

The Future of Japan's Water Supply

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Japan

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1. Abstract

People think Japan has surplus water and so are prone to water waste. Japan receives 70~80% of its rainfall during the monsoon (June-July) and typhoon (August-September) seasons. With climate change, this cycle is suffering damage. Studies show a long-term increase in intense rain and expect longer and more frequent drought periods in the future. With Japan's short, fast flowing rivers, heavy rainfall leads to flooding and erosion. Storing an adequate water supply is problematic.

The majority of Japanese people are not aware of this issue, so it is vital to spread awareness. By studying successful campaigns in Japan and other countries, we may find ways to convince companies and media in Japan to champion water conservation.

We will focus not just on awareness, but also on practical solutions. As Japan is one of the top rice producers in the world, we also focus on saving water in agriculture. There is already some available technology such as rice which can be grown in saltwater or red rice that does not require flooding to grow.

By analyzing this issue, we hope to make Japan rich in water and to set a good example for the world.

2. Keywords

Water scarcity, Education, Conservation, Agriculture

3. The purpose of this research

The Earth is called "ocean planet." About two-third of earth's surface is covered by water and it has about 14 billion km³. However, water resources, specifically fresh accessible water, only account for 0.01% of this water. Other freshwater is in the form of snow or glaciers. Most of the Earth's water is sea water. Therefore, accessible water is now recognized as a rare resource. This rarity is made worse because of people's modern lifestyles. Once water is contaminated, this valuable resource becomes unusable unless a lot of effort and energy is spent on cleaning it. In Japan, the idea of water scarcity is not such a major issue yet, and without the government and mass media spreading awareness people may not become aware of this issue. Too many people in Japan are unaware of the consequences of wasting water and this contributes to water scarcity. Through this conference, we would like to look at the habits that contribute to wasted water, and to spread awareness about the necessity of changing people's mindsets regarding water. To do this, we first need to examine known water issues and then consider what solutions Japan can offer. Spreading awareness of water security through education in schools is necessary. We can also use commercials and Social media, which people use in their daily lives.

4. Method of the research

Both qualitative and quantitative research methods were used in this study. In Order to determine what the main issue of water is in Japan, we gathered and analyzed data from reliable sources such as the Japanese Ministry of Land and Infrastructure and the United Nations Food and Agriculture Organization. We focused on two research questions to specify our understanding of the issue of water scarcity in Japan. To further our research, we also conducted surveys with the Japanese public to get more specific data on this issue.

4.1 Gathering and Analyzing Data

We would like to begin by focusing on the general issue of water scarcity and water conservation in Japan. In order to delimit our analysis, we came up with two research questions regarding the current Japanese views of this issue.

The first question is, "Is water scarcity truly a problem in Japan and, if so, how and why." The second is "How many Japanese citizens believe water scarcity is an issue in Japan and are trying to conserve water." To determine the answer to the first question, we decided to research the ratio of the annual water consumption in Japan to the amount of water the nation conserves. To conduct this research we used sources from the Japanese Ministry of Land and Infrastructure in addition to research done by "The Tokyo Foundation" who are an independent, non-profit think tank funded by the Nippon Foundation, which is a non-profit, grant-making organization [1]. By conducting this analysis we can determine where Japan is in terms of the amount of water the nation has and if the nation is in a state of surplus of water or in a water deficit.

After explaining the results of this analysis, we shift our focus to the second part of the question, "how and why," in which we seek to understand the contributing factors to Japan's current state of water scarcity or lack thereof. In order to interpret this question, we compare Japan to nations with similar, more, and less amounts of water usage. We also want to determine the top sources of water usage in Japan and in other Nations. To do this, we will be pulling data on the US, Italy, Mexico, and the United Kingdom for comparison. These countries are significant when looking at water usage because The United States has the largest amount of water consumption per capita in the world, Italy and Mexico have a water usage rate that is comparable to Japan, and the UK has a fairly low water usage rate. By analyzing this data it is possible to make some assumptions about what Japan is doing wrong and what Japan should do in order to lessen water consumption, as well as to determine what factors and habits of citizens cause larger amounts of water usage. By taking examples from Italy and Mexico we are able to see what other countries in similar situations to Japan are doing to address the issue. Once we have analyzed the data, we can begin to propose solutions with nations such as the U.K. as our role-models.

