
Rice plantations			112,356	133,716	117,109	74,596	66,518

Source: ONEI. 2021. *Anuario Estadístico de Cuba 2020*, Table 2.17, Extracción de agua por destinos.

only contributed a paltry amount to national consumption. A testament to the poor status and maintenance of the national water distribution system -- documented in official sources and often alluded to in journalistic accounts -- is that much of the available water is wasted while being distributed to consumers. The statistics also show a persistent and at time steep decline in surface area under irrigation for sugarcane, citrus and rice.

Socialist Cuba's management of water resources is the purview of the Instituto Nacional de Recursos Hidraúlicos (INRH), created in 1962. The INRH was a key player in the national strategy implemented from the 1960s onward of rapid agricultural development and increase in water supply for human consumption. An integral part of this strategy was a national study of Cuban water resources and an ambitious plan to build a network of dams to accumulate water to meet economic and population needs and mitigate flooding. According to official statistics, in 1959 Cuba had 13 dams with a holding capacity of 47.8 million cubic meters of water; as of December 1989, thirty years later, the number of dams completed had grown to 101, with a holding capacity of 6,699.million cubic meters of water, and an additional 32 dams with capacity of nearly

2,264 million cubic meters of water were under construction.[14] Dam construction continued in the 1990s and subsequently; official Cuban statistics show that over the period 2019-2021, the number of dams has been stable at 242 with a storage capacity of approximately 9,159 million cubic meters of water.[15]

Rated capacity is not the same as achieved capacity. It is known, for example, that one of Cuba's main reservoirs, the Alacranes Reservoir, has never achieved its full storage potential.[16] Moreover, the actual holding capacity of man-made reservoirs may be diminishing over time due to continuous sedimentation, principally among the shallower western Cuba reservoirs, where water may be most in demand. In 2012 a Cuban geologist arrived at a conclusion similar to that of Pérez and Solo-Gabriele; he noted that the 1,293 cubic meters per capita water availability at that time was perilously close to what is considered a state of "hydric stress" (1,000 cubic meters per capita).[17] This level is alarming as the Meteorological Institute concluded, on the basis of a re-examination of 1961-1990 historical figures, that Cuba had a 21% lower hydric potential than previously assumed.[18] The vast amount of water wasted during distribution suggests than improving the delivery infrastructure network would be, as suggested by several observers, a viable strategy to conserve and make the resource more widely available.

Water and Agriculture: In the late 1960s and early 1970s, Cuba embarked on an ambitious irrigation program that relied heavily, as mentioned earlier, on developing a network of water storage areas through a major dam reservoir construction program and increasing the extraction rate of underground water. The water storage areas were also designed for artificial rechange of aquifers since there was concern about the high rate at which water was being withdrawn from underground stores. The irrigation strategy was meant to support increases in production of the country's export mainstay -- sugarcane -- and of other products, prominently among them citrus and rice. The planned major expansion in the output of these three crops, all prodigious users of fresh water, could only be sustained with additional water supplies, particularly during the dry season.

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[14] Cuba, Comité Estatal de Estadísticas, taken from Díaz-Briquets and Pérez-López, *Conquering Nature*, p. 120.
[15] Oficina Nacional de Estadística e Información, *Anuario Estadístico de Cuba 2021*, Edición 2022. Table 12.4.
[16] Armando H. Portela, "La Presa Alacranes: Un proyecto de otro tiempo," *Cuba Geográfica*, no. 4 (2021), 19.
[17] Luis Fidel Miranda Castañeda, "Diagnóstico de la situación de la intrusión marina al sur de Ciego de Ávila," *Ingeniería Hidráulica y Ambiental*, 2012, XXXIII:1,107; see also, Susanne Becken, "Water Equity: Contrasting Tourism Water Use With That of the Local Community," *Water Resources and Industry,* 2014, 7-8:10
[18] Instituto de Meteorología, Ibid., 37.

Cuba's agricultural sector grew markedly in the 1970 and 1980s. Sugarcane production skyrocketed in the 1980s, as the Soviet Union purchased all sugar produced by Cuba on very favorable terms. In the 1980s, Cuban sugarcane production averaged 69.8 million metric tons per annum, 19% higher than in the 1970s, supporting historically high levels of sugar production, which averaged about 8 million tons in the final years of the decade.[19] Both sugarcane and sugar production fell sharply in 1990s and beyond with the disappearance of Cuba's main sugar buyer – the Soviet Union – and the decision by the Cuban government in the early 2000s to dismantle the sugar production industry, which meant the shutting down of mills and the abandonment of agricultural land previously devoted to sugarcane production, including irrigated sugarcane fields. The restructuring plan called for the creation of an industry capable of producing about 4 million metric tons per annum with high efficiency and low cost; this translated into the immediate deactivation of 71 sugar mills (from 156 that were active in 2002) and the shift of approximately 1.3 million hectares of sugarcane lands (65% of sugarcane lands) to other crops.[20] Spurred by foreign investment, citrus orchards expanded as Cuba became a significant exporter of citrus products, primarily to the Socialist countries and Europe, although its long-term growth was stunted by quality problems and pest infestations. Citrus exports to the former member countries of the Socialist bloc and other European countries fell sharply in the 1990s and beyond.

Geographer Armando Portela has made the point that Cuba's system of water accumulation and management was created to support a centralized economy that was part of a community of socialist nations with an expanding population.[21] Cuba was expected to fulfill the demand for agricultural products not only of its population but also – as mentioned above -- of the socialist community of nations; in the case of sugar, for example, the plan was for Cuba to produce 10 million tons per annum in over 1.5 million hectares of irrigated land, over a million metric tons of citrus and a like quantity of rice to meet socialist bloc demands.

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[19] Jorge Pérez-López and José Alvarez, "The Cuban Sugar Agroindustry at the End of the 1990s," in Pérez-López and Alvarez, editors, *Reinventing the Cuban Sugar Agroindustry* (Lanham, Maryland: Lexington Books, 2005), p. 30. The Metereological Institute concluded, in fact, that from a quantitative point of view, no substantive changes could be foreseen in the hydraulic storage capacity. What was necessary was a more rational and efficient use of water, minimize contamination, and lessen environmental deterioration by careful allocation of water to ensure its preservation. Instituto de Meteorología, Ibid., 35.

