Economic Viewpoint

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# Water: abundant, and scarce

## Water quality and availability present both challenges and economic opportunities

A number of recent events have reminded us that water's availability remains a major issue in our societies. The extreme drought that has been plaguing California since 2011 is one notorious, though not unique case. Just before California was hard hit, Australia was emerging from a drought that was just as extraordinary. It lasted more than a decade. Drought is one of many facets of the issue of water availability. Cities, and sometimes whole regions, are seeing their drinking water supplies dwindle due to overuse of the resource. In other cases, the problem originates with environmental degradation. Quebec, the "land of lakes and rivers," has not had a drought that lasted years. However, it has gone through periods in which the water level in the St. Lawrence Seaway dropped so much that ships' loads had to be decreased. In agriculture, droughts lasting several weeks can leave crops thirsty. One of the main challenges, however, is containing the costs associated with the supply of drinking water. Substantial investments must go into maintaining ageing distribution networks. Here, as elsewhere, water's availability and quality is a growing concern. At the same time, it creates economic opportunities. For example, markets are opening up for Quebec farms as California suppliers affected by the water shortage withdraw. Consulting firms are leveraging their expertise in rehabilitating and restoring drinking water distribution infrastructures and in sophisticated farm irrigation systems. This Economic Viewpoint does not claim to cover all of the issues associated with water. It simply takes stock of the situation, and strives to see how Quebec is affected, right now. It also describes the solutions being deployed and expertise acquired by local businesses.

### 1. AN OVERVIEW WITH MANY LESSONS

Drinking. Washing. Cleaning. Producing. Boating. Swimming. It may seem like water will always be there and accessible, especially in Quebec and Canada. However, a closer look shows that the situation is not that straightforward. Planet-wide, water availability is a growing issue. California, Australia, Brazil, Western Canada: many regions have recently been faced with a major water shortage problem. Even Quebec is not safe. The following revealing overview of the challenges will serve as background for the next part of this Economic Viewpoint, which will deal with development opportunities and economic spinoffs associated with water availability.

#### 1.1 California, the emblematic case

The most notorious contemporary case is California: since 2011, it has been experiencing the worst drought in its history. Exceptionally low rainfall is coming with record heat. In October 2015, the average temperature for 2015 was the highest it had been in 120 years.

To understand what is happening, we have to realize that the state gets three quarters of its supply from surface water (rather than aquifers), thanks to the precipitation that falls in Northern California, primarily in the winter. A complex system of canals, aqueducts and reservoirs—the most complex in the world—directs water from snowmelt to the drier south, where 80% of California's population

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lives. One figure attests to the gravity of the situation: in April 2015, it was estimated that the snow pack in the Sierra Nevada mountains represented barely 6% of normal levels. The Governor of California decided to impose a 25% cut to cities' water consumption. He also announced a US$1 billion assistance plan for the communities that were hardest hit by the water shortage.

The drought's environmental repercussions are becoming tangible. Three quarters of fish species are or could become threatened. And forest fires are getting worse. In 2015, they destroyed over 300,000 hectares.

### 1.2 Farming in jeopardy

Economically, agriculture seems to be the sector most vulnerable to drought. It is a very thirsty sector, using four times more surface water than cities! California is the United States' "garden," on its own producing one third of the vegetables and two thirds of the fruit and nuts in the entire country, without factoring exports of these same products. The agricultural industry is showing stunning resilience. It even managed to set a record for sales in 2013, and fell just short of beating the record again in 2014.

The resilience is due to two factors. Forced to reduce their productive acreage (-9% since 2011), farmers are preferring more profitable crops, or crops that allow for short fallow periods (annuals). Grapes, lemons, almonds and other nut-bearing trees, for example, have partially dislodged cotton, cereals, alfalfa, and cattle and dairy production.

Deprived of surface water, moreover, farmers have made a massive shift to groundwater. In 2014, they are estimated to have made up 70% of their water shortage in this way. Water well diggers' order books are bursting and some farmers are even buying their own drills. Some believe, however, that this is a short-term solution. In numerous regions, the speed at which the pumps are extracting water is faster than the speed at which the aquifer[1] is replenished. Consequently, the level in the aquifer drops, causing some wells to dry out; the ground level can also sink up to 30 centimetres a year in some places! Over the long term, the situation seems unsustainable in some regions. The government is expected to be forced to tighten regulations on well drilling which, for now, are relaxed, to say the least.