Having data that shows that water is a rare resource is not enough to understand the scope of the problem of water scarcity. It is also important to look at people's perceptions of water. Our second question, "How many Japanese citizens believe water shortage is an issue?" looks at this problem. In order to get an idea of how people in Japan think about water, we conducted surveys on 50 Japanese citizens who are students at Kumon Kokusai High School. We asked all participants the question, "Do you believe water shortage is an issue in Japan? Why or why not?" By conducting this survey, are able to see the true reality of what the Japanese citizens believe regarding water scarcity in Japan. Also, we can determine how educated the average Japanese citizen is on this matter. From this information, we are able to propose what actions needs to be taken in order to solve the problem of water scarcity in the future.

4.2 How to Spread Awareness

Once we understand the extent of the problem, we can target the issue of awareness of water scarcity and conservation in Japan. In order to combat the issue of water scarcity, awareness is vital. Through the spreading of awareness, the citizens of Japan will be more educated on this issue, and from there citizens will become more mindful in their daily lives. This could lead to them trying to conserve water and to prevent wasting it. In order to make this possible, we studied various campaigns that have been successful in Japan's past as well as methods that have worked in other countries. We researched campaigns enacted through many platforms ranging from media to schools and workplaces. This research seeks to find the most efficient and effective way to spread awareness which, along with the knowledge of the severity of the problem facing Japan, could lead companies and mass media to champion water conservation.

4.3 Introducing Practical Solutions

Awareness is a good place to start addressing the issue of water scarcity, but practical solutions that lead to action are also necessary. Japan is a nation heavily invested in and dependent on rice agriculture. Not only does Japan produce a mass quantity of rice but also has one of the highest rice consumption rates in the world. According to the United Nations Educational, Scientific, and Cultural Organization, agriculture is said to be by far the largest consumer of the Earth's available freshwater [2]. So, in nations like Japan where agriculture is very developed it is necessary to consider the idea of how agriculture affects water scarcity. One necessary question is, "Are there any alternative agricultural methods that do not require as much water that we can use as a solution to water scarcity?" In order to determine the answer to this question we researched alternative methods proposed by scientists as well as looking at the history of non-water farming. Specifically, we took information from reputable sources such as the Food and Agriculture Organization of the United Nations (FAO) and The International Rice Research Institute (IRRI) to further research sustainable and alternative rice farming methods that do not require as much water as currently popular

methods. Furthermore, in order to expand our research to gain more knowledge on this topic we also looked at the history of non-water farming. Considering the fact that non-water farming and alternative farming methods have been successfully used in more arid parts of world we focused our research on locations such as the Mediterranean, and the American West. By studying the evolution of non-water farming we sought to find realistic alternative solutions as well as accommodating methods in order to have a clear understanding of where and how we can apply this knowledge in the Japanese agriculture industry.

5. Results

In this section we will discuss the results of our research by giving an analysis of the data we researched and the solutions we were able to produce. We focused on the general issue of water shortage in Japan as well, spreading awareness and practical solutions for alternative agricultural methods.

5.1 Water Shortage in Japan

In order to gain a general understanding of Japan's circumstances regarding water scarcity and conservation we analyzed two research questions. The first being, "Is water scarcity truly a problem in Japan and, if so, how and why?" and the second question being, "How many Japanese citizens believe water shortage is an issue in Japan and are trying to conserve water." In order to determine the answer to this, we did some research and compared the ratio of annual water consumption in Japan to the amount of water the nation conserves.

Taking relevant data from the Japanese Ministry of Land and Infrastructure we found that: "The annual use of water in Japan (amount of water intake) is approximately 83.5 billion m^3 in total which can be broken down into approximately 16.2 billion m^3 for domestic use, 12.1 billion m^3 for industrial use, and 55.2 billion m^3 for agricultural use [3]." As for the amount of water conserved, "the amount of precipitation in an average year in Japan is approximately 650 billion m^3 . After deducting about 230 billion m^3 lost in evaporation/transpiration as well as gets washed out to sea. The existing amount of water is roughly 420 billion m^3 (65% of precipitation) [4]." This being the case the consumption of water in Japan totals up to 83.5 billion m^3 and the available resources add up to 420 billion m^3 . This ratio of consumption to available resources can be simplified to 1:5. This ratio shows that Japan still has a large quantity of water compared to its consumption rate.

