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**Bachelor thesis**

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**CHARLES UNIVERSITY**  
**FACULTY OF SOCIAL SCIENCES**

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**Analysis of clean water supply in developing  
countries in the context of SDG framework**

*Bachelor thesis*

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## **Abstract**

Since 1990, privatization of water and sanitation utilities has been promoted as a viable solution to their insufficient accessibility in developing countries, however its aftermath is disputed to this day. The purpose of this thesis is to examine the consequences and effectiveness of private-sector-supplied water and sanitation services in developing countries in the context of SDG. Using the panel data regression methods of fixed-effects and random-effects, the sample of 78 countries in the span of 29 years from 1990-2018 is analyzed to quantify the effect of private-sector and IMF (non-private) investment on expansion of water and sanitation coverage and the extent to which each of them helps diminish WASP mortality rate among the population. The results show that a) neither source of external financial aid significantly contributes to expansion of water coverage and decrease of mortality rate, and b) the degree of countries' economic development (measured by GDP per capita) is the most significant factor in the pursuit of water-related SDG.

## **Keywords**

Sustainable development, water resource management, sanitation, water supply, privatization, accessibility, scarcity

**Range of thesis:** 79,785

## **Abstrakt**

Od roku 1990 je privatizácia vodných a sanitačných služieb propagovaná ako účinné riešenie pre ich nedostatočnú prístupnosť v rozvojových krajinách, hoci sa o jej dôsledkoch dodnes vedú spory. Účelom tejto práce je tak preskúmať následky a efektivitu vodných, a hygienických zariadení poskytovaných súkromným sektorom v kontexte cieľov udržateľného rozvoja. Použitím regresných metód „stálych a náhodných efektov“ pre panelové dáta na vzorke 78 krajín v rozmedzí 29 rokov v období 1990-2018 kvantifikujem účinok kapitálovej účasti súkromného sektora a finančnej (nesúkromnej) pomoci poskytovanej Medzinárodným menovým fondom na rozšírení dostupnosti vody a sanitačných zariadení, ako aj redukcii úmrtnosti v dôsledku konzumácie nekvalitnej vody a nedostatku hygieny. Výsledky ukazujú, že a) žiaden z externých zdrojov financovania neprispieva k signifikantnému zvýšeniu zásobovania vodou a citel'nému zníženiu miery úmrtnosti v dôsledku hnačkových ochorení a b) že stupeň ekonomického rozvoja danej krajiny, meraným prostredníctvom HDP na obyvateľa, predstavuje najvýznamnejší faktor pre dosiahnutie cieľov udržateľného rozvoja v odvetví vodného hospodárstva.

## **Kľúčové slová**

Udržateľný rozvoj, riadenie vodných zdrojov, sanitácia, zásobovanie vodou, privatizácia, prístupnosť, nedostatok

## **Declaration of Authorship**

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.
2. The author hereby declares that all the sources and literature used have been properly cited.
3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague, July 27, 2020

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**Patrik Kratochvíla**

## **Acknowledgements**

I would like to express my gratitude to my supervisor doc. Ing. Tomáš Cahlík, CSc. for his patience, time and valuable comments and insights he devoted to me.

I would also like to specially thank my dearest family for their sincere and tireless support during my whole bachelor studies. Thank you.

# Bachelor's Thesis Proposal

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*Notes: Please enter the information from the proposal to the Student Information System (SIS) and submit the proposal signed by yourself and by the supervisor to the Academic Director ("garant") of the undergraduate program.*

**Proposed Topic:**

Analysis of clean water supply in developing countries in the context of SDG framework
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**Preliminary scope of work:**

***Research question and motivation***

1. Should water as a natural resource be treated as an economic good subject to supply and demand mechanism?
2. Would it be socioeconomically beneficial if water resources were transferred to private-sector ownership?
3. Would privatization thereof lead to a much more equitable allocation and higher effectualness in terms of a water quality-standards guarantee and sustainable development goals?

Analyzing bilateral sector of water resource-proprietorship, both from the standpoint of private corporations as well as public or communal one, might be significantly beneficial with regard to distributive and consumptional responsibilities and decision-making procedure. Privatization of water has been a controversial concept for many years, since on the one hand, proponents of the idea point to water's potential wastage when freely available, whereas on the other hand, opponents argue that privatization is likely to cause a dramatic increase of rates and environmental pollution resulting from over-extraction due to firms' centeredness on profit-maximization.



### ***Contribution***

It might be beneficial to scrutinize both contrasting standpoints of such a controversial topic that would systematically elucidate the complexity of the issue and eventually endeavor to produce a conclusive outcome based on the socioeconomic implications of each derived from their comprehensive comparison. That is to say, does water privatization represent an important step towards socially-targeted goal of more equitable and effective water reallocation, or is it rather a strategic intention of corporations to gain influence over another vital natural resource?

The contribution of this thesis, among other things, should be to direct reader's attention to environmental impacts and negative externalities, which each of these two sectors (especially private) brought about, and thus proffer some sort of reasonable solution for long-run maintenance of SD goals.

### ***Methodology***

- Data analysis of most influential corporations (e.g. Nestlé) and supranational organizations (e.g. the World Bank Group) involved in water privatization efforts worldwide
- These include:
  - graphs displaying safely-managed drinking water services, water scarcity etc.
  - coverage of improved water and sanitation facilities in rural and urban areas in developing countries worldwide
  - figures demonstrating adverse environmental consequences, such as pollution or water exploitation, triggered by private companies in their effort to maximize profit that significantly aggravated the socioeconomic situation of developing countries
- Data analysis will lie in a statistical comparison of the above-mentioned data, which will include contrasting the private with public undertaking in the matter of water management
- Particular attention will be focused on evaluating the overall contributions, socioeconomic cost and externalities which each sector's involvement in water management brought about

### ***Outline***

- Introduction:
- Description of the nature of water as an increasingly more valuable commodity
  - Water as a global, but scarce good
  - Water as an issue on the international agenda
- Introductory examination of private and public sector endeavors intended towards global water management policies in the framework of SDG (such as water security and sanitation programs) focused on developing countries
  - Water as a need becoming a millennium development goal
  - Motivation of businesses and supranational organizations for privatization of water management

### Main Body:

- Global water access analysis with a particular focus on developing countries
  - poverty and issues with water accessibility
  - countries that suffer the most from a shortage of clean water supply
  - attempts to improve the situation
- Sustainability factors, assessing and planning, challenges
  - how are these different in developing countries in comparison to developed ones?
- Governmental and corporate obligations toward the human right to water, advantages and disadvantages of each
  - their respective effort to tackle the problem with shortage of water
  - major and possible economic, political or geographical hindrances
- Case studies of several developing countries concerning private and public water management and their consequent outcomes in terms of efficiency, equity and sustainability impacts

### Conclusion:

- Concise summary of the results obtained from the analysis of private and public proprietary sectors comprising economic effectivity, environmental impact and societal implications of water management
- Reference to introductory part of the thesis, that is confirmation/refutation of proposed researched questions and derivation of prospective development of global management endeavors of water as an increasingly scarcer commodity

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## 1. Introduction

Still increasing worldwide dependence on industrialization as an apparently inevitable consequence of technological advancement steering the endeavors to achieve socioeconomic globalization does on the other hand present itself as being progressively more detrimental to the environment. One of the most serious threats which the environmental pollution constitutes is the contamination of water resources, especially in developing countries which are often stricken with the shortage of clean water supply, owing to which satisfying daily human needs like nutrition and sanitation is becoming progressively more difficult.

In recent years the topic of water scarcity has been raising global awareness among the political as well as business leaders as a potential issue affecting to some extent every single continent. In 2015 this trend has been presented by World Economic Forum as the largest global risk with regard to its potential impact over the next decade. [1] Owing to this fact, the society calls for efficient and equitable allocation of water resources and water management which prompts governments and numerous private corporations around the world to introduce various strategies with regard to treatment, proprietorship and commodification of water as a scarce natural resource purportedly designed to expedite the fulfilment of *sustainable development goals*.

Supranational private corporations propagate water privatization as an effective solution to global water crisis, arguing that treating water resources as a commodity subject to supply and demand mechanism would prevent their possible wastage when freely accessible and their distribution remaining unregulated. Conversely, opponents of water privatization maintain that free-of-charge access to water should be deemed as an inalienable human right and any form of water management regulation potentially leads to her inequitable reallocation and eventual disentanglement of humans to this fundamental privilege. Furthermore, assumption of water management by private corporations caused in many case extensive and often irreparable environmental damage, especially in developing countries, where the corporate exploitation of fresh water continues to have profound implications for sustainable development and the realization of human rights.

Both developing and industrialized countries have recently experienced riots and civil unrests in the aftermath of exploitative corporate assumption of water management. [2] Considering the lower levels of government revenues in addition to the wave of privatization encouraged by international financial institutions across the developing world, it is especially interesting to investigate whether the privatization of water utilities in developing countries has brought about the positive impact it was expected to have in the context of sustainable development goals. This paper intends to provide a comprehensive quantitative analysis of the impact of water privatization on access to water on an international level, complementing thereby both the sub-national and national-level studies that have been carried out on this subject.

The outline of the thesis is structured as follows. Chapters 2-9 are devoted to water characterization in the context of a scarce economic good, theoretical framework of sustainable development and its socioeconomic goals, the related literature review and the examination of case studies of concrete developing countries and the aftermath of water privatization therein. Section 10 is devoted to the entire empirical analysis, including the description of data gathering procedure along with its limitations, model specifications, empirical testing of assumptions and presentation of results. Section 11 then discusses the results' socioeconomic implications and concludes with a suggestion for future research.

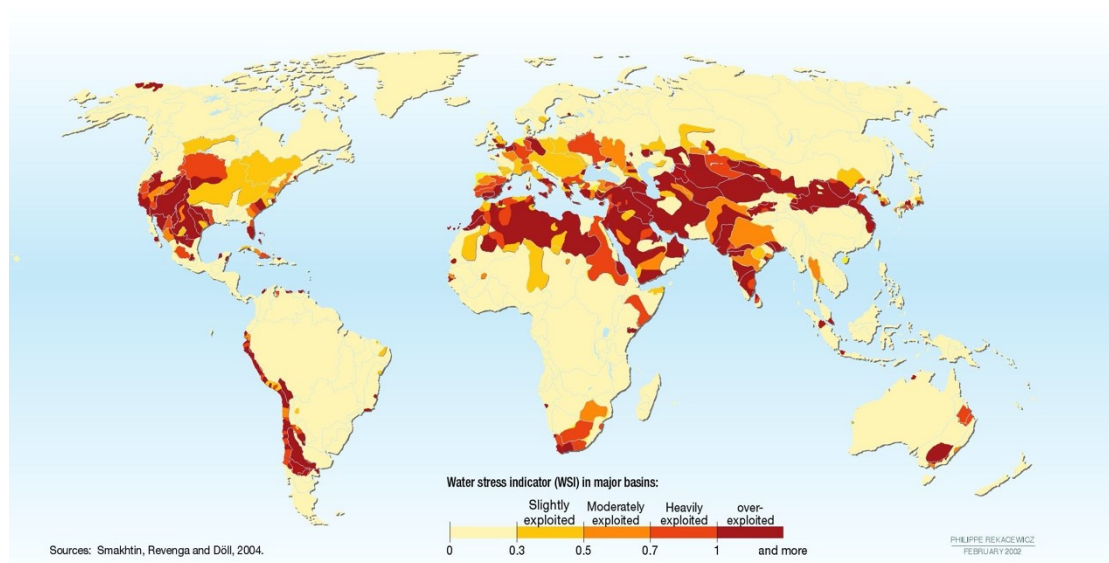
## 2. Water as a Global but Scarce Good

*" Water promises to be to the 21st century what oil was to the 20th century: the precious commodity that determines the wealth of nations." [3]*

