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Review

Urban Water Consumption: A Systematic Literature Review

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Abstract: The study and analysis of urban water consumption habits in different regions contribute to the development of strategies aimed at secure water reduction and distribution. Within this context, knowledge of global water availability and the analysis of factors that influence consumption in different regions in distinct situations become extremely important. Several studies have been carried out in a number of countries and describe different approaches. The objective of this article is to learn about the strategies used in water consumption forecast and analysis. Most of the studies analysed seek to understand the factors influencing consumption in different building types. When it comes to residential buildings, the number of residents and the influence of economic issues on water consumption have an important role in this matter. In this context, pieces of research present the use of awareness campaigns as a strategy towards water use reduction. As a contribution, this article presents a systemic view of the pieces of research conducted and their contribution to forecasting water consumption in different regions. In conclusion, one observes the importance of analysing the factors influencing water consumption in different regions and scenarios, such as during the COVID-19 pandemic. This article can help managers and researchers understand the main factors that influence water consumption and how this consumption takes place in different regions.

Keywords: water consumption; water availability; COVID-19; urban environment

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1. Introduction

In several countries around the world, studies on water consumption in residential buildings are carried out in order to help local governments define policy strategies aimed at managing this resource. Research is based on analyses of the main factors related to water use in certain regions distributed across several countries. Some studies have developed methodologies for forecasting water consumption in the urban environment.

In China, Xiangmei et al. [1] found that in more than 50% of the cities studied, annual water consumption shows a downward trend with an increase in Gross Domestic Product (GDP) and population growth. Such analysis was made using a multivariate statistical method. In the city of Calgary, Canada, with the help from the Calgary Water Management Model (CWMM), Wang et al. [2] observed that weekly water demand was more sensitive to population growth than to climate change. With the adoption of policies to reduce water consumption, with grey water reuse programmes and the use of a more sustainable landscaping process that reduces or eliminates water use, per capita water consumption would be reduced by 10%.

In the city of Mecca, Saudi Arabia, Ajbar et al. [3] developed a neural network model to predict monthly and annual water demand in the region and compared it with an econometric model. In conclusion, they observed that the neural network model better absorbs the water consumption dynamics in the short and long term when compared to the econometric model.

Due to the climate change impact on water resources, research was conducted to identify possible factors influencing water consumption associated with climate. For Hurlimann et al. [4], the climate changes should be addressed appropriately, as they represent a threat to the sustainability of cities and society.

In the city of Brossard, province of Quebec, Canada, Rasifaghihi et al. [5] studied the climate change effect on urban water consumption forecasting. Using Bayesian statistical methods, they verified a seasonal increase in water consumption over time. In England, Anderson et al. [6] analysed scenarios of domestic water demand under drought conditions. The authors verified, through statistical analysis (microsimulation), that households with a water consumption meter consume less water than those without a meter for all final uses analysed. In some uses, such as the shower, external use, bathtub and washing machine, a seasonality influence on consumption was noted.

Polebitski et al. [7] analysed the spatial patterns of water consumption in the city of Seattle, Washington, USA, in 100 census tracts. Using the regression model with combined, fixed and random panel data, the authors concluded that fixed and random regression models provide better estimates of water consumption within individual census tracts. The estimates for the elasticity statistical analysis indicate that water demand is more sensitive to the effects of price and income in the summer months than in the winter months, showing that variations in price and income in the summer months will affect water demand in a direct manner. In a study conducted in the Jianghuai ecological economic zone, China, Guo et al. [8] analysed the impact on water-related environmental services in projections from different scenarios, based on management and climate change. The authors observed, through analysis with the INVEST model, that climate drove changes in water yield more significantly than in land use and land cover.

Climate change effects have intensified over the years and strategies aimed at reducing water consumption should be analysed. To develop these strategies related to the adequate management of water resources, studies and pieces of research have been carried out in order to design innovations in this area. In the city of Quebec, Canada, Leveque et al. [9] state that scientific advances in protecting drinking water supplies and infrastructure can only be achieved with the active participation of those interested in water resources. In Africa, Nyiwul [10] analysed the driving effects of innovation in policies related to mitigation and adaptation to climate change and water stress and resource management in the water sector. Through statistical results, the author found that countries more prone to climate change-induced water stress tend to develop fewer innovative technologies. In Africa, Wehn et al. [11] analysed water-related challenges due to climate change. By carrying out interviews and bibliographic analysis of agendas and plans, they found that the subject of water–energy–food was absent in 81% of the sample. The topic related to water security, however, was absent in only 22% of the agendas analysed. For 48% of the research participants, there was a knowledge gap in issues related to groundwater and water storage and use.

These innovations become important tools in drinking water management, as they help reduce water consumption and distribute water equally. Nevertheless, for this to happen, user participation is necessary for water consumption analysis. Within this context, some researchers address this topic when developing research based on water end-uses.

With regard to developing tools that help reduce water consumption, Manouseli et al. [12] analysed the impact on water savings generated by water efficiency programmes in the United Kingdom and observed, by means of a multilevel model, a 7% water consumption reduction, mainly attributed to the water efficiency programme. Kumar et al. [13] studied two cities in India: Ahmedabad and Gandhinagar. Using statistical analysis, they concluded that sociodemographic issues (income, education, and family size) determine water consumption patterns in the regions studied in a distinct manner. These spatial differences in final water consumption in regions with a similar geographic scenario—at a distance of 40 km between Ahmedabad and Gandhinagar—show that specific internal plans have to be designed for each area. They observed that water conservation practices, based on consumption patterns in the regions under study, depend not only on water-saving devices, but also on understanding how to use them consciously. They point out that is necessary to understand the water consumption patterns to develop specific solutions for each location.

These pieces of research show the importance of analysing the tools to be applied, as the successful water efficiency programmes are related to users' understanding of using water consciously.

Urban water consumption is a broad topic with several factors to be analysed, such as climate, population characteristics, regional characteristics, and consumption habits. Researchers in different world regions have analysed these and several other factors differently. Most research on the subject employs a certain topic in its analyses, often related to local needs, so comparing the results and analyses with different approaches is challenging.

This article aims to present the research developed on water consumption in different regions, with their results and methodologies applied. Thus, this analysis can become a reliable source of information, with several studies with different themes, to assist in developing a tool for building water management.

2. Methodology

This literature review was based on research related to water consumption in different regions. To understand this water demand, we first analysed the urban water availability and the global water situation. Then, a second analysis was developed to verify the factors that influence such consumption in different building types and contexts, such as during the COVID-19 pandemic.

In this article, studies by several authors and data from organisations and agencies were summarised. In order to find relevant articles, searches were carried out on the Scopus, Google Scholar and Science Direct databases using several keywords, such as "factors influencing water consumption", "water consumption", "water consumption in buildings", and other word combinations.

Information about urban water availability was obtained from organisations and agencies, with images and current data on water consumption in different parts of the world. Some of the search terms used in this research were "water scarcity", "water consumption", "climate change", and several other keywords associated with the global water consumption situation.

The keyword "buildings", associated with terms related to water consumption, was used in searches on Scopus, Science Direct and Google Scholar databases to collect information about the factors that influence water consumption. In this analysis, we collected information about different building types, the influence of awareness campaigns on water consumption, users' perceptions on the quality of water consumed, and the effects associated with water consumption in different regions.

To gather information about water consumption during the COVID-19 pandemic, the keyword "COVID-19" was associated with the search terms mentioned above, as well as a combination of similar words.

The review structure is presented in Figure 1, as well as the questions to be answered in this article.

This review structure helped select several studies that address the topic of urban water consumption with different approaches. The complementary topics supported the search for accurate information about the main topics related to the subject proposed in this article.

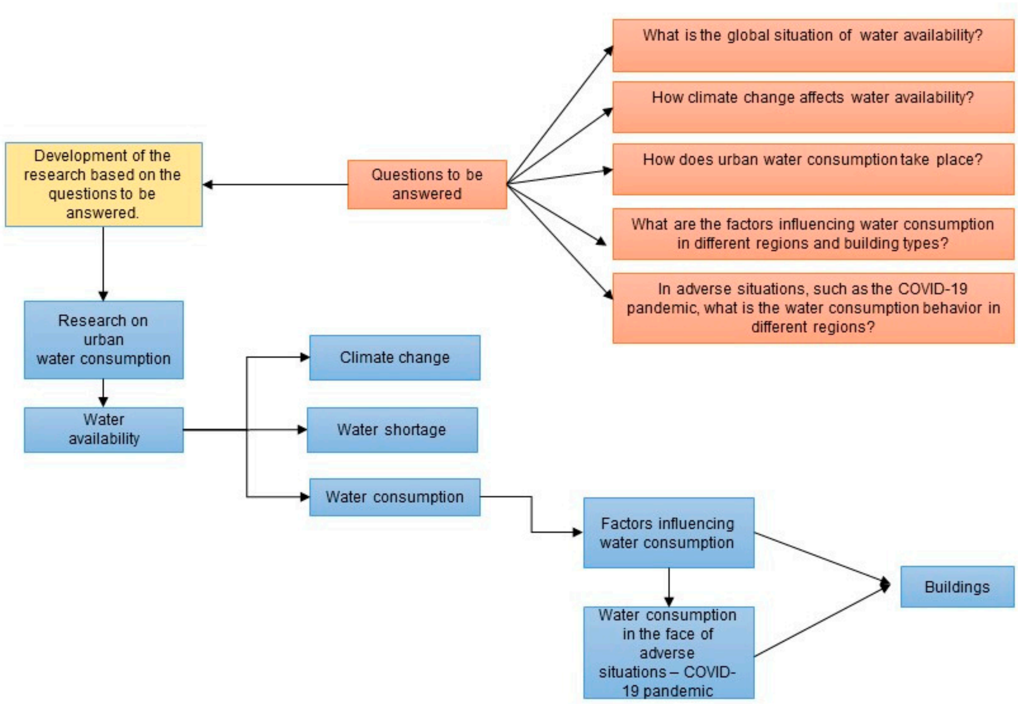


Figure 1. Flowchart of the methodology.

3. Water Consumption

3.1. Water Availability—Global Situation

Restrictions on a valuable resource such as water should attract new investments and policies to increase demand and supply [14]. Meeting this growing water demand will be a major challenge, especially for regions that suffer from a scarcity of this resource already [15], as continuous water supply is essential for life and socioeconomic activities [16]. Domestic water use is vital for daily routines, hygiene and, consequently, for public health [17].

According to the United Nations (UN), between 3.5 billion and 4.4 billion people will live with limited water access by 2050 [18]. The increase in water consumption and the pollution of water sources have been issues faced in several places.

Data presented by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) indicate that water consumption has increased six-fold over the past 100 years, and continues to grow at a rate of 1% per year [19]. This increase is related to population growth, economic development, and changes in consumption patterns [19]. The same report states that climate change worsens the scarcity situation. As a result, water quality will be impaired due to high temperatures and reduced dissolved oxygen [19]. Jaramillo et al. [16] state that the effect of climate change, population growth, and socioeconomic activities could represent a serious threat to water availability worldwide.

