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The current situation of water resources and future feasible plans in Taiwan

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Abstract: Water is the essential substance for the operation of all ecological systems on Earth. Taiwan has been experiencing a shortage of water, and in 2021, encountered the most severe drought in the past 56 years. In this study, the researcher mainly explored the current situation, problems, and importance of water resources in Taiwan by citing statistics in the present databases. Through focusing on the unbalanced distribution and shortage of water resources, the researcher probed into the main causes of the water shortage to propose solutions. This study attempted to find solutions through the accessibility of water resources, the provision of effective water resources, renewable water resources per capita, and comparisons of water rates in Taiwan with those of other countries. According to the research findings, the government has established short-term, middle and long-term policies (including the development of water sources, reducing water usage, and dispatching and backup).

Keywords: water resources; water shortage; renewable water resources per capita; water rates.

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1 Introduction

Water is a necessary substance in the earth environment to maintain the operation of all ecosystems. Water on the earth is distributed everywhere including in the oceans, glaciers, rivers, lakes, underground rock formations and the atmosphere; the operation of water in all places follows a circulatory system, and this allows water resources to continue to emerge. The problem of water shortage in Taiwan is closely related to its topographic and geological conditions, climate change, reservoir siltation and human factors, which all are the main reasons for Taiwan's current problem of water shortage.

From the perspective of Taiwan's topography, the land is narrow and densely populated, the slopes are steep, the rainfall is concentrated and the rivers are short, so most of the rainwater flows quickly into the ocean. Regarding human factors, Taiwan's average daily water consumption is 284 l per person, which is 34 l more than the international standard value of 250 l. Taiwan's water price is relatively cheap compared to other countries, which may also be why people are not keen on saving water. In terms of reservoirs, according to the statistics of the Water Resources Agency, one-third of the reservoirs in Taiwan have siltation, meaning Taiwan lacks 26 tons of water a year, and rainfall cannot be fully stored and utilised. From the perspective of climate factors, although Taiwan is surrounded by the sea and has abundant rainfall brought by the plum rain season and typhoons, the rainfall periods and rainfall areas are not evenly distributed because of climatic and geographic factors, and the water that can be stored is limited because of the size, distribution and siltation of reservoirs. However, the demand for domestic and industrial water has increased significantly due to economic development. With an increase in demand and a decrease in supply, the water shortage crisis has become an urgent issue.

Long-term observations have pointed out that the rainfall brought by typhoons contributes about 40% of Taiwan's annual rainfall; however, the strong Pacific subtropical high in 2020 led to the lack of typhoons in Taiwan that year, resulting in Taiwan's worst drought in 56 years in 2021. As of 2020, the storage volume of many reservoirs was less than 20% of their capacity, and the water level of some reservoirs was even lower than 10%. Indeed, the average rainfall in Taiwan is 2.5 times that of the world. Is there a lack of effective management of water resources? The large-scale drought in the western part of Taiwan's main island in early 2021 has caused various regions to reduce the pressure in the water supply, restrict the water supply, suspend farming activities and close businesses to different extents. This is the worst drought since 1947 and has been called the worst drought in 100 years. It has affected agriculture, service industries and power supplies, and caused rivers, lakes and reservoirs to dry up. This study used relevant information to have an in-depth discussion of the current status and importance of Taiwan's current water resources, as well as the main reasons and feasible response methods for water shortage based on the uneven distribution and insufficiency of water resources.

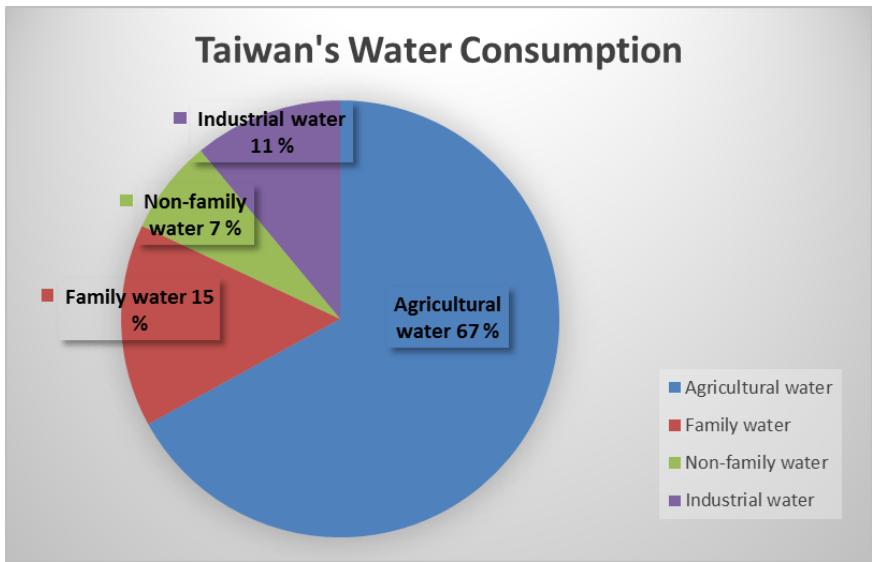
2 Allocation of water resources in Taiwan

Taiwan's water consumption can be divided into three categories of agricultural water, industrial water and domestic water. Agricultural water consumption is the highest, accounting for about 70% of the total (including 60% for irrigation, nearly 10%

for cultivation, and a small amount of water for animal husbandry), while domestic water consumption accounts for about 20%. Industrial water consumption only accounts for 10%.