Fortune

The Earth abounds with substantial water resources with its overall stock of approximately 1.4 billion cubic kilometers. The vast majority of the stock (nearly 97%) comprises oceanic salt water. Around 35 million cubic kilometers constitutes the world's more limited freshwater stocks which, however, are mostly retained in Antarctic glaciers and Greenland, permanently snow-covered regions or deep underground reservoirs practically inaccessible to humans. Only small fractions are readily available to humans in river flows, reachable surface lakes and groundwater, soil moisture or rainfall. [4] Humanity faces serious water challenges, including ecological disruption of aquatic ecosystems, increasing concerns of freshwater deficiency, and prospective deterioration in regional hydrology and water management which are increasingly more affectable by exacerbating climatic changes. [4]

**MAP 1: GLOBAL WATER STRESS**



*Source:* Lobina & Hall, 2013



After millennia of human development where water has been a plentiful resource in most areas amounting virtually to a free good, the situation is now abruptly changing. Continuous population and economic growth impose greater constraints and limitations to water availability. More than one million people living in arid regions are prospected to experience *absolute* water scarcity by 2025. [5] These regions suffer from inability to maintain 1990 levels of per capita food production due to agricultural irrigation deficiency, in consequence of which agricultural water use will have to be reduced, causing decline in domestic food production and forcing inhabitants to resort to increasing import of food from abroad. Approximately 348 million more people face *severe* economic water scarcity, meaning their regions have water resources sufficient to meet reasonable water requirements by 2025, yet massive water development projects involving enormous costs and possible environmental harm will have to be embarked on to achieve those needs. [5]

### 3. The Economic Nature of Water

Water constitutes a crucial determinant of global socioeconomic development. It is a vital natural resource for maintaining health, growing food, effective management of the environment as well as creating jobs. [6] Inherently specific characteristics of water as a natural resource have naturally prompted questions as to whether it can truly be classifiable as an economic good. A Canadian professor Karen Bakker refers to water as an “*uncooperative commodity*” for her problematic classification and due to her virtual non-substitutability as a natural resource. [7] Nonetheless, economic theory maintains that the fact of water’s relative and absolute scarcity makes it categorizable as a scarce and therefore economic good.

Her unique properties make water characterizable as a public good (since society as a whole benefits from an adequate and safe public water supply), a private good (bottled water consumption entails both rivalry and excludability), an economic good (as has been established since the formulation of the Fourth Principle of Dublin 1992), a merit good (meaning that allocation of water should be based on the concept of need, rather than ability and willingness to pay) and a welfare good (for the reason that safe drinking water accessibility has a major influence on health and well-being of households). Moreover, water can also be classified as a common pool resource by reason of exclusion (even though possible, yet often costly) and the property that outcomes from her use are collectively beneficial. [7]

Physical attributes of water are factors shaping her allocation and management systems. It is heavy to transport relative to value and so is typically used in the proximity of source. Distribution and production are extremely capital-intensive, requiring huge networks of pipeline and mechanical pumps which render high-cost water delivery intrinsically monopolistic. Because of water’s often unpredictable availability and thus inability of market to fully occupy the socio-environmental externalities of her distribution mechanisms, her ownership thus mostly remained in the public-sector domain. [7]

## 4. Worldwide Sustainable Development Goals

### 4.1 *Key Principles of Sustainable Development*

The concept of sustainable development states that humanity is capable of attaining such a degree of long-run development, which would ensure that contemporary social needs are satisfied to such level that the ability of future generation to fulfil their own needs will be uncompromised. [8] This agenda currently comprises seventeen development goals which are meant to represent world's best strategy towards building a better planet by 2030. They recognize that cessation of poverty must occur simultaneously alongside strategies targeted at economic growth and addressing multiple social aspects including healthcare, education, gender equality etc., while coping with disruptive climate change mitigating environmental catastrophes. [9] The number six goal of sustainable development agenda pertains to clean water and sanitation utilities, whereby sustainable and available-for-all water management should be ensured. [10]

#### 4.1.1 Economic Efficiency

According to welfare economics, goods should be allocated in such a way that the maximum level of social welfare is achieved. Since social welfare is difficult to gauge empirically, primarily due to problems associated with true valuation of equity, which resulted in economists developing more pragmatic concept of the so-called *Pareto optimality* to capture whether society is operating at its optimum level. The Pareto optimal condition with respect to resource allocation exists when it is impossible to alter the well-being of an individual by changing the distribution framework without simultaneously worsening the well-being of another individual. Socially optimal outcome may not be attained when a decision is made on purely private grounds, because of various externalities such as public health and public good nature of water, which may hence require government intervention to attain social efficiency. [10] The issue of economic efficiency in water management and allocation will be discussed separately in a much greater detail from the perspective of both private and public sector ownership.

### **4.1.2 Equity**

The second principle of sustainable development goals regarding the water management is equity representing the perception of socioeconomic fairness. It constitutes one of the most hardly definable terms for economics, since the concept inherently involves numerous social factors, like politics and ethics, which are not easy to objectively quantify. Economics is usually not involved in expressing judgmental positions towards validity of different social values and attitudes concerning equity, but rather in providing description of nature and consequences arising from individual value judgements in efficiency terms. In the context of water utilities, some contemporary equity-related social values which are observable nowadays can be outlined as follows: [11]

- reliable, potable piped running water is perceived as a basic human right (officially recognized in 2010 by the UN [12]) or entitlement to a greater extent than a normal good, due to its role in promoting and sustaining acceptable public health;
- society appears to feel an obligation to financially assist small and rural communities in building their water infrastructure, both to achieve good public health, and to offset the economic burden of establishing effective water systems.

### **4.1.3 Environmental Sustainability**

The final principle refers to environmental sustainability, which is reflected in water management in the form of, for example, increased water conservation. Moreover, it can be perceived in operational terms as a long-term non-declining level of environmental well-being and public health. Water-related examples include minimization of discharging hazardous effluent or overall reduction of per capita water use. [11]

## **5. Emergence of and Rationales behind Privatization**

Although economic efficiency is an elegant criterion to found allocation decisions on, many choices cannot be measured in monetary terms. To avoid adverse environmental impacts, social equitability and environmental sustainability are two crucial criteria to arrive at a fair allocation of water resources.

Many economists argue that markets are the most feasible method for achieving environmental goals, pinpointing them particularly with regard to water management, suggesting that system of public allocation of water may result in significant inefficiencies and wastage, especially in the absence of a mechanism shifting water from old uses to new ones. Furthermore, water resources are said to be manageable more productively when treated as a tradable standardized commodity rather than as an engineering product or an integral part of nature. Thus, the most efficient use of water is claimed to be realizable only through private, profit-oriented markets, primarily due to prospective benefits of market competition. [13]

### ***5.1 Economic and Allocation Efficiency from the Perspective of Private and Public Sector***

#### **5.1.1 Privatization as a means of reducing water allocation failures**

Private-sector involvement in infrastructure was vigorously promoted by development agencies and international institutions in the 1990s and early 2000s with the expectation to inject both investment and efficiency into these supposedly malfunctioning public sectors in developing countries, suffering from underinvestment and inefficiency due to excessive political interference and rent-seeking behavior of government officials. This extension of private-sector involvement was assumed to be economically more successful and generally welcomed. [14]

Local governments are investing unprecedented amounts of financial resources into public water delivery systems, which still face serious infrastructure reinvestment gaps because of the absence of adequate federal support. For instance, U.S. water systems are predicted to require a staggering investment of up to \$4.8 trillion over the next two

decades. [15] Hence, private corporations are waging a national campaign for the purpose of presenting privatization as a universal solution promising overall reduction of costs and increase of efficiency. At the same time, there is accumulating evidence concerning the problematics of water privatization and the risk posed by the prospect of private sector water management to the communal well-being. [18]

Private corporations have sought to distance themselves from the notorious term “privatization” with respect to water management, given its deep-seated worldwide unpopularity. Instead, water giants have been proposing somewhat more promissory and innovative-sounding contractual model of public-private partnership (PPP) to mayors and other public officials. In the US, for example, water corporations like Veolia and Suez present themselves as trustworthy partners capable of helping the government officials to tackle complex challenges linked with high-quality-water delivery services with limited financial resources. The private sector industry devotes substantial funds to this marketing initiative which, whereas abounding with appealing promises, remains deafeningly silent on their failure to maintain these promises. [28]

### **5.1.2 Public Opprobrium at Corporations' Non-Compliance with SDG**

As private corporations have demonstrated a long-term contractual interest in water management thereby managing to ensure profitability often at the cost of local governments and communities, political interference of private corporations in the sector of water management imposes a threat on democratic governance and sustainable management of communal water systems. [15] The failure of private sector to fulfil the expectations and SD goals in the variety of ways has consequently rendered privatization widely unpopular encountering strong political opprobrium which will be discussed in a greater detail later on.

Therefore, public sector management of water resources has been recognized by communities around the globe to be of strategic importance for cities to guarantee social welfare, as a result of which the funding, planning, ownership and regulation by publicly accountable institutions has remained the global norm. The recognition of the importance of water services has been a determinant factor in preventing their delegation entirely to the private sector, which shaped thus the history of water allocation since the introduction of centralized piped systems. [15]

## **6. Corporate and Governmental Obligations towards the Human Right to Water**

Human rights obligations, such as the right to clean water access, are the primary responsibility of states. The protection of these rights requires a state to prevent third-party interference with the enjoyment of the human right to water, for example via adopting necessary and effective legislative measures to disallow unequal access to safe water, restrain pollution or exploitation of water resources. Moreover, governments are responsible for taking appropriate steps to ensure corporations' awareness and consideration of the importance of the human right to water in the pursuit of their business activities. [17]

In addition, impotence of governments to comply with their regulatory and guiding obligations along with the economic power and market position of corporations allows them to act independently and oblige thus to some extent arbitrarily with regard to human rights. The secondary obligation to promote, respect and secure the fulfilment and protection of the human rights is recognized both in national as well as international law. In this regard, transnational corporations are obliged to have due regard for socioeconomic, cultural and political rights and should also contribute to the realization of the fundamental right to food and potable water, being responsible for complete refrainment from obstructive measures which would impede exercising of human rights. Water services distribution provided by the private sector shall ensure equality of opportunity and treatment so that racial, cultural, gender and other discrimination were eliminated. Most importantly, corporations shall take the full responsibility to ensure safety and adequate quality of the goods and services provided and are strictly prohibited from producing, distributing and marketing any harmful products for consumption. Finally, general conduct of corporations' business activity shall be in a manner contributing to the wider goals of sustainable development. [17]