Unfortunately, this calculated surplus does not tell the whole story. According to the Ministry of Land and Infrastructure of Japan, The amount of precipitation in Japan is on a decreasing trend when viewed in the long term, meaning that water is growing increasingly scarce [5]. There is a growing difference in precipitation between high and low rainfall depending on the year. This being the case, Japan should assume the possibility of a frequent occurrence of extremely

low rainfall, and a decrease in snowfall. Since, 65% of Japan's water comes from precipitation and the others comes from rivers, lakes, and dams which rely on precipitation, it is possible for Japan's water resources to drop by 30%.

There have been instances in the past where Japan has experienced sudden water shortages. For example, in 1964, during the Tokyo Olympic, Japan faced a serious problem with water shortage due to lack of rain and Japan's topographical conditions and since then, a large-scale water shortage has occurred once every 10 years. This was notably the case in 1994, when a nationwide water shortage affected about 16 million people due to insufficient tap water supply, and caused damage in the agricultural industry with product losses adding up to roughly 140 billion yen [6]. In Japan, especially considering its history as a nation with sudden water shortages due to the unstable rain patterns, citizens must start being more informed on this matter as well as begin cutting down their usage of water to prevent future crisis incidents.

As we have established the fact that Japan does indeed have a problem with water scarcity, the next step is to resolve the question: "how and why is Japan in such a state?" We must also begin looking for sustainable and effective methods to reduce the water usage in Japan. To achieve this, we compared Japan to nations with similar, more, and less water usage. Specifically, we pulled data from the United States, Italy, Mexico, and the United Kingdom.

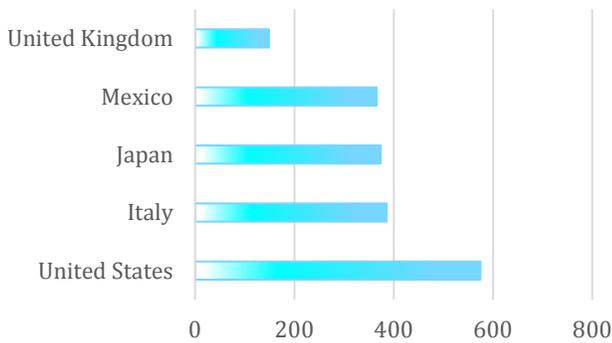


Figure 1: Water use around the world (Liters per day)

Starting off, Japan's top three factors of water usage are agricultural, industrial, and domestic usage. The top factor is agriculture coming in first with 55.2 billion m³ and domestic use coming to a second with 16.2 billion m³ and industry coming in third with 12.1 billion m³.

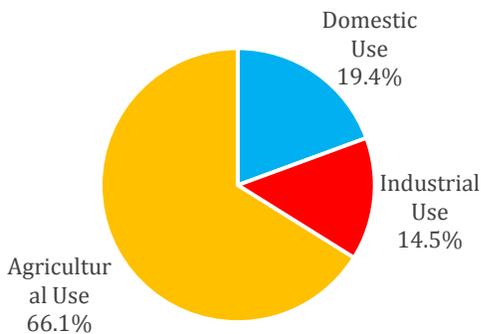


Figure 2: Water use in Japan

Looking at the global situation, the United States has the highest rate of water consumption in the world. According to the United States Geological Survey (USGS) thermoelectric power, irrigation, and public supply are the largest categories that cumulatively make up about 90% of the total national water usage [7]. Thermoelectric power uses 161,000 million gallons per day (Mgal/d) in the nation which is a little less than half of the total water consumption.

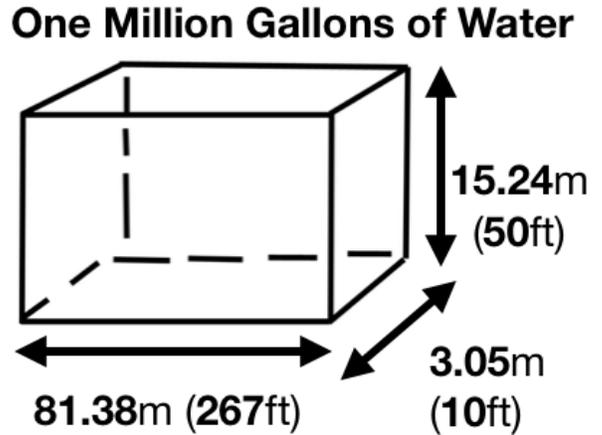


Figure 3: One million gallons of water

Even though thermoelectric power is not a leading factor in Japan's water usage rate according to the National Institute for Materials Science of Tsukuba, thermoelectric power has been promoted by the Japanese government since 1978 [8]. In 2013, the Japanese Ministry of Economy, Trade and Industry (MITI) has launched a 10-year project of "Development of the innovative utilization of technologies for unused heat energy [9]." Japan, being a nation with very advanced technology, is in danger of thermoelectric energy becoming a major issue in the future. In order for Japan to not follow America's example, it should rely on other sources of energy in order to conserve water.