According to the Water Resources Agency, the annual change in agricultural water consumption in the past decade has ranged from 11.3 billion tons to 13.2 billion tons. As shown in Figure 1, agricultural water consumption accounts for about 70% of Taiwan's water consumption. In 2019, the agricultural water consumption was about 11.88 billion tons, which was 71% of Taiwan's 16.74 billion tons of water consumption. At present, agricultural water consumption is mainly from river diversion; the water from reservoirs is about 1.1 billion tons, accounting for about 10% of the overall agricultural water consumption. Among them, the irrigation water provided by major reservoirs accounts for about 40% to 80% of the reservoirs' annual water consumption. According to the statistics on water use in 2019, agricultural water consumption accounted for about 50% of Shimen Reservoir's water consumption, and this figure was about 60% for Mingde Reservoir, about 40% for Shigang Reservoir, and about 80% for Wushantou Reservoir.

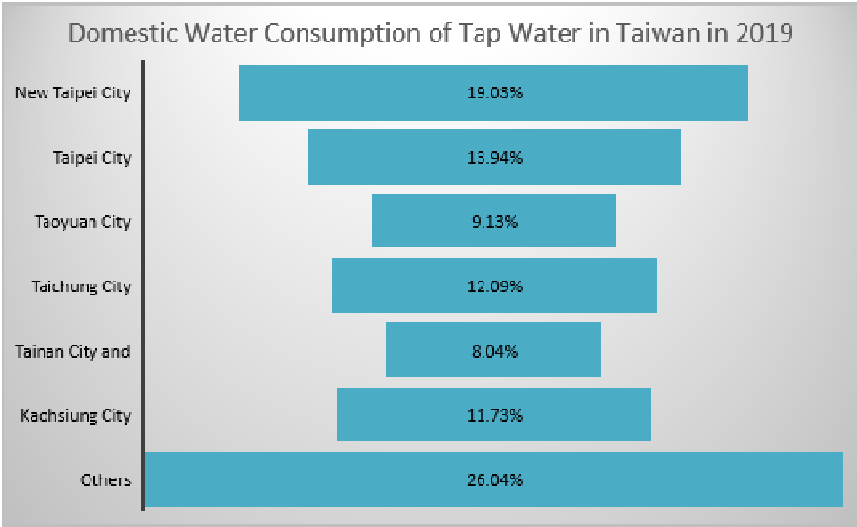
Figure 1 Taiwan's water consumption (see online version for colours)



Source: MORRIS

Figure 2 shows the distribution of domestic water consumption in each county and city and the distribution of daily domestic water consumption per person in each county and city. Because the populations of these six municipalities (Taipei City, New Taipei City, Taoyuan City, Taichung City, Tainan City and Kaohsiung City) are larger than those of other counties and cities, the water consumption is also relatively high.

Figure 2 Domestic water consumption of tap water in Taiwan in 2019 (see online version for colours)

