WATER SECURITY AND CLIMATE CHANGE
IN THE REGION OF CENTRAL AMERICA & THE CARIBBEAN

IMPACTS OF CLIMATE CHANGE ON WATER SECURITY

IN THE RIO YAQUE DEL SUR WATERSHED OF THE DOMINICAN REPUBLIC

CATHALAC
Water Center for the Humid Tropics of Latin America and the Caribbean

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Published by the Water Center for the Humid Tropics of Latin America and the Caribbean – CATHALAC (for its acronym in Spanish) and the International Development Research Centre (IDRC).

IDRC | CRDI
International Development Research Centre
Centre de recherches pour le développement international

Canada

This work was carried out with the help of a grant from the International Development Research Centre (IDRC, Canada). IDRC – CATHALAC project No. 107084-001.

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ISBN: 978-9962-674-05-4

Between 2012 and 2015, with funding from the International Development Research Centre (IDRC, Canada), CATHALAC prompted a research study on Water Security and Climate Change at the regional level, with attention focused on the political-institutional conditions of water management in the Dominican Republic and Guatemala. In both countries work was carried out hand in hand with the Ministries of Environment and two national universities, the Technological Institute of Santo Domingo (INTEC) and the University of San Carlos of Guatemala, respectively. Together with national partner institutions, the areas of focus were selected.

In the Caribbean nation, a study was made of climate change-related vulnerability in the Rio Yaque del Sur watershed and of local water management in the municipalities of Guayabal and Tamayo. In the selected municipalities, those responsible for municipal planning, together with project researchers, drafted Municipal Plans for Adapting Water Resource Management to Climate Change.

Water Security

Water security is the "ability of the population to safeguard sustainable access to water in the quantity and of the quality suitable for livelihoods, human welfare[1] and socio-economic development, to ensure protection against water-borne contamination and water-related disasters, and to conserve ecosystems, in a climate of peace and political stability"[2].

The concept of Water Security summarizes the level of success of a given population in water management, including:

- Access to potable water
- Waste water collection and treatment
- Protection of livelihoods, human rights and cultural values
- Watershed conservation
- Socio-economic development

1 Human welfare has multiple aspects, including the basics for a good life, freedom of choice and action, health, good social relations, and security (MA, 2003 in UN-Water, 2013).

2 UN-Water. United Nations University. Institute for Water, Environment and Health. 2013. Water Security and the Global Water Diary. United Nations University. Ontario, Canada. 37 p.

The Rio Yaque del Sur

Watershed

The Rio Yaque del Sur watershed in the southwestern region of the country covers an area of 5,061 square kilometers. It is born on the southern slope of the central mountain range at a height of 2,707 masl and empties into the Bay of Neiba. It is the watershed with the greatest water potential in the Dominican Republic and is harnessed and regulated by multipurpose infrastructure, especially for agricultural irrigation. The San Juan valley, also known as the breadbasket of San Juan, is located here. Much of the food consumed by Dominicans is grown here. Regarding infrastructure, highlights are the dams of Sabaneta and Sabana Yegua, with a joint energy production capacity of 19.4 MW. Further down, the Monte Grande dam is under construction, with a generating capacity of 7.83 MW.

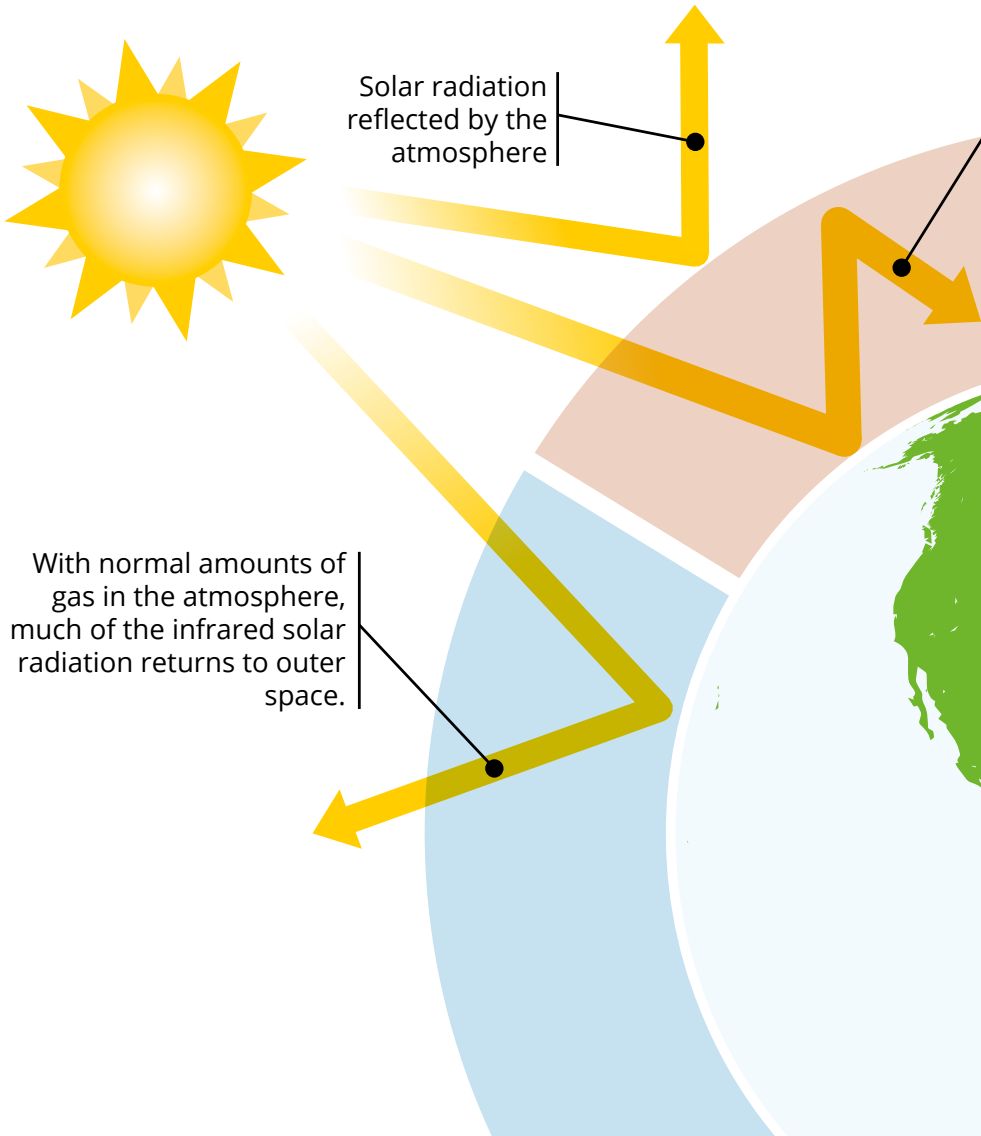
Yaque del Sur is the watershed with the greatest vulnerability to the effects of tropical cyclones, which produce large river swellings and floods. The territory of the watershed comprises 21 municipalities and is home to around 395,000 people, many of whom have dramatic memories of events such as Hurricane Georges in 1998 or the Noel storm in late 2007.

This research study evaluated the current vulnerability of the Yaque del Sur watershed to climate change, based on the conditions of two prioritized municipalities, Guayabal in the upper region and Tamayo in the bottom of the watershed.

What is climate change?

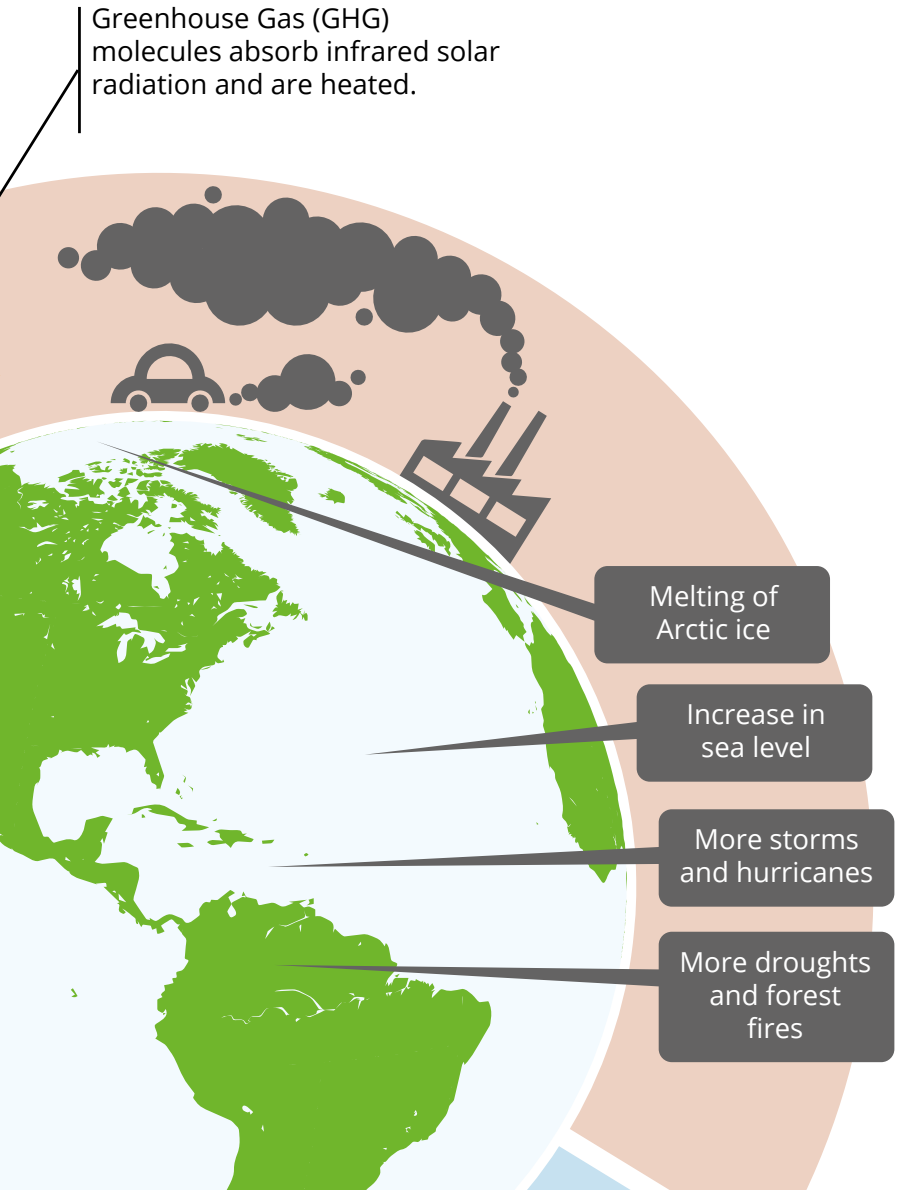
Climate change refers to a change in climate that persists for an extended period, typically decades or more. Climate change may be due to natural processes (such as volcanic eruptions) or people-driven processes (such as the gases emitted by burning vegetation or operating engines). Since human activity in recent years has generated huge amounts of gases called Greenhouse Gases or GHGs (because they function as a layer over the earth similar to the covering over a greenhouse, allowing sunlight to pass through, but storing the heat), the process of climate change has been accelerating in the planet, changing many patterns.