As reported by the UN [20], the population projection will be as follows: in the year 2030, the global population will remain between 8.5 and 8.6 billion; in 2050, it will be between 9.4 and 10.1 billion; and in 2100, it will be between 9.4 and 12.7 billion. According to Forssberg et al. [21], long-term strategies need to be studied by governments to mitigate water consumption and formulate a sustainable policy. This appropriate management will produce water use reduction and increase water reuse, in addition to a decrease in surface and groundwater pollution. For Sønderlund et al. [22], water consumption reduction may happen driven by regulatory and infrastructure actions, and individual conservation efforts in housing and the community. According to the Brazilian National Water and Basic Sanitation Agency [23], ensuring water security depends not only on investments in infrastructure, but also on efficient management.

Several parts of the world already have imminent issues regarding secure and sufficient water availability. In Iran, according to Madani [24], the country's water crisis is related to three main causes: rapid population growth and inadequate population distribution, an inefficient agricultural sector, and inadequate management.

According to data released by the United States Agency for International Development (USAID), Brazil is home to almost 60% of the Amazon, the largest area of tropical forest in the world, and has 20% of the world's fresh water. It is estimated that by 2085, the average annual temperature will increase from 1.7 °C to 5.3 °C in the Amazon, and heat waves are expected to increase from 18 to 214 days [25]. With these climate changes, dry seasons will likely be longer with decreased precipitation [25]. Globally, temperatures have increased faster since 1970 than any other 50-year period in the last 2000 years [26].

In 2021, several drought and flood events occurred in several countries around the world, as shown in Figure 2. In northern British Columbia, an assessment found high basin discharges in 2021. In the United States, a drought that began in 2020 persisted into 2021 in the west, mid-west and northeast regions, worsening in the western part of the country. In Germany, Belgium and the Netherlands, a catastrophic flood occurred in 2021. In central–eastern China, highest-ever rain levels affected more than 350,000 people. In India, the headwaters of the Ganges River showed above-normal discharges. In the European part of the Russian Federation, in Western Siberia and in Central Asia, rivers showed flows below average in 2021. In eastern Siberia, in the region's river basins, runoff was above average. In Australia, in the southeast and west regions, flows were above normal. During this same period, Africa experienced severe drought conditions [27].

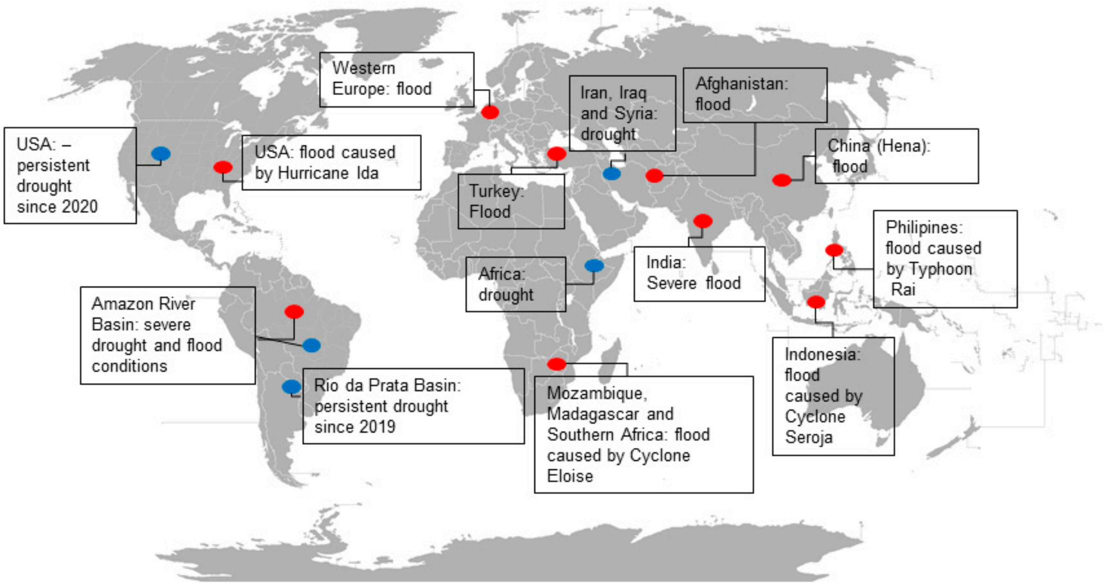
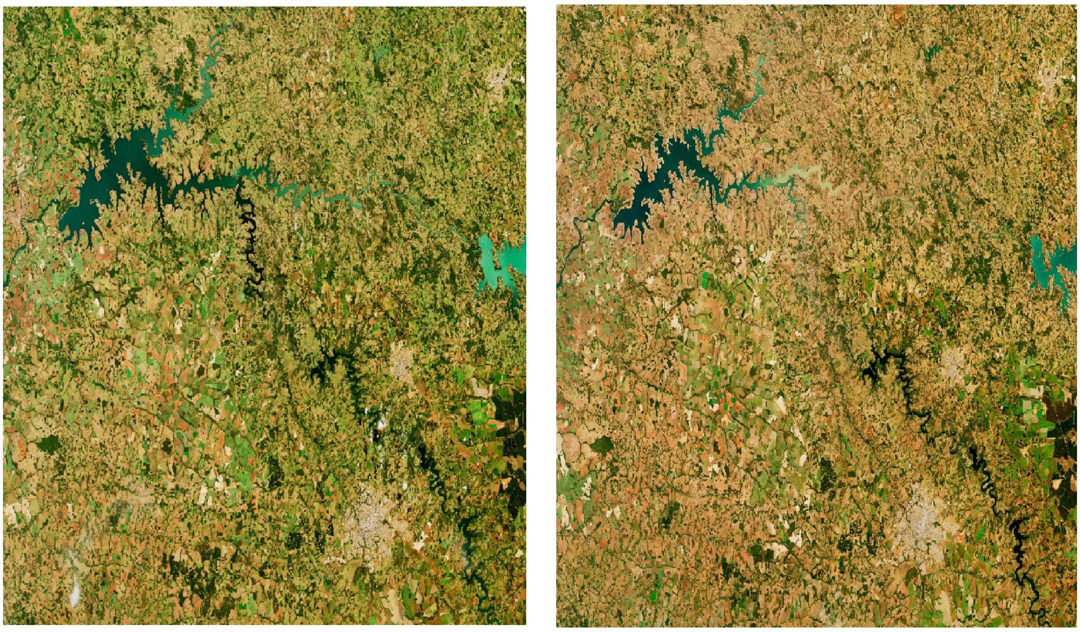


Figure 2. Hydrological events in 2021. Source: Based on WMO [27].

In Brazil, the Amazon basin area suffered floods in the north region and droughts in the south and southeast regions in 2021 [27]. During this period, Brazil faced the worst drought period in the last 91 years, mainly in the southeast and central–west regions [28]. According to information released by the National Aeronautics and Space Administration [29], this drought will cause agricultural losses, water shortages, and an increase in fires in the Amazon rainforest and Pantanal wetlands. As an example, images captured via satellite (Landsat 8) show the levels of reservoirs in Lago das Brisas, on the Paranaíba River, on 17 June 2021 and 12 June 2019. Figure 3 shows the reduction in reservoir levels in this region.



(**a**) (**b**)

Figure 3. Comparison of water levels in Lago das Brisas: (**a**) Lago das Brisas on 12 June 2019; (**b**) Lago das Brisas on 17 June 2021. Source: NASA [29].

In 2023, satellite images show a reduction in water levels in the Mississippi River, in the United States, limiting navigation and water supply in some Louisiana communities. This reduction occurred due to the hot and dry climate recorded during this period. In 2023, worldwide summer temperatures were 1.2 °C higher than average. In Figure 4b, it is possible to observe the appearance of the bottom of part of the river [30].

(**a**) (**b**)

Figure 4. Comparison of water levels in the Mississippi River: (**a**) Mississippi River on 10 September 2021; (**b**) Mississippi River on 16 September 2023. Source: NASA [30].

In Montevideo, Uruguay, the water supply for millions of people reached critical levels in the 2023 autumn and winter, with the Uruguayan government declaring a water crisis in June 2023 [31]. Figure 5 shows the status of the Paso Severino Reservoir in 2022, and its current condition.

(a)

(b)

Figure 5. Comparison of water levels in Paso Severino Reservoir: (**a**) Paso Severino Reservoir on 2 June 2022; (**b**) Paso Severino Reservoir on 13 June 2023. Source: NASA [31].

Human-caused climate change, a consequence of more than a century of greenhouse gas emissions, is causing several extreme climate events [26]. This situation had negative impacts on food and water security, human health, and the economy [26]. According to Núñez et al. [32], long-term climate change affects water availability.

The problem between distribution capacity and increased water demand is one of the main threats to secure and sustainable water supply and rural development [17]. One of the government's main concerns is meeting the growing drinking water demand [13]. For this to happen, developing actions to reduce water consumption should have priority in the formulation of public policies.

Wang and Wang [33] point out that each location should develop water consumption reduction strategies that are best suited to their development. Reducing waste, improving sewage treatment capacity, raising citizens' awareness of the importance of water conservation in an active manner, and improving the water conservation management system could be tools to help reduce water consumption [33].

The increase in water demand places even more pressure on the decline of this natural resource, especially in arid and semi-arid climates [34]. The climate change effect on the urban water security should be assessed with urgency in order to provide the scientific knowledge necessary to assist in the adaptation of operational policies [16]. As stated by Feizizadeh et al. [35], the joint effect of climate change and population growth could place even greater pressure on water resources. According to Leveque et al. [9], climate change makes drinking water sources more vulnerable to contamination and scarcity. For Russell et al. [36], climate change impacts will compromise fresh water availability.

Understanding climate change impact in the short and long term will help managers and users develop strategies to reduce water consumption. Gosling et al. [37] evaluated water consumption impact due to climate change. The study was based on climate change patterns from 21 global climate models in four scenarios, which were applied to a global hydrological model to estimate water resources in 1339 river basins. As a result, the authors found that between 1.6 and 2.4 billion people currently live in river basins exposed to water scarcity. The climate change effect by 2050 will place 0.5 to 3.1 billion people in situations of water scarcity. Balling Jr. et al. [38] state that for a 10% decrease in total annual precipitation, drinking water consumption would increase by 3.9%.

Such a decrease in precipitation, a consequence of climate change, may influence water consumption habits in certain regions, such as the practice of drinking bottled water. Zapata [39] states that bottled water consumption is associated with an increased temperature. The author points out that the use of this resource is influenced by factors related to water availability (per capita water consumption and piped water availability) and the perception of the quality of water received by the public supply system. Regarding climatic conditions, the author states that a 1 °C increase in the average temperature will result in an increase of approximately one fifth in bottled water consumption.