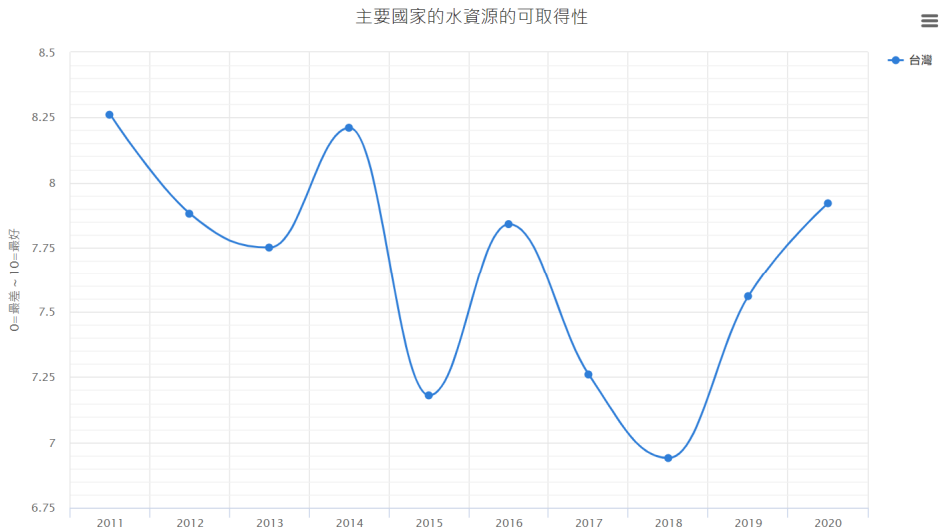


Source: Water Resources Agency

2.1 Availability of water resources

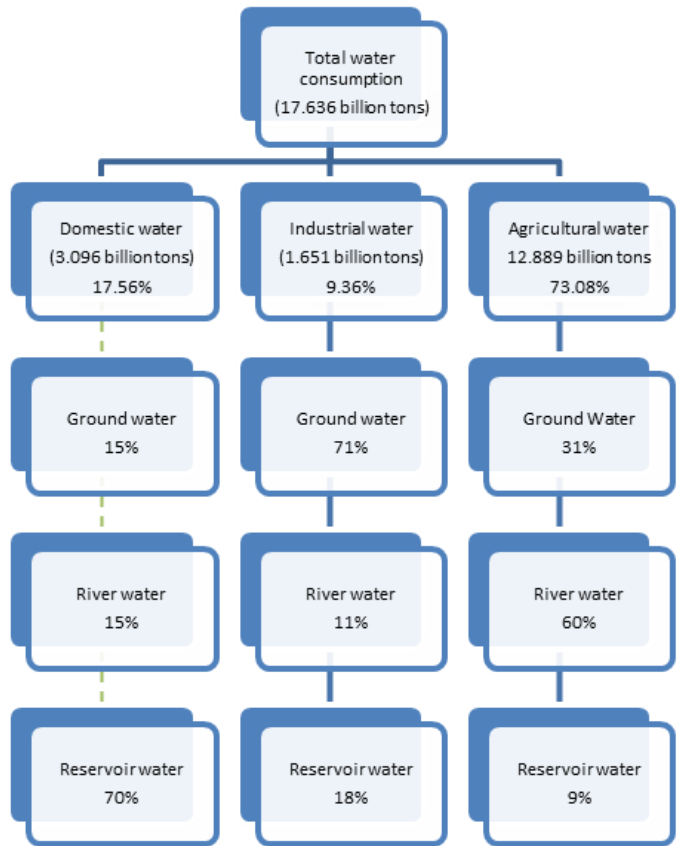
It can be seen from Figure 3 that the availability of water resources in Taiwan is not fixed for every year. Of course, it is greatly related to the amount of rainfall, but it can be seen that the availability of water resources gradually increased from 2018 to 2020.

Figure 3 Availability of water resources in Taiwan (see online version for colours)



Based on the analysis of the environmental supply side, the current total annual rainfall in Taiwan is 103 billion tons. After deduction of the loss caused directly by the discharge from the rivers into the sea plus the groundwater infiltration volume of four billion tons, the total amount of water that can be supplied is about 15.7 billion tons/year. As learned from the analysis of Figure 4, the total water consumption in Taiwan in 1996 was 17.636 billion tons, including 3.096 billion tons of domestic water, accounting for 17.56% of the water used. The industrial water consumption was 1.651 billion tons, accounting for 9.36% of the water used, while the agricultural water consumption was 12.889 billion tons, accounting for 73.08% of the water used.

Figure 4 Rainfall analysis (see online version for colours)



Source: Water Resources Agency

2.2 Effective water resources

Under the condition that the number of reservoirs in Taiwan remains unchanged, there is a trend that Taiwan's effective water resources are increasing year by year, indicating that Taiwan's ability to retain water resources is increasing. It can be seen from Figure 5 that the effective water storage capacity of the reservoirs began to drop year by year from 2010, but after dredging in 2016, the effective water storage capacity began to increase, thus allowing the available water resources to increase year after year. However, even

with the gradual increase in available water resources, Taiwan is still prone to water shortage, which indicates that problems exist at other levels, such as the high leakage rates of old pipelines, ineffective water storage, and people's failure to cherish water resources.

Figure 5 Effective water resources in Taiwan (see online version for colours)



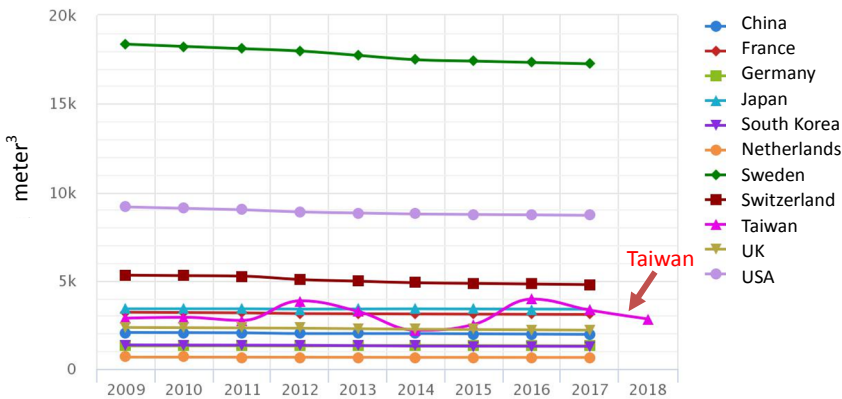
System No.: SD10308-0025.