The fact that agricultural product sales are holding up should not obscure the fact that the difficulties created by the water shortage remain huge. According to a study by the University of California (UC Davis), the costs that can be chalked up to the drought were around US$2 billion in 2015.[2] Well drilling costs alone are close to US$800 million.

### 1.3 Adapting does not mean the problem is over

The drought has lasted for four years, and no one knows when the crisis will end. What is clear to climate specialists, however, is that in California and all low rainfall areas, climage change will make droughts more frequent, longer, and more intense. Scientists have also shown that climate change is partially responsible for the current drought. Depending on the year, they put its share of the responsibility at 5% to 27%.[3]

Scientists are also observing that, increasingly, abnormally low rainfall is combining with above normal temperatures. By increasing water evaporation, such temperatures worsen the impact of drought.

In January 2016, water levels in reservoirs had started to go up and the snow pack was above average, as a result of El Nino. The specialists are thus showing some optimism. However, their optimism is being curbed by two factors. First, reservoir levels were still below normal. If the drought were to end now, water availability would remain just as much of an issue, because it would likely take years to replenish the water reserves. Secondly, California's water reserve system is designed to cover the needs of just one year. The state remains at the mercy of any further drought.

Another factor must be added to paint a full picture of the situation in California: contamination of the water table by uranium, a phenomenon that is just now being gauged. Twenty per cent of ground water has a high uranium content. The research blames farming practices. Uranium occurs naturally in the soil, in insoluble form. However, nitrates in the soil from nitrogen fertilizers make uranium soluble. It then runs into the underlying aquifer. University of Nebraska researchers found a 78% correlation between nitrates and uranium. For human beings, ingesting water containing excess uranium can lead to an increased risk of cancer and kidney problems.[4]

[1] An aquifer is a geological or rock formation that is sufficiently porous or cracked and permeable to temporarily or permanently contain mobile water. See *Wikipedia*.

[2] Economic Analysis of the 2015 Drought For California Agriculture, UC Davis Center of Watershed Sciences, ERA Economics, August 17, 2015

[3] "California Drought Is Made Worse by Global Warming, Scientists Say," New York Times, August 21, 2015

[4] "Western United States struggles with uranium contamination in water," CTV News (The Associated Press), December 8, 2015

### 1.4 Australia and the "Big Dry"

The California case is reminiscent of another one, just as serious. From 1997 to 2009, Australia went through the Big Dry, the worst drought in its history. The resulting forest fires killed 173 people. Rice and cotton production nearly disappeared. One third of vines were destroyed. Several species of animals are near extinction and, of course, thousands of jobs were lost.

In 2009, Melbourne, a city with 4.3 million residents, was down to one quarter of its normal water supply. Melbourne implemented a series of measures which managed to cut water consumption per person by nearly half. Other regions, like California and Brazil, are now using the Australian measures as models.

Australians are getting ready for the next drought. The main lesson they learned from the Big Dry is that droughts will reoccur and can be expected to be longer, and worse. A new term has entered metereorologists' vocabularly: megadrought.

### 1.5 Sao Paulo's critical situation

A drought highlights the weak points in a water supply system, as the city of Sao Paulo, in Brazil, eloquently illustrates. The most populous city in the southern hemisphere, Sao Paulo is having its worst water supply problems in the last 80 years. In October 2015, for example, the Cantareira reservoirs, which serve nine million out of the city's 20 million inhabitants, were at only 12% of capacity. At the same time, electricity prices went up, as the region is primarily powered by hydroelectricity.

While the crisis originates with a drought, three factors made it a lot worse: rapid population growth, inadequate storage and distribution infrastructures, and poor overall management. The Billing's reservoir, which has 20% more capacity than the Cantareira reservoirs, cannot be used due to contamination. As for the Cantareira reservoirs, their low supply is partially due to the excess deforestation in their watershed. An estimated 40% of the forest is degraded or gone, profoundly changing the region's rainfall and suggesting it will take more than one good rainy season to bring the water shortage to an end.

Ironically, Brazil is the country with the world's largest reserves of fresh water (between 12% and 16%). However, that water is primarily in the northern part of the country, while Sao Paulo is in the south.