According to information released by the World Meteorological Organisation [40], over a period of 50 years, climate and water risks represent 50% of all catastrophes, 45% of all deaths, and 74% of all economic losses at a global level. Su et al. [41] state that natural disasters caused by climate, such as drought, may occur in several places, including areas with abundant drinking water. The socioeconomic and environmental characteristics of the affected regions may influence the variation in drought impacts in regions with similar event intensities and duration [41].

According to Vicente-Serrano et al. [42], drought has noticeable effects on vegetation, air, soil, freshwater quality, and the fauna of terrestrial and aquatic ecosystems. In addition to these effects, they state that this condition could cause forest fires and soil erosion.

Globally, urban land exposed to floods and droughts is expected to increase by more than 250% [43]. The authors point out that even without climate change, urban areas subject to flood and drought will increase by double by 2030.

Zhang et al. [44] define urban drought as temporary water stress that could be the main cause of water scarcity. They argue that urban drought represents a shift in balance, while water scarcity mainly describes a state of disequilibrium. For Kummu et al. [45], indicators of water scarcity and stress are related to per capita water consumption.

3.2. Urban Water Consumption

Urban water management presents significant challenges due to population growth, changes in precipitation patterns, and the water supply infrastructure ageing [46].

Such management should analyse the different patterns of urban water consumption in different locations. Voskamp et al. [47] state that in order to formulate effective strategies for the sustainable management of urban resources, it is extremely important to know the urban characteristics that drive consumption patterns.

This information can assist in the development of sustainable construction projects. For Wong et al. [48], in the design of sustainable buildings, water consumption is essential for the development of building water systems.

By such analysis, it is possible to verify consumption projections taking into account local characteristics. In order to make water available to future generations in a secure manner, users' accurate knowledge of water consumption and awareness of rational use become important tools for an efficient management. Oliveira-Esquerre et al. [49] state that awareness of water use is fundamental in rational consumption, but for this to happen, adequate control with accurate consumption measurements is necessary.

According to Daminato et al. [50], investments in new technologies for measuring water consumption may help in the management of utilities responsible for distributing drinking water. The authors state that these technologies help control water use. They concluded that the replacement of meters caused an increase in household water consumption. This fact was justified by the possible failure of the water meters due to gradual age deterioration. Regarding behavioural issues, they observed that users' knowledge of water consumption in real time, with the installation of smart meters, reduces drinking water use by 2%.

Population and economic growth has increased the drinking water demand, even with limited availability of this resource. The severity of this limitation varies between regions. This occurs due to differences in water availability and local socioeconomic conditions [51]. For Alameddine et al. [52], in arid and semi-arid regions, especially in coastal urban areas, water availability and quality are critical factors, as these regions experience continuous population growth despite limited access to fresh water resources.

In China, problems related to the scarcity of water resources and water environment pollution and deterioration have become the main issues concerning the sustainable development of the economy and society [53]. Yao et al. [54] emphasise the importance of water resources for social and economic development.

Globally, irrigation is the largest water consumer in the twentieth century, with a greater share in South Asia, due to rice cultivation, followed by the Middle East, due to arid conditions [45]. In Dunhuang, China, agriculture is the main water consumer, while household, industrial and industrial service consumption plays a small role in water consumption in this region [55]. The lack of water in agriculture could have serious effects on the population health due to food production shortages [51].

Analysing the capacity of water supply sources and their consumers' habits is extremely important for water resource management. Lin et al. [56] mapped the local water consumption impacts on Taiwan's three main river basins. To obtain the results, they analysed the water supply sources and the areas affected by the river basins in the distribution of this water resource on a spatial scale. The authors state that the heterogeneous distribution of water users in a given region results in non-uniform consequences for water consumption.

Vallès-Casas et al. [57] analysed the drought and economic crisis influence on water consumption reduction from 2007 to 2013 in the Catalonia region. The economic crisis effects on water consumption were analysed using the variables *unemployment*, *income*, and *water price*. Through statistical analysis (generalised linear mixed model), they observed that the increase in water prices and drought intensity resulted in a decrease in water consumption. For demographic issues, the results showed that larger and older families consume less water. In environmental behaviour, related to recycling, the greater the environmental awareness, the lower the water consumption.

Users' behaviour in relation to conservation practices plays an important role in water consumption variations [58]. Research on criteria relating to environmental awareness in different regions may assist in developing tools for analysing environmental impacts.

Itsubo et al. [59] studied the weighting factors used in the analyses of life cycle impact assessments (LCIAs) in countries participating in the Group of Twenty (G20). For analysis, questionnaires were administered to households in the countries, and 6400 responses were obtained. The results showed that the weighting factors were the highest for human health (loss of life expectancy), followed by biodiversity (extinction of species), and primary production (inhibition of plant growth). They found that the factors vary between countries, but their values tend to be similar in developed countries.

Developing awareness campaigns to reduce water consumption is a long-term effective tool as people adapt to new uses of water and realise its importance in their daily use. This characteristic is independent of financial issues, as reducing water use is relevant to the user.

In Israel, Katz et al. [60] analysed the effectiveness of water conservation through awareness campaigns. The study was based on daily data from 1000 families in a neighbourhood with homogeneous socioeconomic characteristics over six months. Data were collected in a period of water scarcity and high temperatures. Using the econometric statistical model, they compared the water consumption rate of the families that received the messages requesting water conservation with those that did not. In the end, they obtained a sample of 934 households. An online experiment was applied to complement the field research to evaluate the campaign's cost-effectiveness, with the increase in prices and the additional cost of water through desalination. They observed that the price increase helps to reduce water consumption, but its effectiveness decreased in the long term with the reduction in prices.

According to Mustafá et al. [61], Jordan is considered a country with the most significant water scarcity in the world, with 61 cubic metres of water per capita available for supply, a value that points to absolute scarcity, as reported by the Ministry of Water and Irrigation [62]. According to Benedict and Hussein [63], the Ministry of Water and Irrigation has explored different ways to solve this issue, such as increasing water supply and reducing consumption through awareness campaigns.

In Jordan, Benedict and Hussein [63] studied the effects of water consumption reduction policies due to awareness campaigns. The study was based on questionnaires administered to scholars, government officials, employees of nongovernmental organisations, refugees, farmers, rural communities, donors, and international organisations. The questions were based on participants' views on the reasons for water scarcity in Jordan and daily practices and methods for water reduction. To analyse the programmes used to reduce water consumption, the authors analysed documents from awareness programmes applied in Jordan. They observed that awareness campaigns use two discourses, entitled state insecurity and citizen insecurity. In terms of state insecurity, the discourse is based on political instability, with the implementation of rationing policies in the domestic water supply. For citizen insecurity, they suggest that daily practices to reduce water use, if misapplied, can carry risks of access to water. They found that the national strategy for water reduction attributes a fundamental role in state security to citizens and their water behaviour. They observed that in the awareness campaigns, obedience to state policies regarding water use starts from the daily life of users and from making the use of water governable and punishable. In the end, they found that despite the efforts of such campaigns to reduce water consumption, the methods used for behavioural change remain uncertain in this location, as the population did not fully adopt the conservation measures described in such government materials.

In China, Chai et al. [64] analysed water consumption indirectly (water incorporated in goods and services) and directly (water consumed by the population for drinking, housekeeping, etc.) in different groups of families. The main research objective was to evaluate the consumption impact on the use of drinking water among urban and rural families, with different income levels and in different provinces. They found that the annual per capita consumption in urban areas was higher than in rural areas. They justified this situation by the difference in eating habits. Regarding indirect consumption, the authors observed that in cold regions there was a greater consumption of water in clothing, and in coastal regions in aquatic products. For direct consumption, water use was higher in hot and humid regions. According to the authors, examining how people's lifestyles affect water consumption indirectly, in the production of goods or provision of services, is essential to understanding the socioeconomic water cycle.

Due to the heterogeneous drinking water distribution, secure water consumption in terms of quantity and quality has been one of the factors of great concern. According to Wong et al. [48], household freshwater consumption may vary due to several factors including climate, culture, economy, individual demands, residents' attributes, and characteristics of household appliances.

For this reason, research has been focusing on alternative water sources. Alim et al. [65], by analysing several pieces of research, verified that rainwater use for drinking purposes requires specific treatments, and in economic terms, the system was viable for use on a small scale.

Water consumption varies across regions due to local urbanisation characteristics. In Chinese provinces, Liu et al. [66] determined the urbanisation impact on the regional water footprint of production and consumption. The urbanisation level was assessed using data relating to population, economy, land urbanisation, and social urbanisation. For the regional water footprint, the values corresponded to production in the agricultural, industrial, domestic, and ecological sectors (water consumed in the artificial recharge of some rivers, lakes and wetlands for environmental and ecological use). By using linear regression analysis, the results showed that the water footprint was mainly related to economic urbanisation because of industrial production. For the domestic sector, the regional water footprint was related to the population urbanisation. In the industrial sector, the soil urbanisation role in the water footprint of consumption was greater than that of the population, and economic and social urbanisation. In different regions of China, they observed that the urbanisation impact varies in relation to the water footprint. They found that water consumption is related to the agricultural sector in 80% of the provinces.

Water governance comprises a range of political, social, economic, and administrative systems that directly or indirectly affect the use, development and management of water resources, and the provision of water service at different levels of society. Governance systems determine who gets what water, when and how and decide who has the right to water and related services and their benefits [67].

In Jordan, Liprot and Hussien [68] analysed the relocation of water from rural areas (agricultural use) to urban areas (industrial and residential use). Through questionnaires, the authors analysed issues related to groundwater, demand management policies, relocation, farmers' strategies, and selection of aquifer donors. This research covered government officials, scholars, non-governmental organisation staff, and development agencies. At the end of the study, they found that successful water relocations from rural to urban areas occurred in a region of Jordan, Mudawarra. This region was characterised by a few workers or small owners, low transaction and execution costs, and excessive water capacity. These factors made water reallocation more attractive in this location than in higher regions.

4. Introduction to Factors Influencing Water Consumption

4.1. Factors That Influence Urban Water Consumption

In the urban environment, societies established their water consumption pattern based on socioeconomic conditions, cultural contexts, religious beliefs, traditions, and customs [34]. For Araya et al. [69], a better understanding of residents' perceptions of water consumption can help in designing better strategies to deal with issues related to water conservation.

In some regions, outdoor water use is necessary, especially in homes. In accordance with Campbell et al. [70], a significant factor in household water consumption is its use in the external environment, especially in places where year-round irrigation is needed. This consumption is mainly related to climatic factors, such as evapotranspiration and precipitation.

Humidity is also an influencing factor in water consumption in external environments. The lower the relative air humidity, the greater the water consumption, and the higher the humidity, the lower the water consumption [71].

Knowledge and analysis of the water use in different building types are extremely important when applying methodologies to reduce water consumption. The building type is related to per capita water consumption [72]. Following Meireles et al. [73], the benefits related to water conservation measures depend on the building characteristics and its specific uses.

