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US-Mexico Water Conflict: A Study of Climatic Implications for the Central American Region

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Abstract: The US-Mexico water conflict has significant climatic implications for the Central American region, particularly concerning the transboundary rivers Rio Grande and Colorado. These rivers serve as vital water sources for both the United States and Mexico, but rising water demands, driven by population growth and urbanization, have intensified competition and resource depletion. The 1944 Water Treaty and subsequent agreements have provided a framework for managing shared water resources, but challenges persist due to over-extraction, pollution, and climate-induced droughts. The Central American region, heavily reliant on these water sources for agriculture and daily sustenance, faces severe consequences such as soil degradation, groundwater depletion, and ecosystem deterioration. Additionally, environmental challenges contribute to increased migration pressures. Collaborative water management efforts, infrastructure development, and policy reforms are crucial for ensuring sustainable water access and mitigating conflicts. Enhanced cooperation between the US, Mexico, and Central American nations through initiatives such as reforestation and technological support can help address the ongoing crisis and promote regional water security. Effective governance and data sharing are essential to achieving long-term sustainability and equitable resource distribution.

Keywords: US-Mexico Water Conflict, Climatic Implications, Central American Region

Introduction

The US and Mexico both exist in the North American continent, with the USA being on the northern side of Mexico. Both share rich histories marked by colonialism, independence movements, and, eventually, the development of independent countries. The United States was colonized by the British Colonial Empire back in the 17th century, starting from 1607, when the 1st permanent settlement by English people was made in Jamestown, Virginia (Historic Jamestowne, n.d.) English people (British empire) ruled the state (then 13 British colonies) for almost one and half centuries, during which the native Americans were exploited, and their land was used as a source of acquiring raw material and taking that back to their homeland and using that raw material to make the finished products and again selling those finished products back to Americans (what was already being practised by British colonizers in all of its colonies, including the US).

Background

Over time, people started protesting against their (colonizer's) unjust rule based on exploitation and heavy taxation of the natives, along with several other events that made the independence of the United States come true by July 1776 through the adoption of the Declaration of Independence (Mercantilism and the Colonies of Great Britain, 2015). On the other hand, Mexico was colonized under the Spanish Empire after the "1521 conquest of the Aztec Empire" by Hernan Cortes. Spanish adopted the famous trend of all colonizers of extracting the resources and exploiting the natives, and this system of extraction and

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exploitation remained until the control of the Spanish Empire sustained on the state of Mexico i.e. for 300 years. Mexico gained independence from colonial rule in September 1810 through the Mexican War of Independence. Soon after gaining independence, both states pursued their national interests and worked hard to improve their socioeconomic conditions (Colonial Mexico, 2013).

In addition, both states share a complex and unstable geopolitical tie across history, starting from the Texas Revolution of 1835. Mexican authorities, by the decade of 1820s, allowed American settlers, mostly from the United States, to move to Texas, which was then part of Mexico. After the passage of some time, those settlers started clashing with the higher authorities of Mexico, and the driving factors behind their clash were cultural, political, and legal disparities. Over time, the situation worsened, and by the year 1835, tension had reached such a peak that by the next year, in 1836, Texas declared its independence and separation from Mexico (Whitehurst, n.d.). Afterwards, Texas acted as an independent entity until 1845, when it was annexed by the United States. This event posed a significant threat to geopolitical relations across both the states and disturbed regional peace and stability. Soon after the annexation of Mexico by the US, the United States sought to expand westward to annexe other territories that were already part of Mexico, such as California, New Mexico, and Arizona.