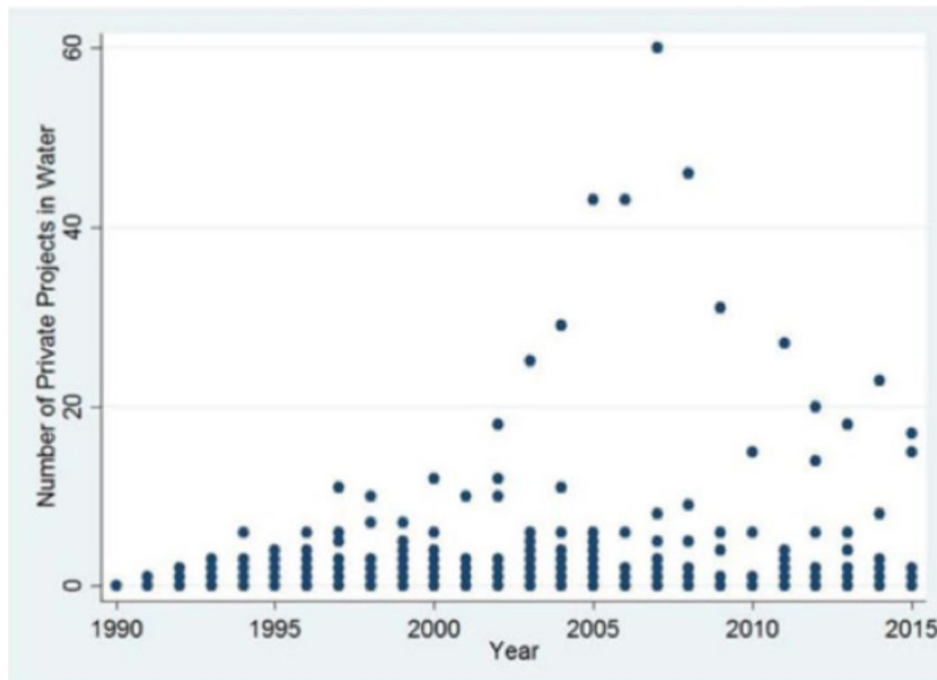
## 7. Most Influential Corporations Involved in Water Privatization Endeavors

*“...It’s a question of whether we should privatize the normal water supply for the population. And there are two different opinions on the matter. The one opinion, which I think is extreme, is represented by the NGOs, who bang on about declaring water a public right. That means that as a human being you should have a right to water. And the other view says that water is a foodstuff like any other, and like any other foodstuff should have a market value. Personally, I believe it is better to give a foodstuff a value...” [30]*

Peter Brabeck-Letmathe, Nestlé CEO

Owing to the fact of water security gradually becoming the divisive issue of the 21<sup>st</sup> century, numerous water corporations along with supranational agencies are attempting to transform scarce water resources into a profitable viewing water scarcity as a profitable business opportunity, developing their own industry of bottled water. Privatization of water services and water commodification conflicts with a variety of United Nations covenants and international treaties which declare free access to water as a fundamental human right. [16]

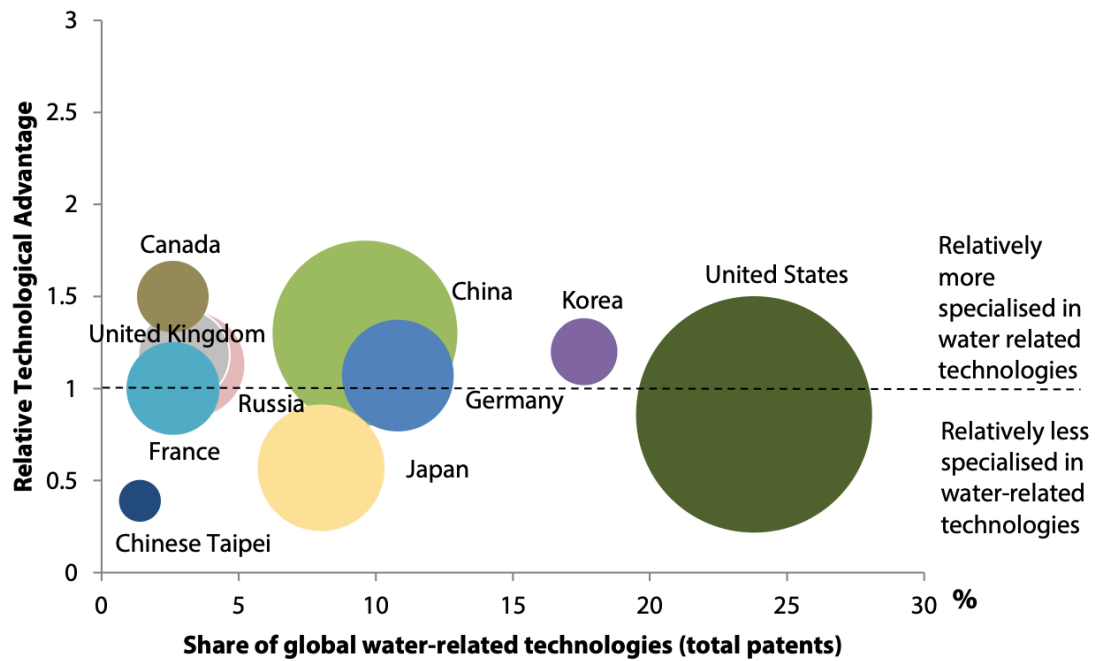
Barrierless access to water and safe sanitation services constitute the crucial factor in an effective poverty eradication strategy. Due to institutional and financial obstacles afflicting developing countries in achieving universal water access, many governments have addressed the private sector with the offer to manage water and sanitation utilities to improve public health outcomes. Furthermore, in the 1990s water privatization recorded increased support from international financial institutions which usually included conditional loans based on the Washington Consensus, with the aim of addressing worldwide under-provision of water and public debt alleviation. [18]

**FIGURE 1: PRIVATE PROJECTS IN WATER, ACROSS TIME**

*Source: Cesar (2018)*

As demonstrated in Figure 1 above, private sector involvement in water services has been continuously rising over the past decades, especially in the period around the global financial crisis of 2007-2008. Nevertheless, it is not certain whether the global improvement in water accessibility could primarily be ascribable to increased private sector participation, and thus the notion of effectivity and appropriateness of policies encouraging water privatization as a development strategy in the pursuit of achieving sustainable development goals remains questionable.

Moreover, Figure 2 below illustrates the degree of involvement of global superpower countries in water-related technological projects, clearly showing the U.S. as the global leader in the water investments endeavors. Overall the figure corresponds to the individual case studies concerning several concrete supranational private corporations and their participation in water-sector management in developing countries which are yet to be elaborated.

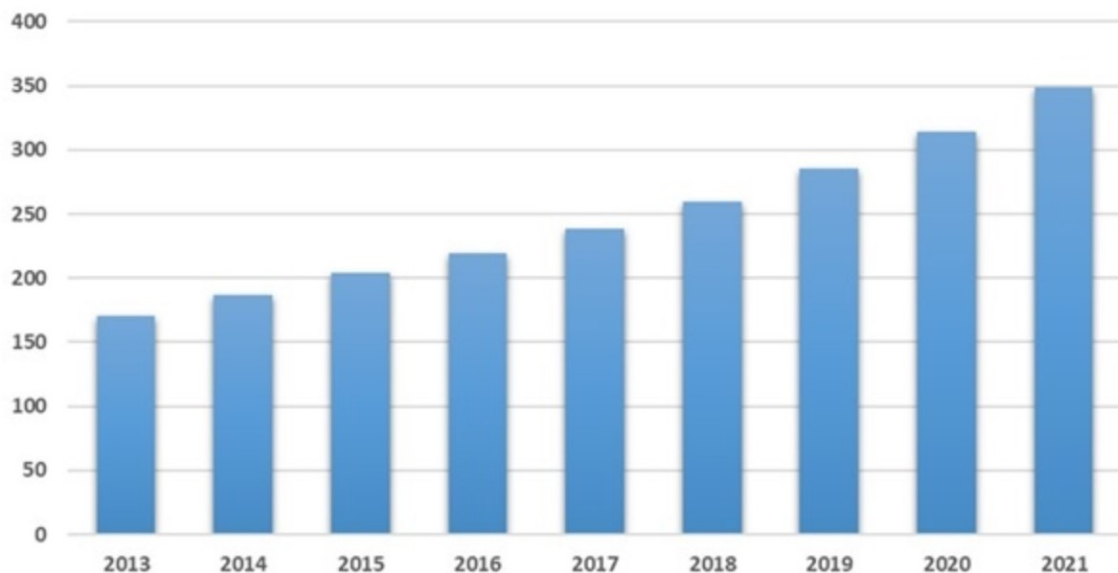
**FIGURE 2: TOP WATER-RELATED INVESTOR COUNTRIES, 1990-2013**

Source: OECD, *Financing Water: Investing in Sustainable Growth*, (2018)

### 7.1 *Bottled Water as a Private Sector Solution to Water Crisis*

It is estimated that bottled water consumption has recorded an exponential growth in the past ten to fifteen years. According to statistics available, bottled water consumption in developed countries of North America and Europe increased to the staggering level of twenty per cent in the period of just three years from 2000, despite having safe tap water available. [17] This dramatic surge in bottled water consumption ensued the spawn of a global industry with its international market production value expected to surpass the \$270 billion in sales by 2020, and estimated annual growth rate of 7.5 per cent. [38] [40]

**FIGURE 3:** GLOBAL BOTTLED WATER MARKET, 2013-2021 (IN \$ BILLION)



Source: MarketResearch.com (2018)

The global bottled water market is dominated by four food and beverage giants: Nestlé, Danone, Coca-Cola and Pepsi Co. These transnational corporations are involved in development of high-capacity bottling plants to extract groundwater worldwide. However, the significant majority of water extracted in southern nations serves for local consumption. Progressively, corporate water giants are therefore engaged in acquisition of local companies and targeting middle- and upper-class consumers, whereas poverty-stricken residents are often supplied with low-quality water at inordinate prices and whose distribution is usually reliant on unregulated local vendors. [19] Transportation of water constitutes a crucial commercial issue by reason of which corporations are building

massive pipeline systems while others are involved in the construction of giant sealed water bags to facilitate transoceanic transportation of vast amounts of water for mercantile purposes to paying customers. These technological endeavors are further corroborated by the statement of the World Bank's ex-manager of water resources: "*One way or another, water will be moved around the world as oil is now.*" [20]

According to Barlow (2007), almost twenty-five per cent of all bottled water is sold to rich markets in the global North after extracting the resources in poor southern communities. [19] Moreover, bottled water represents one of the limited sources of safe drinking water in developing world, and water firms are directing their objectives to meet demands for potable water to the questions of bottled water as a secure and feasible alternative for its shortage.

Conversely, bottled water industry is associated with numerous environmental problems comprising discharging of pollutants as byproducts of the manufacturing process, transportation and disposition of plastics or high fossil fuel dependence which contribute to hydrology deterioration, [21] giving thus the appearance of further aggravation of the problem in developing countries rather than providing an environmentally sustainable solution.