[20] Jose Alvarez and Jorge Pérez-López, "The Restructuring of Cuba's Agroindustry, 2002-2004," in Pérez-López and Alvarez, editors, *Reinventing the Cuban Sugar Agroindustry,* p. 147.

[21] Armando H. Portela, "El agua: sobrerregulación, administración, medio ambiente," *Cuba Geográfica*, no. 4 (2021), 16-18, 20-21.

The breakup of the socialist community at the start of the 1990s, the economic crisis that enveloped the Cuban economy, and the slowdown of population growth rendered obsolete water accumulation and distribution projects under construction or planned. Portela, for example, has examined the performance of the large Alacranes reservoir, built in 1972 in the northern part of Villa Clara province, intended to provide the water needs of anticipated agriculture, industry, and population growth in Central Cuba.[22] In reality, the projected water needs did not materialize, and the reservoir has been vastly underutilized. In fact, five of the nine sugar mills in the vicinity of the reservoir, whose agriculture needs were supposed to be satisfied by Alacranes, were shuttered in 2002. Portela has also reported that around 2015, Cuba's irrigation system was operating at 16% of its capacity because of the poor state of the system's infrastructure of canals and pumping stations,[23]with some reservoirs having long been abandoned and unlikely to ever be used again.[24]

Although the cutback in size of the sugar industry when it was announced appeared draconian to most analysts, the actual performance of the industry has been far worse than could have been anticipated. Thus, sugar production during the first three years after the restructuring plan was put in place barely exceed 2 million tons and, in fact, the 2 million ton mark has not been exceeded in any year since then, with production falling to closer to 1 million tons.[25] For the most recent crop year 2021-2022, sugar production has been reported at 473,000 tons, an amount insufficient to meet domestic demand let alone support exports.[26]

In other regions of Cuba, agricultural demand for irrigation water and pressure to supply dense urban populations had led to a significant deterioration of coastal aquifers. Most notorious is the case along western Cuba's southern coast.[27] Overextraction of water from these aquifers has given rise to severe marine water intrusions, salinization of potable water sources, and progressive chemical deterioration. Most critical has been the damage along the so-called Cuenca Sur, a major source of drinking water for the capital city of La Habana.

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[22] Portela, "La Presa Alacranes," 23-24.
[23] Portela, "La Presa Alacranes," 24.
[24] Portela, "El agua," 16.
[25] Jorge Pérez-López, "The Cuban Sugar Industry 1959–2019: From Front-Runner to Back of The Pack," *Cuba in Transition*, Vol. 29, 2019.
[26] Roberto Alvarez Quiñones, "Cuba produjo este año menos azúcar que cuando la Guerra de los Diez Años," *Diario de Cuba* (10 junio 2022).
[27] Juan Reynerio-Fagundo Castillo and Patricia González Hernández, "Agricultural Use and Water Quality at Karstic Cuban Western Plain," *International Journal of Speleology*, 1999 (28 B,1/4):175-185; Rosa María Valcerce-Ortega and Carlos Enrique Forcada-Labrador, "Evaluación de la vulnerabilidad a la intrusión marina en el sector Güira-Quivicán del acuífero costero Cuenca Sur de Artemisa y Mayabeque," *Minería y Geología* 2021 (37/1):30-43.

What is puzzling is that despite the major contraction in agricultural production, as reflected in output and acreage assigned to primary crops (sugar, citrus, rice), the volume of water assigned to irrigation, as shown in Table 1, only declined by 28% between 2017 and 2020, even though agricultural output continued on its downward trend.[28] This trend validates Portela's conclusion that some of Cuba's reservoirs are vastly underutilized thus supporting the notion that a more rational allocation of water among competing uses (agriculture, human consumption, and industrial), along with conservation, in Cuba's relative water scarcity environment is a valid option as long as water diverted from agricultural uses is apt for human consumption and could be economically diverted to human consumers. A limiting factor behind this option is that in some instance it would be physically impossible or too costly to transfer the excess available water to where it is needed, as would be the case with stored water in Isla de la Juventud.[29]

Water and Population Consumption: Cuba's record in providing drinking water supply services to its citizens, as expressed by official statistics, was quite remarkable. Cuba reported to the Pan American Health Organization (PAHO) that in 1992 it provided drinking water to 100% of its urban population and 91% of its rural population,[30] a record that exceeded that of most countries in the Americas, including the more economically advanced ones.

The statistics reported above are the more remarkable given that La Habana's water infrastructure is very old, and pumping plants, distribution and collection systems have received very little maintenance in the last six decades, with interventions focused almost exclusively on repairing pipe breaks and leaks. The city's main water distribution lines go back to 1870, when the Isabel II or Canal de Vento aqueduct was built; in the 1950s, the Cuenca Sur and Marianao aqueducts were built, and some major repairs made to main waterlines. The neglect of the water distribution system manifests itself in two ways: (1) water is available only at certain times of the day; and (2) water is lost because of leaks in the distribution system. Cuban experts estimate that in the mid-1990s, only about 8% of the population of La Habana had water service twenty-four hours per day, with most homes receiving running water between 8 and 15 hours per day. In May

[28]Between 1990 and 2019, the extension of land allocated to sugar production declined by 76%. See Table 1.
[29] Portela, "La Presa Alacranes," 21.
[30] Pan American Health Organization, *Health Conditions in the Americas, 1994 Edition* (Washington: Pan American Health Organization).

2022, INRH officials reported that 31,800 residents of La Habana were without running water because of breaks and other disruptions in the water distribution system.[31]

But the water shortage problems threatening La Habana's supply extend beyond the problems caused by the deteriorated water distribution system. Overexploitation of the Cuenca Sur aqueduct complex, located in the Güira-Quivicán sector of the Artemisa and Mayabeque provinces -- providing 58% of the water consumed in the metropolitan area and fed by 19 wells pumping water 24 hours a day -- has resulted in the emergence of an expanding saltwater intrusion wedge reaching many kilometers inland in some areas. There is concern that this seawater breach in coming years could extend further inland as the sea level rises due to climate change.

Saltwater intrusion in this region is a long-standing problem, whose effects were to be counteracted by the Dique Sur de La Habana, a 100-kilometer underground concrete barrier, erected between 1985 and 1991 to interfere with the normal course of potable water draining to the sea while blocking further saline intrusions, a massive project that may prove insufficient to the task.[32] According to a recent vulnerability map assessment of the Güira-Quivicán coastal aquifer sector located along Artemisa and Mayabeque provinces, 31.5% of the study area was found to be highly susceptible to further marine intrusions, 49.5% had medium risk, and the remainder low risk. The high-risk zones are located up to eight kilometers inland along the seacoast; however, in the immediacy of the Cuenca Sur, it reached 16 kilometers inland.[33] Particularly problematic is that these aquifers are located where Cuba is at its narrowest and water-use demand is expanding to serve the tourism sector.