One of the direct effects of Climate Change is on the water cycle, i.e., on water availability, which means a lot in terms of human development, reducing poverty, food security, energy security, etc. Hence the need to analyze how Climate Change will affect water security, since this concept summarizes the use that society makes of this precious resource.



How will Climate Change affect water availability?

To answer this question, we explored what the climate will be like in the future. Different institutions around the world have modeled the planet's climate for different levels of Greenhouse Gas emissions. CATHALAC selected two of these models, the Norwegian model NorESM1-M and the Japanese model MIROC5, for both a low level (2.6 W / m2) and high level (8.5 W / m2) of emissions to 2050. The annual temperature and precipitation values for both models and their emissions scenarios were used to evaluate changes in the water cycle of the Yaque del Sur watershed using the SWAT program (Soil and Water Assessment Tool).

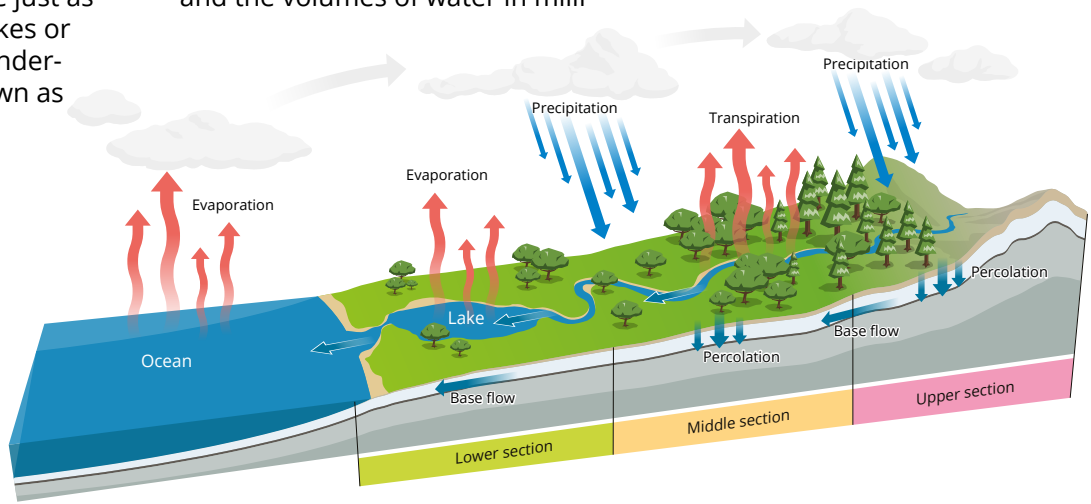


What is the water cycle and how does it work in a watershed?

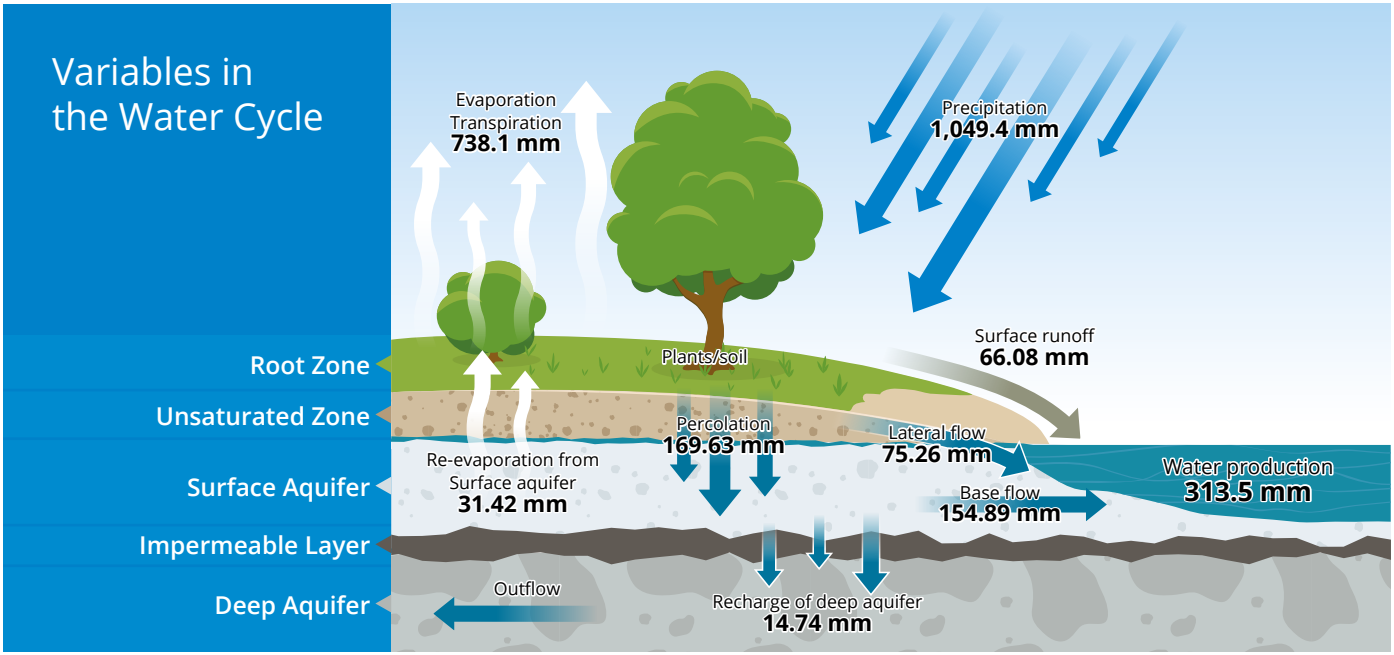
The water cycle describes the movement of water on the planet. Its movement may be in a liquid, solid or gaseous state and covers several stages: precipitation, which in our country refers mainly to rain but in other countries includes snow and hail; infiltration, which is water that penetrates the ground; the runoff that creates rivers; and the water that evaporates from surfaces (bare ground, ground with vegetation, bodies of water, etc.) to the atmosphere to form new clouds. This process is carried out in a land space called a watershed that acts like a "huge bowl" in which we can quantify how much water there is in each component of the cycle.

Soil and vegetation are key elements in this cycle, since just as water accumulates in lakes or dams, it is also stored underground in what are known as aquifers. The capacity of aquifers to store water depends first on their ability to infiltrate, which in turn depends on the type of surface; for example, in ground without vegetation the water will have difficulty penetrating deeper layers for storage, and in a storm, the water will run off quickly with no opportunity to infiltrate, possibly causing a flood disaster. That is why it is important to take care of forests; otherwise, there will be problems storing the water in rivers and underground, which are the main sources for the systems that transport water to our homes.

The figure Variables in the Water Cycle of the Yaque del Sur Watershed presents the different components of the water cycle and the volumes of water in millimeters that have been calculated for each one in the Yaque del Sur watershed. The chart that follows presents monthly averages for these variables throughout the year. It can be observed that average precipitation for the watershed is 1,049 mm. Of this amount, 70% evapotranspires, a portion of the surplus runs over the ground, another part runs through the topsoil as lateral flow and another percolates. Of the water that percolates, part evaporates from the ground, another part flows horizontally and only a small 1% infiltrates to recharge deep aquifers. The amount of water counted as Water Production is the sum of the Superficial Runoff, Lateral Flow and Base flow.



Variables in the Water Cycle of the Rio Samala Watershed



Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Precipitation (mm)	23.07	24.88	52.95	95.31	149.33	100.94	94.31	119.54	162.93	114.24	79.18	32.73	**1049.41**
Surface Runoff (mm)	0.18	0.39	1.55	7.40	15.98	2.67	2.49	2.72	17.66	4.91	9.34	0.80	**66.08**
Lateral flow (mm)	3.57	2.40	2.74	3.96	7.08	7.35	6.63	7.22	9.98	10.14	8.39	5.81	**75.26**
Percolation (mm)	2.30	3.08	5.51	8.85	19.28	14.00	11.17	16.79	35.72	25.57	20.18	7.19	**169.63**
Underground flow/ Base flow (mm)	14.08	12.02	12.45	11.55	11.98	12.01	12.28	12.19	12.67	14.35	14.50	14.80	**154.89**
Recharge to deep aquifer	-11.78	-8.94	-6.94	-2.71	7.30	1.99	-1.11	4.60	23.06	11.21	5.68	-7.61	**14.74**
Evapotranspiration (mm)	22.70	24.32	64.36	89.57	88.87	75.79	69.84	74.47	77.92	69.97	50.10	32.38	**738.1**
Water production (mm)	19.39	16.21	18.26	24.33	36.48	23.40	22.80	23.52	41.65	30.83	33.67	22.94	**313.49**

CURRENT VULNERABILITY

The IPCC[3] defines vulnerability to climate change as "the degree to which a system is susceptible or unable to cope with the adverse effects of climate change, including climate variability and extremes." In the Yaque del Sur watershed, CURRENT vulnerability was evaluated in three aspects: Exposure, which is the type of impact that the watershed is exposed to and the degree or the intensity of the impact; Sensitivity, the degree to which the watershed is affected by the weather; and Adaptive capacity, which refers to the watershed's ability to adapt to change, mitigate possible damage, take advantage of opportunities or face the consequences.

The factors related to vulnerability were determined by the indicators in the following figure and were graded on a scale of 1 to 3, where 1 (low) is better than 3 (high) for the Exposure and Sensitivity indicators, while 3 (high) is better than 1 (low) for Adaptive capacity.

3 Intergovernmental Panel on Climate Change, technical advisory body of the United Nations Framework Convention on Climate Change.