Moving on, Italy has a similar amount of water consumption to Japan. 85% of the water usage comes from Agricultural use, 8% from domestic use, and the remaining 7% comes from industrial use. Also according to the World Atlas, Italy is notable for having the highest rate of bottled water consumption in the world [10]. This being the case, Italy does not seem to be focusing much on water scarcity but more on cutting down on plastic bottles to help save the environment. Japan, being a nation with a highly advanced vending machine culture, may have to start focusing cutting down on plastic bottles as well.

Lastly, the United Kingdom has a fairly low rate of water consumption compared to the amount of precipitation it gets as well as considering how developed it is. The UK has suffered dry winters in the past few years, so cutting down on water has been essential. In order to do this, the UK has taken this issue of water scarcity to the mass media. For example, the front page of BBC News has made it a priority to publish an article giving tips on how to save water [11]. According to the Bristol UK Technical Bid which won the European Green Capital Awards 2015, UK's water

consumption went down by 20 litres per day since 1993, by successfully using tactics such as providing Over 10,000 water efficiency kits to domestic water users, saving more than 800,000,000 litres of water in total [12]. Seeing that the UK has been successful in reducing the water consumption, we believe Japan can learn and benefit from the UK's tactics.

Next, we will move on to the second research question, "How many Japanese citizens believe water shortage is an issue." In order to answer this question, we conducted a survey and gathered responses from 50 Japanese students at Kumon Kokusai High School.

We asked participants the question, "Do you believe water scarcity is an issue in Japan and why?" The results revealed that 39 out of the 50 participants believe that water scarcity is not an issue in Japan, while 10 participants were unsure, and only 1 believe that water scarcity is an issue. A couple of reasons as to why participants believe water shortage is not an issue in Japan is because, "Japan is an island country," and "Japan is a country with rich natural resources due to the rainy season and pure rivers." These results show how Japanese citizens are not aware enough of the reality of water scarcity in Japan.

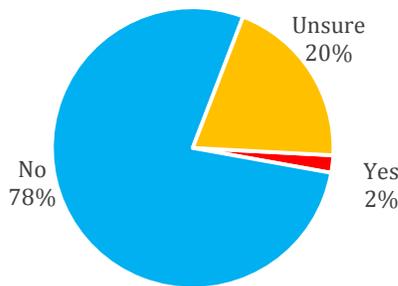


Figure 4: Survey- Do you believe that water scarcity is an issue in Japan?

5.2 Spreading Awareness

Having researched Japan's lack of knowledge about water scarcity and lack of effort to conserve water, we concluded that spreading awareness is the first and most vital step in warning the citizens about water scarcity and teaching them how to conserve resources. In order to begin planning how to spread awareness, we researched various successful campaigns on water conservation that have been done in Japan and other countries. First we focused on recent campaigns, such as Colgate's "#EveryDropCounts" campaign or the detergent brand Sunlight's "Sunlight Saves Water Campaign."

The Colgate campaign is a thirty second video clip that illustrates how almost four gallons of water are wasted when people keep the faucet running while brushing their teeth.

Colgate advises that we can save three thousand gallons of water each year by turning off the faucet while brushing. This ad campaign went viral and has garnered more than ten million views on YouTube.

The Sunlight campaign came up with solutions to ameliorate the water crisis in South Africa. In 2016, the company introduced the "Sunlight Saves Water" campaign by setting up a billboard made of eighty JOJO tanks (water storage tanks) on the N1 Ben Schoeman Freeway. With the help of a public poll, the JOJO tanks were distributed to the neediest



communities.

Figure 5: "Sunlight Saves Water" campaign

There have also been conservation campaigns run in Japan, although the focus has been on electricity rather than water. After the 3/11 earthquake and tsunami, total electricity supplied by the ten major nuclear power plant utilities in Fukushima dropped by almost nine percent, or 83 billion kilowatt hours, in comparison to the supply in 2010, according to the Federation of Electric Power Companies [13]. This being the case, a campaign called the "setsuden [saving electricity] campaign" was implemented nationwide. This campaign used media to convince Japanese households and businesses to cut back on electrical usage. For example, public networks aired television advertisements and *setsuden* posters were hung around places such as temples and convenience stores. Also, companies such as Panasonic and Tokyo Electric Power Company created pages which provide energy saving information. One sign that the campaign was effective is that Companies and public institutions such as schools reinforced the need to reduce energy consumption by adjusting their use of heating and air-conditioning. This campaign led energy usage during peak hours to fall by around 20%, with maximum usage falling from 60 gigawatts to 49 gigawatts [14].

