

## Bioethical issues related to the principle of utility in the residential consumption of drinking water in Colombia

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### ABSTRACT

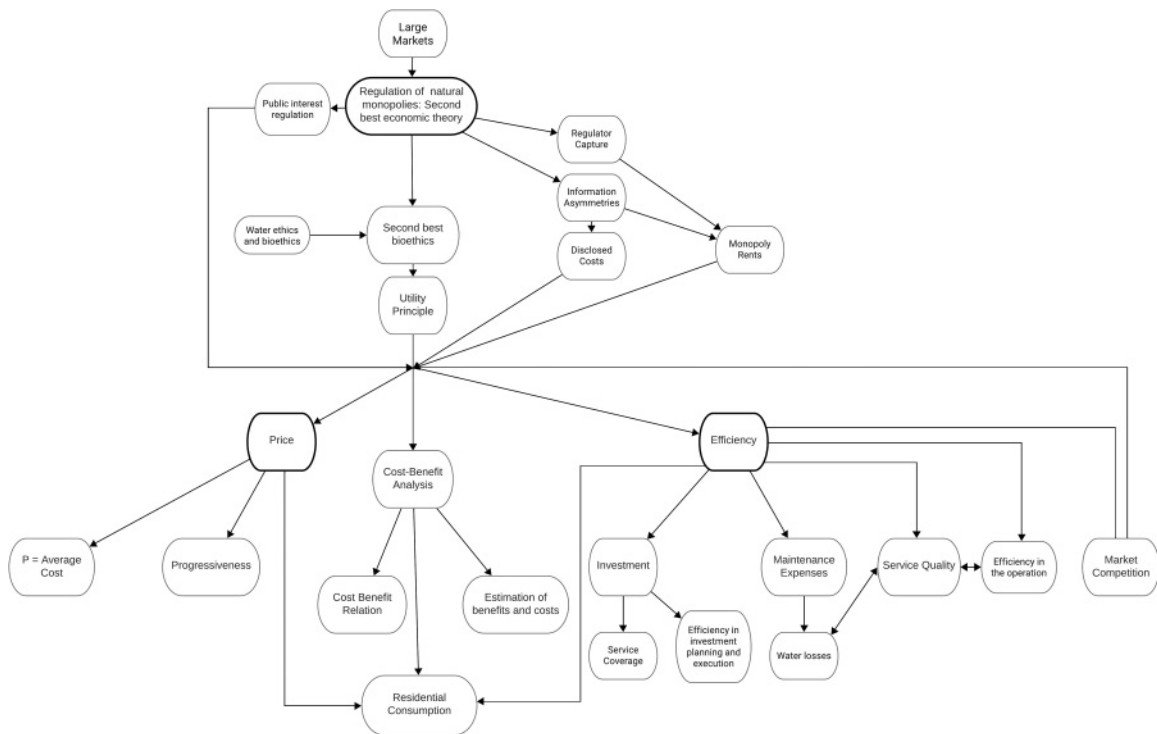
This article is part of the research on bioethical issues related to residential consumption of drinking water in Colombia; through the use of the hermeneutic method and quantitative methodology, we analyze evidence in the monitoring of the tariff policy from the regulatory stages implemented between 1994 and 2021, which have generated increases in the coverage and quality of service, in a good of public interest with high interference of political interests. Thus, from the ethical doctrine of utilitarianism and its principle of utility versus economic theory, we have sought to unveil the bioethical issues associated with the residential consumption of drinking water stipulated in the tariff policy; obtaining among other results that: the companies responsible for drinking water supply operate inefficiently; tariff policies are regressive with negative social impact; high dependence on the political management of the service, affecting the criteria of freedom in decision making; water management and policies should be based on a bioethical perspective

**Key words:** Bioethics, Cost-benefit analysis, Efficiency, Residential drinking water consumption, Tariff policy, Utility principle

### HIGHLIGHTS

- Inefficient billing and regressive tariffs by Colombian water companies create a balance issue.
- Colombian drinking water regulations fail to ensure quality or defend user rights.
- Technical and economic biases overshadow ethical and bioethical considerations, impacting coverage and quality.
- High rates of unaccounted for water harm vulnerable populations, violating dignity, and human rights in bioethics.