2.3 Per capita reclaimed water resources

In order to motivate the sustainable use of water resources and promote the development, supply, use and management of reclaimed water, water reclamation is the most important goal of global sustainable development.

As seen from Figure 6, the amount of reclaimed water reused in Sweden is much higher than that of other countries and is almost ten thousand cubic metres higher than in the US, which is the nation with the second highest reuse of reclaimed water. Countries with higher consumption of reclaimed water also have relatively higher water prices. In recent years, the supply of water has been decreasing, and the extent of the water price increase has gradually become more obvious.

Figure 6 Per capita reclaimed water resources of Taiwan (see online version for colours)

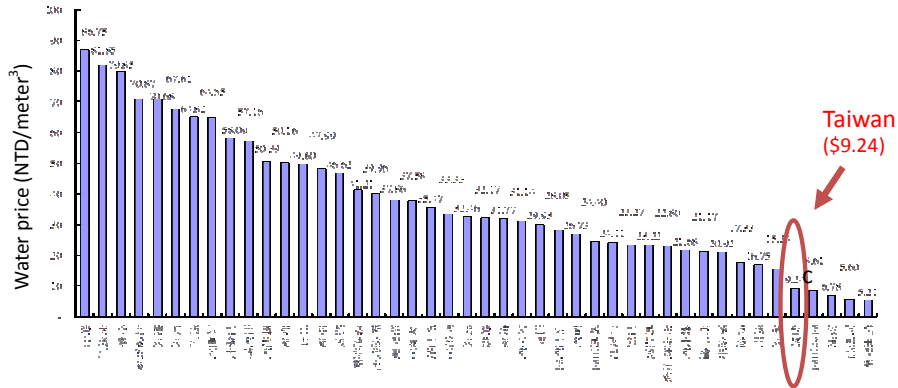


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3 Comparison of Taiwan's water prices with other countries

Figure 7 shows that compared to other countries, Taiwan's water price ranks fifth from the bottom. Not only has the water price not increased for 20 years, but all industries and regions (except Taipei City) also enjoy the same water price. In addition, as it is in charge of Feitsui Reservoir, Taipei City enjoys the benefits of higher average water consumption and lower water prices.

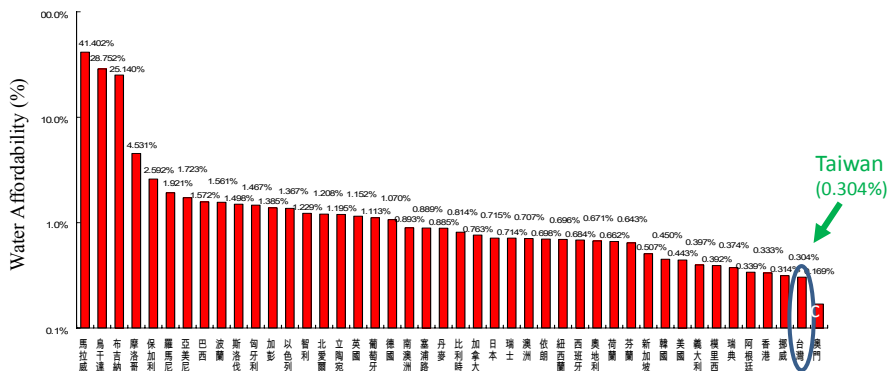
Figure 7 Comparison of average water prices of various countries in 2011 (see online version for colours)



Source: Taiwan Water Corporation

Regarding water prices, each country's water affordability assessment is calculated based on the national income and gross domestic product (GDP). A higher water affordability assessment means that a country's water price is relatively higher under the same GDP per capita, which indicates that the public carries a heavier water cost. We can see from Figure 8 that Taiwan's water affordability assessment is the second lowest, showing that Taiwan's water is indeed inexpensive.

Figure 8 Comparison of the water affordability assessment of various countries in 2011 (see online version for colours)



Source: Taiwan Water Corporation

In order to address the unfairness caused by water prices, some countries have adopted the strategy of charging higher water prices for those who use more water, particularly in large cities such as Tokyo, Osaka and Beijing, where the average water price was NT\$ 67.7 once water. UK also uses the method of having the rich pay more and the poor pay less to allow certain disadvantaged groups to enjoy lower water prices or even free water.

4 Issues of water resources in Taiwan

Water scarcity is a common global problem. Due to the El Nino phenomenon in the world and the late arrival of seasonal winds and rains, one-third of the world's population is currently short of water, which means two billion people are living in water-scarce countries, and this figure is estimated to increase to two thirds by 2025.