### 1.6 Western Canada is no stranger to the issue

In Alberta, Saskatchewan and British Columbia, 2015 was marked by record temperatures, and rainfall that was well below normal. It was the worst drought of the decade. Vancouver had to ration water. Agriculture also took a big hit: yields fell while the price of commercial hay quadrupled in some regions. In Alberta alone, where 80% of the farms were affected by the drought, the government agency responsible for farm insurance forecast last August that it would have to pay out CAN$1 billion on farmers' claims. Simultaneously, fire laid waste to several thousand hectares of forest over all three provinces. In Saskatchewan, the fires affected ten times the area of a normal year. And the previous year had been exceptionally wet! Some are saying normal doesn't exist anymore.

Meteorologists in these regions are astounded by the size of the drought area, which extended from Ontario's Western border to the Pacific Ocean, and from the Mexican border to the Arctic Ocean. Factoring in the unusually warm Pacific Ocean, the University of Saskatchewan's Canada Research Chair in Water Resources and Climate Change says he increasingly suspects there is a connection between these phenomena and climate warming.[5]

### 1.7 Quebec is not completely safe

Although Quebec has never experienced a drought of the kind described previously, it still gets some major droughts, as in 2012. The water in the Saint Lawrence was so low that Seaway managers recommended that shipowners cut loads by 10% in order to reduce their drafts.[6] Several of Quebec's big rivers reached record low water levels. In July 2012, hydroelectric production was 20% lower than the year before. Farmers in some parts of Quebec, like the Outaouais, saw a very serious decline in yields.

Since Quebec's water clean up program (Programme d'assainissement des eaux du Quebec) was introduced in 1978, over CAN$7 billion has been invested to keep wastewater out of the environment, protect water quality in the St. Lawrence, lakes and rivers, and provide Quebecers with quality drinking water. The current challenge involves rebuilding municipal drinking water distribution systems. These networks are invisible, and everywhere, serving 86% of Quebec residents. Some of the infrastructures are reaching the end of their life cycle, and the result is a twin impact. On one hand, breakage tends to increase, triggering

[5] "Is this drought caused by climate change?" National Observer, July 13, 2015

[6] The draft is the height of the submerged part of the boat, which fluctuates with load. It corresponds to the vertical distance between the water line and the lowest point on the hull, usually the keel. See Wikipedia.

substantial direct and indirect costs. Leaks are increasing as well, a sneaky and serious problem. In 2011, the Ministère de l'Environnement estimated that an average of 30% of potable water was being lost across Quebec due to leaks and breaks. In other words, nearly one litre of water out of three does not get to users.

In 2011, the Quebec government created the Stratégie québécoise d'économie d'eau potable (Quebec potable water conservation strategy),[7] in which one primary goal is to reduce leakage. As potable water is estimated to cost $1.51 a cubic metre, the government thinks that reducing consumption by 20% would save the province around CAN$2 billion over 20 years. Municipalities are being asked to reduced leakage to at most 20% by 2017. More than 400 municipalities representing 80% of the population have instituted programs to find and repair water leaks.

Note that the challenge of upgrading water distribution networks is one Quebec shares with several other provinces and many countries. According to the Canadian Municipal Water Consortium, "Most municipalities face significant challenges from historic underfunding that leads to backlogs of infrastructure repair or replacement, while simultaneously facing greater system demands."[8] Here, in the budget tabled March 22, 2016, the federal government announced that it was creating a "new Clean Water and Wastewater Fund" for provinces, territories and municipalities. CAN$2.0 billion will be invested over four years as of the 2016-2017 fiscal year.[9] In 2005, the Environmental Protection Agency estimated that it would cost the United States US$277 billion over the next twenty years to maintain existing networks and build new ones.

At the same time, while a lot of progress has been made, the quality of the water in the St. Lawrence, and rivers and lakes remains a major concern. The water supply networks for 70% of Quebec's population draw from these sources. However, in some places, the deterioration of the water quality means increasingly complex and expensive processes must be used to make it potable. Quebec City's problems with Lac Saint-Charles speak eloquently to this issue. Quebec's capital draws half of its drinking water from this lake. A recent study revealed accelerated degradation of the lakewater as a result of such things as residential development, tree clearing, defective sanitary facilities and even the salt used to de-ice a nearby highway. Public authorities warn that it will cost milions of dollars to solve this problem.

This is not the only place where de-icing salt is being blamed for water degradation. At Lac Saint-Augustin, a body of water close to Quebec City surrounded by traffic arteries, the Ministère des Transports and Université Laval has been engaged in an experimental project to reduce salt contamination since 2009. Among other things, the project involves creating a filter bed and a purifying marsh.