## GRAPHICAL ABSTRACT



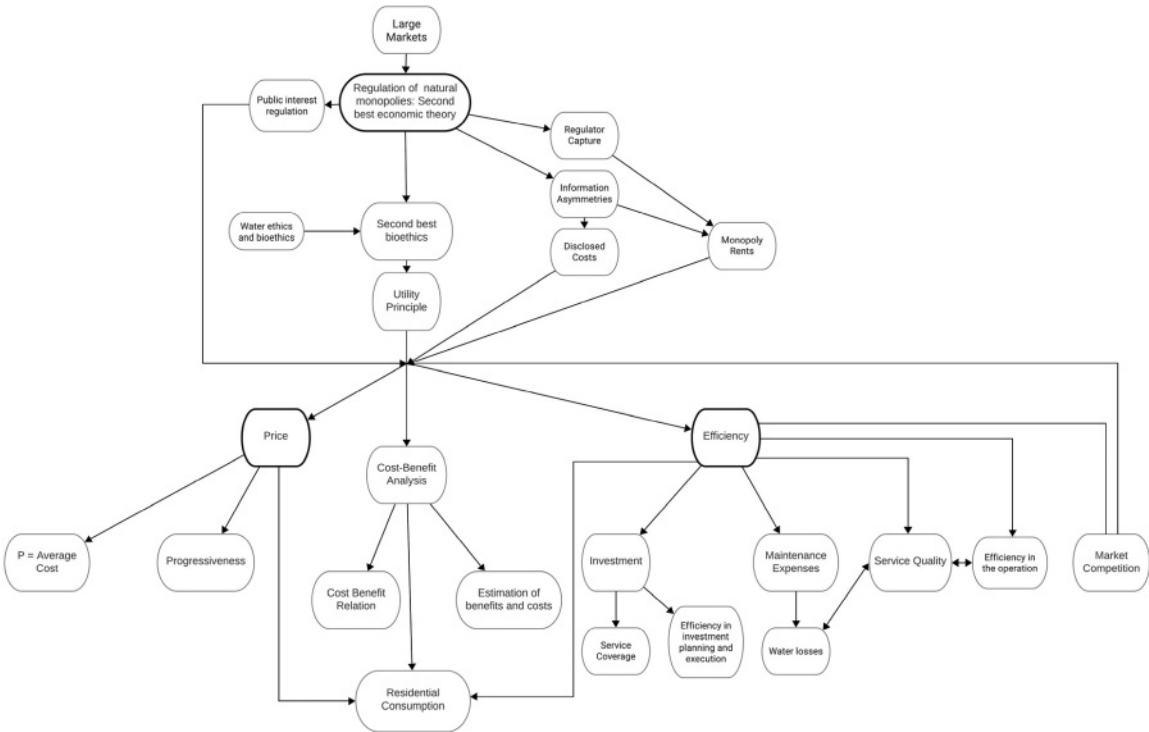
## 1. INTRODUCTION

Water is a substantial element that sustains life. Ninety-seven percent is found in the seas and 3% is equivalent to the planet's fresh water, where only 1% is used by humans (UNESCO, 1997). In this context, it is stated that the waters of rivers, lakes, and reservoirs, among others are exposed to organic and chemical pollutants from industrial waste. In addition, there are conflicts over access to fresh water due to the unequal distribution between regions and countries, where geographic aspects prevail that generate feelings of scarcity in the community, leading to overexploitation of the resource in quantity and quality (Liu *et al.*, 2011).

The 74th UN General Assembly scheduled the Climate Summit, which is associated with the climate crisis that continues to generate alarms and reactions worldwide. The crisis points to air, land, and water pollution as causes of death for millions of people a year. In this context, the water resource is mentioned as one of the protagonists and deserves priority attention as an essential factor for present and future life on planet Earth (UNESCO, 2019).

The Rio Conference on Environment and Development noted that water has an economic value in all its competing uses and must be recognized as an economic good. The basic right of all human beings to have access to safe drinking water and sanitation at an affordable price is prioritized (Young *et al.*, 2004). Failure to recognize the economic value of water in the past has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way to achieve efficient and equitable use, and to promote the conservation and protection of water resources (Priscoli *et al.*, 2004).

Water management seeks to rely on the bioethical perspective, since at the individual, social, and environmental levels it involves ethical issues arising from human interactions with living beings, species, and



**Q13** Fig. 1 | Categories, principles, and variables related to residential water consumption. *Source:* Authors, 2023.

ecosystems, as well as matters related to biodiversity, sustainable development, and imbalances in the biosphere; also the allocation of scarce resources with disturbances to human beings and nature, that is, what is related to the survival of man and the environment (Potter, 1988; Hottois, 2007). Likewise, bioethical discourses deal with dangers and threats to the environment, the human being, and his body (Buxó & Casado, 2005).