An innovative study conducted by U.S.-based academics sought to assess water quality in Cuba relying on methodologies associated with audience research and software end-user evaluation projects.[34] The motivation for the study was to examine the state and availability of drinking water and ambient water throughout Cuba, seeking to reconcile the very impressive official record regarding affordable access to drinkable water and anecdotal information from recent travelers to the island and from family, friends, and acquaintances who live in Cuba about

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[31] "No amanece para los cubanos: a los apagones se suman problemas con el suministro de agua," *Diario de Cuba*, 30 de mayo de 2022.
[32] Díaz-Briquets and Pérez-López, *Conquering*, 128-130.
[33] Valcerce-Ortega and Forcada-Labrador, *Evaluación de la vulnerabilidad*. Equally rich, but just as vulnerable, are the aquifers in southern Matanzas and Ciego de Avila provinces (Instituto de Meteorología, Ibid., 36).
[34] Enrique S. Pumar, Helena Solo-Gabriele and Joseph Treaster, "Perceptions of Water Quality in Cuba as Reported by Users: Preliminary Findings of the Cuba Water Project," *Cuba in Transition*, Vol. 26 (2016).

a lack of water availability and concerns of illness from consuming contaminated water in Cuba. The researchers gathered data directly from consumers: Cubans and others arriving at Miami International Airport from the island and relatives, friends and acquaintances who visited the island less than a year before taking the survey designed by the researchers. The results of the study confirmed the concerns of many, namely that water quality throughout the island is alarmingly poor. Moreover, the continuing struggles of the Cuban economy only make the situation worse for the average Cubans, i.e., those who do not live in hotels, do not have access to the facilities offered to tourists, and are the ones most dependent upon public water supply.

WATER AND INTERNATIONAL TOURISM IN CUBA

As we undertook this second look at water, development, and environment in Cuba we were struck by the fact that in our initial assessment we did not explicitly consider the tourism industry either as an economic sector that consumed Cuba's water resources or as having an impact on water quality and pollution. To a large extent this was a function of the relatively limited importance of tourism within the Cuban economy prior to the economic crisis of the 1990s. Since then, tourism shifted from being a complementary area of economic activity to a dominant one, with significant implications for water consumption and the environment.[35]

In the early years of the Cuban revolution, the regime shunned international tourism for ideological reasons, even though tourism had been a growing source of jobs and income, the country having hosted 356,000 American tourists in 1957.[36] As Cuban tourism expert María Dolores Espino put it,

> tourism was perceived as too closely associated with the capitalist evils of prostitution, gambling, and organized crime. … During the 1960s and early 1970s, no major investment in tourism was undertaken. The vast tourism infrastructure developed during the pre-revolutionary years was left for the use of Cuban citizens and international guests from socialist countries or simply abandoned. Some 16 hotels were closed down and hotel capacity was reduced by 50%.[37]

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[35] Gilberto Javier Cabrera Trimiño, *Economía ecológica, demografía ambiental y desarrollo* (La Habana, Editorial de Ciencias Sociales, 1997), p. 209.
[36] Renata Rettinger and Miroslaw Wójtowicz, "Regional Differences in the Development of Tourism in Cuba," *Environmental and Socio-economic Transformation in Developing Areas as the Effect of Globalization* (Cracow: Pedagogical University, 2014).
[37] María Dolores Espino, "Tourism in Cuba: A Development Strategy for the 1990s?" in *Cuba at a Crossroads*, edited by Jorge Pérez-López (Gainesville: University of Florida Press, 1994), p. 148.

This began to change -- initially very gradually -- in the mid-1970s with the creation of the Instituto Nacional de Turismo (INTUR) and in 1987 and 1988, respectively, of two government corporations, Cubanacán S.A. and Gaviota S.A., to develop joint ventures with foreign investors seeking participation in the Cuban tourism industry.[38]

At the start of the 1990s, Cuba faced its most severe economic crisis since the Great Depression, the result of a combination of external (e.g., the disappearance of the socialist community of nations and the virtual end of economic assistance from the former Soviet Union and enhanced economic sanctions from the United States) and internal (misguided economic policies) factors. The economic downfall was precipitous, with real gross domestic product falling by 35% between 1993 and 1989, per capita GDP by 41%, and physical production of sugar by 48%, of nickel by 36%, of citrus fruits by 32%; exports and imports shrunk by over one third. One of the positive developments, in this otherwise chaotic economic scenario, was the growth in income from international tourism. The economic recovery measures implemented by the Cuban government starting in the mid-1990s, called the "Special Period in Time of Peace," included the promotion of international tourism and, in 1995, the adoption of a new foreign investment law that eased foreign investment in the island.

Cuban Tourism

Cuba's tourism development strategy has centered on mass appeal and low price, typically in enclaves segregating tourists seeking "sun and sand" tourism from urban communities and the general citizenry as opposed to other forms of tourism such cultural tourism or ecotourism. [39] While this emphasis has begun to change, as Cuba seeks to showcase its rich historical attractions, the initial impetus continues as evidenced by the fact that among Cuba's current international airports, two are located in Cayo Coco and Cayo Largo del Sur, sites of some of the major off-main island tourist enclaves.[40] To be sure, sun and sand tourism in a setting such as Cuba's, with miles and miles of beaches and breath-taking vistas, has the potential to generate massive numbers of tourists and revenue, but it also raises challenges with respect to infrastructure construction and maintenance, price competition from other sources and the environment.

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[38] Gaviota is controlled by the Cuban Armed Forces, which since the late 1980s began to play a very active role in the civilian economy.

[39] Pablo Martin de Holan and Nelson William Phillips, "Sun, sand, and hard currency: Tourism in Cuba," *Annals of Tourism Research,* October 1997, 24(4):777-795.

[40]Rettinger and Wójtowicz, "Regional Differences," 142.