Afterwards, Mexico claimed the "Rio Grande River" as Texas' southern boundary, while the United States claimed the Nueces River as a border between the both. These events led to a confrontation between the US-Mexican army and a war situation occurred across both states by the year 1846 (The Annexation of Texas, the Mexican-American War, and the Treaty of Guadalupe-Hidalgo, 1845-1848, n.d.). The war between the United States of America and Mexico began officially when, in 1846, US forces, in the presence of the leadership of Zachary Taylor, the military general of the United States of America, fought the Mexican forces along the conflicted borderline between the both. Moreover, during this war, the United States annexed Mexico City, Monterrey, and Veracruz cities of Mexico. The war between the both finally reached its conclusion after signing the "1848 Treaty of Guadalupe Hidalgo," As a result of this war, Mexico paid a high amount in the form of losing its major cities, like Arizona, and New Mexico, Texas, and modern-day California) (Future President Zachary Taylor fights the Battle of Palo Alto, n.d.).

Since then, the states have never lived a single moment of normal geopolitical ties across history, which is also evident from the ongoing water conflict between the US and Mexico, dating back to the 20th century when the rising populations and agricultural activities in both states increased the need for usage of excessive water. The water conflict between the both revolves around the management and distribution of water across both states, especially the water of Colorado as well as of Rio Grande (RAO, 2024).

Moreover, these rivers are far more important for the fishing industry, agricultural purposes, and drinking water purposes, and there arises a significant concern from both sides (the US and Mexico) over who gets what amount of water. Both states, to manage the water distribution, solve the long-standing water conflict, and avoid every environmental degradation in the Central American region, have signed several treaties and agreements, like "the 1906 agreement across both the states, United States of American and Mexico," during this agreement, there was decided that annually, the amount of about 60000 acre-feet water across the river (Rio Grande) be allocated for the other state (Mexico) for agricultural purposes near Ciudad Juarez (International Boundary, and Water Commission, 1906). Under the 1944 treaty of water (which dealt with the flow of water across both the states), it was decided that the United States would be sending an amount of about 1500000 water per acre-feet from the river of Colorado annually, adopting its way for Mexico, in return, the other state (Mexico) would be sending 3500000 water per acre-feet from the river of Rio Grande towards the US (UTILIZATION OF WATERS OF THE COLORAO AND TIJUANA RIVERS AND OF THE RIO GRANDE, n.d.).

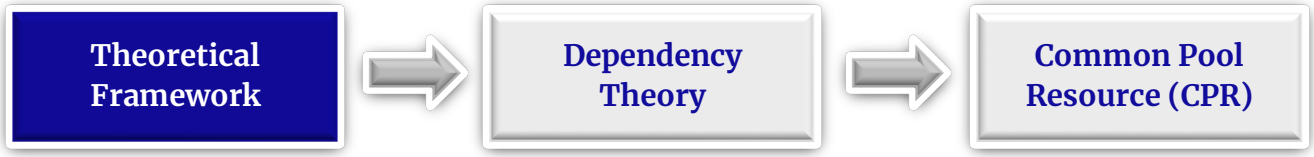
In addition, under the 1944 treaty for water governance, a commission called "IBWC" was also formed to observe water distribution and to resolve water disputes. Minute 206 of 1958 concentrated more on controlling the flood and constructing the dams to regulate and manage the water flow of the river Rio Grande (Sharing the Colorado River and the Rio Grande: Cooperation and Conflict with Mexico, 2018). Furthermore, Minute 242 of 1973 was introduced to ensure the resolution of the salinity crisis in the Colorado River; as a result of this treaty, the United States made a desalination plant to improve the water

quality, which was to be sent to Mexico, as was decided underwater treaty of 1944. Moreover, Minute 261 of 1979 emphasized improving the water infrastructure management and flood control along the common river between both states (INTERNATIONAL BOUNDARY AND WATER COMMISSION UNITED STATE AND MEXICO, 2013). In addition, in 2002, 308 Minute highlighted the temporary water crisis in the Colorado River Basin. Minute 319 of 2012 was introduced to settle the Colorado River shortages and environmental issues. Moreover, Minute 323 of 2017 focused on enhancing drought planning and environmental cooperation across both nations (the United States and Mexico) (Minute 319: A Creative Approach to Modifying Mexico-U.S. Hydro-Relations Over the Colorado River).