## **8. Public Resistance to Privatization: Case Studies of its Consequences in Developing Countries**

### ***8.1 Disillusionment with Privatization***

Conflicts over fresh water are reported to have occurred for thousands of years notably in drought-scourged regions of Africa and Middle East having only finite water resources available. More recently, politics of water commodification and its catalytic ramifications for environmental sustainability driven by profit-oriented entities abusing local insufficiency of water resources has instigated civil riots, arrests and deaths not only in developing countries such as Bolivia or Ghana, but also in affluent Western states. [2] As demonstrated in Figure 4 (see Appendix), these events are indicative of criminological omnipresence of the water privatization issue apparently afflicting states irrespective of whether their citizens are experiencing water scarcity or water abundance. [25]

Water shortages and environmental degradation (e.g. water depletion, salinization, qualitative exacerbation of groundwater or edaphic destructuralization) resulting from corporations' indiscriminate extraction of groundwater resources, coupled with landlessness and farming in low-fertility areas leads to uncertainty in livelihood and further intrenchment of poverty. Especially the poor indigenous Asian communities are reported to be forced to displace from their ancestral lands in the aftermath of building dams. Also, vast majority of communities is said to be largely dependent on contaminated and unfit-for-drinking water supply from rural water wells to meet sanitation and consumption demand, thereby engendering dysentery and other health problems. [16]

## **8.2    *Nestlé and the Business of Bottled Water in Pakistan***

### **8.2.1    Pakistani Bottled Water Market**

Nestlé S.A. is a supranational food and drink corporation employing more than 328,000 people in 418 factories operating within 191 countries worldwide with a total turnover accounting for more than EUR 83,5 billion for the year 2016. The corporation's sector of *Nestlé Waters* comprises 51 different water brands, such as Pure Life, San Pellegrino or Vittel, and overall represents 11.3 per cent of the aggregate market share and their bottled water brand Pure Life holds the supreme market position in terms of global product sale. [26]

Seeing that spring water remains a highly regulated resource in Pakistan, Nestlé availed itself well of the idea of using groundwater for their production instead, since groundwater resources are characterized with a massive regulation deficiency. Nevertheless, the Nestlé corporation declares direct commitments to human rights and puts emphasis on their world's leading position in the food and beverage market towards the sustainable use of freshwater resources.

Bottled and drinking water are both classified under 'beverages' and their nature as commodities are accounted under the Sensitive Price Indicator (i.e. the degree of affectability of price change on customers' purchasing willingness), thereby showing Pakistan's low bottled water consumption. In 1999, annual consumption thereof moved around 33 million liters and its market was described by the national government as *small but growing*. Estimates of the bottled water consumption for the year 2003 was about 70 million liters or 0.5 liters per capita. [17] Since the introduction of Nestlé's 'Pure Life', bottled water market registered the fastest worldwide expansion rate reaching 140 per cent in the year 2000, and currently giving an approximate of five-liter annual per capita consumption. [22] Although this figure may give a misleading impression of an inconsiderable amount, especially in comparison to other developing countries, such as Philippine's 15 liters or 43 liters in Thailand [17], when taking into account the Pakistani population totaling more than 200 million, [23] one has to make a total estimate of 1 billion liters.

### 8.2.2 Impacts of Nestlé's 'Pure Life' and Human Rights Concerns

Groundwater constitutes the primary source of potable water in Pakistan. According to the research conducted by UNESCO in the Province of Sindh, its long-run sustainability is being severely endangered should groundwater extraction continue at the present rate highly exceeding her renewable volume. Furthermore, Pakistan as a country is lacking any integrated water management regulatory policy (except for the Province Balochistan) which would curtail groundwater over-exploitation, like in the case of concerning Nestlé and its findings concerning water extraction which, besides being in contradiction with their business principles, raise uncertainty about the degree of compliance with human right to water. The situation caught the attention of the World Bank because of its potential impact threatening the Pakistan's sustainable development, thereby providing a donation of ca. USD 2.8 million for framework regulation, which has ostensibly never been enacted. [17] Overall, groundwater extraction exceeding renewable resources culminates in a two-fold communal problem consisting of the overall groundwater lowering and a decline in water quality due to unregulated discharge of industrial effluents.

The system of water delivery in Pakistan is reliant on various technological mechanisms including pipelines, tube-wells and in the vast majority mainly hand pumps. In the district of Lahore, the vicinal area of Nestlé's 'Pure Life' production, 8.49 per cent of population have their water supplied through pipes, whereas 9.27 per cent depends on 24 tube-wells and 78.76 per cent on 204 hand pumps. [17]

A tube-well is assumed to extract groundwater at a level of 90-180 meters, which is considered a sufficient depth for obtaining safe and potable water, while extraction of water in shallow depths of 15-18 meters is mostly unsafe for consumption. Tube-wells excavate approximately 56-85 liters of water per second, which in ten-hour time can amount up to astonishing 3.06 million liters of groundwater. [17] Owing to the lack of regulation in water management in the whole Pakistan, Nestlé's production ought to be in compliance with its corporate responsibilities towards the sustainable development goals, which unfortunately tend to be violated when taking Nestlé's bottled water manufacturing policies into consideration. An example can be provided by analyzing the case in Sheikhpura, the district of Nestlé's reportedly first established factory in



Pakistan, which is stated to have suffered tremendous groundwater decline from 30 to 120 meters below the sea level since the building of the factory and the consecutive commencement of water extraction. [26]

These water policies of Nestlé's represent significant concerns for the local community and local government officials, as they are not only implying the corporation's short-sightedness from the water management perspective, but also show signs of jeopardizing the acknowledgment of human rights to water. Nestlé's future in terms of water policies can be summarized in the company's following statement: *"Water is a top priority for Nestlé – and always will be."* [31]

What still remains questionable is to what extent will the corporation's water management policies regarding the human right to water impact the communities affected by water extraction and collective dependence on for the poor often unaffordable corporate alternative of bottled water, which poses a threat as to proper public health maintenance, since the inability of purchasing safe potable water leaves the public inevitably reliant on unsafe resources of surface water.

### **8.3 Aguas del Tuarni and Water Sector in Bolivia**

The collapse of private sector water management system in Cochabamba, the fourth largest city in Bolivia, is a hotly debated case. Prior to the privatization of its water services, they had been provided by SEMAPA, a municipal company, which had been deemed inefficient in terms of achieving sufficient water delivery to Cochabamba citizenry, comprising approximately 600,000 residents out of which merely 57 per cent had been provided the service and moreover, the public delivery system had allegedly been ineffective due to excessive wastage of around 50 per cent of the total amount of water during transportation. [24] Water as a resource was dependent on the system of rationing and those lacking the access to the public infrastructure used private wells or had to purchase water from private suppliers at high costs.

In 1998, the Bolivian government was reportedly pressured by the World Bank to convey the water management to the corporate sector conditionally on the government being guaranteed a \$25 million loan for the system's infrastructural improvement. Since only

one company bid for the call for tender, the forty-year agreement provided Aguas del Tuarni, a subsidiary of the transnational parent company Bechtel Enterprises, exclusive rights and control over the entire water delivery network, attaining an annual fifteen to seventeen per cent return on investment. [24]

However, the agreement required the company to procure water delivery to existing users as well as expansion of the whole system coverage, securing of fairness and efficiency of user-dealing, yet the company's inadequate protection of their customary users and its non-compliance with contractual agreements led to increased communal anxiety, especially among peasant groups. The water rates were raised by 35 per cent (some users even reported an increase of 200 per cent), which translated itself into workers having to pay bills amounting to almost 25 per cent of their monthly disposable income. [24]

The situation culminated in a civil unrest (a conflict sometimes referred to as the "Water War"), forcing the government to terminate the contract with the aforementioned corporations in the aftermath, replacing the private water management sector with a cooperative. Nevertheless, the cooperative appears to hold deficient capital, by reasons of which the community system is neither capable of fully repairing nor expanding quickly enough, and the system thus remains plagued by the corruption and insufficient service provision. [24]

## **8.4    *India – The Case of Coca-Cola and PepsiCo***

### **8.4.1   Economic Environment and Thriving Bottled Water Market**

Water represents a virtually free and highly lucrative natural resource for private corporations and its accessibility combined with wholesale attraction of foreign investments and low costs of labor facilitate the penetration of transnational corporations into the water industry. The socio-political environment of liberalization in India provides the background knowledge to understand the entry of The Coca-Cola Company into the district of Plachimada in 1999. [25]

In consequence of sizeable growth of urban middle class in 1900s, the soft drink and bottled water industry started burgeoning, creating favorable conditions for The Coca-

Cola Company and PepsiCo to capture this marketing opportunity, eventually achieving 80 percent market share with annual sales of around \$2 billion. According to Bhushan (2006), the growth of bottled water market recorded the astonishing rate of 25 per cent a year, making India world's tenth largest consumer of bottled water. [25]

Since natural mineral water is still highly expensive and inaccessible to many Indians, despite the local producers contending with the brands like Evian or Perrier, the vast majority of bottled water sold constitutes the groundwater which has undergone proper treatment and purification after extraction, the costs of which in India are supposedly next to nothing. Bearing in mind the 2006 exchange rate of 45-50 Rupees to \$1 (1 Rupee = 100 paise), the explanation provided by Bhushan should present a more illustrative picture regarding the costs of bottling water in India:

*“Take for instance the case of Coca-Cola’s bottling plant in drought-prone Kala Dera near Jaipur. Coca-Cola gets its water free except for a tiny cess (for discharging the wastewater) it pays to the State Pollution Control Board—a little over Rs. 5,000 a year during 2000–02 and Rs. 24,246 in 2003. It extracts half a million litres of water very day—at a cost of 14 paise per 1,000 litres. So, a Rs. 10 per litre Kinley water has a raw material cost of just 0.02–0.03 paise . . . However, water is not that cheap in the United States, home to Coca-Cola and PepsiCo. The average cost of industrial water in the U.S. was Rs. 21 per 1000 litres in the late 1990s. It was Rs. 90/1000 litres in the United Kingdom and Rs. 76/1000 litres in Canada. Treatment and purification accounts for the next major cost. Even the state-of-the-art treatment system with reverse osmosis and membranes, the cost of treatment in a maximum of 25 paise a litre (Rs.0.25/litre). Therefore, the cost of producing 1 litre of packaged drinking water in India, without including the labour cost, is just Rs.0.25. In a nutshell, in manufacturing bottled water, the major costs are not in the production of treated and purified water but in the packaging and marketing of it.” [25]*

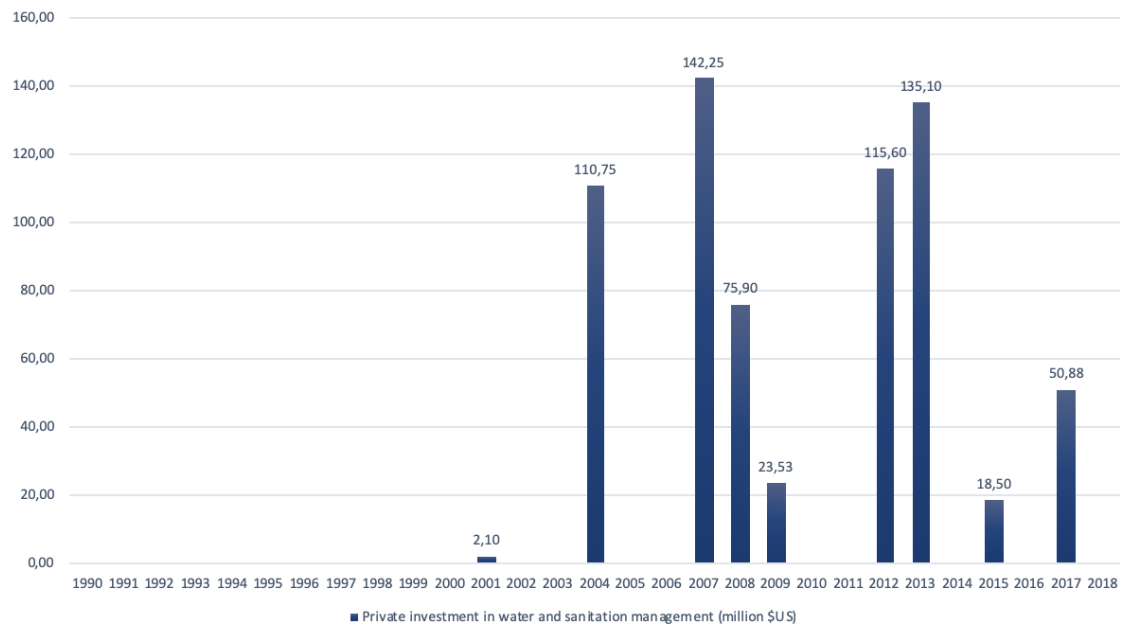
#### 8.4.2 Plachimada's Struggle against Coca-Cola