Talpur et al. [74] analysed water consumption patterns in an institutional building in Pakistan. Two scenarios related to the total number of occupants were studied. One of them referred to the number of building occupants during the research period (398), and the other to the projection of the maximum number of occupants in the building (630). The authors compared water consumption using conventional and water-saving equipment, taking into account the criteria established by the LEED (Leadership in Energy and Environmental Design) reference guide. They observed that total water consumption can be reduced by 33.5% using the water conservation criteria presented in the LEED reference guide, and drinking water consumption would be reduced by 25% to 42% by using grey water.

In building types such as university buildings and hotels, Meireles et al. [73] verified the water efficiency measures impact on water consumption, energy, and carbon dioxide (CO_2) emissions. The study was carried out in 2015 in five regions of Portugal. The methodology was based on data relating to bathrooms in university buildings. In hotels, guest rooms were analysed. The authors concluded that in university buildings, 66% of savings in water, energy, and CO_2 emissions would be due to the retrofitting of toilets. In hotels, a 67% reduction in water use and 97%-98% in energy and CO_2 emissions would occur through the re-adaptation of hot water use devices (showers and lavatory taps). The results showed a reduction in water consumption, energy, and CO_2 emissions with the re-adaptation of equipment with water consumption reduction devices, in a Mediterranean climate. With these device interventions, the authors state that water consumption would decrease by 56% in university buildings and 50% in hotels.

In semi-detached houses, Rathnayaka et al. [72] found that per capita water consumption is 13% higher than in multi-storey buildings, and 13% lower than in detached houses. This difference is attributed to the presence of a garden and swimming pool among these building types.

With regard to the different building types, in the city of Brasília, Federal District, Brazil, Sant'Ana et al. [71] analysed the relationship between household water consumption and building type, family income, and the number of occupants. For this, data about the water end-use were collected from 118 households. The research was based on a stratified random sample of 481 households in seven administrative regions of the Federal District. This sampling pattern was necessary to verify the main statistical patterns of water end-uses and household consumption. By means of interviews, there was collection of data about the water socioeconomic aspects and housing characteristics. The explanatory variables described in the questionnaires referred to the *number of residents per household*, *income*, *construction area*, and *external area use* (floor/garden). In the end, they concluded that high-income families have different water consumption habits, pointing out that use time is longer and use frequency is greater compared to low-income families. They found that housing characteristics and family income are directly related and affect both indoor and outdoor water use.

Dias et al. [75] analysed the factors influencing water consumption in multi-family buildings, in the city of Joinville, state of Santa Catarina, Brazil. Data were obtained through questionnaires, with consumption data from 2015 to 2016. To interpret the data obtained, multiple linear regression analysis was used because of the existence of more than one regressor in the model (independent variables) and due to the dependent variable being quantitative (water consumption). The results showed that building water consumption increased according to some factors, namely a longer distance from the city centre, higher number of flats, higher number of floors, greater property age, and higher number of residents per flat. This higher water consumption was also related to the existence of the sewage network and the increase in the building market value. The consumption reduction is related to the existence of an alternative water supply system and a higher percentage of building residents. With regard to per capita consumption, the authors observed that water consumption increased according to a longer distance from the city centre, greater property age, higher building market value, existence of swimming pools, and existence of a sewage network. The reduction in per capita water consumption was due to the percentage of residents, average number of residents per flat, existence of individual water metering, and an alternative supply system.

Factors related to the users' socioeconomic situation may influence water consumption in different building types. Marinoski et al. [76] state that household water consumption is related to the residents' lifestyle. They found that there is no correlation between water consumption and income in 48 households in the city of Florianópolis, state of Santa Catarina, Brazil. By means of interviews, they observed that residents in low-income families have the habit of preparing their meals at home, unlike high-income families, where the habit of having meals at restaurants may be more frequent.

In Amsterdam, Voskamp et al. [47] studied factors related to water, energy, and gas consumption. They divided the city into four distinct spatial units with high-resolution data. Two units were determined by distributions at the level of neighbourhoods and districts, and two units determined by square divisions of 100 metres and 500 metres at the spatial level of the city. The results obtained through statistical analyses showed that the variables *income level*, *number of residents*, *resident age*, *building type* and *garden size* were explanatory in the analysis of water, energy, and gas consumption. By analysing only water consumption, they pointed out five explanatory variables in the four models, exemplified as follows: *migration history* (percentage of people with a non-Western migration history), *building type*, *resident age*, *rental housing type*, and *building age*.

Users' perception of water use can help in the development of policies aimed at the sustainable management of this water resource. In Spain, Gómez-Llanos et al. [77]

analysed consumers' awareness of water use in activities or products consumed daily. Users were asked about their daily routine in relation to direct household water use and indirect water use (services and products that consume water in their process), and knowledge of urban services (water supply, wastewater treatment, waste recycling, and energy supply). Through statistical analyses, they concluded that young consumers have better understanding of how their water footprint influences water consumption. They state that to raise the population awareness of responsible water use, it is necessary to incorporate knowledge of indirect water consumption.

In Japan, Singha et al. [78] analysed psychosocial and behavioural components in water conservation and consumption. Information was obtained from 514 people through the application of questionnaires from September to October 2021. To measure residents' water consumption, six months of water consumption were analysed. Structural models and ordered logistic regression analysis were used. They found that the structural model explained 57% of the variation in water conservation behaviour and 55% of the variation in water consumption. They observed that personal involvement in water conservation and the emotion and habit of using this water resource had a positive and significant impact on conservation behaviour and a negative impact on consumption. Using the ordered logistic regression model, they analysed the robustness of the results and observed that participants who reported having a greater awareness, a greater sense of responsibility, habit, emotion and involvement with water use were more likely to save water. They found that water use behaviour is a complex operation and depends on the stimulation of personal (attitude, awareness, emotion, and responsibility) and external (habit and involvement) elements.

Within this context, awareness campaigns on water use emerge. Tiefenbeck et al. [79] analysed the influence of an environmental campaign on water and energy consumption in a multi-family building with 200 flats, in the city of Lynnfield, Massachusetts, USA. The authors divided the flats into two experimental conditions: one group of residents participating in the research would receive information about their water consumption, and the other group would receive no information. The study was based on data from readings from water meters and electricity meters. It was observed that residents who received information about their water consumption reduced their use by 6%; however, electricity consumption increased by 5.6%. The authors suggest that more comprehensive environmental programmes should be adopted in order to quantify and mitigate these unintended effects.

Tong et al. [17] analysed the effect of awareness, perceptions, and individual behaviour control, and gender (male and female) influence on water conservation practices. The research was based on questionnaires applied from April to August 2014 to residents of the Shaanxi Plain, located in northern China. The research recruited 622 randomly chosen residents—318 women and 304 men—living in the districts of Baoji, Yanglin–Wugong, and Weinan, which have similar climate and socioeconomic characteristics. The information obtained in the questionnaire involved questions related to the water users' characteristics (age, educational level, family income and family size), attitudes and expected results in relation to water conservation, individual behaviour control (ease or difficulty of saving water), social norms (public perception and authorities' attitudes towards water conservation), and water conservation practices. Using the Cronbach's α test, they analysed the questionnaire reliability, and the Kolmogorov–Smirnov test was used to analyse data normality. The authors used structural equation models to identify relationships in the information obtained from the questionnaire. They concluded that factors that affect water conservation practices vary between men and women. Women adopt conservation practices mainly to reduce water costs, while men adopt these attitudes to mitigate the lack of water supply.

Manouseli et al. [80] analysed the effectiveness of a water efficiency programme applied by a water distribution company in single-family homes in southeast England. The project was launched in 2007 with the installation of water-saving devices in homes (double flush, tap insertion, aerated shower, and rainwater storage tanks). Multilevel regression was the statistical analysis used in the study, as it considers the statistical dependence between sequential observations of the same group. In the study, the authors describe the opportunity to make use of temporal data (climate and water efficiency dummy) and time-invariant variables (Acorn Class and household size). The analysis showed that families that participated in the water efficiency programme reduced their water consumption by 15%. The research results showed that families with a single resident and with financial difficulties have a greater potential to save water than larger families with greater economic potential.

Another important issue in water consumption is the user's perception of the quality of water received. This information about potability and security standards in relation to water consumption has influenced different forms of consumption. According to Alameddine et al. [52], consumers' perception of the quality of the water that reaches their families can affect its use.

In Belgium, Geerts et al. [81] studied the main reasons consumers prefer to consume tap and bottled water. To obtain the data, a questionnaire was applied with questions regarding attitudes and behaviours in drinking water use. For analysis, 2309 interviews were studied. They observed that environmental and financial considerations drive the consumption of tap water, but negative perceptions of quality have made people prone to consuming bottled water. Considering sociodemographic issues, the study showed that bottled water consumption is more common among the older people, men, and groups with less education.

In Beirut, Lebanon, Alameddine et al. [52] analysed people's perception of the quality of the public water supply network and underground water collection wells. According to the authors, the area covered is densely populated and suffers from water scarcity issues. For data collection, stratified sampling, determined through population density, was adopted in 11 administrative zones. Visits were made to 310 buildings with private wells, and 177 of them agreed to participate in the study. The results obtained by the authors indicate that residents' perception of the public water supply network is affected in a direct manner by the inferior quality of water from unregulated wells in the region under study. They found that user's satisfaction with the use of well water is related to the season, interviewee's age, resident type (owner or tenant), and water quality. For public water consumption, they found a weak correlation with actual water quality.

In the city of Yangon, in Southeast Asia, Ko et al. [82] studied the factors that influence household water consumption, including household characteristics and perceptual factors. By applying questionnaires in 2020, they obtained data from a sample of 100 households. The interviewees' characteristics were classified into *building type* (social housing or residential flat), *resident type* (owner or tenant), *education*, *income*, *family size,* and *time living in the city* (five years or more, or less than five years). There were questions about the availability of tap water and existence of a water storage system in the building, household water treatment application, and bottled water consumption with its cost and purchase method. For data analysis, the Chi-Square test was used to study potential factors influencing water consumption behaviour, including household perceptions and characteristics, future tap water consumption, and the choice regarding charging methods (fixed tariff/water meter). They found that behaviour related to water consumption is associated with time living in the city. Decisions to drink water are associated with perceptions of the human senses, such as taste. They observed that residents perceived the quality of bottled water as higher than that of tap water. Regarding the charging method, the authors found that choosing between fixed tariff and water meter is associated with education, family size, income, and willingness to spend more on better-quality water.

Quantifying the effect that drives water consumption in different regions leads to the formulation and adoption of differentiated water resource policies [54]. Several studies have observed differences in water consumption in different regions.

In 38 cities of China, Lu et al. [83] analysed the temporal and spatial characteristics of urban household water consumption over a period of three years, identifying the main factors that influence water consumption. These regions, distributed to the country's north and south, presented differences in climatic issues and economic levels. They concluded that the amount of available water resources, the water price, and the use of water-saving devices are the main factors that influence urban water consumption.

A study performed in 30 provinces in China, where 11 were located on the coast and 19 in the northeast region, over a period of 10 years, verified the relationship between household water consumption and the CO_2 emission impact due to energy use. They observed that China's rapid urbanisation significantly affected water and energy consumption mainly in coastal regions. Household water consumption showed decreasing trends, regardless of the location of cities, in values related to the increase in water price [84].