In a recent paper, Cuban tourism expert Miguel Alejandro Figueras argues that it was a strategic and intelligent decision on the part of Cuban authorities to open opportunities for international hotel chains that have strong operational ties to large tour operators and international airlines to participate in the development of Cuba's international tourism industry.[41] Participation by these multinational concerns, with the ability to deliver mass tourism flows, began modestly with Spanish chain Sol Meliá. In the early 1990s, Cuba had management contracts for three hotels combining 1,330 rooms; three decades later (2018), Cuba had such arrangements with 20 foreign hospitality companies – mostly from Spain, but also from Canada, France, Portugal, Mexico and other countries -- managing and promoting 118 hotels with a total of 43,805 rooms suitable for international tourism. By 2022, the number of foreign hospitality companies managing Cuban tourism hotels had grown to 21, operating 124 hotels and 45,333 rooms.[42]

The number of tourist arrivals to Cuba grew by leaps and bounds since the 1990s. According to Cuban official statistics,[43] the number of foreign tourists arriving in the island rose from 742,000 in 1995, to 1,741,000 in 2000, 2,261,000 in 2005, 2,507.000 in 2010, 3,505,000 in 2015 and a record high 4,683,655 in 2018, declining to 1,084,728 in 2020, the latter figure reflecting the decline in world travel associated with the onset of COVID-19. A related metric is the yearly number of tourist-lodging days; they rose from 5,541,773 in 1990 to 19,535,691 in 2018. For 2021, Cuba has reported 356,470 tourists, a significant decline from previous years attributable to the raging global COVID-19 pandemic.[44]

To accommodate the rising number of tourists, Cuba has made significant investments in the construction of hotels and other tourism facilities. As shown in Table 2, close to 50% of all construction investment (combining investment in "Hotels and restaurants" and "Commercial and real estate") between 2017 and 2021 probably were geared to tourism as it is likely to have been the case for construction investment categorized as "Utilities."

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[41] Miguel Alejandro Figueras, "Foreign Participation in the Development of Tourism in Cuba," Horizonte Cubano, Cuba Capacity Building Project, Columbia Law School, February 27, 2020.
[42] Ministerio de Turismo*, Oportunidades de Negocios para la Inversión Extranjera en el Sector de Turismo en Cuba* (La Habana, MINTUR, 2022), p. 8.
[43] These statistics and the ones in subsequent paragraphs have been taken from the section titled Series Estadísticas of the website of Cuba's Oficina Nacional de Estadística e Información.
[44] Oficina Nacional de Estadística e Información, *Turismo Nacional e Internacional: Indicadores Seleccionados enero-diciembre 2021,* March 2022.

Table 2. Construction and Related Investment, Selected Sectors; 2017 to 2021

	2017	2018	2019	2020	2021
Construction and Related Investment (Selected sectors in millions of pesos)					
Total	4,872.1	5790.0	6,053.3	6,348.7	33,388.2
Agriculture	125.3	155.5	166.4	241.1	882.7
Mining	57.2	53.9	60.2	70.1	2381.0
Sugar industry	152.5	111.7	130.6	127.1	162.9
Manufacturing (other than sugar)	288.6	349.7	515.6	709.1	4,522.4
Utilities (electricity, gas, and water)	556.9	584.9	274	296.9	1840.0
Construction	571.1	643.1	634.1	540.9	602.3
Hotels and restaurants	104.7	71.6	104.4	107.3	456.0
Commercial and real estate	2,221.8	2,889.1	3,094.6	3,196.3	17,096.3
Public administration and defense	267.0	243.8	456.0	487.9	1566.9
Construction and Related Investment (Selected sectors, percent)					
Total	100.0	100.0	100.0	100.0	100.0
Agriculture	2.6	2.7	2.8	3.8	2.6
Mining	1.2	0.9	1.0	1.1	7.1
Sugar industry	3.1	1.9	2.2	2.0	0.5
Manufacturing (other than sugar)	5.9	6.0	8.5	11.2	13.5
Utilities (electricity, gas, and water)	11.4	10.1	4.5	4.7	5.5
Construction	11.7	11.1	10.5	8.5	1.8
Hotels and restaurants	2.2	1.2	1.7	1.7	1.4
Commercial and real estate	45.6	49.9	51.1	50.3	51.2
Public administration and defense	5.5	4.2	7.5	7.7	4.7

Source: ONEI. 2022. *Anuario Estadístico de Cuba, 2021*, Table 12.3, Valor ejecutado y montaje por actividad económica.

Construction of tourism lodging facilities in recent years has favored high-end properties, which are deemed to be what consumers demand and moreover are more profitable. While the number of five-stars hotels increased from 29 in 2010 to 68 in 2020, and those with four-stars from 86 to 121 during the same period, the combined number of lower rated hotel facilities declined from 441 in 2010 to 134 by 2020. Percentagewise, five-star rated hotels increased from 5.1% in 2010 to 15.7% in 2020, while four-star rated facilities nearly doubled from 15.2% to 27.9%. See Table 3.

Cuba's international tourism strategy since the 1990s has privileged construction of facilities at certain tourism zones or poles that had the characteristics demanded by foreign tourists. In addition to La Habana and Varadero, two traditional tourism zones, Cuban authorities designated six other non-traditional regions: (1) Jardines del Rey (cays and islands located in the

Table 3. Tourist Facilities by Type of Accommodation, 2010 to 2020

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
All types	565	562	473	450	430	434	447	471	483	506	434
Hotels	380	378	303	304	295	301	310	272	283	326	323
5 stars	29	36	37	40	30	35	45	41	45	66	68
4 stars	86	73	79	79	73	75	76	94	98	126	121
3 stars	108	120	100	101	103	102	101	69	66	75	76
2 stars	68	65	62	59	63	63	62	49	53	43	43
1 star	89	84	25	25	26	26	26	19	21	16	15
Apart-hotels	7	7	7	7	7	7	7	7	7	7	5
Motels	54	54	48	33	35	38	41	63	58	63	3
Hostels	11	11	12	12	12	12	10	8	10	10	10
Tourist villas	60	60	60	58	44	31	35	31	36	38	52
Other (1)	53	52	43	36	37	45	44	90	89	62	41
Percent Distribution											
Accommodation Type											
Hotels	62.1	67.4	64.0	67.6	68.7	69.4	69.4	57.7	58.6	64.4	74.5
5 stars	5.1	6.4	7.8	8.9	7.0	8.1	10.1	8.7	9.3	13.0	15.7
4 stars	15.2	13.0	16.7	17.6	17.0	17.3	17.0	20.0	20.3	24.9	27.9
3 stars	19.1	21.4	21.1	22.4	24.0	23.5	22.6	14.6	13.7	14.8	17.5
2 stars	12.0	11.6	13.1	13.1	14.7	14.5	13.9	10.4	11	8.5	9.9
1 star	15.8	15.0	5.3	5.6	6.0	6.0	5.8	4.0	4.3	3.2	3.5
Apart-hotels	1.2	1.2	1.5	1.6	1.6	1.6	1.6	1.5	1.5	1.4	1.2
Motels	9.6	9.6	10.1	7.3	8.1	8.8	9.2	13.4	12.0	12.4	0.7
Hostels	2.0	2.0	2.5	2.7	2.8	2.8	2.2	1.7	2.1	2.0	2.3
Tourist villas	10.7	10.7	12.7	12.9	10.2	7.1	7.8	6.6	7.4	7.5	12.0
Other (1)	9.4	9.2	9.1	8	8.6	10.4	9.8	19.1	18.4	12.2	9.4