Research Questions

1) How does the US-Mexico water conflict impact the transboundary water management system of the region of Central America?
2) How effective are the existing bilateral treaties, like the Water Treaty of 1944, in tackling the climatic issues linked to water conflict and their implications for the Central American region?
3) How, could, the collaborative water management activities between the US, Mexico, and the Central American region, lead to diminishing the climatic impacts of water conflicts?

Theoretical Framework



Dependency Theory

Dependency theory provides a lens to critically analyze an ongoing water conflict between both the states of Mexico and the US by focusing on an unequal power dimension between developed and developing states. The theory claims that core states like the US influence the peripheral or semi-peripheral states like Mexico and the Central American region in terms of politics, economy, environment, etc. Dependency theory further says that the core has always practised an edge of decision-making on the periphery, and one core state has access to the interconnected water bodies flowing to the peripheral state too, now the core state would start influencing the peripheral state and start pressurizing the peripheral state to do whatever core is saying to do, this is the stage where peripheral states often compromise on their sovereignty. In the context of the US-Mexico water conflict, this unfair distribution of the flow of water is evident, where the United States is acting as the core and often influencing the peripheral state, Mexico, leaving the Periphery dependent on the core.

This is evident from the 1944 Water Treaty, which provides an edge to the United States of America over governing the water distribution across the shared water bodies. For instance, the treaty binds the USA by sending an amount of 1500000 water per acre-feet to the states of Mexico every year, but this allocation often goes unfulfilled during the drought seasons. Moreover, the US, after building dams like Hoover Dam, has diverted the flow of water, which prioritizes the national interests over fair water sharing across Mexico (Sanchez, 2006). Such dominance in water governance places Mexico in the category of the periphery, where it's solely dependent on the United States for access the water resources, limiting its capacity to demand the fair dealing of water sharing across both states.

Furthermore, the climatic implications of this peripheral position further reach the Central American States. Central American states, such as EI Salvador, Honduras, and Guatemala, are heavily dependent on water-intensive agrarian exports, including coffee and bananas, to boost their economic conditions. Lowering the water availability to an entire region of South America because of upstream US-Mexico water issues would lead to severe economic vulnerabilities (Kosiewicz, 2018). This exploitation of upstream states emphasizes the structural unfair dealings that dependency theory highlights as peripheral states go through the endurance of the environmental and financial costs of decisions made by core states.

Common Pool Resource (CPR)

The theory gives an effective lens to make sense of the complexities carried out by the US-Mexico water conflict and its climatic implications for the region of Central America. This theory takes into account the resources that are shared by various users, like forests, rivers, and fisheries, which are far more complex to exclude others from using these and where one user's consumption minimizes the availability for others. Moreover, the common rivers between the United States and Mexico are subject to the use of both states, creating obstacles in governing and allocation. The Colorado River, for example, has always been over-allocated for years, with promises to deliver water exceeding the river's natural flow in many years.

This issue along with climate change has minimized the precipitation and increased the drought ratio in the region (Dire conditions in the Colorado River Basin call for collaborative solutions, 2022). Under the Umbrella of Common Pool Resource (CPR) theory, this overuse is a practical example of the tragedy of the commons, where the absence of effective management and cooperation leads to the exploitation of shared resources.

Moreover, the Water Treaty of 1944 tried to manage this common pool resource by defining rules for the allocation and usage of water. The United States, as an upstream user, exercises full control over the flow of the water through dams and reservoirs, which hinder the approach of water flow, which was decided during the 1944 treaty for water that occurred across both (Mexico and the US). This power imbalance is the reflection of one of the critical issues highlighted by CPR theory, that there occurs complexity in acquiring equal and fair management of common resources, especially when the stakeholders possess unfair and unequal access to and influence of those resources.

Discussion

Water has always been a very crucial commodity and a source of sustenance on the earth. The world population increased by three-fold in the last century and during the same tenure use of water grew six-fold. In the context of the North American region, human settlements are directly proportional to the availability of reliable water sources, like, aquifers, massive rivers, mountains, snow-caps, etc. Over time, the region has experienced a rise in water demands that exceed the water resources available to it.