In 31 provinces of China, from 1997 to 2013, Bao et al. [85] analysed the factors that influence water consumption efficiency. The variables used in the study were described as follows: dependent variable—*water consumption efficiency* (total water consumption/GDP)—and independent variables—*per capita water resources* (total water resources/total population); *GDP per capita* (GDP/total population); *urbanisation level* (urban population/total population); *ratio of value added in tertiary industry to GDP* (value added of the tertiary industry/GDP); *per capita total investment in fixed assets*—properties of a company (total investment in fixed assets/total population); *per capita social retail sales of consumer goods* (social retail sales of consumer goods/total population); *urban per capita disposable income* (national sample survey data); *rural per capita net income* (national sample survey data); and *per capita grain yield* (total grain yield/total population). Through statistical analysis, they concluded that the water consumption efficiency in a province may be influenced not only by socioeconomic and environmental factors, but also by the water consumption efficiency in neighbouring provinces. They found that with a 1% increase in water consumption efficiency levels in neighbouring provinces, there will be a 0.34% increase in the local province.

From 2000 to 2015, Yao et al. [54] analysed the factors driving water consumption in 31 provinces of China. The research was based on data about population, production, and water consumption indicators. They found that in eastern China, water efficiency is higher than the national average, except in the regions of Jiangsu and Shanghai. They point out that, in these locations, it is necessary to continually stimulate the development of technological innovations, improvements in production technologies, changes in forms of irrigation, and an increase in the rate of industrial water reuse. They state that in some regions, especially in the central and eastern ones, with a high population concentration, controlling the population size could be an auxiliary measure in reducing water consumption.

In several regions of China, Long et al. [86] studied the factors influencing water consumption. The analysis was based on data obtained from the agricultural, industrial, and residential sectors. Through statistical analyses, the results showed a reduction in water consumption with the use of household appliances that have efficient technologies in the residential sector. In such a sector, per capita income has driven the increase in water consumption. Throughout the research, the authors identified different patterns of water consumption in the regions analysed. In the residential sector, the increase in consumption occurred in all regions analysed. They suggest that investment in efficient equipment in the agricultural, industrial, and residential sectors should be increased. The authors affirm that, in the residential sector, standards for constructing new buildings will need to be improved, and water facilities will need to be rebuilt in older communities.

Fan et al. [87] assessed household water consumption in 286 cities in China. Data used in the analysis included daily household per capita water consumption and fifteen factors that affect household water consumption. The variables used in the analysis were described as follows: *climatic factors* (two variables); *water price*; *socioeconomic factors* (seven variables); *water appliance factors* (two variables); and *water supply and conservation factors* (three variables). The cities were classified according to water consumption into groups of low (less than 70 litres per person per day), medium (between 70 and 140 litres per person per day), and high consumption (more than 140 litres per person per day). The statistics were based on correlation analysis, path analysis, conditional inference tree, and random forest. They found that water consumption in Chinese cities was affected by climate, socioeconomic factors, and water supply capacity and conservation in a significant manner. In high-consumption cities, high rainfall and the economic situation were the main factors that contributed to increased water consumption. In low-consumption cities, the authors concluded that household water consumption was lower than what would be necessary for secure water supply. They argue that this restriction is due to the city's water storage capacity and residents' economic matters.

In seven cities in India, Shaban [88] analysed household water consumption. Data were collected through interviews with 2734 families, obtaining information about consumption, availability, access, and methods adopted to drinking water conservation. The cities were categorised into five different areas—that is, high, medium, and low income groups—located in places with well-planned buildings slum areas, and mixed areas. Through measurements, they estimated the volumes of water for shower, washing clothes, drinking and cooking, toilet, cleaning the house, and washing utensils. Socioeconomic characteristics were determined based on values corresponding to weights and family assets (television, car, refrigerator, and so on). The results found showed that the volume of water consumed by families is lower than that determined by local standards, and families are satisfied with this level of supply. This result is justified by the adaptation of residents to such a situation. In the study on water end-uses, the highest consumption observed was for the washing machine, bathing, bathrooms, and washing dishes and utensils. Regarding socioeconomic class, results showed the upper class as the largest water consumer. Regarding water availability, it was observed that only 18% of the population received a continuous 24 h water supply, provided by the local utility.

In the Wallonia region of Belgium, Bich-Ngoc et al. [89] analysed the factors that determine household water consumption, its spatial variation, and possible explanations in relation to this spatial variability. For data collection, questionnaires were administered to 15,000 homes in 2015 and responses were obtained from 2793 families. For statistical analysis, a linear regression model was developed to provide a baseline for more complex models with spatial regressors. To analyse the spatial patterns of water consumption, two approaches were used, namely, fixed-effects regression with spatial predictors, and mixed-effects regression. As a result, they observed that family size could explain water use. As an alternative source (well, rainwater, bottled water and others) for drinking, cooking, toilet use, garden irrigation, and the swimming pool, they observed that using rainwater, especially inside homes, would lead to water savings of around 20% to 35%. Regarding household location factors, they observed that after controlling household characteristics, family composition (adult/child), income, lot area, practice of using rainwater, and the existence of a garden or swimming pool, the spatial effect of water consumption becomes insignificant. They justified this fact by the similarity of the building characteristics in the same study area.

In Brazil, Grespan et al. [90] verified factors that affect water consumption, through independent variables on residents' socioeconomic and demographic aspects, data on residents' water consumption behaviour, and information about the building construction characteristics. The study was carried out in the city of Joinville, southern Brazil, in 394 single-family buildings. Data about water consumption, characterised as a dependent variable, were obtained from the local water utility for the years 2017 to 2019. The univariate regression tree was applied to identify the main factor influencing water consumption. The results pointed out the number of residents and the presence of children and teenagers as significant variables in water consumption. For per capita water consumption, the most important variables in the regression tree were the floor-plan area per resident (m^2/resident), per capita income (salary/person), and the presence of a swimming pool. In monthly household water consumption, the number of residents was the variable that stood out.

Table 1 shows a summary of the main pieces of research cited throughout this article.

Table 1. Pieces of research related to factors influencing water consumption.

Authors/Year	Study Field	Building Type	Factors Influencing Water Consumption
Talpur et al. [74]	Pakistan	Institutional	Water conservation criteria (LEED) and grey water use
Meireles et al. [73]	Portugal	University building and hotels	Interventions in water use devices
Rathnayaka et al. [72]	Australia	Residential	Number of residents; presence of children; building type and efficiency of appliances (shower and toilet)
Sant'Ana et al. [71]	Brazil	Residential	Housing characteristics; number of residents and family income
Dias et al. [75]	Brazil	Multi-family	Distance from the city centre, number of flats, number of floors, property age, number of residents per flat, existence of the sewage network, and building market value, existence of an alternative water supply system, percentage of residents in the building, existence of swimming pools and existence of individual measurement
Marinoski et al. [76]	Brazil	Residential building	Water end-uses (shower)
Voskamp et al. [47]	Amsterdam	Residential	Migration history (percentages of people with non-Western migration history), building types, resident age, rental housing type, and building age
Singha et al. [78]	Japan	Residential	Psychosocial and behavioural components, awareness, greater sense of responsibility, habit, emotion and involvement with water use
Tiefenbeck et al. [79]	Massachusetts	Multi-family	Environmental campaign on water and energy consumption
Tong et al. [17]	China	Residential	(Gender)—factors that affect water conservation practices vary between men and women
Manouseli et al. [80]	England	Residential	Water efficiency programme
Geerts et al. [81]	Belgium	General user	Environmental and financial considerations drive the consumption of tap water, but negative perceptions of quality have made people adept at consuming bottled water
Alameddine et al. [52]	Lebanon	Residential	User satisfaction with the use of well water is related to the season, interviewee age, resident type (owner or tenant), and water quality. For public water consumption, they found a weak correlation with actual water quality
Ko et al. [82]	Yangon	Residential	Time living in the city and perception of water quality
Lu et al. [83]	China	Residential	Quantity of available water resources, water price and the use of water-saving devices
Cai et al. [84]	China	Residential	Urbanisation and water price
Bao et al. [85]	China	General user	Socioeconomic and environmental factors, and water consumption efficiency in neighbouring provinces
Long et al. [86]	China	Agricultural, industrial and commercial	Water-saving devices and economic factors
Fan et al. [87]	China	Residential	Climate, socioeconomic factors, water supply capacity and water conservation factors
Shaban [88]	India	Residential	Water end-uses and economic factors
Bich-Ngoc et al. [89]	Belgium	Residential	Number of residents and alternative source (well, rainwater, bottled water and others)
Grespan et al. [90]	Brazil	Residential	Number of residents, presence of children and adolescents, floor-plan area per resident (m^2/resident), per capita income (salary/person), and presence of a swimming pool

4.2. Water Consumption in Adverse Situations—Influence of COVID-19 Pandemic

The global Coronavirus (COVID-19) pandemic has exposed how connected society's diverse problems are. This situation showed the significance of addressing another crisis in the world, that is, climate change [91]. The measures imposed by governments to mitigate the spread of COVID-19 have caused positive changes in the environment, and negative impacts in some sectors.

In China, the implementation of traffic restrictions brought significant changes in air quality, as well as in Rome, Madrid, and Paris [92]. For the authors, this decrease will have little impact on the accumulations of greenhouse gases that have occurred for decades in the atmosphere. The increase in domestic and hospital waste, and the restriction of waste recycling in countries such as the USA and Italy, brought negative impacts to the environment [92].

These changes in air quality were presented by NASA in 2020 [93]. Information released showed significant reductions in nitrogen dioxide (NO_2) levels in China. The analyses were based on images collected via satellite from January 1st to 20th (before the quarantine) and from February 10th to 25th (after the quarantine). For NASA, there is evidence that this change is related to the economic slowdown due to the spread of COVID-19.

According to Petteri Taalas, Secretary-General of the World Meteorological Organisation [94], previous experiences show that the reduction in greenhouse gas emissions levels in periods of economic crises is followed by rapid growth.

This change in relation to the environment occurs both in air quality and in water quality. Yunus et al. [95] analysed these changes in the Vembanad River in India. Using satellite images, the authors observed that there was a decrease in suspended particles in water during the pandemic contingency period.

During this period, different sectors of society changed the way they lived together, which led to significant changes in consumption habits. The pattern of water consumption in different building types showed different characteristics during the COVID-19 pandemic.

In Brazil, Kalbusch et al. [96] analysed the impact of actions to prevent the spread of COVID-19 on urban water consumption in residential (houses, buildings, flats and condominiums); commercial (shopping centres, stores, restaurants, hotels, supermarkets, and service providers); industrial (factories and industrial parks), and public (schools, hospitals, and other government facilities) environments. Data about daily water consumption were collected remotely via telemetry, installed in the distribution system of each building, from February 21, 2020 to April 12, 2020, totalling 64,376 measurements of daily water consumption. The analysis considered the total daily water consumption in each category. Through statistical analyses, the authors found that industrial water consumption had the largest reduction (53%), followed by commercial water consumption, with 42%, and public water consumption, with 30%. The increase in water consumption occurred in the residential environment (11%). Using the Kruskal–Wallis H statistical test, they observed that the increase in water consumption in the residential environment was higher in multi-family buildings than in detached houses or condominiums.