INDICATORS FOR EVALUATION OF VULNERABILITY VARIABLES IN THE RIO YAQUE DEL SUR WATERSHED

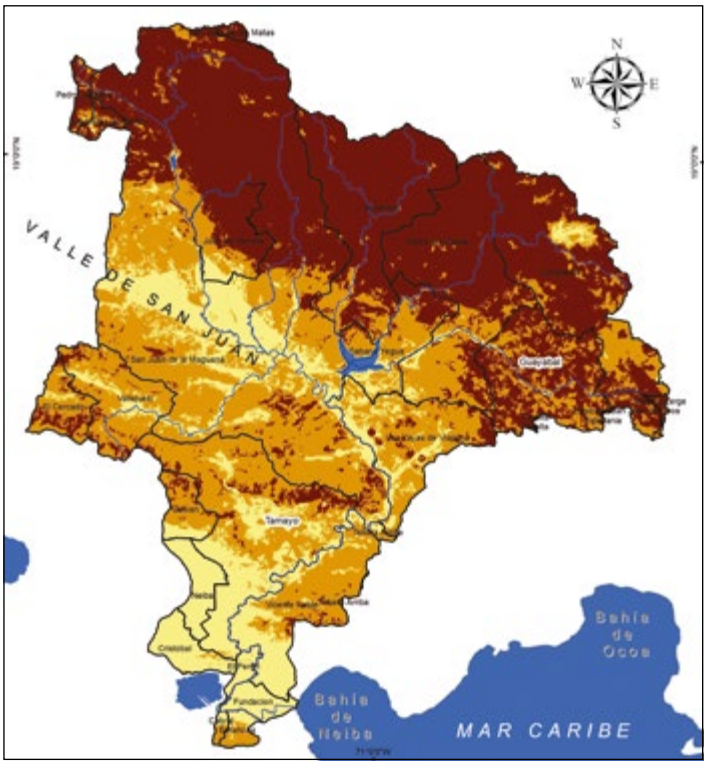
EXPOSURE	SENSITIVITY	ADAPTIVE CAPACITY
Phenomena associated with climate change	What elements of water security will be most affected by the impacts of climate change (drought, floods, frost and landslides) in the municipalities of the Yaque del Sur watershed?	How can water security be adjusted, maintained or increased to address climate change in the municipalities of the Yaque del Sur watershed?
▸ Floods ▸ Drought ▸ Frost ▸ Landslides	▸ Water flow available ▸ Water quality at source ▸ Aquatic ecosystem ▸ Potable water ▸ Housing (Building materials) ▸ Access roads (permanence) ▸ Access to electricity ▸ Economic activities dependent on natural resources ▸ Food Security: Local food production ▸ Illiteracy ▸ Disease: Incidence of diarrhea and parasites ▸ Disease: Incidence of dengue and malaria ▸ Food Security: Incidence of malnutrition, anemia, low birth weight or delayed growth in children under 5 ▸ Population density ▸ Migration caused by hydro-meteorological risk ▸ Water-related conflicts	▸ Forest cover ▸ Territorial management plans / watershed management ordinances ▸ Risk management ▸ Water infrastructure ▸ Technologies applied to water management ▸ Road density, alternate communication routes ▸ Energy network ▸ Health care facilities ▸ Productive diversification ▸ Nation's wealth ▸ Access to credit, support and subsidies ▸ Highest educational degree available locally ▸ Organizational level ▸ Waste management and cleaner production ▸ Penetration of media ▸ Presence and development of state institutions ▸ Municipal capacities for water management and sustainability of water management systems

Exposure

The municipality of Guayabal belongs to the province of Azua. It has an area of 235.6 square kilometers and, according to the last census in 2010, a total population of 5,263 people.

As shown in the map of flood exposure, the municipality of Guayabal is located in a very steep area, which is why it appears on the low end for this indicator. Historically, however, it has been susceptible to flooding by the Las Cuevas river. As for landslides, the municipality is highly vulnerable due to the sharp incline of the terrain. For windstorms, the analyses reflect that 98% of the land has a middle to high level

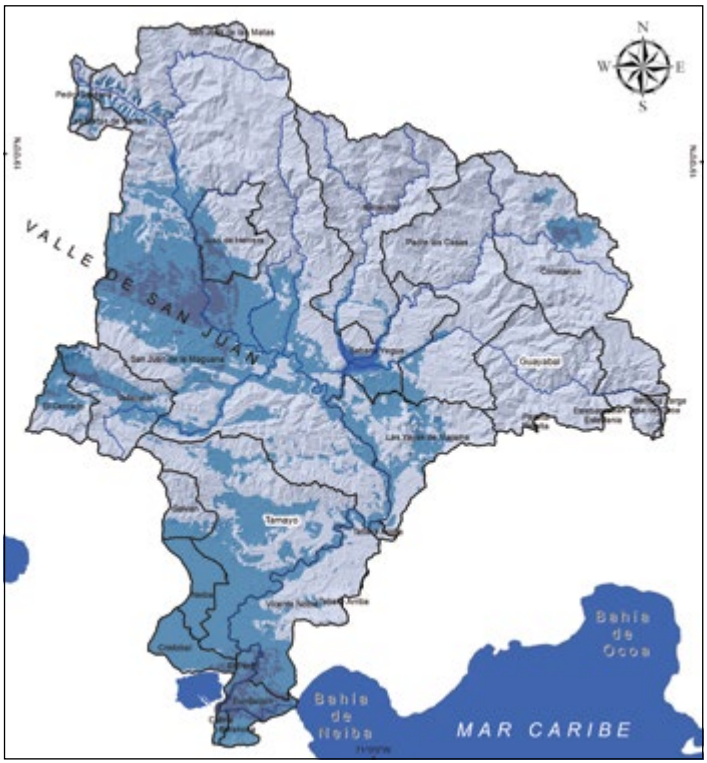
Landslides



Degree of Exposure

Low Medium High

Flooding



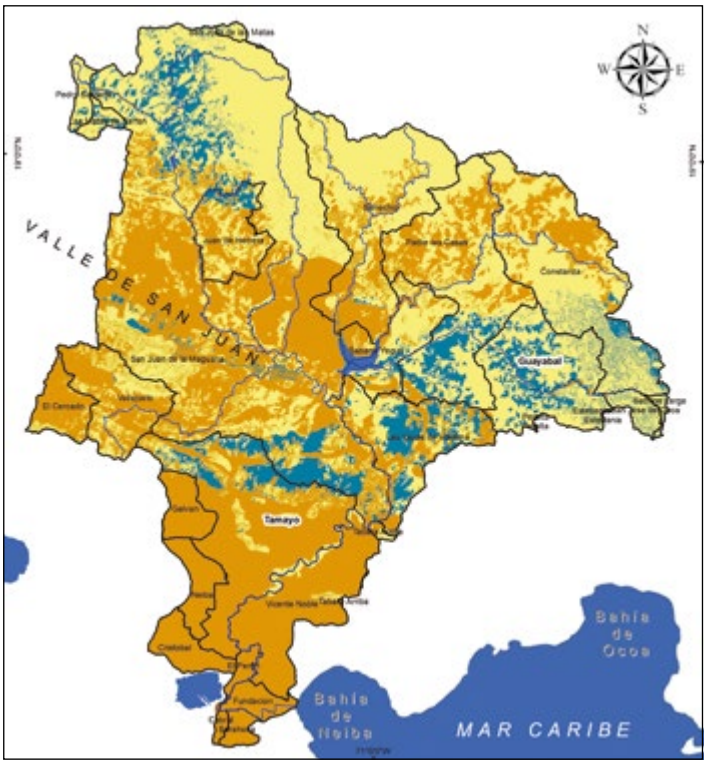
Degree of Exposure

Low Medium High

of exposure, while the level of exposure to drought is medium to low within the territory. In summary, the municipality of Guayabal has a medium exposure level (2.0) to the climate hazards analyzed.

The Municipality of Tamayo belongs to the province of Bahoruco. 26,772 people live in its 434.3 km², 74% in urban areas. The municipality of Tamayo is affected by constant flooding of the Yaque del Sur river; it is also very exposed to drought and the effects of windstorms; being located on flatter lands, it is not as exposed to landslides. The municipality has an average exposure index of 2.2.

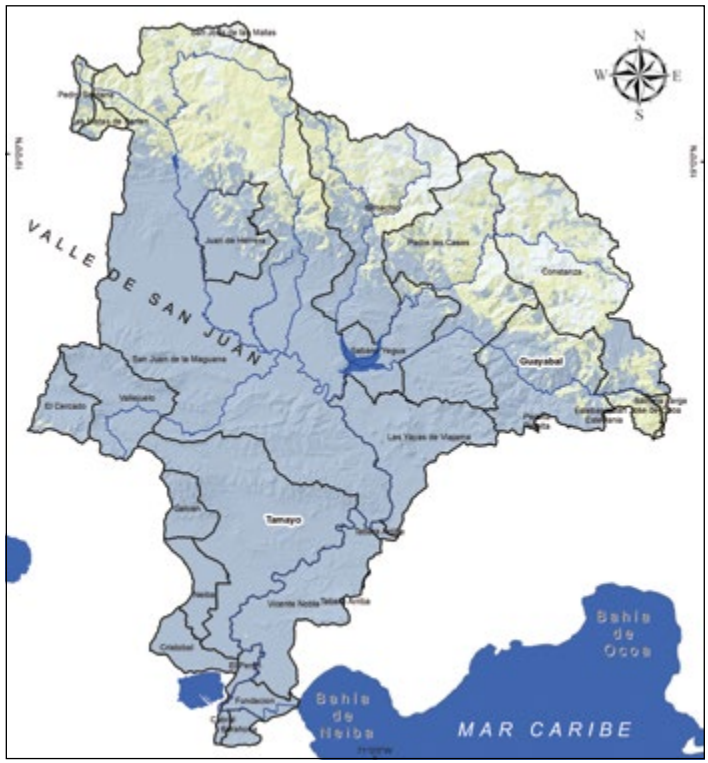
Drought



Degree of Exposure

Low Medium High

Windstorms



Degree of Exposure

Low Medium High

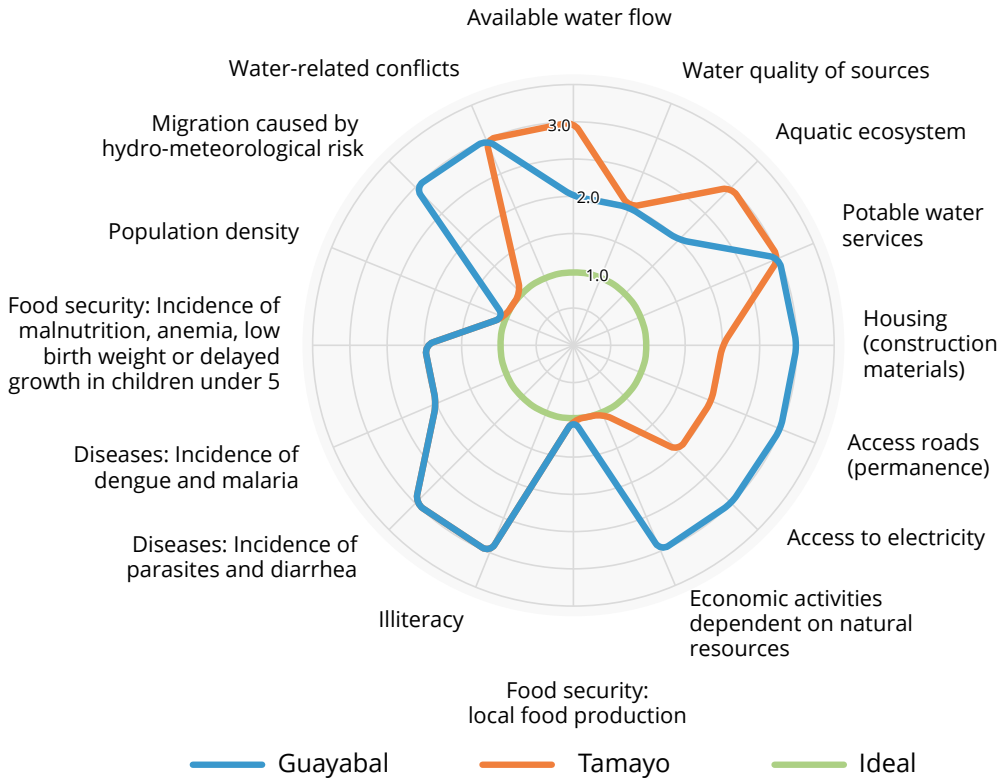
Sensitivity and Adaptive capacity

The Sensitivity and Adaptive capacity indices were obtained through socioeconomic indicators, which were evaluated be means of 396 semi-structured interviews done by a research team from the Technological Institute of Santo Domingo (Contreras et al, 2015[4]), secondary and census information.