In addition, the increasing need for water usage and the availability of water creates a water conflict across the US and, at the same time, Mexico over the distribution of water from rivers like the Rio Grande and Colorado. Rio Grande River originates from San Juan Mountain of Colorado, US, it further flows south via New Mexico, then forming a natural boundary line between Texas (USA) and the Mexican states of Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas, going into the Gulf of Mexico (SOUTHWEST RIO GRANDE IN HIGH DEMAND, n.d.).

On the other hand, the Colorado River originates from the Rocky Mountains of Colorado, United States, then it flows southwest via Utah, Arizona, Nevada, and California, while forming the borderline between the US and Mexico and finally reaching to Gulf of California in Mexico. Both rivers act as interconnected water bodies between the states (the United States and Mexico), and at the same time, both water bodies are the point of water conflict between the states. In 1985, Mexico accused the United States of exploiting the flow of the Rio Grande, which resulted in flow reduction. The United States responded to the situation with its Harmon Doctrine, claiming that it's the right of states to determine how much resources it uses it can use (Ray, 2018).

Moreover, by the year 1906, both states had signed an agreement dealing with the diversion of the water flow of the Rio Grande River, where Mexico was given 40% of the water share from the river. Due to the growing need for water, which is more than what is available to both states, each state violated the terms and conditions set in the 1944 Water Treaty. In addition, the United State's population growth, accompanied by urbanization, has contributed to the increased demands for water usage across both states (The United States and Mexico). For instance, as of 2023, the Mexican population of about 81.58% live in urban areas, while only 18.42 live in rural regions. While, in the case of the United States, approximately, 80% of its population resides in urban areas, and the remaining 20% in rural areas (THE WORLD FACTBOOK: Mexico, 2024). Furthermore, most of the water is used by agriculture.

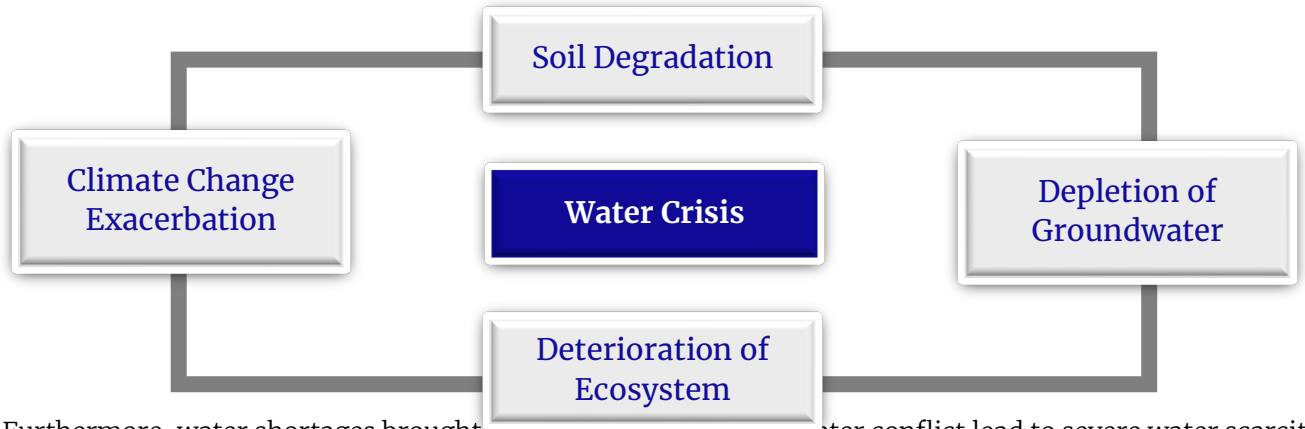
Furthermore, urbanization demands a higher consumption of water in cities for drinking, sanitation, industrial use, and landscaping. As the trend of Urbanization in both the states (USA and Mexico) grew (such as United States cities like California, Arizona, and Texas, while Mexico's Tijuana and Mexicali), the need for water also increased (Wirz, 2024). Additionally, these rivers (Colorado and Rio Grande) were already stressed by agricultural demands, and once this trend of urbanization grew, it further led to water scarcity during the dry seasons. At the same time, where a significant portion of the Colorado River and the Rio Grande are used in agricultural activities in the region of Southwest US and Northern Mexico, Urbanization demands a high use of water for a variety of activities; there seems to have an increasing competition among urbanization and agricultural activities.