Taiwan is surrounded by the sea, and its annual average rainfall is 2.5 times that of the world. However, it is densely populated, resulting in an annual rainfall per person that is less than one-sixth of the world average. It is a country with severe water shortages and ranks eighteenth in the world for countries with water shortage issues. By summing up the above data and information, this study summarised the five major problems of current water resources, as explained in the following section.

4.1 Inability to retain water

Taiwan's rivers have high gradient and are not long in length, with serious deforestation and exploitation of land upstream, small catchment areas and steep slopes, making it unable to retain water. In addition, people's living standards have improved in recent years, resulting in an increasing demand for tap water.

4.2 Inability to hold water

Due to the severe problem of reservoir siltation, coupled with serious tap water leakage, one-fourth of Taiwan's water is lost every year. Whenever there is a drought, the reservoir beds become visible, and when people see serious siltation at the bottom of the reservoir, they often blame this as one of the reasons for water shortages. However, an exploration of the causes points to the steep slopes and rapid currents in the Taiwan area, as well as its location in the seismic zone, frequent heavy rainfall, and slope collapse and soil erosion, which are all inevitable phenomena of nature. It is necessary to strengthen soil and water conservation to reduce the amount of collapse and erosion. Next, even if the 96 reservoirs in Taiwan still maintain their original storage capacity from the beginning of construction and are completely free of siltation, the total storage capacity is only 2.45 billion tons and the per capita allocated reservoir capacity is only about 106 tons, which is still low compared to other countries in the world and is far from enough to cope with possible droughts.

4.3 Uneven rainfall

The rainfall intensity and rainfall distribution in Taiwan are uneven, resulting in a large difference in rainfall during the rainy season and the dry season.

1 *Excessive differences between the rainy season and dry the season*

In 2021, Taiwan faced the most severe drought in recent years. All reservoirs in Taiwan had the lowest water storage in history. Landforms on the reservoir beds that had not been seen for a long time, such as Nine Frog Statue (a water level indicator in Sun Moon Lake) became completed exposed. This scene was extremely inconsistent with the popular impression that Taiwan is a rainy island. However, rainfall in Taiwan is uneven. The main rainfall in Taiwan is concentrated in the rainy season and typhoon season from May to November each year; there is less rainfall in other months, causing water shortages to tend to occur in the winter.

Figure 9 shows that the average annual rainfall in Taiwan is about 2510 mm, which is 2.6 times the world average. Taiwan ranked thirteenth when its rainfall was compared with 180 countries in 2014, as announced by the Food and Agriculture Organization of the United Nations (FAO). There is no doubt that Taiwan is an area with abundant rainfall.

Figure 9 Rainfall in Taiwan over the years (see online version for colours)



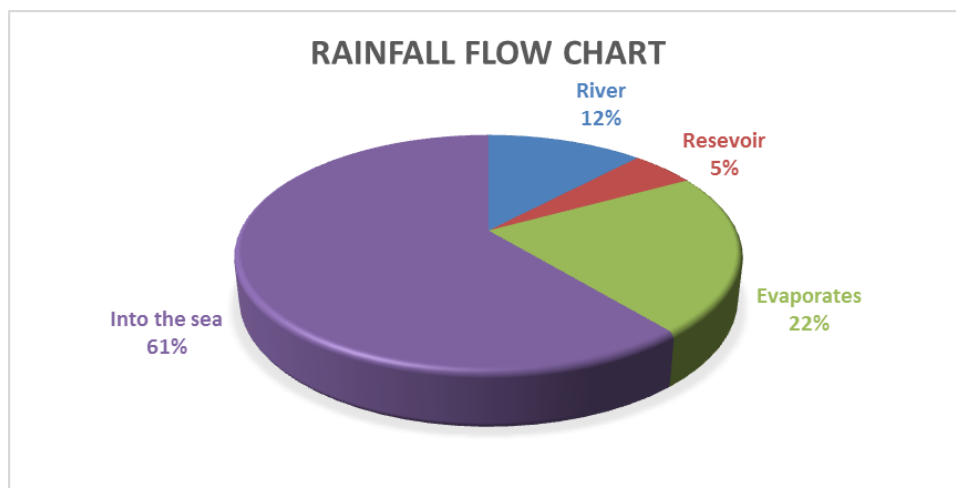
Source: Central Weather Bureau

Figure 10 shows that in addition to being a water-scarce country, Taiwan is also facing the inability to fully store and use its rainfall. Over the last 10 years, the average rainfall in Taiwan was about 95.2 billion tons, and the utilisation rate was only about 19%. Both the surface water (in reservoirs and barrages) and the groundwater from rainfall infiltration have become the main source of water supply for domestic, industrial and agricultural water; about 19.7 billion tons evaporates, and more than 55 billion tons of runoff flows into the sea.