The indicators were added by capital type, following DFID methodology (1999[5]):

- Natural resources: The presence of natural resources on which people depend both directly (i.e. for income or medicine) and indirectly (i.e. flood control, protection from storms).

SENSITIVITY

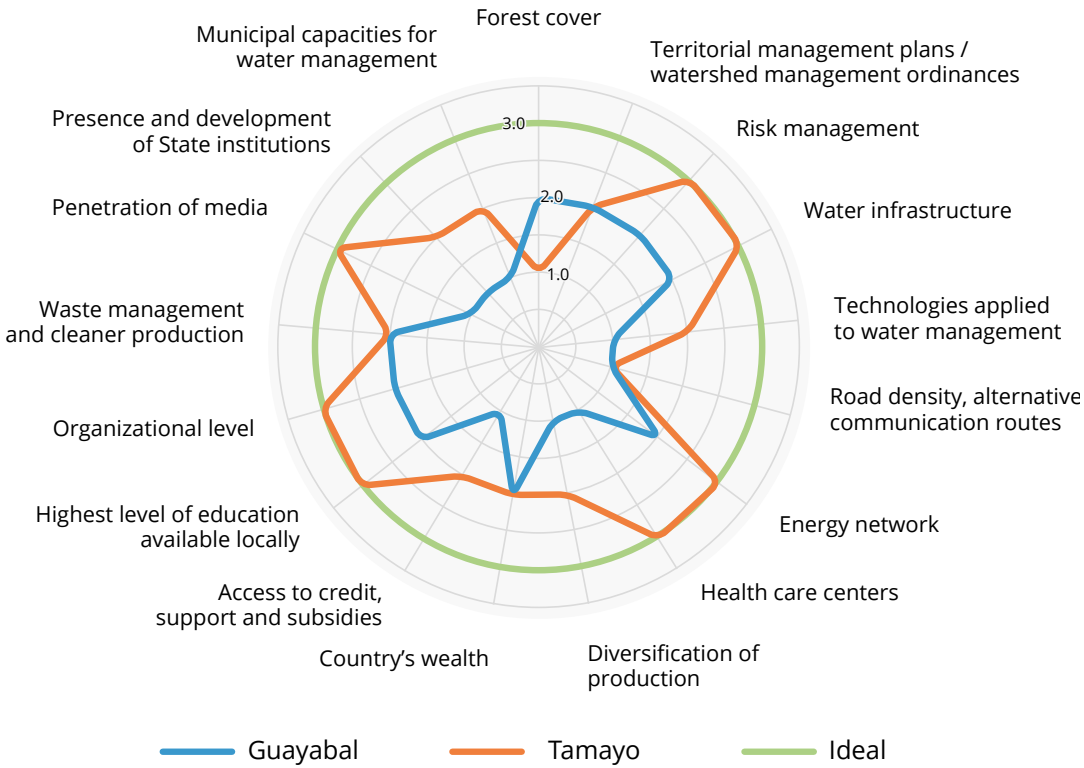


Sensitivity in Guayabal is slightly greater than in Tamayo. Guayabal is sensitive mainly in the aspects of physical resources (services and infrastructure) and human resources (illiteracy and disease). Tamayo's biggest weaknesses are found in the area of natural resources, as they reflect the accumulation of impacts from the management of the watershed upstream.

4 Contreras Jose, Ramon Villaman, Angela Carrillo, Eva Nuñez. 2015. Indices of Sensitivity and Climate Change Adaptation in four municipalities of the Yaque del Sur river basin in the Dominican Republic. Working document. Project on Water Security and Climate Change in Central America and the Caribbean.

- Physical Resources: the basic structure and productive capital for transportation, buildings, water management, energy and communications.
- Financial resources: The existence and flows of money that enable people to achieve their goals with regard to livelihoods.
- Human Resources: the skills, knowledge, capacity and good health necessary for achieving livelihoods.
- Social Resources: the formal and informal social relationships and institutions on which people's livelihoods depend.

ADAPTIVE CAPACITY



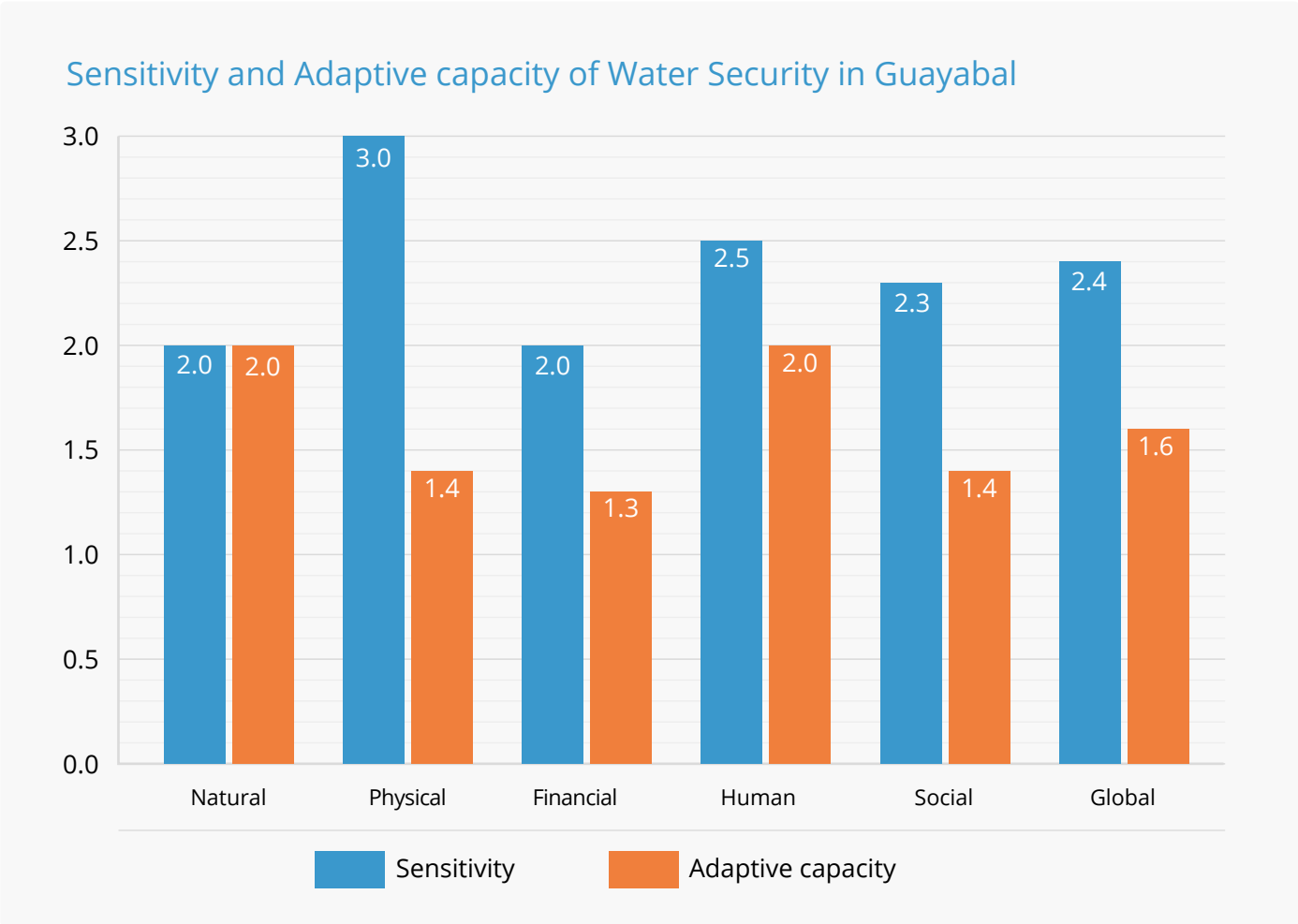
With regard to Adaptive capacity, Tamayo has certain elements that would facilitate better adaptation to the impacts of climate change when compared to Guayabal, such as accessibility, communications, organizational level and possibilities of access to financial services.

5 DFID (Department for International Development UK). 1999. Sustainable Livelihoods Guidance Sheets. Consulted on October 15, 2013. Available at: http://community.eldis.org/.59c21877/SP-GS1.pdf http://community.eldis.org/.59c21877/SP-GS2.pdf

Current Vulnerability of Water Security in Guayabal Guayabal

Guayabal is highly vulnerable. It has a rich natural capital due to the forest cover and the management plans that have been developed, although it requires strengthening of capacities to implement these plans. As for physical capital, public services are deficient in Guayabal, especially with regard to potable water and sanitation; access roads are very vulnerable, as well as housing, and there are only one public and one private health center. Production technologies are elementary; the good news is that there is good water resource management experience in the community of Recodo. With respect to financial capital, the main economic activity in Guayabal is subsistence agriculture, which is poorly diversified and aimed at local consumption. Producers have difficulty accessing financing mechanisms to improve their systems. As for human capital, the illiteracy rate is greater than 20% and middle school is the highest level of education offered in the municipality. Regarding health, a significant percentage of people suffer from water-related diseases and national statistics suggest the need for improvement in the diet of the population. Finally, with regard to social capital, local organizations can be strengthened to promote greater opportunities for local development; increased media penetration and the presence of state institutions are also necessary, and municipal capacities need to be strengthened in order to participate more actively in the water resource.