Urban areas, having more political and economic influence, are often prioritized over the agricultural sector's water demands, which could lead to severe tensions between both sectors. Moreover, urbanization also led to environmental degradation and degradation of water quality, which further produces water conflict. As urbanization grew, the amount of household, agricultural, and industrial waste increased, often mixing up with fresh bodies of water, like the Rio-Grande water body and Colorado. In addition, pollution from the urban areas highly affects the quality of freshwater flowing downstream into Mexico, worsening the equitable distribution of freshwater across both states. High urbanization has always worsened the climatic conditions of the state.

Climatic Implications for Central America

The US-Mexico water conflict has serious implications for Central America, as the region is directly affected by common water bodies, such as Rio-Grande and Colorado. These rivers act as a lifeline not only for the US and Mexico but also for almost the entire Central American region, which is heavily dependent on these two rivers for their agrarian activities. Moreover, as the US-Mexico conflict continues, various climatic and environmental consequences further extend to Central America, impacting the region's agricultural activities, migration pattern, water supply, and frequency of extreme weather (IN CENTRAL AMERICA, DISASTERS AND CLIMATE CHANGE ARE DEFINING MIGRATION TRENDS, n.d.). One of the main and alarming implications for Central America is the rising water scarcity in the region. Colorado and the Rio Grande flow into Mexico, and any decrease in water flow ratio due to an ongoing water conflict between the US and Mexico can have a challenging impact for all the downstream states, including the region of Central America.

For instance, the Colorado River, which originates from the USA and adopts its way towards Mexico, has always been facing a water crisis, especially during the dry season. This will lead to reduced water flow in a river delta, contributing to a heavy impact on the states of Central America, such as Honduras, Guatemala, and Nicaragua, which are highly reliant on both rainfall and river water irrigation. This water shortage further intensifies the temperatures in the region and changes the precipitation patterns, disrupting the seasonal variations in weather. In recent years, both Mexico and the United States have observed more prolonged and frequent droughts, which have heavily destroyed their water supplies.



Furthermore, water shortages brought about by the US-Mexico water conflict lead to severe water scarcity and environmental degradation,

Soil Degradation: Water scarcity or lack of proper management of water leads to soil degradation, which affects the fertility of arable land. Moreover, overuse of water for agricultural purposes can cause depletion of groundwater and soil moisture, resulting in desertification.

Depletion of Groundwater: Once there is a water or water crisis, groundwater is adopted as an alternative way to fulfil water needs, and this plenty of extraction of groundwater during the era of a water crisis can contribute to environmental degradation. Moreover, over-extraction of the groundwater results in land subsidence, where the ground sinks because of the collapse of underground water reservoirs, and this will lead to damage to infrastructure, roads, and buildings.

Deterioration of Ecosystems: Water crisis and pollution after water crisis can disrupt the ecosystems, especially the aquatic ecosystems. Survival of animals, plants, and other organisms is heavily dependent on access to fresh water in rivers, lakes, and wetlands. Furthermore, a reduction in both water quality and quantity could lead species to either die or migrate. Aquatic plants, fish, and other organisms may feel unable to survive once the water becomes very polluted or unavailable (Water Pollution and its Effect on Aquatic Biodiversity, 2021). With water scarcity, wetlands get dry, leading to the loss of habitats for many species, like birds and amphibians.

Climate Change Exacerbation: The water crisis is often driven by droughts, which increase in frequency due to climate change. This further leads to soil erosion, loss of plant and animal lives, and minimizing water availability. At the same time, if water resources are not well-managed properly or over-extracted, it could lead to flooding, particularly during the monsoon season, as the natural water systems will not be able to absorb or distribute rainwater properly. This also contributes to soil erosion, habitat destruction, and loss of arable land.