By analyzing these campaigns, it is clear that most share similarities. Specifically, they are promoted by Large companies through the use of mass media and further spread by social media. Seeing that campaigns that follow these traits have been successful in the past, developing similar campaigns in the Japanese market could make a big impact in helping to spread the word about water scarcity.

5.3 Practical Solutions

Awareness is a good start to addressing the issue of water scarcity, but practical solutions are also necessary. As explained above, agriculture is one of the leading sources of

freshwater consumption in the world. Japan is a nation heavily invested in and dependent on agriculture, particularly on rice farming. Japan produces massive amounts of rice and has one of the highest rice-consumption rates in the world.

While a simple solution would be to reduce the size of the agriculture industry, this is not a practical solution as people depend on agriculture for food. As it is not plausible to reduce the amount of food grown, we must ask ourselves "Are there any alternative agricultural methods that do not require (as much) water?" According to research done by K. Padmavathy, a professor of the Department of Ecology and Environmental Sciences, at Pondicherry University in Puducherry, India, some methods of alternative farming are, biodynamic farming, no tillage farming, urban and peri-urban Farming, and eco-farming [15]. While all these alternative farming methods are useful, in circumstances where saving water is the priority, dry farming is currently the best solution. Dry farming is a farming tactic that was used in the Mediterranean and in much of the American West before the rise of dams and aquifer pumping made water more accessible in these regions. Dry Farming occurs when farmers break up soil which then becomes saturated with water during the rainy season. Next, using a roller, the first few inches of the soil are compacted and left to form a dry crust, or dust mulch that seals in the moisture against evaporation. Although this method has been proven to be effective in the past, According to Michael J. Coren, a science journalist and co-founder of Publet, dry farming is unlikely to win over farmers who still have abundant access to water, fertilizer, and big markets due to the fact that it is not a yield maximization strategy due to how costly it is. Coren points out that dry farming "allows nature to dictate the true sustainability of agricultural production in a region [16]." Because of the lower yields, dry farming may be a good strategy for rice farming in Japan when there is an expectancy of low precipitation in the future, but not a replaceable method for generic rice farming.

While the future of dry-farming is unclear, especially among populations that have access to substantial water supplies, there are sustainable and effective alternative methods of farming that just target rice. One alternative method is a rice called "red rice" which can be grown in soil without water flooding. This rice grows in the Kingdom of Bhutan in the eastern Himalayas, and may be a good alternative to Japanese rice being that it originated from Japanese rice, and the texture and flavor is very similar. However, red rice can only be grown in an environment like the Eastern Himalaya with its cool dry climate, so growing this alternative rice in Japan may not be as realistic. Another alternative rice farming method is the method of saltwater farming. As technology has developed, scientists have figured a way to grow rice in salt water. This method still needs to be further researched by scientists but, a farm in the Netherlands has managed to grow healthy and tasty vegetables in soil irrigated with salt water. It may be a good idea to establish funding and research to see if this cultivation technique can be adapted to rice as well as see how this method affects the nutritional content of the rice. Even though, these alternative methods of farming may take time to popularize and become

common, mass media and education can help with spreading awareness of this issue as well as including these methods in campaigns. Since Japan is a nation heavily reliant on rice, having these rice farming methods as a backup for times of drought may be a necessary solution to water scarcity.

6. Conclusion

In this research paper, we considered many issues related to water in Japan. Through this research we found that the Japanese lack awareness of water scarcity and knowledge regarding the country's natural resources. We think that spreading awareness is vital in protecting Japan's water in the future. Spreading awareness using education in schools and media has been successful in the United Kingdom and other countries, and these methods should be applied in Japan. Also, as rice is a staple food in Japan and agriculture uses a lot of the country's water, we examined alternative agricultural methods aimed at reducing or eliminating water use. Reconsidering the way we use water in growing rice may be a key to ensuring an adequate water supply in the future.

This study can be expanded by future, more comprehensive, studies of alternative agriculture and media campaigns, but our research has provided a clear starting point for addressing the problem of water scarcity in Japan.

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