A study by the Ministère de l'Environnement du Québec indicates that pollution in three rivers in southern Quebec is hitting peaks. More than 96% of the samples taken from the Yamaska, Richelieu and Nicolet rivers and their watersheds showed pollution levels that were above acceptable standards.[10] That is seven times higher than it was five years ago.

In recent years, the proliferation of cynobacteria (blue-green algae) also attests to the deterioration of some lakes and water courses. In some cases, it is forcing municipalities to acquire additional equipment to get the toxins produced by these bacteria out of the drinking water. Moreover, cynobacteria can limit water-based activities.

To sum up, many parts of the globe have experienced severe drought in recent years. California, Australia, Brazil and the Prairie provinces attest to the environmental, economic and social repercussions of drought. Climatologists note that the droughts are getting longer and more intense, a phenomenon that is at least in part due to climate disruption. For its part, Quebec must tackle the twin challenge of protecting the quality of its lakes and water courses, and reducing the costly waste of potable water.

[7] Gouvernement du Québec, La stratégie québécoise d'économie d'eau potable, 2011, 38 pages [in French only]. http://www.mamrot.gouv.qc.ca/pub/grands_dossiers/strategie_eau/strategie_eau_potable.pdf

[8] 2015 Canadian Municipal Water Priorities Report, Canadian Municipal Water Consortium, 2015.

[9] Source: Finance Canada, 2016 Budget, p.106

[10] Présence de pesticides dans l'eau au Québec - Portrait et tendances dans les zones de maïs et de soya – 2011 à 2014, MDDELCC, 2015.

## 2. REPERCUSSIONS AND OPPORTUNITIES

The previous section set out a number of major issues associated with water. The regions affected are on the watch for technological solutions that will help achieve an adequate supply, in terms of quantity and quality. In Quebec, demanding upgrades to potable water distribution networks are relying on an array of rehabilitation techniques that have emerged in the last few years. In California, the water shortage accelerated the development of wastewater recycling technologies.

Along with technological solutions come market opportunities. The water shortage is forcing businesses to get out of some traditional markets. Also in California, the drought is leading to a decline in overall cultivated areas, particularly for vegetable crops. It is also prompting a decline in raising cattle for beef and dairy production due to a lack of feed and water, the core elements in these animals' diets.

Whether we like it or not, in additional to being essential to life, water has been tied to Quebec's prosperity for a very long time. The St. Lawrence has always been an essential artery for the country's economic activity. The shores of the St. Lawrence, and other rivers and lakes were the first to be settled. To this day, freight is transported over the water. Water also nourishes us, by means of its fish resources, among other things. Harnessing the current has made it possible to deploy an enviable hydro-power network, fostering industrialization.

At this time, the most immediate concerns involve water preservation. Potential scarcity, avoiding waste and water quality are among the many challenges that must be tackled right away. The adage "necessity is the mother of invention" comes into concrete application here. Business opportunities can arise from a problematic situation. Here, many Quebec businesses are already at work, as we can see.

### 2.1 Upgrading potable water distribution networks

The Quebec government's 2011 adoption of its potable water conservation strategy shows the importance given to upgrading public drinking water distribution networks. By setting water conservation goals and providing financial support through a variety of programs, the government is mobilizing the energies of the various stakeholders.

The government's aim is also reflected in the 2013-2023 Quebec Infrastructure Plan, which has set aside a CAN$3.5 billion envelope to upgrade underground networks, drinking water facilities, and wastewater treatment facilities.

Many consulting firms have developed solid expertise in the area. When the strategy was unveiled, the Association des ingénieurs-conseils du Québec declared that "Quebec engineering consulting firms have internationally renowned water management expertise. They work all over the world, on many projects. This presence in international markets gives Quebec clients the benefit of expertise developed abroad, and keeps them abreast of cutting-edge technologies and methods."[11]

Simultaneously, numerous Quebec organizations have developed equipment and techniques that are specifically designed for work on underground infrastructures. Universities such as Université de Montréal, McGill, École de technologie supérieure and Université Laval devote resources to it, as does the Centre eau terre environnement, at the Institut national de la recherche scientifique (INRS).

Lastly, these organizations are networked within organizations such as the Centre d'expertise et de recherche en infrastructures urbaines (CERIU, the urban infrastructure expertise and research centre). The packed program of CERIU's annual conference highlights the proliferation of new processes and technologies.