Effectiveness of Treaties for Shared Water Bodies:

The effectiveness of existing bilateral treaties, such as "1906 agreement" across both states, Minute 206 in 1958, Minute 242 in 1973, Minute 261 in 1979, Minute 308 in 2002, Minute 319 in 2012 and Minute 323 in 2017 and finally the "1944 Water Treaty." Moreover, the 1944 treaty for water between both states (the United States and Mexico), in tackling climatic issues regarding water conflicts across both the states and its implications for the region of South America, are limited. The treaty has played a crucial role in providing a set of rules for managing shared water resources such as the Colorado water body and Rio Grande water body.

Furthermore, the 1944 Treaty for Water has provided an efficient framework to tackle the water crisis and drought across both the nations that these states were already facing, such as the droughts in the Colorado River basin since 2000 and remained till 2020, which lowered the flow of water, leading to a decline for about 20 long years at lake Mead and Lake Powell (two largest reservoirs of US) (Interior Department Announces Actions to Protect Colorado River System, Sets 2023 Operating Conditions for Lake Powell and Lake Mead, 2022). However, the treaty's mechanism has not provided enough strategy to overcome the long-term water crisis but provided an effective framework for ensuring the sustainable use of these water body resources not only across both states but also provided the solutions for Central American states, as they may prevent any further water crisis or drought-like situations and optimize use for water body resources. Additionally, both states afterwards established an International Boundary and Water Commission (IBWC). This independent body acted there to manage the water flow from either of the sides across both the water bodies (Colorado and Rio Grande) to prevent any further disturbance of geopolitical ties across both the United States and Mexico (International Boundary and Water Commission (IBWC) United States and Mexico U.S Section, n.d.).

In addition, collaborative water management practices between the United States of America and Mexico are required to significantly lower the climatic effects carried out by water conflicts. This can be gained via collective efforts in resource sharing, policy-making, infrastructure development, and data sharing; all of these aspects help to minimize the challenges linked to climate change, such as floods,

droughts, and water scarcity. Infrastructure-based collaborative investments, like reservoirs, dams, and desalination plants, could easily tackle the water crisis in drought-prone areas. For instance, Mexicali Valley in Mexico and some parts of the United States's Southwest are already utilizing the shared water infrastructure.

Some Central American states, such as Guatemala and Honduras, often lack such infrastructure, causing heavy dependence on rain-fed agrarian activities (Determinants of food insecurity among smallholder farmer households in Central America: recurrent versus extreme weather-driven events, 2020). US and Mexican technical assistance, along with investments in infrastructure, could help improve water management across these regions while reducing the risks of climatic consequences. Water conflicts often erupt because of a lack of authentic data on the availability of water and its consumption ratio across the states. The United States has made advanced metrological and hydrological systems, such as those functioned by NOAA, which can deliver prior warnings before the occurrence of any draught or flood-like situations (National Integrated Drought Information System (NIDIS), n.d.).

Moreover, this could benefit a lot, primarily Mexico and other neighboring states, especially lying in the Central American region, through which they could take effective and well-prepared steps before the occurrence of any drought or flood and overcome any kind of damage brought about by these droughts and floods, either to infrastructure, agriculture or environment. Practises such as deforestation (the process of removing or destroying the forests for several other purposes) in Central America, especially in states like Guatemala, Nicaragua, and Honduras, have contributed to observing soil erosion and lowering access to water resources. Collaborative reforestation efforts promoted by the United States and Mexico could assist in improving as well as reviving the ecosystems and stabilizing water supplies by lowering the effects brought about by the various droughts and floods (More trees, less water stress in El Salvador, 2023).

United States of America has been involved in providing financial assistance for the revival of forestation projects via USAID, and increasing these initiatives in Central America can lead to enhanced regional water security. Moreover, these water conflicts are usually driven by climate-induced migration, particularly in the region of the Northern Triangle of South America, including states like Salvador, Guatemala, and Honduras). Severe conditions like drought and water scarcity become the root factors behind the people's migration choices, and afterwards, they often migrate to the United States of America and Mexico. Collaborative water management initiatives like bringing positive improvements in the agricultural systems while establishing sustainable water access points and curbing the migration pressures.