(1) Includes houses and cabanas, camping sites, shelters, and tourist camps but excludes all non-state accommodations

Source: ONEI.gob.cu, Series Estadisticas, Table 15.10

northern coast of central Cuba); (2) Playa Santa Lucía and cays in the northern coast of Camagüey province; (3) the northern coast near Holguín; (4) Santiago de Cuba; (5) the southern central coast, including the cities of Trinidad and Cienfuegos; and (6) the Canarreos archipelago, in the southern coast, with Cayo Largo del Sur being the principal location.[45] "Sun and sand" tourism facilities

[45] Rogelio Quintana, Manuel Figuerola, Mariano Chirivella, Damarys Lima, Miguel Alejandro Figueras and Alfredo García, *Efectos y Futuro del Turismo en la Economía Cubana* (La Habana: Instituto Nacional de Investigaciones Económicas, 2005), pp. 139-140.

are principally located in cays and coastal zones, away from urban areas. For example, the Jardines del Rey tourism zone includes lodging facilities at Cayo Santa María (Playa Perla Blanca and Cayo Santa María dolphinarium), Cayo Ensenachos (Mégano Beach) and Cayo Las Brujas (Playa Las Salinas); all three cays are connected to each other and to the mainland through a causeway (*pedraplén*). Also, part of Jardines del Rey are Cayo Coco (Playa Larga, Playa Flamencos and Playa Las Coloradas) and Cayo Guillermo (Playa Pilar, Playa del Medio, Playa de El Paso), connected to each other through causeways and Cayo Cruz. As noted, some of the enclaves have been provided with international airports – at Cayo Santa María (Las Brujas Airport) and Cayo Coco (Jardines del Rey Airport) -- to accommodate tourists traveling to the area.

In 2014, the Cayo Coco beaches, ranked among the 20 most beautiful in the world, hosted ten hotels. Of these, three were managed by the Melia Group, two by the Iberostar Group, two by the Blue Diamond Group, and three operated by Cuban companies. Plans call for the construction of up to 50 hotels with a total of 20,000 rooms and two new golf courses, in addition to the one currently available. A marina is also located in the key. The development of the Cayo Santa María tourist resort may be one of the most emblematic examples of a tourist enclave. With nine all-inclusive hotels in 2011 and served by the Las Brujas international airport, catering mostly to charter flights, no permanent Cuban inhabitants reside there. Hotel staff commute through a Causeway to Caibarien, 48 kilometers away. To satisfy visitors' needs, an extensive network of shopping centers and service centers has been established in the broader Cayo Santa María complex (including the nearby keys of Cayo Ensenachos and Cayo Las Brujas), together with entertainment, sports, and recreational facilities.[46]

At the 40 Feria Internacional de Turismo, FITCuba 2022, held in May 2022, Cuba's Minister of Tourism Juan Carlos García Granda announced that as part of its tourism development plan, Cuba was seeking foreign participation in 106 tourism business opportunities in the island, including management of hotels, recreation parks, and leisure facilities.[47] García Granda further stated that priorities for foreign participation are tourism projects in La Habana, cays and small islands in the north coast of central Cuba, Holguín, Santiago de Cuba, and Cayo Largo del Sur.

[46] Rettinger and Wójtowicz, "Regional Differences," 149-150.
[47] "Cuba destaca un centenar de oportunidades de negocios en el sector turístico," *Travel Trade Caribbean*, May 4, 2002.

Tourism and Water

Fresh water resources are a critical ingredient of international tourism. As a major study of tourism and water use puts it:

> Tourism is both dependent on freshwater resources and an important factor in freshwater use. Tourists need and consume water when washing or using the toilet, when participating in activities such as ski or golf tourism (snowmaking and irrigation), when using spas, wellness areas or swimming pools. Fresh water is also needed to maintain the gardens and landscaping of hotels and attractions and is embodied in tourism infrastructure development, food and fuel production. … Recreational activities such as swimming, sailing, kayaking, canoeing, diving, or fishing take place at lakes and rivers, which also form important elements of the landscapes visited by tourists. … Many forms of tourism are also indirectly dependent on water, including, for instance, winter tourism (white winter landscapes), agritourism or wildlife tourism. [48]

Although tourism accounts for a minute percentage of global fresh water consumption compared to the very high share accounted for by agriculture, tourism is often an important user of freshwater in areas where such resource is scarce or renewal rate of aquifers is limited, for example in coastal zones.[49] This would seem to be relevant in the case of Cuba, where tourism enclaves geared to sun and sand tourists have been built in coastal zones and cays with very limited capacity for collecting rainfall and virtually nil running surface water.