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Therefore, the water managed as an environmental issue and the scarcity of the resource derived from its misuse and contamination has neglected the ethical importance that its management implies for the different



**Q14** Fig. 2 | Accessibility to water service in small markets. *Source:* Authors, 2023.

uses on the planet and especially the use for the life of human being. The scarce efforts to introduce the bioethical perspective in the management and use of water resources, which implies, among others, the principle of utility in the efficient and progressive management of water resources for society. Thus, the research aims to determine the bioethical issues related to the residential consumption of drinking water in Colombia from the perspective of the principle of utility, which complements the technical and economic dimensions of residential water consumption.

## 2. LITERATURE REVIEW

Systematic studies on water ethics began with UNESCO-COMEST and The International Hydrology (IHP) Program on Water and Ethics during the period of 1998–2004, with the publication of 14 essays and 5 case studies (Priscoli *et al.*, 2004; Liu *et al.*, 2011; Groenfeldt, 2021). These ethical issues go beyond accessibility issues and focus on water management, covering all aspects of water use, such as access, use, allocation, quality, continuity, and protection, among others (Liu *et al.*, 2011). Concerns about articulated water management are articulated with the universal ethical principles of the United Nations Universal Declaration of Human Rights (UNESCO, 2005).

However, the management of drinking water has been dominated by technical and economic criteria in decision making. Water analysis has emphasized microeconomic efficiency, which does not adequately capture the social, environmental, and economic dimensions (Cuervo, 1997). Microeconomic efficiency analyzes of drinking water supply tend to ignore ethical considerations, including the ethical criteria that govern these economic analyses, which are based on principles such as utility, which in the field of economics is expressed in price formation, efficiency, and cost–benefit analysis.

The supply of drinking water is characterized by complex and dynamic interactions between the social and the natural with strong ethical implications that make it necessary to resort to methodological resources such as bioethics, overcoming the traditional conception of reducing it solely to human health.

Goodin (2012), supported by the findings of economic theory, advocates ‘second best’ bioethics due to the inconveniences generated by the attempt to solve the problems of the ‘real’ world from the approaches of an ideal theory (‘first best’) that you think about what to do in ideal circumstances. However, a situation is morally ‘non-ideal’ if resources are inadequate to accomplish tasks that are morally obligatory. For example, in developing countries there should be 100% preventable serious illnesses and deaths caused by unsafe water supply in vulnerable communities, but resources are often scarce and highly constrained to be executed quickly. The ideal solution is to provide safe water supply solutions to the whole community; however, due to economic and time limitations, a second viable and ‘good’ alternative must be chosen that seeks to benefit the greatest number of people with the budget and time available. In other words, this set of limitations must be supported by certain moral principles such as the principle of utility.

In this scenario, the principle of utility is connected to bioethical issues because it is concerned with encouraging increases in the well-being of the population through the provision of residential public service, helping to remedy: (a) the low coverage through the home networks that cause impacts on users, such as underconsumption, overpricing, and increased levels of poverty, (b) the poor quality of the water service is mainly reflected in the health conditions of children under 3 years of age and their chances of intellectual and physical development, (c) the prices of drinking water can give distorted economic signals since there are positive externalities that cause the social value to be well above its market price. These market failures can generate serious impacts on productive efficiency and social equity, which is why public intervention is important. Therefore, the principle of utility as an ethical criterion from a bioethical perspective is expressed in three elements: (a) prices, (b) efficiency, and (c) cost–benefit analysis.

Utilitarianism applied to the economy brings a series of advantages and is evidenced in the following variables (Fontrodona, 1987): (a) the price is a magnitude that transmits information about the goods or services that an agent can acquire in exchange for what produces, this mechanism is valued by the parties involved in the exchanges through a weighting that includes not only economic but also ethical aspects; (b) the cost-benefit analysis provides the method to evaluate the ethical dimension of a decision since it allows establishing the greatest benefit for society or determining the least damage and; (c) the efficiency that allows using fewer resources for greater results, in utilitarian terms the ethically correct action is the most efficient since it achieves greater benefits with lower costs and is related to techno-scientific progress because the benefits increase with greater production capacity at lower cost.

It is known that, in perfect competition, efficiency is reached when the price is equal to the marginal cost, but in the case of a natural monopoly such as the public drinking water service, the company cannot charge the marginal cost because it would present losses for the fact that marginal cost is less than average cost. Therefore, water companies are not willing to operate at prices equal to marginal cost unless they receive a subsidy to supplement the income they receive from their users; however, government subsidies are problematic because the utility's total cost exceeds the revenue it receives from consumers, and the utility's management has no incentive to control costs, knowing that utility losses public service company will be compensated anyway by public subsidies, which in turn is inequitable because it forces taxpayers to subsidize a good that the population enjoys to varying degrees or simply does not have access to. If this policy is adopted, the drinking water sector with a price equal to the marginal cost is known as 'the first optimum' and aspects of social equity are affected.