4.4 *Excessive waste of water*

The average daily water consumption per person in Taiwan is 284 l, which is 34 l more than the international standard value of 250 l, which is equivalent to the water storage capacity of Feitsui Reservoir or 1.5 times that of Shimen Reservoir.

Figure 10 Rainfall flow chart (see online version for colours)



Source: Special Report on Efficient Use of Water Resources in Taiwan

4.5 Low water prices

Taiwan is world-renowned for its low water prices. Agricultural irrigation water accounts for 70% and industrial water accounts for more than 10% of the water sold, but water prices are only between NTD 7.5 and NTD 11. Taiwan's water supply companies are selling at a loss, as the current development cost for tap water has reached NTD 20 to NTD 30 once water.

5 Other countries' methods to address water shortage

5.1 Israel

Israel, which is known as a model of water conservation, uses irrigation pipes to save water. The improved irrigation pipes can direct water to plants, saving at least 40% of water per acre. In addition to saving water through irrigation, Israel also innovates in agriculture, and it developed drought-resistant seeds in 1939.

The majority of water resources losses are caused by water leakage and waste due to pipeline problems. Hagihon, an Israeli listed company, has adopted an advanced system to detect and repair water leakage. In this system, sensors in the water pipes record the sound of the water flow and send it back to headquarters every ten seconds. When water leaks, the sound of the running water will be different. At this time, a GPS system will guide a robot through the pipe to find the leakage and automatically repair it before it can grow.

Moreover, there is the use of water and wastewater. Loeb, known as the father of reverse osmosis, invented reverse osmosis (RO) during his research at UCLA. The cost of this method is only half of that required by other methods. He planned the first industrial-scale desalination plant in 2005 in Israel, and five plants had been successively

established by 2014, thus providing about half of Israel's drinking water. The technology has been studied and imitated by countries around the world.

As for wastewater, Israel established a robust wastewater treatment infrastructure in the 1990s. Today, 85% of the country's wastewater is reused for agriculture, 10% is used to increase river flow and extinguish forest fires, and only 5% flows back into the sea. Israel has even directly changed the pricing of water as the ultimate solution. The government passed a new law in 2008 that required consumers to pay all water charges, except for some preferential treatment for farmers. Soon after, household water consumption dropped by 15%, and even farmers began to adopt more water-saving methods.

5.2 Singapore

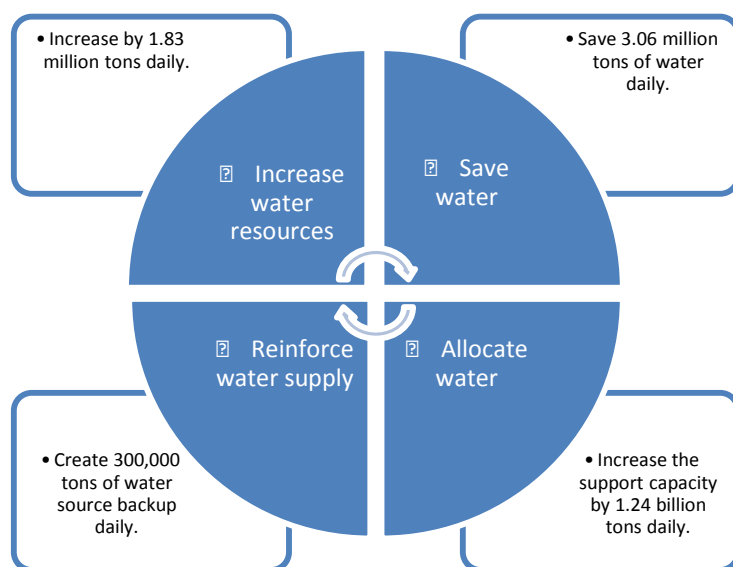
In Singapore, 33% of its water comes from neighbouring Malaysia, so proper water management is important for the country. In order to save water, Singapore's water bill is five times that of Taiwan, and restaurants do not provide two bottles of water like they do in Taiwan. Singapore started planning as early as 1998 to recycle and reuse domestic wastewater. The resulting plan was called NEWater, which provided water that could not only be reused for industrial and commercial use but could also be directly consumed.

6 Taiwan's response to addressing water shortage

There are limited dam sites in Taiwan that can be used to build reservoirs. This problem, coupled with high environmental awareness, difficulties in land acquisition, local requirements for feedback and other important pressures, has made it extremely difficult for the government to build reservoirs. At present, people in Taiwan are extremely wasteful in their water use. When the water consumption rates of major cities around the world are taken for comparison, the daily water consumption per capita in Taipei is 353 l, while the same is 204 l in Hong Kong and is 155 l in Singapore. With its limited water resources and the waste of water by the people of Taiwan, the problem of water shortage is becoming more and more serious. Therefore, in Taiwan, which regards economic development as its lifeblood, the provision of stable and sufficient water resources is one of the key elements to improve the quality of life and promote the vigorous development of society and the economy.