The tourism industry tends to overuse water resources in hotels, swimming pools, golf courses, and personal use by tourists. Tourists tend to consume more water during their holidays than they do at home, sometimes twice as much. Data on water consumption in Indo-Pacific tourism hotels developed by researchers at Griffith University in Queensland, Australia, show that average water use per guest in Asian hotels was 677 liters per night, compared to 313 liters per night in Australia/New Zealand hotels. Water usage was higher by 33% if the hotel facility had swimming facilities.[50] The tendency for tourism related water use to exceed that of other municipal

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[48] Stefan Gössling, Paul Peeters, C. Michael Hall, Jean-Paul Ceron, Ghislain Dubois, La Vergne Lehmann and Daniel Scott, "Tourism and water use: Supply, demand, and security. An international review," *Tourism Management*, 33 (2012), p. 4.
[49] Stefan Gössling, "Tourism and water: Interrelationships and management," *globalwaterforum.org*, July 16, 2013.
[50] *Environmental Impacts of Tourism*, 3/6/2021, https://tourismteacher.com/environmental-impacts-of-tourism/

users is most pronounced in developing countries as opposed to higher income countries, where consumptions rates are comparable. Extreme examples of this disparity -- can be up to a factor of eight times -- such as Fiji and Sri Lanka, reflect both more exuberant use of water by tourists and very constrained use of the same by the local community.[51]

Statistics on water consumption by tourists visiting Cuba are not available. Gossling et. al. estimated Cuba's water consumption at 300 liters/tourist/day, with tourism accounting for 0.3% of water consumption, a figure well in line with the experience of most other countries, but excessive for some of the locations where some of the major tourism poles have been established.[52] However, recent studies have concluded that prior estimates of water consumption in the hotel industry have been grossly underestimated, since they only considered direct (accommodation) uses. When indirect uses ("imported/embodied water needed for the production of infrastructure, fuels and foodstuffs") tourism is considerably more water intensive "since most of its water footprint is associated with indirect water consumption," with food alone accounting for 87% of total water consumption.[53] In any particular setting, the ultimate calculus, including environmental and monetary costs, would depend on the mix of available water (green, or precipitation water; blue, or surface and ground water; and grey, or that needed to dilute pollutants whether from agriculture or other sources) and other inputs. As a rule, costs would be higher in small island ecosystems and in all-inclusive high end tourist resorts. In Cuba's case, water uses associated with domestic agriculture inputs (to supply tourism restaurants) would be at the low end given the national tourist industry high foreign food import component.

Early on some observers felt that Cuba would be able to avoid some of the pitfalls that today are recognized as adversely impacting the long-term sustainability of sun and sand resorts in other national tourist destinations, including in the water sector, when the industry went into high gear.[54] But this was not to be, as a growing body of evidence suggests that the top-down tourist industry development strategy pursued in Cuba -- characteristic of a command economy,

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[51] Susanne Becken, "Water Equity: Contrasting Tourism Water Use with That of the Local Community," *Water Resources and Industry*, 7-8 (2014).
[52] Gössling, el al, (2012), pp. 2-4.
[53] Stefan Gössling, "New Key Performance Indicators for Water Management in Tourism," *Tourism Management*, 2015, 46:36.
[54] Lourdes Ruiz Gutiérrez, *La Evaluación del Impacto Ambiental de las Construcciones Turísticas en la Cayería Norte y Otras Zonas Costeras de Cuba.* 1999. Disertación Doctoral, Instituto Superior Politécnico José A. Echeverria: La Habana.

wherein the coordinated input of multiple specialized ministries and government departments would presumably lead to more sustainable and environmentally benign outcomes -- did not materialize. Much lip service was given to extensive compliance mandates promoted by these entities but, in practice, such mandates have often been overlooked in Cuba if they conflicted with other priority goals.[55] Aggravating matters is widespread mismanagement in government entities plus a lack of response to operational demands made by international hotel managers to address even urgent maintenance requirements.[56]

The haste with which the strategy was initially implemented often persisted, with many unfortunate interventions repeated time and time again. Localized environmental damage has been documented in marine ecosystems due to the construction of causeways and other facilities; construction of hotels brought about disturbances to the native vegetation, threats to the local fauna, landscapes, and soils, and major aggressions to local surface and underground water bodies. In the view of Ruiz Gutiérrez:

> most tourist construction projects did not consider the environmental dimension in their planning and projection. This situation was provoked by a lack of knowledge regarding how to intervene in cays and other highly fragile and ecologically sensitive zones without causing severe environmental impacts and an absence of conceptual integrity to harmonize tourism development approaches with sustainability objectives … Even though the Cuban investment model considers economic and investment costs, it does not consider the long-term costs associated with environmental costs (cost-benefit analysis) so they may be excluded in the decision-making process, even when assessing decisions of national relevance.[57]

[55] Examples of faulty implementation of environmental regulations despite their enactment may be found in Daniel Suman. 2003. "Can you eat mangrove?: Balancing conservation and development in the management of mangrove ecosystems in Cuba," *Tulane Environmental Law Journal*, 2003, 16:619-652. Given economic constraints and the absence of financial resources, this pattern has likely persisted.

[56] ¿Cuán seguras son las instalaciones hoteleras en Cuba? *Cubanet.org*, 2022, May 27.

[57] Ibid. See also, Ruiz Gutiérrez, "Impact Assessment of Tourism Construction in Cuba," *Journal of Building Construction and Planning Research*, 2015:3, 10-17; Ruiz Gutiérrez, "The Effects of Tourism Architecture on Island Ecosystems," *Journal of Building Construction and Planning Research,* 2015:3,163-170; and Ruiz Gutiérrez, "The Environmental Effects of Tourism Architecture on Island Ecosystems in Cayo Guillermo, Cuba," *Journal of Environmental Protection*, 2015:6, 1057-1065.

As documented in studies of tourist development in other small island ecosystems, in Cuba the high-water demand generated by tourists and the relative water scarcity characteristic of these locations not only contributed to water quality deterioration, but also led to dependence on costly alternatives to satisfy the sector's increasing water demand. Some of the tourist projects along the northcentral keys, for example, required that for every hotel built, three hectares of lagoons and three hectares of mangroves be destroyed, with obvious consequences for the hydrology of the region in question. Landscaping with non-native vegetation and plans for the construction and operation of several irrigation-intensive golf courses only worsens the situation.[58] Since the absence of potable water has proved to be the main constraint for the development of tourism in these settings, the authorities have been forced to rely on expensive options to transport water, including pipelines from the mainland[59] and tanker ships,[60] and, in some cases (see Table 1) the use of small desalinization plants.[61] Reliance on these costly alternatives indicates water availability in cays locations is insufficient and storage facilities are not available and/or prone to be contaminated as a result of man-made (e.g., construction debris, landscape alterations) and natural interventions (climate change, aquifer saltwater intrusions).