Exposure		Capital	Sensitivity	Adaptive capacity	Vulnerability Index
Flooding	1.0	Natural	2.0	2.0	2.8 HIGH
Landslides	2.6	Physical	3.0	1.4	
Drought	1.7	Financial	2.0	1.3	
Windstorms	2.8	Human	2.5	2.0	
		Social	2.3	1.4	
Global	2.0		2.4	1.6	

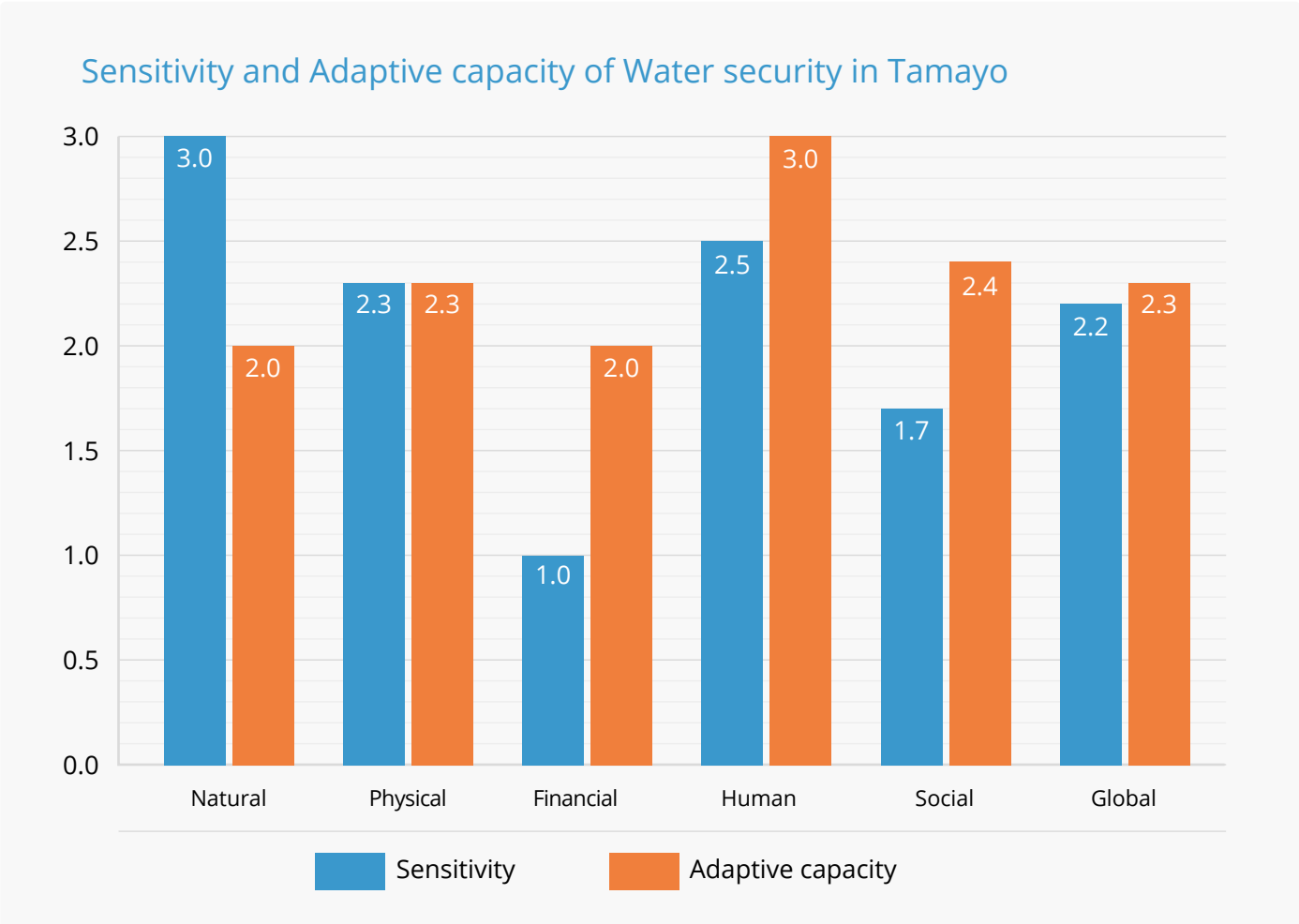


Remember that 1 (low) is better than 3 (high) in the Sensitivity indicators; while 3 (high) is better than 1 (low) for Adaptive capacity.

Current vulnerability of water security in Tamayo

Tamayo revealed a medium level of vulnerability. In the area of natural capital, due to its location in the lower part of the basin, Tamayo accumulates the impacts of management practices upstream and therefore may present problems related to the quantity and quality of water and the agricultural capacity of the soil, since most of its forests have been eliminated. With regard to physical capital, Tamayo has better infrastructure services, access and health care centers. It is important to note that the Monte Grande Dam will have significant impact on mitigating floods in the city and surrounding areas. It is also important to continue improving the quality of services, especially water and sanitation. As for financial capital, this municipality has greater financial capacity. Its human capital is strengthened by better educational opportunities, but there are still high levels of illiteracy. Moreover, deficiencies in water services are affecting the health of the population. Regarding social issues, the effects of unequal development can be observed in Tamayo, such as the monopolization of water by large producers, affecting subsistence farmers and small aqueducts; another sign of inequity is seen in the quality of life of agricultural workers. The municipality has little influence in these areas and participation by other agencies is low.

Exposure		Capital	Sensitivity	Adaptive capacity	Vulnerability Index
Flooding	1.5	Natural	3.0	2.0	2.0 MIDDLE
Landslides	1.7	Physical	2.3	2.0	
Drought	2.6	Financial	1.0	2.0	
Windstorms	3.0	Human	2.5	3.0	
		Social	1.7	2.4	
Global	2.2		2.1	2.3	



Remember that 1 (low) is better than 3 (high) in the Sensitivity indicators; while 3 (high) is better than 1 (low) for Adaptive capacity.

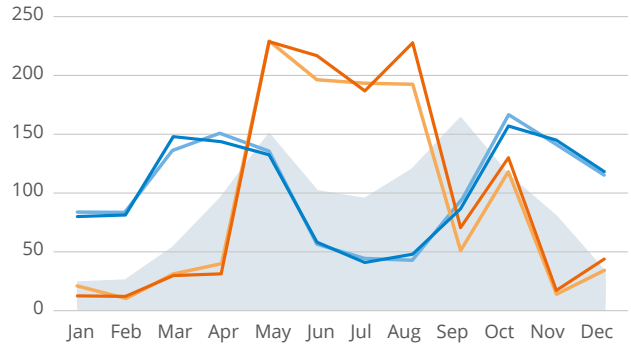
Impacts of climate change on the water cycle in the Rio Yaque del Sur watershed

Following are four graphs (hydrographs) showing the monthly averages in millimeters (mm) of water in the Yaque del Sur watershed. The shadow is the current baseline (calculated from 1983 to 2004) and the lines represent the values projected to 2050 according to two models and two scenarios of greenhouse gas emissions.

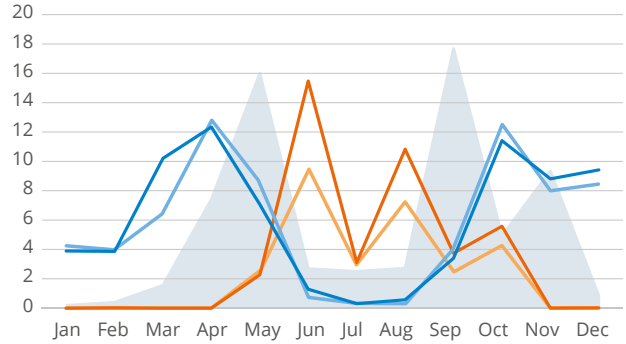
The NorESM1-M and MIROC5 models were selected for their relatively drier and wetter (respectively) behavior relative to historical averages in the region. It can be seen in the precipitation graph that both models detect the intra-summer drought period (the veranillo or "little summer"); however, the Norwegian model (orange line) indicates an abrupt onset of the rainy season that ends in May (before the baseline) and a third maximum peak of rains in October. The Japanese model (blue line), meanwhile, reports an earlier onset and later end of rains, but a more prolonged and intense period of veranillo. Both models show increased water production during the months of June and July.

MONTHLY CHANGES (AVERAGE)

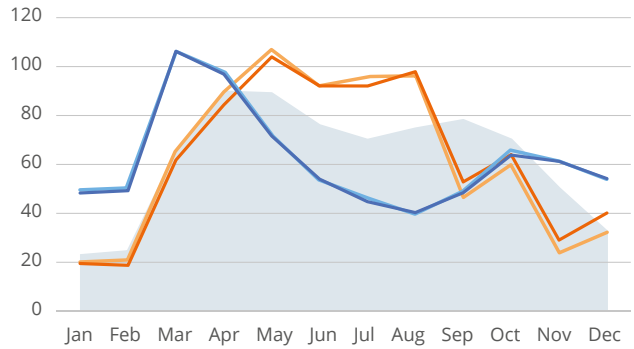
PRECIPITATION (mm)



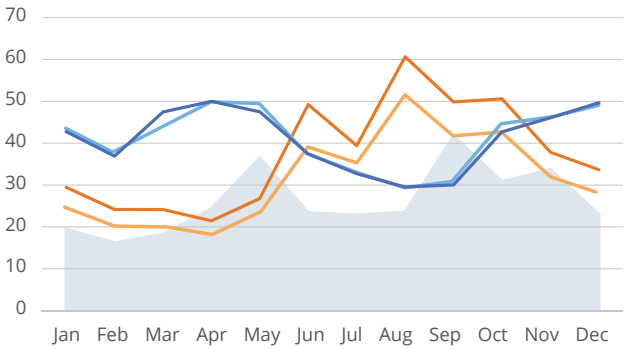
RUNOFF (mm)



EVAPOTRANSPIRATION (mm)



WATER PRODUCTION (mm)