Plachimada is characterized as a deeply impoverished region located in the southern state of Kerala, whose population consists mostly of landless or land-poor castes. In 2000, The Coca-Cola Company was granted a license from the local Perumatty *panchayat* – the smallest governance unit in rural India, giving the company a permission to commence the bottled water production. Soon after, daily groundwater extraction purportedly amounted up to staggering 1.5 million liters. Besides, it is said that 3 liters of groundwater are required to produce 1 liter of bottled water. [25]

Within a two-year period, significant decrease of groundwater level was reported to have occurred, along with the belief of subsequent groundwater contamination in the surrounding areas, due to allegedly discharging its hazardous waste sludge in nearby farmlands and distributing it free-of-charge to local farmers as a fertilizer. [25]

In 2004, the high court eventually concurred with the panchayat's refusal to renew the license for Coca-Cola mainly because of the aforementioned groundwater depletion and environmental intoxication. Accompanied by severe drought which struck Kerala in that year the region of Plachimada was subsequently declared a "water impoverished" zone and by 2005, following the spread of multilateral struggles for water management and irrigation rights along with the further aggravation of the situation, several agitations against The Coca-Cola Company were reportedly instigated afterwards. [25]

Figure 5 below illustrates the development of privatization in India, showing its dramatic growth since 2001, peaking around the period prior to the onset of the world financial crisis. Following that, the private-sector investment decreased rapidly which seems to be in line with the case studies reporting the diminishment of the strength of private investment in water sector as a response to public outrage.

**FIGURE 5: DEVELOPMENT OF WATER PRIVATIZATION IN INDIA**

*Note:* Data retrieved from World Bank Database, visualization made by the author

However, during 2012-2013 the trend quickly rebounded, reaching almost the previous level of 2007. One possible explanation for such an abrupt change may be the increasing market power of French multinationals of Veolia and Suez in an effort to rehabilitate water privatization endeavors. [41]

## **8.6 *Cases of Other Countries***

### **8.6.1 Uruguay**

A study conducted by the World Bank concerning the efficiency of water privatization in the sector of water management until its eventual remunicipalization in 2000s proved unsuccessful in attaining the promised results and became thus highly unpopular due to perception of supplying low-quality and overpriced water to citizens. In consequence, the widespread displeasure led the then-incumbent Minister of Economics and Finance, Alejandro Atchugarry, to order Uragua and Aguas de la Costa, subsidiaries of the Spanish water corporations Aguas de Barcelona and Aguas de Bilbao, to withdraw from the country. [27] Conversely, after the aforementioned remunicipalization in 2000s, the accessibility of sanitation networks in the treatment group of 3 of the 35 largest Uruguayan cities improved by 15 per cent, benefitting especially the poorest members, whereas network access rates were not found to be different from those prior to the privatization period. [27]

### **8.6.2 Nicaragua**

To service the accumulated debts of the country, several structural regulations including fiscal austerity, privatization of water resources in 4 cities (Matagalpa, Jinotega, Chinandega and Leon) as well as full recovery of costs (monthly increase in water consumer fee by 1.5%) have been proposed by the International Monetary Fund. Furthermore, \$14 million investment has been promised by The Inter-American Development Bank on terms of transferring water management rights to the private sector of multinational corporations in two of the aforementioned cities. Nonetheless, the project itself allegedly did not oblige the companies to further expand the existing municipal infrastructure, despite the bank's promising outlook on expansion of accessibility to water resources. [29]

The cities of Matagalpa and Jinotega experienced significant zoom of prices constituting around 30 per cent soon after the privatization had occurred, affecting the majority of the population therein. Companies thereby violated both the law requiring a 30-day advance notice for price increase and agreed-upon fixation of prices for the period of five years. In response to public outcry, the National Assembly in Nicaragua unanimously passed

the bill to suspend private profit making in the use of water, yet the alleged pressure from international financial institutions should have compelled the president to veto the bill. [29]

### **8.6.3 The City of Jakarta – Indonesia**

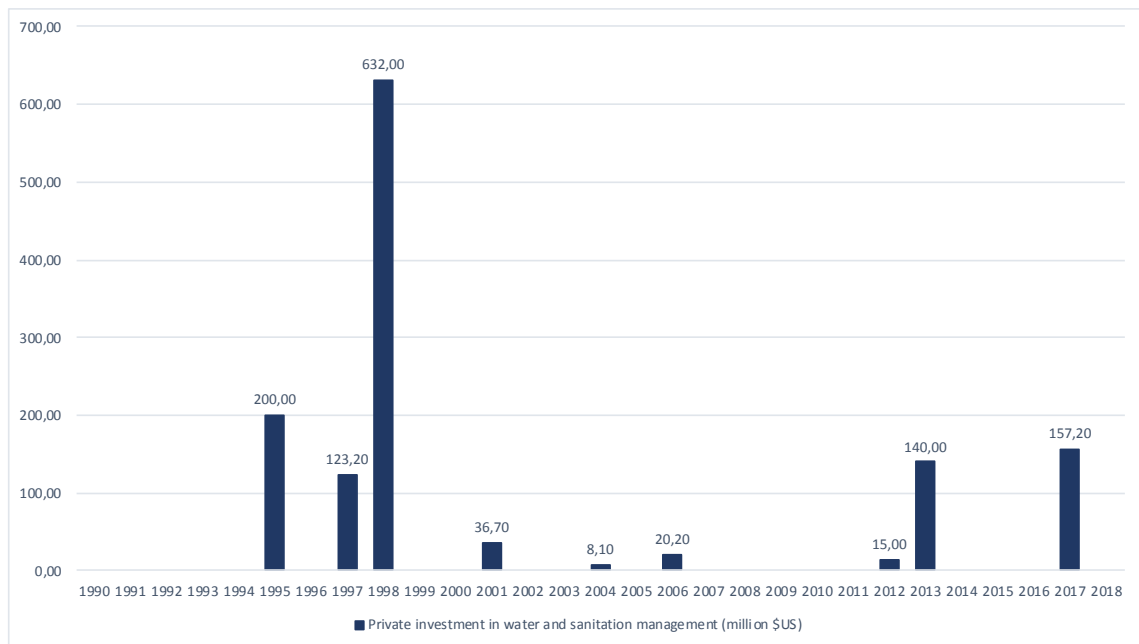
Two concession contracts were signed during the Suharto political regime.<sup>1</sup> Privatization occurred in 1995, leading to the appointment of two private companies to take over the water management agenda, which soon after resulted in corruption that severely damaged the effectivity of water allocation network. Specifically, the companies were unable to make sufficient profits and meet the targets stipulated by the original contracts and to levels below those previously achieved by publicly-owned PAM Jaya company in 1995. [28]

The allocation network of Jakarta arguably had the lowest coverage rate among the major Asian cities, yet the water price per cubic meter was the highest, despite the fact that its quality was disproportionally worse, owing to which the citizens were forced to firstly boil the tap water before consuming it. On top of that, the companies' production was hardly efficient, as more than 50 per cent of water supplied generated virtually zero-revenue. The fact that citizenry of Jakarta is afflicted with poor and unacceptable water service quality for both personal and domestic uses severely affects the human right to access to safe and affordable water. According to Lobina & Hall (2013), it is quite plausible that in the event of the absence of privatization, remunerations by PAM Jaya, otherwise paid to concessionaires, would provide the necessary financial resources to ensure full realization of the human right to water in the Capital. [28]

Figure 6 below depicts the development of private-sector investment in Indonesia. Consistent with the case study of Jakarta, privatization commenced in 1995, followed by a period of sharp increase in investment, most likely reflecting the private corporations' take-over of water management sector. Soon after the peak of 1998, the strength of privatization significantly abated, the outcome perhaps reflecting the public disgrace associated with the failure to meet conditions of sustainable development goals.

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<sup>1</sup> Suharto was an Indonesian military and political leader who later became the second president of Indonesia, holding the office from 1967 until 1998. [34]

**FIGURE 6: DEVELOPMENT OF WATER PRIVATIZATION IN INDONESIA**

*Note:* Data retrieved from World Bank Database, visualization made by the author



## 9. Literature Review

Previous sections presented individual case studies showing the socio-ecological impact of private-sector operations in the water management domain. This part reviews relevant academic papers containing empirical analyses quantifying the extent of impact the privatization had on expansion of water service coverage in developing countries.

For instance, Cesar (2018) examines whether increased private-sector involvement in water utilities contributes to expansion of water accessibility in developing countries. She tests the relationship using the methods of multivariate OLS and 2SLS on the sample of 62 countries in the span from 1990 to 2015, employing the World Bank's and UNIFEC's Joint Monitoring Program data.

The OLS results show that privatization produces a very small positive effect on water access (ca. 0.005% increase of water coverage for every 1% increase in private-sector investment), yet the effect is statistically insignificant. Furthermore, she finds that the effect of time trend is very significant, the *ceteris-paribus* worldwide water accessibility improving by ca. 0.5 per cent with each passing year. Conversely, the second-stage regression results indicate a small positive and statistically significant effect of privatization on water coverage, amounting to the increase of ca. 0.1 per cent for every 1 percentage-point increase in private ownership. Cesar concludes that the inconsistency is most probably ascribable to the impossibility to isolate the contribution of the sole capital availability from the effect of privatization *per se*.

Moreover, the estimation is affected by the endogeneity bias, implying that privatization as a catalytic solution to clean water crisis is more likely to be chosen by governments whose countries are more afflicted with lack of water availability. Lastly, Cesar finds that except for GDP per capita, none of the control variables including IMF credit or corruption, is statistically significant. As for GDP, the coefficient implies that 1-percent increase in GDP is on average associated with 1.7 percentage-point increase in water coverage.

In another study [42], the author Andre de Oliveira (2008) studies Brazil's past and ongoing experience with private provision of water services and assesses its performance with regards to access and affordability indicators. Using the National Sanitation Information System (SNIS) database, he constructs an unbalanced panel dataset of 1,548 Brazilian municipalities across the years 2001-2003 containing information on 41 socio-economic quality indicators. To estimate the effect of privatization on water access, the random-effects method and Hausman-Taylor approach are used. Both methods produced virtually identical results in terms of coefficients' signs. However, unlike the municipality location factor, the effect of time was found to be insignificant. Similar to Cesar (2018), the variable GDP was found to be significant.