Whether the Cuban government or foreign tourist hotel operators assume the cost of providing water is not entirely clear, but it appears that in at least some cases the latter is the case. In 2016, as reported by Portela, hotels in Cayo Coco were charged US$1.30 per cubic meters of

[58] The Cuban government's foreign investment opportunities guide for 2020-2021 identifies 503 opportunities, of which 131 are in the tourism sector. One of the priorities regarding investment in this sector is "to promote real estate development associated with tourism (totally Cuban-owned golf courses and marinas) and the construction of theme parks that incorporate the use of high technology." *Cuba: Portfolio of Opportunities for Foreign Investment 2020-2021* (La Habana: Ministerio de Comercio Exterior y la Inversión Extranjera, 2022). At present, Cuba has only two golf courses and neither one is sited on tourism areas in the Central Cuba cays. This may change in the future, however, should the ambitious plans of entity Cuba Golf S.A. to build 27 golf courses over the next 25 years materialize in part or in whole; it is worth noting than an investigative report on the plan to build numerous "ecologically sustainable" golf courses point out that promotional materials on the projects are silent on sources and availability of water to operate such facilities. Priscila Hernández Flores, "Campos de Golf sin Respuesta sobre el Agua en Cuba," *Connectas* (nd). See also "Abre otro hotel in cayo paradisiástico de Cuba, administrado por una hotelera española," *Diario de Cuba*, 31 Julio 2022.

[59] Reportedly, 140 liters per second of water is delivered daily from the mainland via a pipeline to Cayo Santa María to supplement some 50 liters per second extracted from underground resources to meet tourism demand. See "Infiernos medioambientales en el 'paraíso' de sol y playa llamado Cuba," Cubanet, 16 de abril de 2021.

[60] Tanker ships to transport potable water is frequently used in island countries, including some heavily reliant on tourism, such as the Bahamas, Antigua and Barbuda, and some Greek islands. Gössling, et.al., "Tourism and Water Use," 4.

[61] In similar nearby island settings, such as the Bahamas, small desalination plants are used to serve the tourist industry.

water delivered from the Alacranes reservoir, 160 kilometers away. Meanwhile, the cost of providing water to La Habana was a more modest US$0.60 per cubic meter.[62]

Among the major issues identified behind the water scarcity facing some of the most environmentally fragile sun and sand cay and coastal tourist resorts are failure to store and use rainwater, loss of opportunity to recycle wastewater, and failure to adopt water efficient procedures and appliances. Not only is the local natural water resource base largely exhausted, but the remaining stocks are contaminated, making it increasingly costly to operate tourist facilities. The tendency of tourism facility architects and landscape designers to ignore landscaping with natural vegetation, adapted to the local environment and less dependent on irrigation, also exerts pressure on water availability, as does the high-water consumption associated with irrigating golf courses.[63] Similar issues, although perhaps less severe, have also been reported in resorts sited or planned along the main island coastal areas, including the Pinar del Río region in westernmost Cuba.

These problems will only intensify as Cuba continues its drive to transition from the low end of the tourism spectrum (one-to-three-star quality rating lodging facilities) to the more costly to operate but potentially more profitable four- and five-star quality standard hotels. The latter generally have a greater number of rooms and, on a per tourist basis, consume far more water than the former.[64] Between 1990 and 2020, the number of five-star hotel rooms increased by more than 3,045% (from 1,027 to 32,298), while four-star hotel rooms rose by 538% (from 3,543 to 22,593), whereas the combined number of lower-rated hotel rooms remained relatively constant, increasing by just 12% (from 12,445 to 13,988).[65] Localized water use impacts are further magnified by the seasonality of the industry as Cuba -- as other tropical countries -- hosts most of its sun and sand tourists during the northern winter months when rainfall is less abundant and water demand peaks. In 2018, for example, 51% of the tourists visiting Cuba arrived in the period November-March, the peak of the dry season.

The growth in the number of hotels and hotel rooms, shift to higher-quality hotels, poor management practices, and seasonality of the industry, however, are not the only factors threatening long-term water availability for the industry: climate change is an even greater threat.

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[62] Portela, "La Presa Alacranes," 21.
[63] Ruiz Gutiérrez, *La Evaluación del Impacto*, Chapter 3, Table 33.T.1.
[64] Gössling, et.al., "Tourism and Water Use," 8.
[65] ONEI.gob.cu, Series Estadísticas, Table 15.11, Habitaciones existentes de servicios de alojamiento.

Most coastal tourist development poles, whether on coastal areas or adjacent cays, are extremely vulnerable to the anticipated, inevitable, and gradual sea rise expected as the earth continues to warm due to the emission of CO^2 and other pollutants. According to simulation assessments based on several models conducted in 2002 by Cuba's Instituto de Meteorología:[66]

> … the most likely hydrological scenarios indicate a substantial decline in the country's hydric potential, both superficial and subterranean, with the greatest diminution expected in the commonly humid months. Aside from the reduction in water availability, this will result in the biological and chemical deterioration of the resource … Seawater intrusion of subterranean water [due to sea level rise] will be one of the most serious problems arising from climate change given that the richest Cuban aquifers are open to the sea. Subterranean reserves will be gravely impacted by their physical-chemical deterioration and by a diminished hydric potential due to a rainfall deficit.

As daunting as this scenario may appear, it is worth pointing out that the Instituto de Meteorología study was conducted more than two decades ago. The results of its simulations today would have been far gloomier as the current scientific consensus is that the likely consequences of climate change will be far more serious than anticipated then.

The Challenge of Supplying Water to La Habana Hotels

We would be remiss if we concentrated our attention exclusively on the sun and sand resorts that have sprouted all over Cuba without discussing the tourism-water connection in the most important tourism pole of all: the city of La Habana. The capital city's metropolitan area is perhaps Cuba's most water-stressed zone, as it is not only home to by far the biggest urban agglomeration -- accounting for nearly 20% of the country's population -- but is also located in the northern coast at the narrowest part of the island, just tens of kilometers away from the southern coast where the main coastal aquifers from which it draws most of its drinking water are found. As was examined earlier, much of these water sources for decades have been subjected to excessive water withdrawal rates. La Habana has also become emblematic of the obsolescence and decay for which Cuba has become notorious, beyond its crumbling architecture. Much attention has also been placed on the difficulties to maintain a reasonable water supply due to the serious

[66] Instituto de Meteorología,54.

deterioration of the aqueducts and associated water distribution system serving the city. To counteract these deficiencies, some measures have been introduced – such as the use of water meters - to regulate consumption. But their impact has been minimal. Only 4% of La Habana households around 2020 were equipped with water meters but, even then, the fees paid just covered 7% of the actual cost of water deliveries, the balance being assumed by the state.[67]

Yet, a priority of the national tourism development strategy is transforming La Habana into one of the Caribbean's primary visitor destinations. It rests on renovating many of the city's historical architectural jewels in *La Habana Vieja* and transforming them into high end hotels. The strategy also entails refashioning what for centuries was the country's premier commercial port and historical shipping facilities into idyllic havens foreign tourist could enjoy. Cleaning the water of the bay, an effort long underway, and transferring most of the port's commercial activities to nearby Mariel harbor, are complementary components. One sign of the strategy's implementation is the growth in number of hotels in metropolitan La Habana: between 1985 and 2020 they increased from 27 to 91, with the number of rooms expanding by 182% over the same period (from 4,047 to 11,436).