Base line

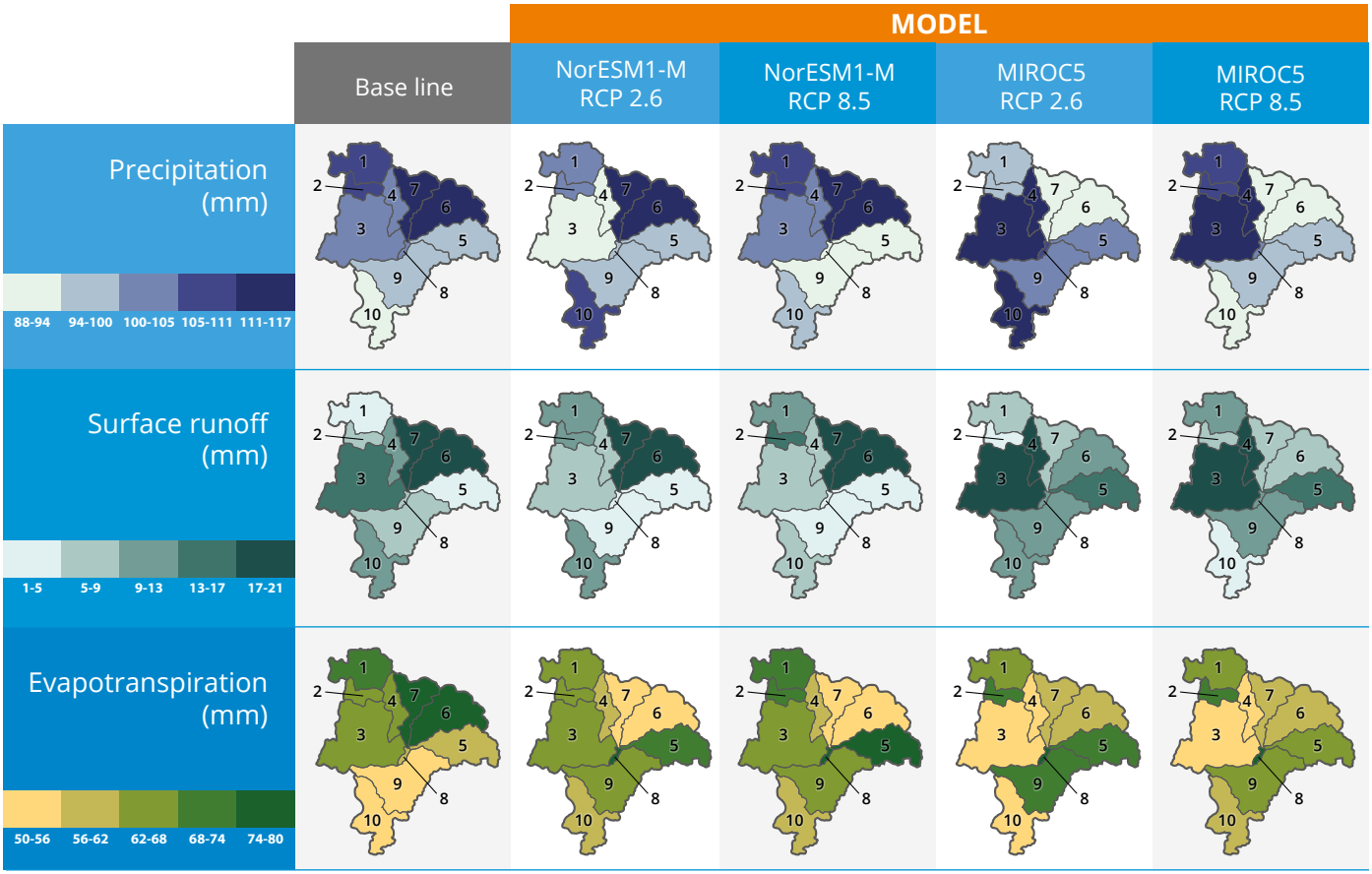
NorESM1-M (2013-2050), RCP 2.6

NorESM1-M (2013-2050), RCP 8.5

MIROC5 (2013-2050), RCP 2.6

MIROC5 (2013-2050), RCP 8.5

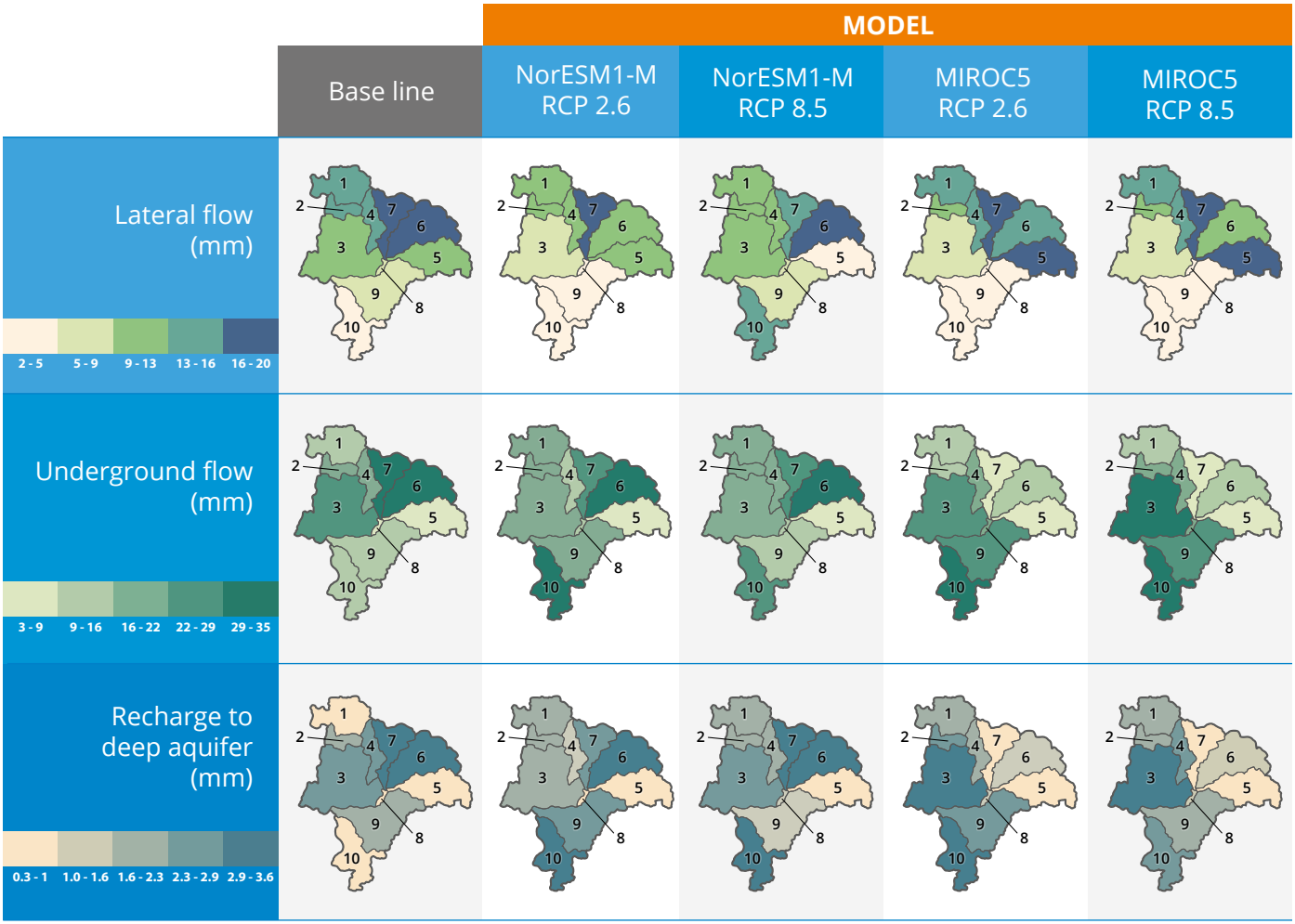
Impacts of climate change by subwatershed



Code	1	2	3	4	5	6	7	8	9	10
Subwatersheds	San Juan			Río Mijo	Río Las Cuevas	Río en Medio	Río Yaque del Sur			

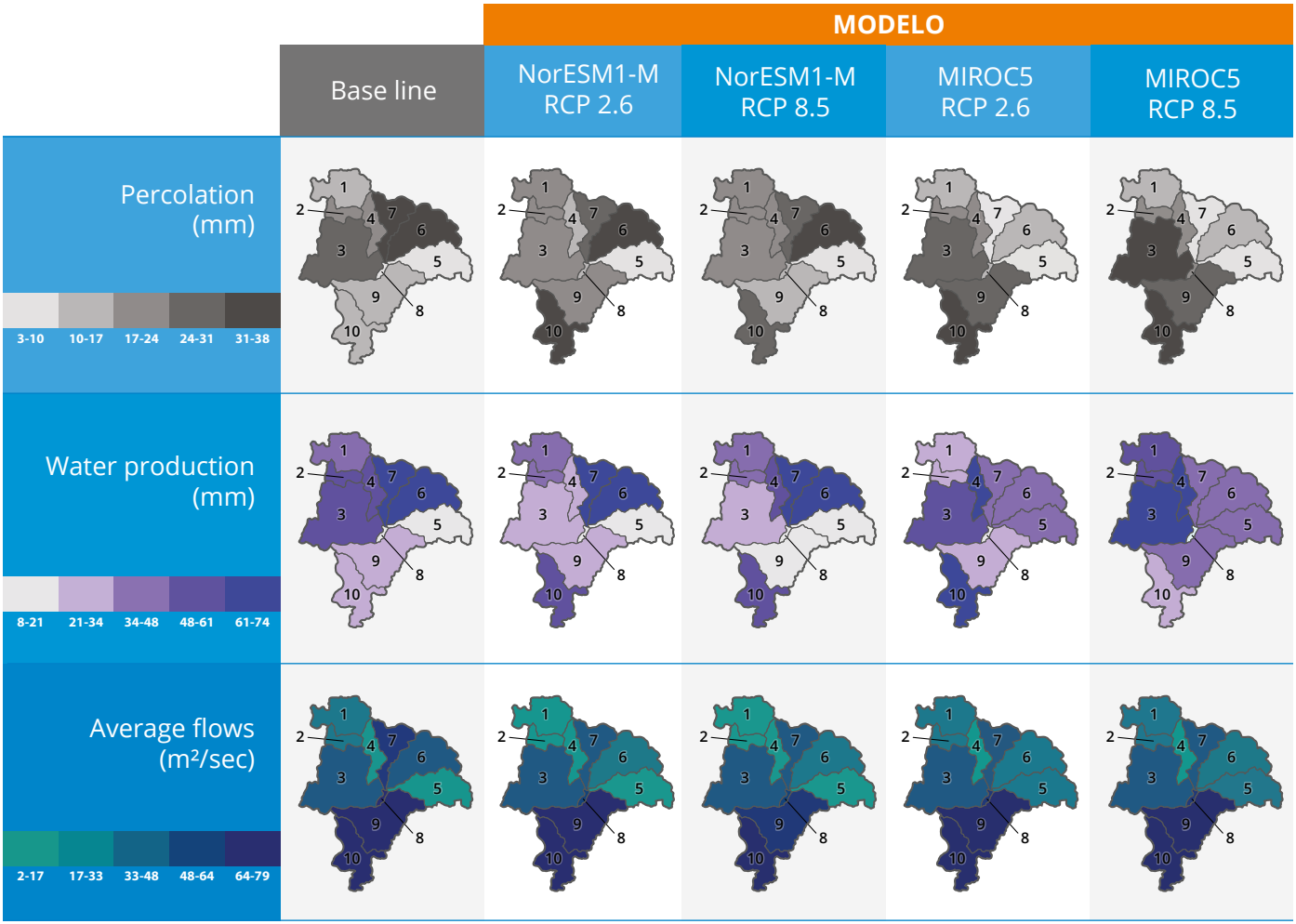
The municipality of Guayabal is found in the Rio Las Cuevas subwatershed (number 5). Greater changes are observed under the Japanese model (MIROC5), especially greater runoff, increased flow rates and consequently, greater impacts in terms of silting.

In the southern part of the watershed (numbers 9 and 10) where the city of Tamayo is found, more precipitation is expected, especially in a low emissions scenario (2.5 W / m²), which has some effects in terms of water production and sediments, while the RCP 8.5 scenario indicates a significant reduction in rainfall.