In England, Abu-Bakar et al. [97] quantified the COVID-19-related social isolation impact on household water consumption patterns in 11,528 households. The data were collected remotely by smart meters from January to May 2020. They used the k-means clustering algorithm to analyse the data and observed a significant change in water consumption patterns during the period of social isolation.

In the metropolitan area of Tabriz, Iran, Feizizadeh et al. [35] investigated COVID-19 pandemic impacts on urban water consumption patterns and verified future water demand in this region. The analysis was based on water consumption data from 650,000 households for the years 2018, 2019 and 2020. Through spatio-temporal analysis and the use of statistical tools, the authors concluded that household water consumption increased significantly in the months of January, February and March 2020. They found that water consumption is directly related to land use (residential area; shopping centre; area in regions with hospitals and health centres; educational, military and industrial areas), population density, and the existence of leaks in the water distribution system. According to the authors, in order to develop appropriate plans and strategies for the sustainable management of water resources, it is extremely important to monitor the water resources that supply cities.

In such studies, changes in water use habits in different sectors due to the COVD-19 pandemic were observed. This change highlights the need to predict water consumption in the face of adverse situations, in order to obtain access to water in a secure manner.

In several regions of the world, access to drinking water is restricted, making it difficult to comply with measures to restrict the spread of COVID-19. According to Zvobgo et al. [98], in developing countries, millions of people do not have access to drinking water, not to mention the use of water for washing hands, one of the most effective measures to control the spread of COVID-19.

Stoler et al. [99] analysed the challenges faced by families to follow the recommendations imposed to control the spread of COVID-19 considering the water insecurity existing in their locations. They observed that 71% of families experienced problems related to water use and 46% faced difficulties in washing their hands due to restricted water availability, therefore requesting to borrow water from other people, which could undermine the measures imposed regarding social distancing.

In the republic of Zimbabwe, in Africa, Zvobgo et al. [98] studied the limitations of residents in the municipality of Chitungwiza due to restricted access to drinking water and handwashing as a measure to help mitigate the spread of COVID-19. Through interviews at four wells distributed in the municipality, they collected residents' opinions about access to water and the threats posed by the scarcity of this water resource in the spread of COVID-19. They found that the practice of using water to wash hands would increase domestic water consumption by 9%. Given the water supply issues, the authors described that residents may not be able to meet established handwashing requirements.

This consumption pattern, in terms both of water use and of electricity use, presented different characteristics in different regions.

In the city of Doha, Qatar, Abulibdeh [100] analysed the COVID-19 pandemic impact on water and electricity consumption in six different socioeconomic sectors (villages, flats, businesses, industries, and agricultural and government sectors). Three temporal levels were considered in the study (monthly, annual and four phases related to COVID-19 prevention measures). To explain in a spatial manner the impact of different social parameters on water and electricity consumption, the variables *population density*, *number of households*, *gender* (men and women), and *age categories* (14 and 39 years and 40 and 64 years) were used in the study. Three statistical approaches were studied and described as follows: statistical analysis (coefficient of variation), spatial statistical analysis (Moran index and Getis–Ord test), and regression analysis (Ordinary Least Square and geographically weighted regression). As a result, it was found that water and electricity consumption have notable local properties in terms of geographic distribution. The author observed statistically significant clusters with high consumption in the south and west zones of the city due to the high population density and the concentration of commercial and industrial areas. During the lockdown phase, the results showed a strong positive correlation between water and electricity consumption in the residential, industrial, and commercial sectors. In the residential sector there was an increase in water and electricity consumption due to the change in people's way of life during this period of confinement. Reductions in consumption occurred in the industrial and commercial sectors as a result of contingency measures to slow the spread of COVID-19.

The analysis of water consumption in different periods, such as during the COVID-19 pandemic, becomes an important tool for managers to verify the different forms of water distribution. The pieces of research show high consumption in the residential sector, evidenced by the change in ways of working.

5. Conclusions

This research aimed to elucidate issues related to urban water consumption. Bibliographical research shows that water scarcity in several global regions is evident and has led to reflections on water management. Climate change appears to be one of the precursors to this situation.

Within cities, municipalities, and countries, the characteristics attributed to water distribution vary, depending on building types, region characteristics, and residents' habits. Research shows that water distribution may vary in a given region due to the economic condition and water availability, and in different regions the climate is the main factor attributed to this difference. Socioeconomic, environmental, and construction factors should be analysed in each location and, therefore, strategies aimed at reducing water consumption can be designed.

Different strategies are used as a way of encouraging water consumption reduction, such as the development of awareness campaigns. Research related to this issue shows the importance of raising users' awareness of correct water use.

In several studies, the factors influencing urban water consumption are addressed in different building types. This approach shows the need to analyse different tools for each situation, as each building type has its own characteristics of occupation and use. In residential buildings, several studies describe the influence of the number of residents on water consumption, in addition to economic issues, which varies in different regions. The increase in water consumption in most studies is related to high economic standards, and in some cases, such as that presented by Marinoski et al. [76], income is not related to water consumption. In the commercial sector, the importance of knowing water end-uses is observed in order to develop strategies to reduce water consumption.

Adverse situations, such as the one experienced during the COVID-19 pandemic, showed the importance of developing tools adapted to different scenarios. During this period, research shows the difference in water use in different sectors and its impact on environmental issues. Water use in the residential sector was significant during this period, as a result of people spending more time in their homes.

This research, by analysing characteristics related to water use, shows the importance of developing tools adapted to different situations, building types, and regions. These regions often have different economic, population, climate, and cultural characteristics, thus changing water use in buildings. Therefore, different measures applied in each region can help reduce water use so that future generations can access this resource safely. The results described herein may be useful for creating water resource management strategies.

As a research suggestion, new regions may be included in developing the issue on the global water situation, complying with the availability of groundwater or surface water.

Another issue is addressing water scarcity with respect to quality or availability. This can be developed by observing regional or local characteristics, agglomerations (rural or urban), economic characteristics, and population characteristics concerning water availability and climatic conditions.

Issues related to tourism, in which there is a population increase over certain months, are hardly addressed in the literature. An analysis involving this variable linked to environmental and economic characteristics could help managers develop tools to reduce water consumption in such locations.

The constant updating of data regarding water availability due to local characteristics becomes the main limitation of review studies on this topic.

The approach and determination of the main research and data for analysis, when topics are addressed at a global level, are extensive, making the entire approach on this topic unfeasible due to the research time.

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References

1. Xiangmei, M.; Leping, T.; Chen, Y.; Lifeng, W. Forecast of annual water consumption in 31 regions of China considering GDP and population. *Sustain. Prod. Consum.* **2021**, *27*, 713–736. [CrossRef]
2. Wang, K.; Davies, E.G.R. Municipal water planning and management with an end-use based simulation model. *Environ. Model. Softw.* **2018**, *101*, 204–217. [CrossRef]
3. Ajbar, A.; Ali, E.M. Prediction of municipal water production in touristic Mecca City in Saudi Arabia using neural networks. *J. King Saud Univ. Eng. Sci.* **2015**, *27*, 83–91. [CrossRef]
4. Hurlimann, A.C.; Moosavi, S.; Browne, G.R. Climate change transformation: A definition and typology to guide decision making in urban environments. *Sustain. Cities Soc.* **2021**, *70*, 102890. [CrossRef]
5. Rasifaghihi, N.; Li, S.S.; Haghighat, F. Forecast of urban water consumption under the impact of climate change. *Sustain. Cities Soc.* **2020**, *52*, 101848. [CrossRef]
6. Anderson, B.; Manouseli, D.; Nagarajan, M. Estimating scenarios for domestic water demand under drought conditions in England and Wales. *Water Supply* **2018**, *18*, 2100–2107. [CrossRef]
7. Polebitski, A.S.; Palmer, R.N. Seasonal Residential Water Demand Forecasting for Census Tracts. *J. Water Resour. Plan. Manag.* **2010**, *136*, 27–36. [CrossRef]
8. Guo, M.; Ma, S.; Wang, L.-J.; Lin, C. Impacts of future climate change and different management scenarios on water-related ecosystem services: A case study in the Jianghuai ecological economic one, China. *Ecol. Indic.* **2021**, *127*, 107732. [CrossRef]
9. Leveque, B.; Burnet, J.-B.; Dorner, S.; Bichai, F. Impact of climate change on the vulnerability of drinking water intakes in a northern region. *Sustain. Cities Soc.* **2021**, *66*, 102656. [CrossRef]
10. Nyiwul, L. Innovation and adaptation to climate change: Evidence from the water sector in Africa. *J. Clean. Prod.* **2021**, *298*, 126859. [CrossRef]
11. Wehn, U.; Vallejo, B.; Seijger, C.; Tlhagale, M.; Amorsi, N.; Sossou, S.K.; Genthe, B.; Onema, J.M.K. Strengthening the knowledge base to face the impacts of climate change on water resources in Africa: A social innovation perspective. *Environ. Sci. Policy* **2021**, *116*, 292–300. [CrossRef]
12. Manouseli, D.; Kayaga, S.M.; Kalawsky, R. Evaluation of water efficiency programs in single-family households in the UK: A case study. *Water Supply* **2017**, *17*, 1785–1792. [CrossRef]
13. Kumar, M.; Sharma, A.; Tabhani, N.; Otaki, Y. Indoor water end-use pattern and its prospective determinants in the twin cities of Gujarat, India: Enabling targeted urban water management strategies. *J. Environ. Manag.* **2021**, *288*, 112403. [CrossRef]
14. 2030 Water Resources Group; Water Resources Group. *Charting Our Water Future: Economic Frameworks to Inform Decision-Making*; McKinsey & Co.: Chicago, IL, USA, 2009. Available online: https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/sustainability/pdfs/charting%20our%20water%20future/charting_our_water_future_full_report_.ashx (accessed on 22 May 2020).
15. Russ, J. Water runoff and economic activity: The impact of water supply shocks on growth. *J. Environ. Econ. Manag.* **2020**, *101*, 102322. [CrossRef]
16. Jaramillo, P.; Nazemi, A. Assessing urban water security under changing climate: Challenges and ways forward. *Sustain. Cities Soc.* **2018**, *41*, 907–918. [CrossRef]
17. Tong, Y.; Fan, L.; Niu, H. Water conservation awareness and practices in households receiving improved water supply: A gender-based analysis. *J. Clean. Prod.* **2017**, *141*, 947–955. [CrossRef]
18. Organização Das Nações Unidas (ONU). *No Dia Mundial da Água, Guterres Lembra Que Cerca de 2,2 Bilhões Carecem de Água Potável*; ONU News; ONU: New York, NY, USA, 2020. Available online: https://news.un.org/pt/story/2020/03/1708162 (accessed on 25 November 2020).
19. Organização Das Nações Unidas Para a Educação (UNESCO). A Ciência e a Cultura: Relatório Mundial das Nações Unidas sobre Desenvolvimento dos Recursos Hídricos. Água e Mudança Climática; Resumo Executivo. 2020. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000372882_por?fbclid=IwAR0yBI24uVUHZp5Gm4pLws8vYjRmdq4AX282A-aUfcpyXtYjC8olwrON4JA (accessed on 25 November 2020).
20. Organização Das Nações Unidas (ONU). *World Population Prospects 2019—Highlights*; ONU: New York, NY, USA, 2019. Available online: https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf (accessed on 14 January 2021).
21. Forssberg, B.; Malmqvist, P.-A.; Sörelius, H. *Process of Change Successful Implementation of Good Water Management Practices in Six Cities*; Working Paper Nr. 26; SIWI: Stockholm, Sweden, 2015. Available online: https://www.siwi.org/wp-content/uploads/2016/10/SWH-Working-Paper-Process-of-Change-web-1.pdf (accessed on 14 January 2021).
22. Sønderlund, A.L.; Smith, J.R.; Hutton, C.; Kapelan, Z. Using Smart Meters for Household Water Consumption Feedback: Knowns and Unknowns. *Procedia Eng.* **2014**, *89*, 990–997. [CrossRef]
23. Agência Nacional de Águas e Saneamento Básico (ANA). Atlas Águas: Segurança Hídrica do Abastecimento Urbano. Brasília. 2021. Available online: https://metadados.snirh.gov.br/files/d77a2d01-0578-4c71-a57e-87f5c565aacf/ANA_ATLAS_Aguas_AbastecimentoUrbano2021.pdf (accessed on 28 October 2021).
24. Madani, K. Water management in Iran: What is causing the looming crisis? *J. Environ. Stud. Sci.* **2014**, *4*, 315–328. [CrossRef]
25. United States Agency International Development (USAID). Climate Risk Profile Brazil. 2018. Available online: https://www.climatelinks.org/sites/default/files/asset/document/2018-April-30_USAID_CadmusCISF_Climate-Risk-Profile-Brazil.pdf (accessed on 14 January 2021).