In a national setting of scarce resources and competing needs, decisions have been made to prioritize hotels and tourism while downplaying the population needs. While a breakdown by type of infrastructure investment is not available, the figures in Table 2 for utilities investments nationwide show that expenditures for expansion and maintenance of basic services declined by half between 2017 and 2021, just as the number of high-end hotels in La Habana and elsewhere was expanding. These diverging trends support the proposition that authorities have chosen to neglect the maintenance of the water distribution infrastructure (along with other urban services), ignoring the resident population essential concerns, while investing in the tourism industry. The international literature suggests there is a wide gap in per capita water use between locals and tourists, the latter consuming 3 to 8 times more water than the former.[68] Moreover, given the geographical concentration of tourist facilities, occupancy rate seasonality, and the cyclical nature of rainfall availability, water access for residents could only worsen, during the tourist high season.

While there is only scant information regarding how hotels in La Habana are supplied with water, it is likely that in the higher income western suburbs (e.g., Vedado, Miramar, Playa), where

[67] Portela, "El agua,"21.
[68] Becken, "Water use."

many of the newer hotels are located, the aqueduct system might be robust enough to provide a reliable water supply year-round.

In La Habana Vieja,[69] in contrast, where the overall infrastructure is dilapidated, residents constantly complain about lack of service and are regularly supplied by water tank trucks, an inefficient and costly method, likely to be used as well with hotels, although on a far more reliable and ample basis. According to press reports, in 2022 close to one million Cubans received water via tank trucks, about half of them in La Habana. The INRH reported that on an annualized basis as much as 3.4 million cubic meters of water were lost in 2015 through cracks, a volume that may have doubled by 2022.[70] Reliance on tank trucks for water distribution is not unlike the method used to guarantee a reliable supply of propane gas to hotels in La Habana, more so in the historic district, given the unreliable nature of the city gas distribution network, as revealed by the May 6, 2022, gas-induced explosion in the five-star Saratoga hotel. The tragedy, which resulted in the death of 47 persons and injuries to one hundred more occurred as propane gas was transferred from a pressurized tank truck to the hotel's storage facility.[71]

CONCLUSIONS AND IMPLICATIONS

This review of Cuba's water sector has shown the remarkable changes it has experienced since the 1990s. The most dramatic from the demand side was in agriculture, where the need for irrigation water for previously priority crops collapsed, the country facing today unprecedented food shortages and unable to meet sugar export commitments or even satisfy domestic demand. While there is excess irrigation capacity in agriculture, it is not entirely clear if the available excess water supply could be shifted to human consumption, where demand is considerable. This would depend on the suitability of stored agricultural water for human consumption, treatment capability, and transport capacity. The other notable development over these three decades is a 60% increase in the amount of water used in other economic activities, most likely in the expanding tourism sector, whether during its construction, operation or maintenance phases.

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[69] This Havana neighborhood has suffered from water shortages for decades. It was revealed in 2011 that 70% of the 3,158 kilometers of pipes serving the city were in poor shape and responsible for the loss of much of the water pumped from the aquifers south of the city. EFE," Suministro de agua en La Habana pasa por etapa más crítica de los últimos 50 años," *Cubaencuentro.org*, April 12, 2011.

[70] "Cuba celebra el Día Mundial del Agua con más de 6,000 salideros en sus acueductos," *14YMedio.org*, March 22, 2022.

[71] Julio Aleaga Pesant, "Explosión en el Hotel Saratoga, otro accidente laboral," *Cubaencuentro.org*, May 9, 2022.

As our review has shown, the overall significance of tourism water consumption as a share of total available water volume is modest -- around 3%, well in line with international experience. However, per capita use tends to be much higher among tourists than among residents, a stressor impacting capacity to fulfill water needs in tourism poles located in water-scarce areas. This is evident along Cuba's coastal sun and sand tourism resorts, where there is evidence of persistent water shortages being addressed through costly interventions, a situation Cuba shares with other tourist destination countries having similar geographic and climatic characteristics.

A notable development in Cuba's case is the disregard the authorities have demonstrated for the water consumption needs of the population. There is much evidence – substantiated by official construction expenditure statistics – that despite urgent urban infrastructure requirements in La Habana as well as in other Cuban cities and towns, the decision was made to prioritize construction investments (including water-related ones) to expand the hotel and related tourism network, rather than to serve the population. The outcome is but one more indication of the lack of agency of the Cuban consumer, whose demands for even the most essential water services have been sacrificed at the altar of the governing elite's overarching economic development priority. Overdependence on a "tourism at any cost economic development model" may make Cuba as vulnerable to financial vicissitudes as those confronted by the country when in decades past all bets were on the sugar industry. And that vulnerability is not hypothetical, as demonstrated by the 2021-22 Covid-19 pandemic when tourism flows were significantly affected.

The pandemic may have been a transitory problem for the tourism industry, but the effects of global warming will not be so. Under current projected scenarios, sea level will rise one foot by 2050, and by as much as two feet by 2100.[72] Such seawater rise will damage or make unusable many of the tourist resort facilities Cuba has already built or is in the process of building in cays and coastal areas. But even if they were not to disappear under the waves, it would be challenging, as anticipated by Cuba's Meteorological Institute, to economically operate those resorts as their infrastructure is eroded and coastal seawater intrusions damage vulnerable coastal aquifers.

[72] National Oceanic and Atmospheric Administration (NOAA), "U.S. Coastline to See Up to a Foot of Sea Level Rise by 2050," February 15, 2022, https://www.noaa.gov/news-release/us-coastline-to-see-up-to-foot-of-sea-level-rise-by-2050.