Concerning the effect of privatization per se, both random-effects and Hausman-Taylor approach showed a significant, positive and relatively strong effect, suggesting that private provision, on average, increases the water accessibility by approximately 26.7 per cent and 41.4 per cent, respectively. In addition, using the per capita GDP deciles, the impact of private-sector water provision is higher in the lower deciles, thereby suggesting that the benefits of privatization accrue mostly to poorer municipalities.

Thirdly, the study of Banerjee and Munger (2004) analyzes the factors influencing decisions to embark on privatization among the group of 35 low and middle-income developing countries over the period from 1982 to 1999. [43] The authors employ a three-fold estimation method of Cox proportional hazards model, random-effects negative binomial model and random-effects model to quantify the effect of privatization with respect to timing, pace and intensity, respectively. Various explanatory macroeconomic and institutional variables, such as political rights, corruption, ethnic tensions are included in the models.

According to the results, in countries which are characterized by greater population heterogeneity, higher inequality and lower market capitalization, the rate of privatization progresses much faster in comparison to more stable countries. Regarding the pace, the authors find conclusive evidence that economic crisis accelerates privatization. This is consistent with the graphs presented above (see Figure 5), where can be seen that the private-sector investment in water peaked around the period of global financial crisis.

Furthermore, the institutional infrastructure of an economy significantly impacts privatization decisions. Although countries with poor institutional quality privatize sooner, the pace and intensity are higher for countries with qualitatively superior institutions. Also, development of market mechanism unambiguously impacts privatization decisions, indicating that countries with superior market functioning privatize later, even though the implementation of divestiture would be much faster once the privatization were decided to be adopted.

## **10. Empirical Analysis**

### ***10.1 Motivation***

As private-sector provision of water has been promoted in developing countries since 1990s so that the expansion of water service coverage to low-income households could be secured, the consequences of these privatization endeavors are still disputed. Some studies such as Oliveira (2008) have found a positive effect on areas with private-sector-managed water supply, whereas others maintain that water's inherent nature as a public good renders her private-sector supply inefficacious. Another reason for investigating the contribution of privatization to water supply management is the purported empirical evidence suggesting that following privatization, several previously state-provided services experienced a significant rise in quality, productivity and profitability, presumably by reasons of the so-called *principal-agent problems* being more efficiently dealt with via monitoring of agents' performance, whereby corporations directly benefit from. [18] Therefore, it is crucial to analyze whether increased privatization of water provision in developing countries brings about desired expansion of water and sanitation accessibility for their inhabitants.

## ***10.2 Data Description***

For the purpose of this paper, a specific dataset was created utilizing the World Bank Open Data database containing numerous macroeconomic meta-indicators of its 189 member-states, where most of the data comes from the statistical systems of individual member countries, and Our World in Data, a free public online database founded and operational under the aegis of the University of Oxford. [32] [33]

The dataset comprises 78 developing countries from various regions representing the total world population of developing countries. Each country was chosen randomly based on the United Nations classification list of developing countries (refer to Figure A.1 in Appendix). The countries were subject to a time-series analysis in the span of 29 years, the period starting from the year 1990, representing the approximate commencement of worldwide privatization trend, to the year 2018, which constitutes the last accessible measurement period for the macro-indicators analyzed in this thesis, i.e. data recorded and thus available for being taken into consideration. However, due to possible irregularity, or rather non-annual measurement frequency, particular macro-indicators were missing observations for some years, or for certain developing countries, altogether. Thus, the sample to be analyzed constitutes an unbalanced panel dataset consisting of 2,260 available observations.

### **10.2.1 Description of Variables**

The primary objective of the thesis is to examine the impact of private-sector investment on water accessibility and sanitation quality. Moreover, several other independent macroeconomic variables, such as GDP per capita, declining groundwater levels or foreign investments in the form bank credit were included in the analysis to account for both economic and environmental international differences. Table 1 below presents individual variables and their description along with the corresponding source of data.

**TABLE 1:** LIST OF VARIABLES INCLUDED IN THE REGRESSION ANALYSIS

Variables	Description	Source of Data
Explained Variables		
improvedwater	Percentage of population with access to improved water resources	World Bank Open Database
WASPdeathrate	Mortality rate attributed to unsafe water and sanitation (per 100,000 individuals)	Our World in Data
deathsbydiarr	Deaths by diarrheal diseases (per 100,000 individuals)	Our World in Data
Explanatory Variables		
safes sanitation	Percentage of population using safely managed sanitation services	World Bank Open Database
privatefunds	Private-sector investment in water and sanitation (in million \$US)	World Bank Open Database
IMFcredit	Use of IMF funds by country (in million \$US)	World Bank Open Database
waterstress	Annual freshwater withdrawal (as a proportion of total available resources)	Our World in Data
GDP	Per-capita Gross Domestic Product (in \$US)	World Bank Open Database

Concerning the regressands, the primary variable of interest in assessing the impact of privatization on water resources in developing countries is the variable *improvedwater*, which stands for the total percentage of people in selected countries who have got access to improved freshwater resources. Secondly, as the World Health Organization corroborates direct correlation between unsafe water consumption and diarrheal diseases [44], the second dependent variables of interest are the *WASPdeathrate* or *deathsbydiarr*, accounting for total number of deaths attributed to unsafe water, sanitation and hygiene, and total deaths caused by diarrheal diseases both per 100,000 inhabitants, respectively.

Regarding the regressors, five independent variables influencing the access to improved water services and mortality rate attributed to unsafe water consumption were selected for the analysis. Most importantly, the analysis is concentrated on both the extent of correlation between *privatefunds* and *improvedwater* variable, as well as the statistical significance of the former. Furthermore, the sign of the coefficient of *privatefunds* variable is of equal interest, since both correlations are possible. For example, it is reasonable to assume that increased provision of private funds to a developing country may instigate greater infrastructural development in the water sector, thereby enabling more people in the afflicted regions gain access to freshwater resources. Contrariwise, in the case that privatization endeavors actually lead to the exacerbation of regions' effectivity in water allocation management, the increased private-sector investment would eventually have a negative impact on the *improvedwater* variable.

Secondly, the variable of *IMFcredit* is included as an additional (non-private) source of financial credit for individual developing countries. International Monetary Fund (IMF) is a multigovernmental organization of 189 countries engaged in a global monetary cooperation, securing cross-national financial stability, facilitating international trade and promoting sustainable economic growth alongside poverty reduction around the world. [35] Significant relationship between *IMFcredit* and *wateraccess* is expected as the IMF has long been involved in efforts targeted at diminishing this water scarcity issue across developing countries, not only by means of credit provision, but also via incentivization programs, such as better pricing policies, which would help ensure using water resources in a more efficient manner and increase future resilience to water supply variability. [36]

Thirdly, per-capita GDP is included as a measure reflecting the differences in economic development among nations. The basic intuition is that countries with higher GDP are economically more developed, and thus have more financial resources available for adequate freshwater procurement for their inhabitants.

Since freshwater withdrawal is generally a serious issue in developing countries, it is perfectly reasonable to gauge its impact on the populations' accessibility to freshwater resources. Freshwater withdrawal constitutes the total amount of freshwater removed

from available resources in a given region comprising irrigation use, agricultural and industrial sector utilization etc., except for evaporation losses. [37] According to the above-mentioned case studies, it seems that privatization activities have often been linked with corporations overexploiting available water resources. Since these kinds of activities appear to be an undesirable consequence of bottled water production, like for instance in the case of Pakistan and Nestlé's 'Pure Life', they would to a considerable extent contribute to freshwater withdrawal in the regions these corporations established their bottled water production. Thus, it may be assumed that the more declining the levels of available freshwater, the lower the percentage of people with access to improved water resources.

**TABLE 2: DATASET SUMMARY STATISTICS**

	<b>Minimum</b>	<b>Median</b>	<b>Mean</b>	<b>Maximum</b>	<b>St. Dev.</b>
<b>Improved Water</b>	13.20	77.60	73.49	100.00	18.55
<b>Safe sanitation</b>	3.16	32.43	33.64	100.00	21.30
<b>Private Investment</b>	1.00	55.72	213.74	7,565.60	797.12
<b>Use of IMF Funds</b>	0.07	197.36	478.50	11,148.90	1,063.32
<b>Water Scarcity</b>	0.02	7.53	52.42	673.25	105.40
<b>GDP per Capita</b>	95.19	899.16	2,544.48	48,582.22	5,486.59
<b>Deaths by Diarrhea</b>	0.26	54.35	67.69	279.21	62.17
<b>WASP Mort. Rate</b>	0.21	21.68	69.30	406.14	85.77

### ***10.3 Specification and Testing of Models***

The key difficulty in estimating the effect of privatization of water resources on her subsequent allocation efficiency is the fact whether the individual country characteristics affect the equation, that is to say, whether the unobserved (and most probably heterogeneous) effects vary stochastically over time or not. It can be assumed intuitively that individual developing countries differ in numerous respects, such as inherent geographical, topographical or socioeconomic features. These variables are empirically unobservable, yet they might significantly influence our predictor variables and eventually, could confound the effect by causing the omitted variable bias in the event of not accounting therefor, as they are likely to be correlated with the explanatory variables. Therefore, to address this issue of heterogeneous effects formal tests were performed to verify firstly whether the unobserved effects are time-invariant across the whole sample and secondly, whether they are correlated with the regressors.

Thus, five different models along with their corresponding hypotheses were created to analyze the effect of private-sector investment in water infrastructure on the improvement in freshwater provision, safe sanitation service coverage measured by the first two and the second model, respectively, along with the effect of increased private water management funding on the population health, quantified as a decrease in deaths caused by diarrheal disease and mortality rate ascribable to unsafe water consumption and lack of adequate hygiene captured by the third and the fourth model, respectively.



**MODEL 1: THE EFFECT OF PRIVATIZATION ON ACCESS TO IMPROVED WATER**

$$\begin{aligned} improvedwater_{it} = & \beta_1 waterstress_{it} + \beta_2 GDP_{it} + \beta_3 privatefunds_{it} + \\ & + \beta_4 IMFcredit_{it} + \alpha_i + \epsilon_{it} \end{aligned}$$

**MODEL 1.2 (RESTRICTED):**

$$improvedwater_{it} = \beta_2 GDP_{it} + \beta_3 privatefunds_{it} + \beta_4 IMFcredit_{it} + \alpha_i + \epsilon_{it}$$

**TESTED HYPOTHESES (BOTH MODELS):**

$$H_0: \beta_3 = 0 ; \beta_4 = 0$$

$$H_A: \beta_3 < 0 ; \beta_4 > 0$$

**MODEL 2: THE EFFECT OF PRIVATIZATION ON ACCESS TO SAFE SANITATION**

$$\begin{aligned} safes sanitation_{it} = & \beta_1 improvedwater_{it} + \beta_2 GDP_{it} + \beta_3 privatefunds_{it} + \\ & + \beta_4 IMFcredit_{it} + \alpha_i + \epsilon_{it} \end{aligned}$$

**TESTED HYPOTHESES:**

$$H_0: \beta_3 = 0 ; \beta_4 = 0$$

$$H_A: \beta_3 < 0 ; \beta_4 > 0$$

**MODEL 3: THE EFFECT OF PRIVATIZATION ON WASP MORTALITY RATE**

$$\begin{aligned} WASPdeathrate_{it} = & \beta_1 improvedwater_{it} + \beta_2 GDP_{it} + \beta_3 privatefunds_{it} \\ & + \beta_4 IMFcredit_{it} + \beta_5 safes sanitation_{it} + \alpha_i + \epsilon_{it} \end{aligned}$$

**TESTED HYPOTHESES:**

$$H_0: \beta_3 = 0 ; \beta_4 = 0$$

$$H_A: \beta_3 > 0 ; \beta_4 < 0$$

**MODEL 4: THE EFFECT OF PRIVATIZATION ON DEATHS BY DIARRHEAL DISEASES**

$$deathsbydiarr_{it} = \beta_0 + \beta_1 improvedwater_{it} + \beta_2 GDP_{it} + \beta_3 privatefunds_{it} + \\ + \beta_4 IMFcredit_{it} + \beta_5 safesanitation_{it} + \alpha_i + \epsilon_{it}$$

TESTED HYPOTHESES:

$$H_0: \beta_3 = 0 ; \beta_4 = 0$$

$$H_A: \beta_3 > 0 ; \beta_4 < 0$$

Prior to the actual model testing, an intervariable correlation analysis using a correlation matrix (refer to Table 3 below) was investigated to determine the suitability of chosen variables in respective models. Based on the *improvedwater-waterstress* correlation results and for the purpose of increasing the explanatory power and precision of the model, a restricted version of Model 1 was included to ascertain which version provides superior results in terms of precision and interpretation. Section 10.4 presents the results for both models to provide empirical comparison and justification for choosing the restricted model.