26. IPCC. 2023: Summary for Policymakers. In *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Core Writing Team, Lee, H., Romero, J., Eds.; IPCC: Geneva, Switzerland, 2023; pp. 1–34. [CrossRef]
27. World Meteorological Organization (WMO). State of Global Water Resources 2021. Weather Climate WA. 2022. Available online: https://library.wmo.int/records/item/58262-state-of-global-water-resources-2021 (accessed on 3 October 2023).
28. Ministério de Minas e Energia (MME). Participe da Campanha Sobre o Consumo Consciente de Energia e Água. 2021. Available online: https://www.gov.br/mme/pt-br/assuntos/noticias/participe-da-campanha-sobre-o-consumo-consciente-de-energia-e-agua (accessed on 6 June 2021).
29. NASA. Earth Observatory. Brazil Battered by Drought. 2021. Available online: https://earthobservatory.nasa.gov/images/148468/brazil-battered-by-drought (accessed on 11 August 2021).
30. NASA. Earth Observatory. The Mississippi is Mighty Parched. 2023. Available online: https://earthobservatory.nasa.gov/images/151897/the-mississippi-is-mighty-parched (accessed on 11 October 2023).
31. NASA. Earth Observatory. Reservoirs Run Dry in Montevideo. 2023. Available online: https://earthobservatory.nasa.gov/images/151574/reservoirs-run-dry-in-montevideo (accessed on 11 October 2023).
32. Núñez, M.; Pfister, S.; Vargas, M.; Antón, A. Spatial and temporal specific characterisation factors for water use impact assessment in Spain. *Int. J. Life Cycle Assess.* **2014**, *20*, 128–138. [CrossRef]
33. Wang, Q.; Wang, X. Moving to economic growth without water demand growth—A decomposition analysis of decoupling from economic growth and water use in 31 provinces of China. *Sci. Total Environ.* **2020**, *726*, 138362. [CrossRef] [PubMed]
34. Feizizadeh, B.; Ronagh, Z.; Pourmoradian, S.; Gheshlaghi, H.A.; Lakes, T.; Blaschke, T. An efficient GIS-based approach for sustainability assessment of urban drinking water consumption patterns: A study in Tabriz city, Iran. *Sustain. Cities Soc.* **2021**, *64*, 102584. [CrossRef]
35. Feizizadeh, B.; Omarzadeh, D.; Ronagh, Z.; Sharifi, A.; Blaschke, T.; Lakes, T. A scenario-based approach for urban water management in the context of the COVID-19 pandemic and a case study for the Tabriz metropolitan area, Iran. *Sci. Total Environ.* **2021**, *790*, 148272. [CrossRef] [PubMed]
36. Russell, S.; Fielding, K. Water demand management research: A psychological perspective. *Water Resour. Res.* **2010**, *46*, 1–12. [CrossRef]
37. Gosling, S.N.; Arnell, N.W. A global assessment of the impact of climate change on water scarcity. *Clim. Change* **2013**, *134*, 371–385. [CrossRef]
38. Balling, R.C., Jr.; Gober, P. Climate Variability and Residential Water Use in the City of Phoenix, Arizona. *J. Appl. Meteorol. Climatol.* **2007**, *46*, 1130–1137. [CrossRef]
39. Zapata, O. The relationship between climate conditions and consumption of bottled water: A potential link between climate change and plastic pollution. *Ecol. Econ.* **2021**, *187*, 107090. [CrossRef]
40. World Meteorological Organization (WMO). Water-Related Hazards Dominate Disasters in the Past 50 years. 2021. Available online: https://wmo.int/media/news/water-related-hazards-dominate-disasters-past-50-years (accessed on 23 July 2021).
41. Su, B.; Huang, J.; Fischer, T.; Wang, Y.; Kundzewicz, Z.W.; Zhai, J.; Sun, H.; Wang, A.; Zeng, X.; Wang, G.; et al. Drought losses in China might double between the 1.5 °C and 2.0 °C warming. *Proc. Natl. Acad. Sci. USA* **2018**, *115*, 10600–10605. [CrossRef]
42. Vicente-Serrano, S.M.; Quiring, S.M.; Peña-Gallardo, M.; Yuan, S.; Domínguez-Castro, F. A review of environmental droughts: Increased risk under global warming? *Earth Sci. Rev.* **2020**, *201*, 102953. [CrossRef]
43. Güneralp, B.; Güneralp, İ.; Liu, Y. Changing global patterns of urban exposure to flood and drought hazards. *Glob. Environ. Change* **2015**, *31*, 217–225. [CrossRef]
44. Zhang, X.; Chen, N.; Sheng, H.; Ip, C.; Yang, L.; Chen, Y.; Sang, Z.; Tadesse, T.; Lim, T.P.Y.; Rajabifard, A.; et al. Urban drought challenge to 2030 sustainable development goals. *Sci. Total Environ.* **2019**, *693*, 133536. [CrossRef]
45. Kummu, M.; Guillaume, J.H.A.; Moel, H.d.; Eisner, S.; Flörke, M.; Porkka, M.; Siebert, S.; Veldkamp, T.I.E.; Ward, P.J. The world's road to water scarcity: Shortage and stress in the 20th century and pathways towards sustainability. *Sci. Rep.* **2016**, *6*, 1–16. [CrossRef]
46. Pluchinotta, I.; Pagano, A.; Vilcan, T.; Ahilan, S.; Kapetas, L.; Maskrey, S.; Krivtsov; Thorne, C.; O'donnell, E. A participatory system dynamics model to investigate sustainable urban water management in Ebbsfleet Garden City. *Sustain. Cities Soc.* **2021**, *67*, 102709. [CrossRef]
47. Voskamp, I.M.; Visscher, M.N.; Vreugdenhil, C.; Van Lammeren, R.J.A.; Sutton, N.B. Spatial, infrastructural and consumer characteristics underlying spatial variability in residential energy and water consumption in Amsterdam. *Sustain. Cities Soc.* **2021**, *72*, 102977. [CrossRef]
48. Wong, L.T.; Mui, K.W. Epistemic water consumption benchmarks for residential buildings. *Build. Environ.* **2008**, *43*, 1031–1035. [CrossRef]
49. Oliveira-Esquerre, K.; Mello, M.; Botelho, G.; Deng, Z.; Koushanfar, F.; Kiperstok, A. Water end-use consumption in low-income households: Evaluation of the impact of preprocessing on the construction of a classification model. *Expert Syst. Appl.* **2021**, *185*, 115623. [CrossRef]
50. Daminato, C.; Diaz-Farina, E.; Filippini, M.; Padrón-Fumero, N. The impact of smart meters on residential water consumption: Evidence from a natural experiment in the Canary Islands. *Resour. Energy Econ.* **2021**, *64*, 101221. [CrossRef]