According to the government's solution to the water scarcity problem presented in the global information network of the Water Resources Agency, the Executive Yuan developed four strategies in November 2017 to increase water resources, save water, allocate water and reinforce water supply to stabilise the water supply (shown in Figure 11). Forward-looking infrastructure and public construction plans were also employed to accelerate the execution of these four strategies. It is expected that upon implementation of the plan, the daily water supply in Taiwan will increase by 1.83 million tons, save 3.06 million tons of water, increase the support capacity by 1.24 billion tons, and create 300,000 tons of water source backup. The overall goal is to increase 5.19 million tons of water sources daily by 2031 to provide a stable water supply for all counties and cities.

Figure 11 Government plan to address water shortage (see online version for colours)



Source: Water Resources Agency

The annual rainfall in Taiwan is about 92.6 billion tons and is mainly brought by typhoons, plum rains and the northeast monsoon. However, the rivers are east-west oriented and have short basins and high flow rates, and the rainfall intensity has increased and become concentrated in recent years. Such heavy rains have caused a large amount of silt and mud to pour into the reservoirs, thus filling them and creating the need for flood discharge. The capacity of the reservoirs has been reduced due to sedimentation, resulting in the actual usage of only about 17.8 billion tons among the 92.6 billion tons of rainfall.

Water scheduling and distribution, as well as fallow methods, have been adopted for the effective use of water resources. The scheduling and distribution of water are mainly based on the provisions of Article 18 of the Water Act, which states that the priority of its application is:

- 1 domestic and public water
- 2 agriculture water
- 3 industrial water.

At present, in addition to the domestic water consumption of about 20%, the water consumption by the agriculture sector (which has an output value of about 1% of the gross national product) accounts for 70% of the total water consumption, while the water consumption by the industry sector (which has an output value accounting for 31% of the gross national product) is less than 10% of the total water consumption. As water resources are precious, Taiwan's environmental awareness is high; however, the demand for industrial water is increasing. The only solutions to this problem are to increase resources, save water and allocate water resources in a mutually beneficial manner.

Short-term and mid- to long-term plans or programs have been formulated under the policies set by the government. Plans to increase resources are aimed at reservoir repair

and reclaimed water utilisation; in terms of saving water, plans include lowering the leakage rate and improving agricultural and industrial water recovery; for water scheduling and backup, plans include dispatching sufficient water resources to important areas and supporting the use of engineering plans.

1 *Increasing resources*

This study recommends building large ponds or artificial lakes to store rainwater during ordinary times and introduce overflows from rivers when a typhoon comes. If a pond or artificial lake can absorb 1% of the rainwater, it can increase the water resources by 900 million tons every year. The treatment and reuse of 13 wastewater treatment plants in Taiwan could also add about 300 million tons of water resources.

2 *Water saving*

- *Tap water:* According to the water supply company's data, the pipeline leakage rate of Taiwan is about 20.83%. If the leakage rate is reduced to the standard of the International Water Association, nearly 400 million tons of water resources can be added per year.
- *Agricultural water:* The current agricultural water consumption is about 12.6 billion tons, accounting for 70% of the total water consumption. If flood irrigation and trench irrigation are replaced by pipeline irrigation, about 40% of the water consumption can be saved.
- *Rewarding industrial water saving:* Since 1995, the Industrial Technology Research Institute has provided technical assistance to the manufacturers of electronics, chemicals and textiles to save water, and considerable results have been achieved. Via investing in water-saving measures, Formosa Plastics Corporation has saved more than 100 million tons of water each year. This study suggested that the government should reward industrial water saving through tax reduction, which could result in increased water saving.

3 *Water resource allocation for mutual benefits between agriculture and industry*

Since Taiwan gained access to the WTO, its agricultural area and output value have continued to decline. However, the agricultural sector with an output value of 1% accounts for 70% of the water consumption, while the industrial sector with an output value of 31%, which urgently needs water, consumes less than 10%. It is necessary to change this unreasonable phenomenon. A feasible approach is to allocate and sell agricultural water to the manufacturing industry as industrial water according to the actual needs of the industry, and then use the money to lay water pipes for the gradual switch to pipeline irrigation or build existing channels to avoid water draining. This approach could save 40% of agricultural water.

Implementation results of the stable water supply plan (as of 2019):

- 1 From 2017 to 2019, daily water resources were increased by 1.01 million tons. During this time, water retention projects for Chungchuang Retention Basin, Hushan Reservoir, and Tzengwen Reservoir, as well as the Kaohsiung Fengshan River

Recycled Water Project, the Tap Water Leakage Reduction Project, and Phase 2 of the Banhsin Area Water Supply Improvement Plan were completed, adding a total of 1.01 million tons of water available per day.