Regarding the dataset testing procedures, Breusch-Pagan Lagrange Multiplier test was conducted to check for cross-sectional dependence in models. The test clearly rejected the null hypotheses of no significant dependence ( $p < 0.000$  for all models) suggesting that the use of Pooled OLS would lead to efficiency loss and invalidation of standard  $t$ -tests and  $F$ -tests.

**TABLE 3: CORRELATION MATRIX OF REGRESSION VARIABLES**

	Improved water	Safe sanitation	Private Investment	Use of IMF Funds	Water Scarcity	GDP per Capita	Deaths by Diarrhea	WASP Mortality Rate
<b>Improved Water Source</b>	1							
<b>Safe sanitation</b>	0.281***	1						
<b>Private Investment</b>	0.034	0.105**	1					
<b>Use of IMF Funds</b>	0.075***	0.150***	0.036	1				
<b>Water Scarcity</b>	0.044	0.340**	-0.042	0.105	1			
<b>GDP per Capita</b>	0.335***	0.222***	0.005	-0.048*	-0.071	1		
<b>Deaths by Diarrhea</b>	-0.689***	-0.253***	-0.039	-0.014	-0.202**	-0.289***	1	
<b>WASP Mortality Rate</b>	-0.733***	-0.162***	-0.082*	0.069*	-0.169	-0.316***	0.918***	1

*Notes:*

\*\*\*. Correlation significantly different from zero at 1% level

\*\*. Correlation significantly different from zero at 5% level

\*. Correlation significantly different from zero at 10% level

Secondly, characteristics of unobserved individual effects were tested using the Wooldridge test. Using the standard OLS, the estimates could reflect the effects of unobserved country-specific characteristics (heterogeneities) which influence the accessibility to freshwater resources. For instance, factors such as infrastructural development, topographical boundaries or unique socioeconomic conditions are very likely to limit the population's access to freshwater, at least for some population groups. So long as the unobserved heterogeneities across nations are important, OLS estimates could overestimate the effect of privatization on accessibility to fresh water and improved sanitation services. F-test clearly rejected the nulls in favor of the alternative hypotheses (all  $p < 0.0000$ ), implying that no significant time-fixed effects, thereby excluding again the possibility of Pooled OLS as an efficient estimation model.

Additionally, correlation between the unobserved individual effects and explanatory variables had to be tested to discriminate between the fixed and the random effects models. The basic intuition is that unobserved country-specific characteristics would naturally influence, i.e. be correlated with other explanatory variables. For example, the extent to which a country's infrastructure is developed certainly has an impact on the effectiveness with which private companies can supply fresh water to local inhabitants. Based on the Durbin-Wu-Hausman test, fixed effects estimation provides more consistent estimates than random effects estimation for the first three models ( $p < 0.024$ ), except for the fourth model (M.4) where the test failed to reject the null on a sufficiently high significance level ( $p < 0.081$ ). Based on the testing results, the last model is therefore estimated using the random effects method.

Lastly, both heteroskedasticity and serial correlation were tested using the Breusch-Pagan and the Wooldridge test, respectively. In case of their presence was detected, current values of dependent variables would be significantly dependent on values from previous years, meaning that the coefficients' standard errors would be biased and inference based thereupon invalidated in the aftermath. Testing detected that models suffer from the presence of both autocorrelation (highest  $p < 0.047$ ) and heteroskedasticity ( $p < 0.000$  in all cases). To remedy the problem, the Newey-West heteroskedasticity and autocorrelation robust coefficient standard errors were implemented to ensure proper and reliable inference.

## ***10.4 Presentation of Results***

The primary interest was to analyze how increased privatization, measured as total private-sector investment in water management services, contributes to expansion of freshwater accessibility, availability of safe sanitation services and subsequently diminishing of mortality rates among the population caused by consumption of unsafe water and lack of hygiene, and how this effect is different in comparison to funding provided by International Monetary Fund. The effects are considered significant if the reported coefficients exceed the 95-percent confidence level. However, it is important to bear in mind the unbalanced panel issue discussed in Section 9.2, as each model used different number of observations due to data unavailability for particular variables, which constitutes a repetitive problem especially for several concrete states. Therefore, the results ought to be interpreted with caution and viewed primarily as indicative rather than conclusive.

Firstly, the results for the effect on access to improved water source are reported, which was analyzed by two separate models. These specifications include both sources of freshwater facilities funding and the variable *GDP*, since it is expected that richer countries have more resources available for proper infrastructure development. The respective effects are quantified by Table 4 below. As the restricted model was chosen as preferable in terms of inference and precision (for greater details regarding the selection refer to T.4: Notes)

For the purpose of explaining the intuition behind two distinct models, a short commentary on the results regarding the inclusion of *waterstress* variable is presented. The basic intuition is that the higher the freshwater withdrawal in a country, the lower the proportion of its population with access to fresh water. Perhaps surprisingly, the effect was found to be insignificant, even though the coefficient's sign is as anticipated. The outcome could most probably be ascribable to the lack of available data for lots of countries in the dataset, nonetheless making a statement as to whether the effect would change significantly with higher number of observations is questionable.

The results show that GDP is a mildly significant factor in improved water coverage, i.e. whether people living in more productive countries have better access to fresh water. On average, in states with per capita GDP \$100 higher in comparison to other countries ca. 8 per cent more inhabitants have access to improved water source. The coefficient has a positive sign which is in line with expectations and intuition.

**TABLE 4: THE EFFECT OF PRIVATIZATION ON ACCESS TO IMPROVED WATER**

	Unrestricted Model (M.1)	Restricted Model (M.1.2)
Intercept	-	-
waterstress	-0.003 (0.035)	-
GDP	0.1187*** (0.033)	0.0776* (0.0474)
privatefunds	0.4503 (0.4017)	-0.0071 (0.0174)
IMFcredit	0.1067*** (0.0253)	0.1137** (0.0502)
$R^2$	0.1896	0.0544
$N$	165	1,975

*Notes:*

\*\*\*. The effect is significantly different from zero at 1% level

\*\*. The effect is significantly different from zero at 5% level

\*. The effect is significantly different from zero at 10% level

All coefficients except for *waterstress* (denoted in percentages) were multiplied by 100. Robust standard errors reported in parentheses. Both model specifications control for time fixed effects, their respective results are reported to demonstrate differences in explanatory power and reliability of inference. The restricted model used almost twelve times more observations than the original (unrestricted) model. Based upon the law of large numbers, the second model provides more reliable results and was thus chosen as preferable. The choice was furthermore validated empirically utilizing Wald Chi-squared statistic which failed to reject the null hypothesis of no significant effect of *waterstress* variable ( $p > 0.9428$ ).

Secondly, both models showed an insignificant effect of increased private sector investment on access to improved water source. However, with increasing the number of observations the coefficient became negative, meaning that with expanding privatization in water sector, the freshwater resources are less accessible for the population.

On the other hand, non-private financing provided by IMF significantly improves freshwater availability. Holding other variables constant, each additional \$1 million investment leads to approximately 0.11 percentage-point increase of access to fresh water among the population, on average.

Further analysis was concentrated on the extent to which increased private sector involvement in water management helps enlarge the safe sanitation coverage among the population in comparison to IMF. The regression results are summarized in Table 5 below.

**TABLE 5: THE EFFECT OF PRIVATIZATION ON ACCESS TO SAFE SANITATION**

	<b>M.2</b>
Intercept	-
improvedwater	1.2523*** (0.2546)
GDP	0.295*** (0.0411)
privatefunds	1.501 (1.0469)
IMFcredit	-0.2375 (0.2072)
$R^2$	0.4491
$N$	589

*Notes:*

\*\*\*. The effect is significantly different from zero at 1% level

\*\*. The effect is significantly different from zero at 5% level

\*. The effect is significantly different from zero at 10% level

All coefficients except for *improvedwater* (reported as elasticity) were multiplied by 100. Robust standard errors reported in parentheses.

In line with the expectation, the first two coefficients are statistically significant. People living in economically more developed countries with higher accessibility to fresh water sources have greater access to safe sanitation services, both factors being statistically significant on 1-percent level.

Contrarily to the previous model, the second regression found opposite relationships between *safes sanitation* and both *privatefunds* and *IMFcredit*. Moreover, the effects of both financial sources on the dependent variable were found to be statistically



insignificant, which appears somewhat surprising considering their relatively strong (and positive) intervariable correlation (refer to Table 3 above). In view of the fact that both variables are statistically insignificant, it seems rather futile to think of any confounding factors which could be the cause of such counterintuitive results.

The third and the fourth model investigated the relationship between privatization and its effect on diminishment of mortality rate ascribable to unsafe water consumption (diarrheal diseases) and lack of adequate sanitation. As private companies engage more in water sector management, or alternatively, external funding from IMF is provided, it is expected that more people will have access to safe sanitation and freshwater resources, thereby decreasing the death rates attributable to their insufficient accessibility by the population. Inasmuch as the correlation between *WASPdeathrate* and *deathsbydiarr* is very close to 1 (refer to Table 3 above), the results may be regarded as (almost) identical in terms of the effect analysis and inference. Furthermore, as more data were available on deaths by diarrheal diseases for countries included in the studied dataset, the obtained coefficients could probably be more reliable. The results from both regressions are summarized in Table 6 below.

Both models produced identical results with regard to significance of included predictors. Apart from the fact of how many people in terms of population percentage have access to improved water source, none of the explanatory variables seems to significantly affect the mortality rate attributed to unsafe water consumption and insufficient hygiene, which is quite unexpected, especially in the case of *safes sanitation* variable. In addition, the random-effects estimation produced a counter-intuitive result, implying that the higher the percentage of people with access to safe sanitation services, the *higher* the respective mortality rates. Perhaps random-effects method biased the coefficient due to its inherent assumption of exogenous heterogeneities, nevertheless, the effects is statistically insignificant and thus needs not to further be investigated.