#### 2.1.1 Preliminary diagnostics

Things would be simple if we only needed to know a pipe's age and composition to establish its condition. However, several other factors are involved, such as the original installation conditions, composition of the soil (associated with corrosion), and weight of the vehicles that travel overhead. Much of the challenge involved in diagnosing the situation is related to the fact that the infrastructures are, for the most part, buried and invisible. Luckily, there are now a variety of efficient, economical inspection and monitoring techniques.

#### 2.1.2 Detecting leaks

One of the main goals of monitoring is detecting leaks. Leaks have two impacts: they waste water and, by causing erosion, they open up voids that can eventually cause the roadway to collapse.

The search for leaks relies on water budgets. By dividing the network into sectors and installing water metres (flow metres) at strategic locations, it is possible to detect abnormal fluctuations in volume that could be caused by leaks. Detection equipment is used to pinpoint the leaks. The technologies available range from ground penetrating radar

[11] "L'Association des ingénieurs-conseils du Québec appuie la nouvelle Stratégie québécoise d'économie d'eau potable," press release, March 28, 2011.

to infrared imaging, but technologies that use sound waves are used the most (leaking water makes noise and sends out vibrations). Remote guidance and robotic inspection equipment that travels within the pipes is also being used more and more. There are also leak locators, devices that are permanently installed in a network. Montreal intends to install more than 700 leak locators in the downtown area.[12]

#### 2.1.3 Rehabilitating conduits

One area that has made very spectacular progress in the last few years is trenchless pipe rehabilitation and replacement. A variety of techniques make it possible to repair, reinforce or even replace pipes without having to dig: lining them by inserting a sheath or injecting a coating, tubing, etc. These techniques are less costly, less disruptive to traffic and reduce environmental risks.

#### 2.1.4 Planning the work

Both costly and demanding in terms of human and physical resources, it often takes several years to upgrade a network. Managers therefore have to create an action plan or investment plan. The planning process requires a complete inventory of the infrastructures: a database of geographic details and descriptions of the components. Diagnostics must also be performed on the infrastructures.

#### 2.1.5 Preserving the quality of lakes and rivers

It takes a wide variety of expertise and services to preserve lake and river water quality. Some background is needed first, however. Water resource management is handled by watershed and involves decision makers, users and civil society. Actors must institute a master plan for water that sets out the issues in the water system involved. Based on an exhaustive analysis of the territory, the plan identifies the major issues and puts forward solutions for protecting, restoring and enhancing water resources. The expertise the plan draws on ranges from engineering, to biology and forestry.

Water quality is checked regularly through the collection of samples. Water quality is assessed through bacteriological sampling (with a special focus on fecal coliform bacteria) and physiochemical characterization. Companies who employ microbiologists, chemists and water technicians offer such services to municipalities, businesses and individuals.

A variety of steps can be taken to maintain or improve the quality of the water in lakes and rivers. Inspecting and replacing residential sanitary facilities is one current case. Shoreline revegetation with species recommended by specialists is another widespread case. There are also less well-known but very important steps, like building wastewater and rainwater retention ponds.

The issue of pesticides is also worth looking into. The latest Quebec government data shows that watercourse contamination rates have shot up in the mostly densely populated or intensely farmed areas: the St. Lawrence lowlands and the Lac Saint-Jean plain. Among other things, the Quebec Pesticide Strategy 2015-2018[13] tightens the conditions for using pesticides in agriculture. Any use of a pesticide that deems to pose the highest risk must be justified by an agronomist beforehand.

### 2.2 Wastewater recycling and desalination

In areas that are grappling with a serious water shortage, all potential solutions are considered. In California, for example, some have proposed importing potable water by boat. It only took a few calculations to show that this solution was unrealistic, given the volume of water required. The idea of an aqueduct to bring water from Alaska to California was also ruled out, given the prohibitive expense.

Plans to export fresh water from Canada, including Quebec, have been raised before, particularly since the end of the 1950s. Note that Canada has 20% of the world's fresh water reserves. Seven percent of these sources are renewable. Quebec has 3% of the world's fresh water within its territory, although it only represents one tenth of 1% of the world's population.[14] For many reasons, Canadian water is raising interest in the area of the bulk export of fresh water. One such project focused on Quebec in particular between the end of the 1950s and the start of the 1980s. The Great Recycling and Northern Development Canal was primarily known as the GRAND Canal. Water tanker projects were also raised, but did not materialize either. There is no consensus surrounding the issue of exporting water from Canada and Quebec. Simply raising the matter can touch off a firestorm. Note that, for the trade agreements signed to date, the limits have never been tested in this area and heavy debate could arise over the water issue.