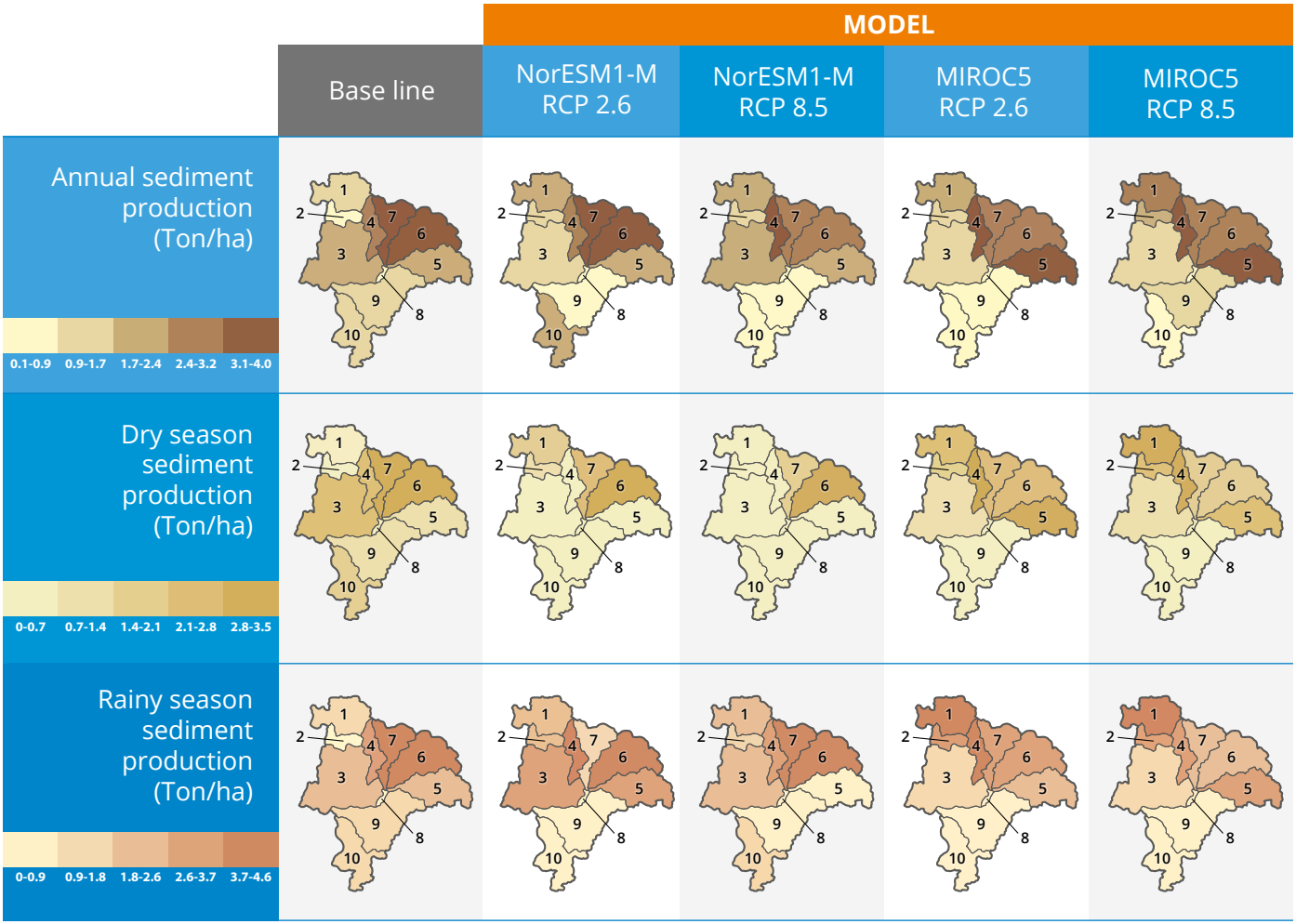
Code	1	2	3	4	5	6	7	8	9	10
Subwatersheds	San Juan			Río Mijo	Río Las Cuevas	Río en Medio	Río Yaque del Sur			

Increased recharge of aquifers could occur in the lower part of the Yaque del Sur basin.



Code	1	2	3	4	5	6	7	8	9	10
Subwatersheds	San Juan			Río Mijo	Río Las Cuevas	Río en Medio	Río Yaque del Sur			

If we observe the water production component in these maps constructed with annual totals by subwatershed, there seem to be no differences with regard to the baseline; however, in the hydrographs showing monthly behavior, we see variations to the current or baseline distribution (Page 21).



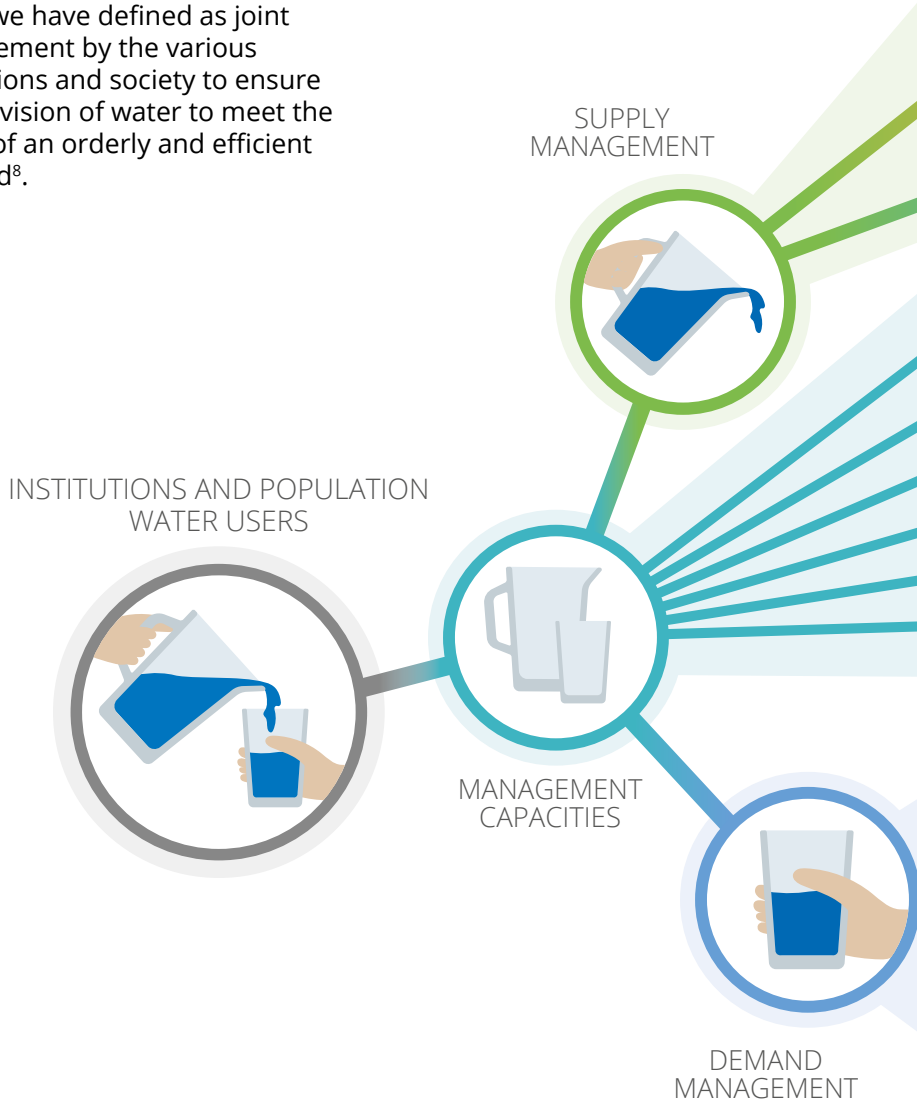
Code	1	2	3	4	5	6	7	8	9	10
Subwatersheds	San Juan			Río Mijo	Río Las Cuevas	Río en Medio	Río Yaque del Sur			

Currently, annual sediment production in the Yaque del Sur watershed is estimated at 11.4 ton/ha. In the dry season, the microwatersheds of the Jinova, Yavano, Los Baos, Cañada, El Sillon and Arroyo Loro rivers produced on average 3.2 ton/ha. Sedimentation increases during the rainy season; the Mijo microwatershed alone produces this amount in September, increasing to 3.9 ton/ha in the lower Yaque del Sur watershed as a result of changing land use over to intensive crops such as rice and sugar cane.

ADAPTATION TO CLIMATE CHANGE

Now that we know how climate change could affect the water resources of the Yaque del Sur watershed both in time (hydrographs, page 21) and space (maps, pages 22 to 25), and the vulnerability of the population to the possible effects (Páginas 10-19), a plan needs to be created in order to be better prepared, i.e., an Adaptation Plan.