**TABLE 6: THE EFFECT OF PRIVATIZATION ON WASP MORTALITY RATE AND DEATHS BY DIARRHEAL DISEASES**

	<b>WASP Death Rate (M.3 – Fixed-Effects)</b>	<b>Deaths by D. Diseases (M.4 – Random-Effects)</b>
Intercept	-	193.08*** (67.65)
improvedwater	-0.0084*** (0.0043)	-0.019*** (0.0078)
GDP	0.0004 (0.0003)	-0.0000 (0.0003)
privatefunds	-0.0058 (0.0049)	-0.0041 (0.0032)
IMFcredit	-0.0127 (0.0096)	-0.0045 (0.003)
safes sanitation	-0.105 (0.0996)	0.0645 (0.082)
$R^2$	0.0457	0.338
$N$	434	589

Notes:

\*\*\*. The effect is significantly different from zero at 1% level

\*\*. The effect is significantly different from zero at 5% level

\*. The effect is significantly different from zero at 10% level

All coefficients except for *improvedwater* (divided by 100) are included in the level-level form. Robust standard errors reported in parentheses. Both fixed-effects and random-effects estimation produced nearly identical results with respect to coefficient signs and their significance. This is in accordance with the intuition when two different response variables (yet identical in principle) were included to increase the explanatory power of the model. Furthermore, random-effects model shows better fit than fixed-effects model, based on the *R-squared*.

Unlike in the previous models, the control variable *GDP* appears to be an insignificant factor in diminishing WASP and diarrhea-related mortality rate among the population in developing countries. Whereas the economic development of countries seems to be among crucial determinants for increasing freshwater accessibility for local inhabitants, higher productivity of nations cannot adequately safeguard reduction of mortality rate from low-quality-water consumption.

Identically to the previous cases, none of the means of external financing has a notable impact on response variables, which means that neither deeper private-sector involvement in freshwater management nor increased financial aid by IMF contribute significantly to limiting respective mortality rates among the population which constitute around 193 deaths per 100,000 of individuals, on average.

## 11. Discussion and Conclusions

Privatization of state-owned water and sanitation utilities has been gaining traction in developing world as a viable solution to water crisis. The first parts of the thesis were devoted to a) providing theoretical background on the framework of sustainable development and b) presentation of case studies which sought to inspect the environmental as well as socioeconomic impact of privatization on developing countries.

Empirical analysis presented in this paper was primarily focused on estimating the extent to which private participation and IMF financing in water sector contribute to reducing freshwater unavailability and lack of access to proper sanitation services. The purpose was to inspect whether publicly available data corroborate the related literature findings on the (in)efficiency of water privatization across developing countries. Furthermore, this thesis, among other things, contributes to the existing literature by extending the analysis for the most recent years.

As outlined in Section 10.2 total private-sector investment in water and sanitation services was used as a proxy variable for privatization, as no other sufficiently appropriate data which would approximate the involvement of (supranational) private corporations in water management in developing countries were available on a global level. This naturally poses an issue of inability to properly distinguish between domestic and foreign share of private-sector funding, in the aftermath of which it is impossible to draw inference and derive adequate conclusions on a subset level of concrete global corporations, which are particularly mentioned in the related literature and case studies. Therefore conclusions, based on the analyses described above, are made with respect to the water-management effectivity and fulfilment of sustainable development goals by private sector in general, and are further juxtaposed with the efficacy of non-private sector financial aid provided by IMF.

Nevertheless, the empirical analysis showed that neither increased private-sector involvement nor external financial aid provided by IMF are effective means of achieving water-related sustainable development goals. Both forms of financial investment turned out inefficacious in terms of broadening the water and sanitation services accessibility,

neither they significantly contribute to mitigation of WASP mortality rates among the population as one of the focal goals of water-sector sustainable development goals.

On the other hand, differences in economic development among countries (measured by *GDP*) constitute a significant factor influencing the extent of freshwater availability and the degree of accessibility to safe sanitation services in individual countries. Its effect on reducing the death rates attributable to unsafe water consumption and insufficient sanitation proved to be negligible, however. This result is consistent with those presented in the section on literature review.

Considering the outcome of the analysis, the thesis concludes that in order to fulfil their sustainable development goals, developing countries should primarily focus on adopting policies aimed at propelling the economic growth, which as a result would enable them to substantially increase government (i.e. domestic, public-sector) expenditure as a necessary means to instigate proper water infrastructure development instead of relying on IMF and private-sector investments.

As a suggestion for the future research, this work could perhaps be extended to the cross-analysis of water management efficacy between private and public (i.e. domestic, government) sector in developed countries in the similar context as presented here. Or alternatively, should the prospective researcher have the ability to cope with the unbalanced data problem more effectively, they could replicate the results using a similar or separate procedure to verify whether the results would change dramatically having more data available or remain nearly identical.

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## Appendix

**FIGURE 4: PUBLIC PROTESTS AGAINST PRIVATE SECTOR WATER SUPPLY BY REGION**

Country	Place	Date
Paraguay	national	2002
Peru	national	2004
Poland	Lodz	1994
Poland	Poznan	2002
South Africa	Alexandra	2002
South Africa	Gauteng, Mpumalanga, and Eastern Cape provinces	1997–98
South Africa	Johannesburg and townships	2001–present
South Africa	Nkonkobe	2002
Sri Lanka	national	ongoing
Sweden	Malmo	1995
Tanzania	Dar es Salaam	2005
Thailand	national	2002
Trinidad	national	1999
Ukraine	Odessa	2000
Uruguay	national	2002
Uruguay	Montevideo	2003
USA	Atlanta, Georgia	2003
USA	Birmingham, Alabama	2000
USA	Mecosta County, Wisconsin	2001
USA	San Francisco, California	2003
USA	Santa Margarita Water District, California	1995
USA	Stockton, California	2002
USA	Washington, DC	1996
USA	Wisconsin Dells, Wisconsin	2000

*Source:* Bakker (2010)

**FIGURE 4 (CONTINUED):**

Country	Place	Date
Argentina	Buenos Aires	Mid- to late 1980s
Argentina	Buenos Aires province	2002
Argentina	Córdoba (province)	2006
Argentina	Tucumán and other parts of Argentina	1993–99
Bolivia	Cochabamba	2000
Bolivia	El Alto and La Paz	2005
Brazil	national	2002
Brazil	Rio de Janeiro	1999
Canada	Montreal	1999
Canada	Sackville	2007
Canada	Vancouver	2001
Colombia	national	2007
Ecuador	Quito	2007
El Salvador	Santa Eduvigés	2006
El Salvador	San Salvador	2006
England	national	1985–89
France	Grenoble	2001
Germany	Munich	1998
Germany	Potsdam	2000
Ghana	Accra	2002
Honduras	national	1995
Hungary	Debrecen	1995
India	New Delhi	2003–2005
Indonesia	Jakarta	2003
Kenya	Nairobi	2007
Malaysia	Kuala Lumpur	2005
Mali	Bamako	2007
Mauritius	national	2000
Mexico	Mexico City	2006
Morocco	Rabat	2006
Nepal	Kathmandu	2006
Panama	national	1999

*(continued)**Source:* Bakker (2010)

**FIGURE A.1: DEVELOPING COUNTRIES BY REGION**

Africa		Asia	Latin America and the Caribbean
North Africa	Southern Africa	East Asia <sup>b</sup>	Caribbean
Algeria	Angola	Brunei Darussalam	Bahamas
Egypt	Botswana	Cambodia	Barbados
Libya	Eswatini	China	Belize
Mauritania	Lesotho	Democratic People's Republic of Korea <sup>c</sup>	Guyana
Morocco	Malawi	Fiji	Jamaica
Sudan	Mauritius	Hong Kong SAR <sup>d</sup>	Suriname
Tunisia	Mozambique	Indonesia	Trinidad and Tobago
Central Africa	Namibia	Kiribati	Mexico and Central America
Cameroon	South Africa	Lao People's Democratic Republic	Costa Rica
Central African Republic	Zambia	Malaysia	Cuba
Chad	Zimbabwe	Mongolia	Dominican Republic
Congo	West Africa	Myanmar	El Salvador
Equatorial Guinea	Benin	Papua New Guinea	Guatemala
Gabon	Burkina Faso	Philippines	Haiti
Sao Tome and Principe	Cabo Verde	Republic of Korea	Honduras
	Côte d'Ivoire	Samoa	Mexico
	Gambia (Islamic Republic of the)	Singapore	Nicaragua
East Africa	Ghana	Solomon Islands	Panama
Burundi	Guinea	Taiwan Province of China	South America
Comoros	Guinea-Bissau	Thailand	Argentina
Democratic Republic of the Congo	Liberia	Timor-Leste	Bolivia (Plurinational State of)
Djibouti	Mali	Vanuatu	Brazil
Eritrea	Niger	Viet Nam	Chile
Ethiopia	Nigeria	South Asia	Colombia
Kenya	Senegal	Afghanistan	Ecuador
Madagascar	Sierra Leone	Bangladesh	Paraguay
Rwanda	Togo	Bhutan	Peru
Somalia		India	Uruguay
South Sudan <sup>e</sup>		Iran (Islamic Republic of)	Venezuela (Bolivarian Republic of)
Uganda		Maldives	
United Republic of Tanzania		Nepal	
		Pakistan	
		Sri Lanka	
		Western Asia	
		Bahrain	
		Iraq	
		Israel	
		Jordan	
		Kuwait	
		Lebanon	
		Oman	
		Qatar	
		Saudi Arabia	
		State of Palestine <sup>e</sup>	
		Syrian Arab Republic	
		Turkey	
		United Arab Emirates	
		Yemen	

Source: United Nations (2019)

**APPENDIX A.2: LAGRANGE-MULTIPLIER TEST**

Model	<i>p</i> -value
Water Access (M.1)	0.0000
Water Access (M.1.2)	0.0000
Safe Sanitation (M.2)	0.0000
WASP Mortality Rate (M.3)	0.0000
Deaths by Diarrhea (M.4)	0.0000

**APPENDIX A.3: F-TEST FOR SIGNIFICANCE OF TIME-FIXED EFFECTS**

Model	<i>p</i> -value
Water Access (M.1)	0.0000
Water Access (M.1.2)	0.0000
Safe Sanitation (M.2)	0.0000
WASP Mortality Rate (M.3)	0.0000
Deaths by Diarrhea (M.4)	0.0000

**APPENDIX A.4: HAUSMAN TEST FOR RANDOM- VS. FIXED-EFFECTS ESTIMATION ( $H_A$ : RE INCONSISTENT)**

Model	<i>p</i> -value
Water Access (M.1)	0.0000
Water Access (M.1.2)	0.0240
Safe Sanitation (M.2)	0.0000
WASP Mortality Rate (M.3)	0.0000
Deaths by Diarrhea (M.4)	0.0809

**APPENDIX A.5: BREUSCH-PAGAN TEST FOR HETEROSKEDASTICITY**

Model	<i>p</i> -value
Water Access (M.1)	0.0476
Water Access (M.1.2)	0.0000
Safe Sanitation (M.2)	0.0000
WASP Mortality Rate (M.3)	0.0000
Deaths by Diarrhea (M.4)	0.0000

**APPENDIX A.6: WOOLDRIDGE TEST FOR SERIAL CORRELATION  
(TWO-SIDED)**

Model	<i>p</i> -value
Water Access (M.1)	0.1365
Water Access (M.1.2)	0.0000
Safe Sanitation (M.2)	0.0000
WASP Mortality Rate (M.3)	0.0465
Deaths by Diarrhea (M.4)	0.0000