[12] La Presse, Louis-Samuel Perron, Montréal veut poser des localisateurs de fuites d'eau, 5 août 2015

[13] Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques. Quebec Pesticide Strategy 2015-2018. 2015. 24 pages. http://www.mddelcc.gouv.qc.ca/developpement/strategie_gouvernementale/exemples_actions.pdf

[14] Montreal Economic Institute Research Papers, August 2008/ http://www.iedm.org/files/cahier0808_en.pdf

One avenue that got a better reception for California, however, is recycling wastewater (see the box below). A number of municipalities are following this path, estimating that it could at at least help solve part of the problem. The state of California has put together a US$200 million reserve to back this kind of project.

A recycling process can be designed to render wastewater clean enough for uses other than human consumption, such as irrigation and toilets. Home and industrial recycling systems are available on the market. Clearly, this assumes the existence of another distribution network parallel to the potable water network. Here, San Francisco has just adopted a by-law that requires every new building that is larger than 250,000 square feet to incorporate such a recycling system.[15] The town of Carlsbad, near San Diego, is starting to build a plant that will recycle the effluent from a wastewater treatment plant. A Quebec firm will provide the technology.

The recycling process can also be designed to purify greywater to make it potable. South of Los Angeles, a plant is turning grey water into drinking water. The plant is being expanded to take capacity to 380,000 million litres of water a day, enough to supply 850,000 people!

Desalinating sea water is another avenue that is being considered. Already in use in Israel and the Persian Gulf, the process has been mastered, technically speaking. But it is very expensive. This is why California, with more than 250 wastewater recycling plants, has just one desalination plant, built in 2000 and located in San Diego. San Diego is now investing US$1 billion to increase its capacity. The plant could treat 200 million litres a day and meet 7% of the county's water needs. Let's just note that the technology used, based on a membrane filtration process, once again comes from a Quebec firm.

### 2.3 Quebec agricultural products, a potential resource in the event of drought

Water is an indispensable resource in agriculture. For both crop and animal production, water is critical, along with other factors such as the weather and soil quality. Water's availability and quality therefore impact the agricultural and agri-food sector, whose mission is to feed the world. This section focuses on what, in terms of water, creates opportunities for Quebec's agricultural and agri-food sector, from food products to production technologies and specialized services.

These days, agricultural and food products can travel a long way. They cross borders and oceans. Consumers have access to a wide array of foods produced in different climates. Who would have thought that this supply method and the resulting dietary habits could become jeopardized? Climate disruption and water availability are responsible.

The situation in California is one illustration. The garden of the United States, California produces one third of the vegetables and two thirds of the fruit and nuts consumed there. It also helps make the country the world's number one food product exporter. California is one of five major Mediterranean climate growing areas in the world. This type of climate features dry, sunny summers and cool, wet winters, making it possible to have two and, in some cases, three harvests a year. The drought that has been plaguing the state for the last four years (affecting the entire U.S. Southwest) is starting to jeopardize its production capacity. Some even wonder if the U.S. food supply capacity is being threatened.[16]

**WASTEWATER, GREY WATER, BLACK WATER**

Wikipedia defines wastewater as water that has been altered by human activity through domestic, industrial, artisanal, agricultural and other uses. Wastewater is deemed to be polluted and must be treated. "Black water" contains various substances that are more polluting or harder to get rid of, such as fecal matter, cosmetics and any type of industrial by-product mixed with the water. "Grey water" does not have a heavy load of pollutants, for example, domestic water from dishwashing, baths and showers, etc. Grey water also results from the treatment of black water.

[15] Services of the San Francisco Public Utilities Commission, Non-Potable Water Program, http://sfwater.org/index.aspx?page=686

[16] "Why Califonia drought matters," Washington Times, December 17, 2015

**Table 1 – Selected fruit, nuts and vegetables for which California leads total U.S. production**

| Products | % U.S. market share | Products | % U.S. market share |
|---|---|---|---|
| Artichokes | 100% | Strawberries | 90% |
| Dates | 100% | Cauliflower | 88% |
| Figs | 100% | Leaf lettuce | 86% |
| Kiwis | 100% | Avocados | 86% |
| Olives | 100% | Carrots | 83% |
| Almonds | 100% | Romaine lettuce | 76% |
| Pistachios | 100% | Head lettuce | 75% |
| Nuts | 100% | Honeydew melon | 73% |
| Garlic | 98% | Peaches | 72% |
| Plums and prunes | 97% | Tangerines and mandarins | 69% |
| Broccoli | 95% | Spinach | 63% |
| Celery | 95% | Chili peppers | 60% |
| Lemons | 93% | Raspberries | 57% |
| Apricots | 90% | Peppers | 56% |
| Tomatoes | 90% | Asparagus | 47% |
| Grapes | 90% | | |