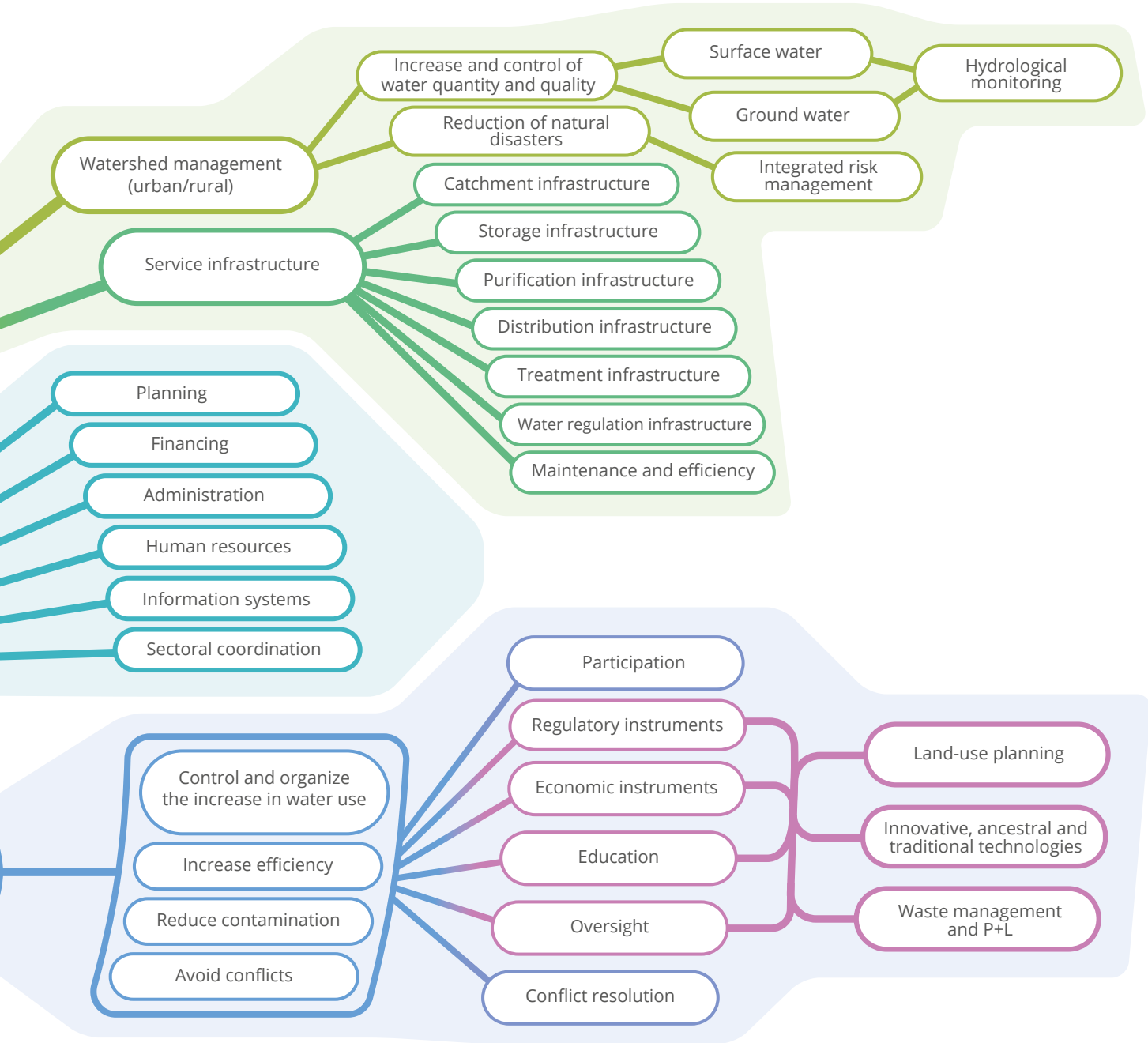
Sadoff and Muller (2010)[6] say the best way to adapt to climate change is by ensuring water security, as climate change has a direct impact on water. In this regard, the international community[7] has found that water management must be integrated in order to progress in terms of water security, so two municipal plans for adapting water resource management to the need for water security were drafted in Guayabal and Tamayo from the integrated water resource management approach, which we have defined as joint management by the various institutions and society to ensure the provision of water to meet the needs of an orderly and efficient demand[8].



6 Sadoff Claudia and Mike Muller. 2010. Water Management, Water Security and Climate Change Adaptation. Anticipated effects and essential answers. GWP. TEC Background Papers No. 14. 101p.

7 For example the United Nations Conference on Sustainable Development (Rio +20) in Planet under Pressure (2012).

8 CATHALAC. Water Center for the Humid Tropics of Latin America and the Caribbean. 2015. La gestión del agua para la Seguridad Hídrica frente al Cambio Climático. Proyecto Seguridad Hídrica y Cambio Climático para la región de América Central y el Caribe. International Development Research Centre (IDRC). Panama. 55 p.



Source: CATHALAC (2015)*

PRIORITY ADAPTATION MEASURES

GUAYABAL

PRIORITIZATION OF WATER SECURITY ISSUES	
1	**Water sources**
2	**Services**
3	Water uses and development
4	Risks
5	Energy security
6	Food security
7	Health
8	Governance

*The municipal water managers identified the adaptation measures for the two prioritized aspects of water security in the municipality

RESPONSE*	TERM S,M,L	PRIORITY
WATER SOURCES		
Reforestation of water sources with native species	S	1
Educational project for the population on the care and management of watersheds	S	2
Technical assistance to implement reforestation projects at the watershed level	S	3
Criminalization of bad practices in forests	S	4
Brigades to care for and preserve watersheds and fight fires	S	
Soil conservation practices with live and dead barriers	S	
Create a municipal water reserve	M	
Construction of reservoir	M	
Installation of irrigation system	M	
Construction of rural aquaducts	M	
Draft farm plans	M	
SERVICES		
Strengthen INAPA staff and other municipal facilitators in maintaining water quality of potable water systems	S	1
Build water treatment plant for the aqueduct	S	2
Environmental education program for farmers on pollution of water sources	S	3
Public education campaigns on the use and care of water	Z	4
Construction of Guayabal sewer system for control and treatment of wastewater treatment	M	
Construction of dams for irrigation and domestic consumption	L	

TAMAYO

PRIORITIZATION OF WATER SECURITY ISSUES	
1	**Water sources**
2	**Services**
3	**Water uses and development**
4	**Risks**
5	Health
6	Food security
7	Governance
8	Energy security

*The municipal water managers identified the adaptation measures for the four prioritized aspects of water security in the municipality.

RESPONSE*	TERM S,M,L	PRIORITY
FUENTES DE AGUA		
Reforestation of water sources with native species		1
Establish round tables and inter-institutional planning for water resources	S	2
Water recharge projects	S	3
Planning of water use and supply	S	4
Awareness campaigns on forest protection and care	M	
Set up payment program for environmental services	L	
Soil conservation and flood mitigation projects	L	
SERVICES		
Blacktop or covering for latrine systems and irrigation canals	S	1
Maintenance and cleaning of irrigation canals of users	S	2
Construction of artificial lakes for water catchment	S	3
Projects to channel water in the river	S	5
Improving residential drainage and sewer services	M	6
Update current water distribution projects	M	
Construction of tanks	M	
Replace the use of lime and "plomerito" (substance with sulfuric acid) with biodegradable products	L	
WATER USE AND DEVELOPMENT		
Plan for management of water use in production systems	S	1
Replace water system infrastructure to prevent leaks	S	
Empower authorities to govern the issue of water use in agriculture	S	
Promote organic farming to reduce outbreaks caused by chemicals	M	
Generate information system for water demand	L	
Recondition water intakes and irrigation systems	L	
RISKS		
Construct drainage systems for urban areas and agricultural lands	S	1
Management and acquisition of tools, machinery and equipment for disaster response in emergencies	S	2
Designing an early warning system for both drought and floods	S	3
Risk management orientation and awareness campaign through the local media		4
Construct water catchment and reservoir infrastructure	M	5
Awareness talks in schools and communities	M	6
Set a work and follow-up schedule for strengthening emergency organizations for natural events	M	7
Riverbank reforestation program with endemic, native and naturalized species	M	8

EDUCATIONAL RESOURCE

What is Climate Change?

What is the water cycle?

What is a watershed; what does it look like?

How can climate change affect water availability?

How can climate change affect you or the activities you or your family do?

What climate change-related phenomena is your community most exposed to?

If you look at how sensitivity and adaptive capacity are measured, what are the greatest vulnerabilities of your community?

What can you do in your community for greater water security, considering the possible effects of climate change?

Why must we protect the forests in a watershed?

ACKNOWLEDGEMENTS

We wish to thank the following individuals, institutions and organizations who have supported us throughout this research: The Ministry of Environment and Natural Resources, especially Jose Alarcon Mella, Vice Minister of Land and Water, Ramon Villaman, Ana Baez, Belkis Fernandez, Ramon Luis, Joan Beras, Laris de los Santos, Ariel Ciprians, Jesus Beltre, Leonel Rosario Mendez, Miguel Mella, Ramon Luis Ramon Marrero, Ricardo de la Cruz. The Technological Institute of Santo Domingo, mainly Jose B. Contreras, Leandro De La Cruz, Angela Berenice Carrillo and Eva Nuñez. Participants of the Focus Groups and Municipal Workshops: Juan Antonio Gomez, Santo Beltre, Manuel Emilio Veloz, Rafael Amable Familia, Natanael Dural, Nicolas Cabral Sanchez, Juden de la Cruz, Jose Enrique Galva Lamarche, Natanael Reyes, Mervin Batista, Nelson Perez, Vicente Alcibiades, Cristobalina Cuello, Eleodoro Terrero, Feliberto Diaz, Leonardo Morillo, Radhames Soto, Antonio Ramon Cuello, Wilson Taveras, Wilson Veloz, Ariel B. Galarza, Felipe Mendez B, Gumercindo Paula, Luis Batista Peña, Menni Acevez, Misicid Leo, Model Subenu, Nestor Ramirez, Nicolas Peña, Solimar Betancur, Tatania Aquino R, Julio Feliz Montero, Conrado Aristides Santana Reyes, Eudalia Perez S., Marvi Alcantara L., Blanca Celeste Diaz, Rafael Antonio Adames Jimenez, Manuel Emilio Veloz, Matias Valenzuela, Ansermo Cuello, Julio Cesar Pineda V., Rafaela Cuello Custodio, Rudilania Montilla, Alejandro Diaz, Carmito Gomez, Estebania Valenzuela, Francisco Ramirez Taveras, Henry Alcantara, Jose Antonio Terrero, Juan Bautista Piña, Marcial Cuello, Mauro de Leon, Maximo Morillo, Rafael Rojas Tejeda, Rene Emilio Grullon, Santiago Cedano, Tirso Cuello Familia, Zaba Morillo, Juan Concepcion Morillo Galaán, Mario Segura Roso, Pedro Cedano, Valentin Minyeti, Manolo Sanchez, Guillermo Mateo O., Juan Ramon Familia, Alexander Diaz, Elpidio Tineo. Organizations: ADUTA of Tamayo, Mayor of Vuelta Grande (Tamayo), Alliance of Guayabal, APROCOPA of Guayabal, AsiPastores deTamayo, San Isidro de Guayabal Association, Santa Clara de Guayabal Association, Association of Coffee Growers of San Isidro de Guayabal. Tamayo Children and Youth Association, ASOINJUT of Tamayo, City Barahona, City of Guayabal, City of Tamayo, Firefighters of Tamayo, CEPROS of Padre las Casas, Guayabal Housewives Club, Development Council of Guayabal, Avocado Cooperative of Guayabal, Guayabal Livestock Farmers General Headquarters, School of Environment and Natural Resources, 1st Elder of Guayabal Adventist Church, Board of Irrigators of Padre Las Casas, Neighborhood Board of Guayabal, Guayabal Youth Network, Church of Guayabal, Sur Futuro; Ministry of Agriculture and Ministry of Sports.

CATHALAC is an international organization established in 1992 and recognized as an intergovernmental body by Act No. 45 of September 16, 2010, whose main objective is to promote sustainable development through applied research, education and transfer of technologies related to water resources and the environment, providing the means to improve the quality of life in the countries of the humid tropics of Latin America and the Caribbean. CATHALAC focuses on: integrated watershed management, risk management, climate change and environmental analysis and modeling.

The International Development Research Centre (IDRC, Canada) is a public corporation created by the Parliament of Canada in 1970 to help developing countries use science and technology to find practical and long-term solutions to the social, economic and environmental problems they face. IDRC has funded more than 2,000 research projects conducted and managed by researchers and institutions in the region.

WATER SECURITY AND CLIMATE CHANGE
IN THE REGION OF CENTRAL AMERICA & THE CARIBBEAN

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