Moreover, Mexico's Sembrando Vida (Sowing Life) program, which supports sustainable agrarian activities, and if extended with United States support, would, no doubt, bring rapid, sustainable agrarian advancements not only in both the states (the United States and Mexico) but also across the entire region of Central America. Furthermore, conflicts over transboundary waters are usually intensified because of a lack of effective governance (Transboundary Waters, n.d.). Training workshops for water resource management or joint water councils' programs, if supported and funded by the United States and Mexico, could equip Central American governments with the strategies to minimize such disputes and implement sustainable practices, like, for example, US-Mexican "Border Environment Cooperation Commission (BECC)" model could be adapted to include all the Central American states for governing and managing the water resources.

Conclusion

Overall, the issue of water conflict across both the states, Mexico and the US, is a multifaceted subject that has severe and challenging implications for the region of Central America. This conflict is all about governing and allocating the water resources across both the states, especially through the Rio Grande River and Colorado River. The share for each state, for delivering what amount of water to another state was already mentioned in the 1944 Water Treaty, which asked Mexico to deliver a total amount of 3.5 million acre-feet water to the United States via the Rio Grande River, and in return the United States of America was asked to deliver an amount of about 1500000 water per acre-feet towards Mexico via Colorado

River. Thus, the Water Treaty of 1944 plays a crucial role in providing the framework for both states to carry out effective governance mechanisms to overcome future clashes over water to ensure the sustainable use of water resources and, finally, to promote peace and stability in the region.

The costs of such conflicts (i.e. Water conflict between the US and Mexico) extend beyond their territorial limits, often reaching far beyond and influencing the socio-economic and climatic dynamics of the Central American region, which is already struggling with the risks of climate change and water crisis. Moreover, climate change has introduced new dynamics for the US-Mexico water conflict, boosting already existing geopolitical tensions and generating new challenges. Rising temperatures, coupled with prolonged droughts and changing precipitation patterns, placed an unpredictable burden on shared water resources. The Rio Grande and Colorado River basins, which are the lifelines for millions of people living across the entire region, have been through limited flow and drought-like situations. These changes regarding climate have produced severe hindrances in fully executing the rules decided in the 1944 Water Treaty, contributing to clashes on the distribution of water. For example, Mexico has always struggled to fulfil its water deliveries to the United States of America, especially during the drought tenures, contributing to diplomatic and geopolitical tensions.

Central American states, though not the direct party to the US-Mexico water conflict, are directly associated with its results. The region is characterized by a heavy reliance on agricultural livelihoods, limited infrastructure, and lack of governance, putting it at risk of climatic-induced water stress. Moreover, the Northern Triangle states of EI Salvador, Honduras, and Guatemala, in particular, have been deeply affected by these worsening conditions of climate change, including extreme weather events and drought tenures. The US-Mexico water conflict has direct and indirect implications for the region of Central America. One of the direct impacts brought about by the water conflict between the United States and Mexico is the prevalence of water scarcity. As the water in both the Rio Grande River and Colorado River is getting lowered with time, there is a rising need for upstream states to 1st prioritize their water needs.

This carries a catastrophic effect on all of the downstream states, where water scarcity is already at its peak. The region of Central America, extending from Mexico to Panama, has observed drought events that have destroyed agricultural production and food security in the region. Over-extraction and lack of water governance of shared transboundary rivers in the US-Mexico border region can accelerate the challenges while limiting the overall, access of water for the Central American States. In addition, there are plenty of socio-economic implications of the water crisis for the Central American region. Water conflicts usually contribute to limited agricultural production, threatening the livelihoods of billions of people, leading to food insecurity and poverty, and compelling the populations to migrate in the exploration of better water opportunities. Thus, the environmental implications carried out by the US-Mexican water conflict are highly considerable.

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