Notes: Data is based on 2011-2013 production.
Source : *Impacts of California's ongoing drought* : agriculture, Pacific Institute, USDA 2015b, August 2015

### 2.4 The impact of the California drought on agriculture

#### 2.4.1 The "California" effect

Most of the lettuce, carrots, celery, artichokes, tomatoes, broccoli and asparagus eaten in the United States come from California. California also produces 72% of the country's fresh peaches and 97% of its plums. Table 1 sets out the detail on California's market shares

The current drought is making California growers take a second look at their crop choices. On one hand, they are letting some of the land lie fallow, i.e., they aren't farming it. According to the California Farm Bureau, at least 202,343 hectares (500,000 acres) out of the 3,237,485 hectares (8 million acres) that are usually irrigated and used for planting were left fallow in 2015. For another, they are turning away from less profitable crops, such as onions, garlic, cotton and tomatoes. They are also tending to turning away from some types of livestock, such as beef cattle, because the profits do not justify the water requirement.

What may at first seem odd is that, at the same time, farmers are increasing some very thirsty crops, such as almonds and nuts, whose areas have increased approximately 80,000 hectares since 2010. It takes a gallon of water to produce just one almond! The intensification had started before the drought, supported by an expanding international market and mouth-watering prices, and it has kept going. Although prices for these foods have dropped recently, growers show no sign of wanting to abandon the crops, particularly since almond and nut trees only start producing four years after being planted. Clearly, when water is scarce, halting production of an annual vegetable like the onion is a much less expensive solution.

Early 2016 saw the start of what is being called the "cauliflower crisis." The retail price for this cruciferous vegetable has skyrocketed, hitting almost CAN$8 a piece. Incredible! Many became worried with this unexpected and surprising increase. In fact, the rise by cauliflower prices was just the most spectacular aspect of a broader phenomenon: a substantial increase in fruit and vegetable prices over just a few months. The price of celery, for example, went up 42% between December 2014 and December 2015, while onions rose nearly 16%. Some vegetables, like the English cucumber, even disappeared from the shelves temporarily, due to inadequate availability in terms of volume or price. The University of Guelph's Food Institute puts the average increase of fruit and vegetable prices in Canada at 9.1% to 10.1% in 2015. When these statistics were released, it also predicted that prices would go up faster than inflation in 2016.

The first factor invoked to explain the phenomenon was the Canadian dollar's tumble against the greenback. It has lost about a quarter of its value in two years. Because most of the fruits and vegetables Canadians eat come from south of the border, it was inevitable for the loonie's slide to affect prices. But there's more. Storms (an El Nino effect) damaged some crops in California at the end of 2015 while Florida, the second leading garden state in the United States, was hit by extreme weather and rain.

Although it is hard to pinpoint the specific effects, it seems increasingly clear that the California drought has a hand in it. According to John Janmaat, an economics professor at the University of British Columbia, "The supply is going to go down and as our currency goes down, they will inevitably lead to a price increase."[17] For its part, the United States Department of Agriculture has noted that due to higher production costs and/or a water shortage, producers may decrease their production areas, driving prices up this year and subsequent years as well. The phenomenon is now being observed, but it is too early to assess its magnitude.[18]

### 2.4.2 Opportunities for Quebec producers

All it takes is one look at the supermarket shelves to realize that the fruits and vegetables we eat here come from around the world. When suppliers raise prices, distributors and wholesalers could well replace them with suppliers located elsewhere that offer better terms. Logically, then, the higher prices for California products caused by the drought could create opportunities for local producers. They immediately make Quebec products more competitive. Also, if the increase affects fruits and vegetables we don't grow at the time it occurs, consumers are tempted to turn to local vegetables that are less expensive. So, when cauliflower prices shot up, consumers reacted by opting for root vegetables, for which there is a local supply.