51. Motoshita, M.; Ono, Y.; Pfister, S.; Boulay, A.-M.; Berger, M.; Nansai, K.; Tahara, K.; Itsubo, N.; Inaba, A. Consistent characterisation factors at midpoint and endpoint relevant to agricultural water scarcity arising from freshwater consumption. *Int. J. Life Cycle Assess.* **2014**, *23*, 2276–2287. [CrossRef]
52. Alameddine, I.; Jawhari, G.; El-Fadel, M. Social Perception of Public Water Supply Network and Groundwater Quality in an Urban Setting Facing Saltwater Intrusion and Water Shortages. *Environ. Manag.* **2016**, *59*, 571–583. [CrossRef] [PubMed]
53. Zhang, C.; Zhang, H. Can regional economy influence China's water use intensity? Based on refined LMDI method. *Chin. J. Popul. Resour. Environ.* **2014**, *12*, 247–254. [CrossRef]
54. Yao, L.; Zhang, H.; Zhang, C.; Zhang, W. Driving effects of spatial differences of water consumption based on LMDI model construction and data description. *Clust. Comput.* **2018**, *22*, 6315–6334. [CrossRef]
55. Zhang, X.; Jin, X.; Bai, X.; Jiang, Y.; He, C. Impacts of water resource planning on regional water consumption pattern: A case study in Dunhuang Oasis, China. *J. Arid. Land* **2019**, *11*, 713–728. [CrossRef]
56. Lin, C.-C.; Chiueh, P.-T. Mapping the local impacts of water consumption with regionalized three-dimensional arrays. *Int. J. Life Cycle Assess.* **2021**, *24*, 1495–1504. [CrossRef]
57. Vallès-Casas, M.; March, H.; Saurí, D. Examining the reduction in potable water consumption by households in Catalonia (Spain): Structural and contingent factors. *Appl. Geogr.* **2017**, *87*, 234–244. [CrossRef]
58. Domene, E.; Saurí, D. Urbanisation and Water Consumption: Influencing factors in the metropolitan region of barcelona. *Urban Stud.* **2006**, *43*, 1605–1623. [CrossRef]
59. Itsubo, N.; Murakami, K.; Kuriyama, K.; Yoshida, K.; Tokimatsu, K.; Inaba, A. Development of weighting factors for G20 countries—Explore the difference in environmental awareness between developed and emerging countries. *Int. J. Life Cycle Assess.* **2015**, *23*, 2311–2326. [CrossRef]
60. Katz, D.; Grinstein, A.; Kronrod, A.; Nisan, U. Evaluating the effectiveness of a water conservation campaign: Combining experimental and field methods. *J. Environ. Manag.* **2016**, *180*, 335–343. [CrossRef]
61. Mustafa, D.; Altz-Stamm, A.; Scott, L.M. Water User Associations and the Politics of Water in Jordan. *World Dev.* **2016**, *79*, 164–176. [CrossRef]
62. Ministry of Water and Irrigation (MWI). National Water Strategy 2023–2040. Available online: https://www.mwi.gov.jo/EBV4.0/Root_Storage/AR/EB_List_Page/national_water_strategy_2023-2040.pdf (accessed on 6 March 2024).
63. Benedict, S.; Hussein, H. An Analysis of Water Awareness Campaign Messaging in the Case of Jordan: Water conservation for state security. *Water* **2019**, *11*, 1156. [CrossRef]
64. Chai, L.; Han, Z.; Liang, Y.; Su, Y.; Huang, G. Understanding the blue water footprint of households in China from a perspective of consumption expenditure. *J. Clean. Prod.* **2020**, *262*, 121321. [CrossRef]
65. Alim, M.A.; Rahman, A.; Tao, Z.; Samali, B.; Khan, M.M.; Shirin, S. Suitability of roof harvested rainwater for potential potable water production: A scoping review. *J. Clean. Prod.* **2020**, *248*, 119226. [CrossRef]
66. Liu, J.; Xuan, K.; Xie, N.; Zhang, J.; Wang, X.; Yu, Z.; Wang, W. Effects of urbanisation on regional water consumption in China. *J. Hydrol.* **2022**, *609*, 127721. [CrossRef]
67. United Nations Educational, Scientific and Cultural Organization (UNESCO). *Water—A Shared Responsibility*; The United Nations World Water Development Report 2; UNESCO: Paris, France, 2006. Available online: https://unhabitat.org/sites/default/files/download-manager-files/Water,%20A%20Shared%20Responsibility.pdf (accessed on 1 March 2024).
68. Liptrot, T.; Hussein, H. Between regulation and targeted expropriation: Rural-to-urban groundwater reallocation in Jordan. *Water Altern.* **2020**, *13*, 864–885.
69. Araya, F.; Osman, K.; Faust, K.M. Perceptions versus reality: Assessing residential water conservation efforts in the household. *Resour. Conserv. Recycl.* **2020**, *162*, 105020. [CrossRef]
70. Campbell, H.E.; Johnson, R.M.; Larson, E.H. Prices, Devices, People, or Rules: The Relative Effectiveness of Policy Instruments in Water Conservation. *Rev. Policy Res.* **2004**, *21*, 637–662. [CrossRef]
71. Sant'ana, D.; Mazzega, P. Socioeconomic analysis of domestic water end-use consumption in the Federal District, Brazil. *Sustain. Water Resour. Manag.* **2017**, *4*, 921–936. [CrossRef]
72. Rathnayaka, K.; Malano, H.; Arora, M.; George, B.; Maheepala, S.; Nawarathna, B. Prediction of urban residential end-use water demands by integrating known and unknown water demand drivers at multiple scales I: Model development. *Resour. Conserv. Recycl.* **2017**, *117*, 85–92. [CrossRef]
73. Meireles, I. Sousa Assessing water, energy and emissions reduction from water conservation measures in buildings: A methodological approach. *Environ. Sci. Pollut. Res.* **2019**, *27*, 4612–4629. [CrossRef]
74. Talpur, B.D.; Ullah, A.; Ahmed, S. Water consumption pattern and conservation measures in academic building: A case study of Jamshoro Pakistan. *SN Appl. Sci.* **2020**, *2*, 7. [CrossRef]
75. Dias, T.F.; Kalbusch, A.; Henning, E. Factors influencing water consumption in buildings in southern Brazil. *J. Clean. Prod.* **2018**, *184*, 160–167. [CrossRef]
76. Marinoski, A.; Vieira, A.; Silva, A.; Ghisi, E. Water End-Uses in Low-Income Houses in Southern Brazil. *Water* **2014**, *6*, 1985–1999. [CrossRef]
77. Gómez-Llanos, E.; Durán-Barroso, P.; Robina-Ramírez, R. Analysis of consumer awareness of sustainable water consumption by the water footprint concept. *Sci. Total Environ.* **2020**, *721*, 137743. [CrossRef] [PubMed]

78. Singha, B.; Karmaker, S.C.; Eljamal, O. Quantifying the direct and indirect effect of socio-psychological and behavioral factors on residential water conservation behavior and consumption in Japan. *Resour. Conserv. Recycl.* **2023**, *190*, 106816. [CrossRef]
79. Tiefenbeck; Staake, T.; Roth, K.; Sachs, O. For better or for worse? Empirical evidence of moral licensing in a behavioral energy conservation campaign. *Energy Policy* **2013**, *57*, 160–171. [CrossRef]
80. Manouseli, D.; Kayaga, S.M.; Kalawsky, R. Evaluating the Effectiveness of Residential Water Efficiency Initiatives in England: Influencing factors and policy implications. *Water Resour. Manag.* **2019**, *33*, 2219–2238. [CrossRef]
81. Geerts, R.; Vandermoere, F.; Van Winckel, T.; Halet, D.; Joos, P.; Steen, K.V.D.; Van Meenen, E.; Blust, R.; Borregán-Ochando, E.; Vlaeminck, S.E. Bottle or tap? Toward an integrated approach to water type consumption. *Water Res.* **2020**, *173*, 115578. [CrossRef] [PubMed]
82. Ko, S.H.; Sakai, H. Perceptions of water quality, and current and future water consumption of residents in the central business district of Yangon city Myanmar. *Water Supply* **2021**, *22*, 1094–1106. [CrossRef]
83. Lu, S.; Gao, X.; Li, W.; Jiang, S.; Huang, L. A study on the spatial and temporal variability of the urban residential water consumption and its influencing factors in the major cities of China. *Habitat Int.* **2018**, *78*, 29–40. [CrossRef]
84. Cai, J.; Yin, H.; Varis, O. Impacts of urbanization on water use and energy-related CO_2 emissions of residential consumption in China: A spatio-temporal analysis during 2003–2012. *J. Clean. Prod.* **2018**, *194*, 23–33. [CrossRef]
85. Bao, C.; Chen, X. Spatial econometric analysis on influencing factors of water consumption efficiency in urbanizing China. *J. Geogr. Sci.* **2017**, *27*, 1450–1462. [CrossRef]
86. Long, H.; Lin, B.; Ou, Y.; Chen, Q. Spatio-temporal analysis of driving factors of water resources consumption in China. *Sci. Total Environ.* **2019**, *690*, 1321–1330. [CrossRef]
87. Fan, L.; Gai, L.; Tong, Y.; Li, R. Urban water consumption and its influencing factors in China: Evidence from 286 cities. *J. Clean. Prod.* **2017**, *166*, 124–133. [CrossRef]
88. Shaban, A. Water Poverty in Urban India: A Study of Major Cities. Seminar Paper UGC—Summer Programme (30 June–19 July 2008). Índia. 2008. Available online: https://www.jmi.ac.in/upload/publication/Water_Poverty_in_urban_India.pdf (accessed on 2 July 2021).
89. Bich-Ngoc, N.; Prevedello, C.; Cools, M.; Teller, J. Factors influencing residential water consumption in Wallonia, Belgium. *Util. Policy* **2022**, *74*, 101281. [CrossRef]
90. Grespan, A.; Garcia, J.; Brikalski, M.P.; Henning, E.; Kalbusch, A. Assessment of water consumption in households using statistical analysis and regression trees. *Sustain. Cities Soc.* **2022**, *87*, 104186. [CrossRef]
91. Perkins, K.M.; Munguia, N.; Ellenbecker, M.; Moure-Eraso, R.; Velazquez, L. COVID-19 pandemic lessons to facilitate future engagement in the global climate crisis. *J. Clean. Prod.* **2021**, *290*, 125178. [CrossRef] [PubMed]
92. Zambrano-Monserrate, M.A.; Ruano, M.A.; Sanchez-Alcalde, L. Indirect effects of COVID-19 on the environment. *Sci. Total Environ.* **2020**, *728*, 138813. [CrossRef] [PubMed]
93. NASA. Earth Observatory. Airborne Nitrogen Dioxide Plummets Over China. 2020. Available online: https://earthobservatory.nasa.gov/images/146362/airborne-nitrogen-dioxide-plummets-over-china (accessed on 11 August 2021).
94. World Meteorological Organization (WMO). Economic Slowdown as a Result of COVID is No Substitute for Climate Action. 2020. Available online: https://wmo.int/media/news/economic-slowdown-result-of-covid-no-substitute-climate-action (accessed on 11 August 2021).
95. Yunus, A.P.; Masago, Y.; Hijioka, Y. COVID-19 and surface water quality: Improved lake water quality during the lockdown. *Sci. Total Environ.* **2020**, *731*, 139012. [CrossRef] [PubMed]
96. Kalbusch, A.; Henning, E.; Brikalski, M.P.; Luca, F.V.d.; Konrath, A.C. Impact of coronavirus (COVID-19) spread-prevention actions on urban water consumption. *Resour. Conserv. Recycl.* **2020**, *163*, 105098. [CrossRef] [PubMed]
97. Abu-Bakar, H.; Williams, L.; Hallett, S.H. Quantifying the impact of the COVID-19 lockdown on household water consumption patterns in England. *Npj Clean Water* **2021**, *4*, 1–9. [CrossRef]
98. Zvobgo, L.; Do, P. COVID-19 and the call for 'Safe Hands': Challenges facing the under-resourced municipalities that lack potable water access—A case study of Chitungwiza municipality, Zimbabwe. *Water Res. X* **2020**, *9*, 100074. [CrossRef]
99. Stoler, J.; Miller, J.D.; Brewis, A.; Freeman, M.C.; Harris, L.M.; Jepson, W.; Pearson, A.L.; Rosinger, A.Y.; Shah, S.H.; Staddon, C.; et al. Household water insecurity will complicate the ongoing COVID-19 response: Evidence from 29 sites in 23 low- and middle-income countries. *Int. J. Hyg. Environ. Health* **2021**, *234*, 113715. [CrossRef]
100. Abulibdeh, A. Spatiotemporal analysis of water-electricity consumption in the context of the COVID-19 pandemic across six socioeconomic sectors in Doha City, Qatar. *Appl. Energy* **2021**, *304*, 117864. [CrossRef] [PubMed]