- 2 In 2020, an additional 540,000 tons of daily water resources were added, and additional projects will cause the water supply to become more stable in the future. The supply to Changbin through the Fuma Canal, the joint use of Tainan-Kaohsiung water resources, water pipes for Taoyuan and Hsinchu, hyporheic flow of Gaoping River watershed and reserve wells are being constructed, adding a total of 540,000 tons of water per day.

Wang and Wang (2014) pointed out that Taiwan's water shortage factors and solutions are in the following order: water resource scheduling (21.26%), appropriate development of water resources (18.56%), promotion of water conservation (14.73%), adjustment of the water rights system (14.02%), adjustment of water prices (13.50%), reorganisation of water conservancy organisations (9.26%), and maintenance of water pipelines (8.66%). Obviously, the strategy of water resource scheduling was the most important in the opinion of the interviewees, thus reflecting the importance of water resource scheduling and management due to the impact of different climate factors on water resources in the north, middle and south. The second most important item was the appropriate development of water resources. Compared with other advanced countries, Taiwan's water resource development has been strengthened, but it is affected by political factors and rising environmental awareness, and the consensus of the people still needs to be integrated to achieve the positive goal of increasing resources. Water waste is a serious problem in Taiwan, and the strategy of promoting water conservation can play a certain role during periods of water shortage. In recent years, water conservancy organisations have achieved some results in promoting water conservation (Wang and Wang, 2014).

Although the amount of water flowing into the sea in Taiwan exceeds 55 billion tons a year, most of it is concentrated in the rainy season, especially from heavy rains and typhoons. If there is not enough water storage capacity, most of the water can only run into the sea rather than be used effectively. Therefore, the government has promoted a series of measures, including water conservation, tap water leakage reduction, rainwater storage, wastewater recycling and reuse, industrial transformation, water price rationalisation, total water use control and the strengthening of water use audits, so that Taiwan's water resources can be used in a sustainable and reasonable manner.

7 Conclusion and suggestions

In order to develop the economy, the government is continuing to develop industrial zones. If the proportion of industrial water recovery and recycling can be increased, it will effectively reduce pressure on the water supply. TSMC has been able to recycle 90% of its factory water for reuse, and it is estimated that an amount of water equal to that stored in Tzengwen Reservoir can be saved in one year if the industry can recover 60% of water for reuse. In terms of domestic water, the average Taiwanese uses more than 250 l of water a day, and even more than 300 l. This is because Taiwan's water prices are so low that people do not realise the preciousness of water resources. Water prices should be

increased appropriately to control water use. If each person can reduce water consumption by 50 l per day, the overall water saving will be considerable. With economic development, the proportion of agricultural water consumption should be adjusted. Based on Taiwan's economic level, rational agriculture water consumption should not account for 70%, and there is room for improvement in the evaporation loss of irrigation water. Taiwan's water price is one-fourth to one-sixth of other regions in the world, causing water resources to be taken for granted. The water price should be increased to at least cover the government's costs for developing water sources to promote water saving. If domestic sewage can be recycled and reused, 2.85 million tons of water can be recovered per day, enough to supply 10 million people with water, which is not only cheaper than constructing a reservoir but is also in line with the concept of a circular economy. The development of a water-saving industry could bring business opportunities to Taiwan as well.

The government's solutions to the water shortage problem are to adjust the overall environment. Taiwan should learn from Israel and other countries and assist industries in the research and development of water resource technologies as well as improve the monitoring, management and data control of water resources to prevent problems before they occur. In addition, other countries have successively invented water-saving tools, four of which are listed as follows. First, 17-year-old Ludwick Marishane created a dry bathing emulsion formula consisting of a blend of essential oils, bioflavonoids and deodorising chemicals. Four litres of water can be saved each time by using dry bathing, allowing a total of 1 million litres of water to be saved. Next, two students from University of Huddersfield came up with a foldable toilet named 'Iota' as a way to improve water efficiency. They claimed that each person could save 10,000 l of water per year after its installation. Third, water pipe leakage detection software named Zonescan Alpha has been developed to detect leaks in a pipeline by setting up a sensor network and then sending the data back to a control centre in real time. A German state-owned enterprise has successfully tested this software and has reported the saving of 2 million litres of water. Finally, Deepika Kurup invented a solar water purifier based on a solar energy chemical water purification method. He found that exposing titanium dioxide and zinc oxide to ultraviolet radiation from the sun produced a photocatalytic compound that could be used to purify water. If the above-mentioned products can be marketed in Taiwan, they could help to save a considerable amount of water in Taiwan.

Through recent mass media coverage, many people have gradually realised that Taiwan's water has been overused, and they have begun to establish a correct concept of water conservation step by step. The government has strengthened the protection of water resources; however, the cooperation and efforts of all people are required to achieve the long-term goal of truly maintaining Taiwan's water resources.

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