Lastly, with California products becoming less competitive, our producers could see opportunities within the United States. The well-populated market on the U.S. Eastern Seaboard is relatively close to Quebec. New York State, with nearly 20 million inhabitants, is 600 kilometres from Quebec and over 4,000 kilometres from California! Quebec exporters already have a presence there and everything suggests that they plan to capitalize on California's climate situation, backed in their efforts by an advantageous exchange rate. The Quebec Produce Growers Association has undertaken a market opportunity study on this region.[19] We can expect fruit and field vegetable growers to respond more quickly than hothouse growers, since it is easier for them to change their crops or increase volumes.

### 2.4.3 Forage

Millet, alfalfa, clover… Quebec is a "land of forage." Easy to grow in cool climates, these crops demand a lot of the water Quebec has in such abundance. Forage is the foundation for Quebec's imposing dairy production.

This is because, over the years, Quebec producers have developed an export market for hay for horses and, to a lesser degree, ruminants. The United States, primarily New England, is their main market. Transportation accounts for a lot of the product's cost, however. To offset the impact, some increase hay's density by crushing it. This gives them access to more remote markets in the United States and elsewhere in the world. In this area, the international market is very scattered, including countries in Europe and the Middle East. For example, Ireland is showing interest in Quebec forage. Drought has reduced the production capacity of its usual supplier, Spain. We now know that Saudi Arabia prefers to import forage over producing its own with irrigation. Quebec commercial hay producers and merchants are prospecting in these markets, or have started to engage in trade.

### 2.4.4 An opportunity for irrigation technology

With less water than they had before, California producers are trying to use it better, leading to fast-paced development of irrigation technology. At least one Quebec company that specializes in irrigation and micro-irrigation technology is in the fields of California and elsewhere in the United States. Its solar-powered equipment takes real time measurements of the plant's hydric stress. The equipment also collates weather data and transmits the data to the grower using cellular telephony, allowing the grower to manage irrigation closely. The irrigation system's motors and valves can be controlled remotely, and flows and pressures can be checked in the same way.

[17] Blame the Dollar and Californian Drought for Produce Prices, Kelowna Now, February 4, 2016

[18] "California Drought: Farm and Food Impacts", USDA, February 2016.

[19] La Terre de chez nous, Sécheresse en Californie, opportunités pour le Québec, 9 avril 2015. http://www.laterre.ca/actualites/foret/secheresse-en-californie-opportunites-au-quebec.php

The two major challenges facing Quebec are upgrading potable water distribution networks and preserving water quality in the water bodies and courses that supply them. Quebec researchers, manufacturers and service providers have developed solid expertise in this field, characterized by rapid development of knowledge and technology. In other places, like California, drought is jeopardizing agricultural production capacity, a situation that creates local and international market opportunities for Quebec growers, as well as for Quebec consulting firms and manufacturers of cutting-edge irrigation equipment.

## THE WATER ISSUE, DRIVING ACTION IN THE YEARS TO COME

Water is a topic that be discussed endlessly, along with the opportunities and uses it offers. This Economic Viewpoint has attempted to identify the issues pertaining to the availability of water, and pinpoint the challenges and economic opportunities.

Quebec's challenges primarily focus on maintaining potable water supply infrastructures and water quality in lakes and rivers. Its infrastructures are ageing and major investments are going into maintaining them. Lakes and water courses, critical habitats and leading sources of the water Quebecers drink, need monitoring and protection. Many are at risk of contamination by bacteria, algae and chemicals. Any action must be based on a knowledge of the ecosystems. Quebec is therefore facing two water-related challenges, and it's not alone.

Other regions face the same challenges, along with water scarcity. These places must develop new sources and reduce consumption and waste. They are going so far as to recycle water.

Faced with these major facts, we must also look ahead and anticipate the challenges of the future. Population growth will slowly increase the water requirement. Earth's population is expected to be 10 billion in 2050 (it is now 7.4 billion). Moreover, everything suggests that climate change will increase the frequency and severity of droughts.

Rehabilitation, decontamination, recycling, environmental restoration, irrigation... In many areas, Quebec businesses have developed renowned expertise, which ranges from process and technological development to equipment installation. Urgency creates needs. With strong creativity, many Quebec businesses in a variety of economic sectors have learned to work in this truly international market.
At the same time, regions that are grappling with serious water supply constraints have to abandon some sectors of activity, for example, certain crops, as they can no longer provide an adequate supply at a competitive price. With an abundant supply of water, local businesses can capitalize on the situation.

In the last few years, the various issues related to water have rapidly made the public sensitive to water's importance. We have a better grasp of the value of good quality, abundant water. Efforts to protect it and ensure it is available have intensified, and both the awareness and effort will keep on growing.