In practice, it is preferred that public water services be self-financing and that the price to be charged is equal to the average cost with zero economic benefit. This policy is known as 'the second best' or 'second best' in order to avoid the problems generated by the granting of subsidies (Comisión de Regulación de Agua Potable y Saneamiento [CRA], 2001).

The need for a 'second best' solution arises when the 'first best' solution is not feasible, because some assumptions of the perfect competition model are not met and, in a natural monopoly environment, plausible solutions must be sought that lead to policies that generate an improvement, even though things in other scenarios are not optimally organized (Lipsey & Lancaster, 1956).

These solutions have ethical implications due to the contrasts between the ideal theory and the non-ideal theory, as Goodin (2012) points out, based on second-best bioethics.

### 3. RESEARCH METHODOLOGY

This article describes the bioethical issues related to the principle of utility in the residential consumption of drinking water in Colombia. The categories, principles, subcategories, and variables that support the research are presented, as well as the methodological process disaggregated in the stages of data collection, processing, and analysis.

#### 3.1. General categories, principles, subcategories, and specification of variables related to residential water consumption

It starts from the large markets of the water industry that are explained from the regulation of natural monopolies and the economic theory of the second best, which allows moving towards ethical decisions with a bioethical perspective with restrictions (bioethics of the second best) and the contributions of the ethics and bioethics of water. A feasible specification for this work that allows analyzing the ethical implications is the utility principle through three notions that arise from the literature review: price, cost-benefit analysis, and efficiency.

The notions derived from the principle of utility are connected with specific variables related to residential water consumption such as pricing based on average cost, rate progression (affordability), rationalization of consumption, analysis tool cost-benefit facilitating investment decisions in expansion and rate setting through the balance of benefits and costs and efficiency that translate into coverage (accessibility), quality of service, reduction of water losses, efficiency in operation and maintenance, as well as the introduction of competition in the market.

The regulation of natural monopolies is approached from 'ethical neutrality' (regulation for public interest) and capture of the regulator (political interests) with the recognition of information asymmetries that lead to problems of undisclosed costs and monopoly rents from the companies. Political interests and information asymmetries affect the three notions of the principle of utility.

Accessibility under quality conditions for small, rural, dispersed, and weak markets is based on the bioethics of protection. The accessibility of the water service must incorporate the direct participation of organized communities in the provision of the service or introduce competition for the market, as the case may be.

### 3.2. Method of data collection

The collection of information was supported by a documentary review through a review of the literature on ethics and bioethics of water, the notion of second best bioethics, the principle of utility, and the construction of the main elements that characterize the observation unit (Drinking water sector in Colombia with emphasis on residential consumption).

The bibliographic sources used were books from the personal repository of the authors, articles from scientific journals from international databases contracted by the District University and El Bosque University, articles, reports from the CRA, Superservicios, National Planning Department and ECLAC, sectoral regulation documents of the CRA, statistical information from the database of the 'Unique Information System' of the Superintendence of Residential Public Services (Superservicios) of Colombia. All these documents were selected based on the pre-established categories and subcategories: (i) regulation of natural monopolies: second best economic theory, (ii) emerging field of water ethics and bioethics, (iii) second best bioethics, (iv) principle of utility and its link with the variables of drinking water supply, and (v) regulations of the drinking water sector.

### 3.3. Processing method

The information was coded with the thematic axes and pre-established variables, beginning with the field of ethics and bioethics of water, best second bioethics related to the principle of utility and its articulation with the economic theory of the regulation of drinking water. The principle of utility in the economic field involves the variables: price, efficiency, and cost-benefit analysis. At this stage, a development called bioethics of the second best and its articulation with utilitarianism arises. The observation unit was characterized through a description of the background and evolution of the drinking water sector with emphasis on residential consumption with ethical implications and a bioethical perspective.

### 3.4. Method of analysis

An analysis of quantitative data was carried out to discuss the theoretical corpus with the findings of the analysis of the drinking water sector. Through the hermeneutic analysis, the characteristics of the relationship between the categories and subcategories and the observation unit were identified.

The main antecedents related to the management of residential water consumption in Colombia are exposed, synthesizing the main regulatory and behavioral findings of companies from the early 1990s to the present. This is supported by the main quantitative and performance variables of the drinking water sector in Colombia.

The facts exposed regarding the regulatory experiences and behavior of the companies allow characterizing and making value judgments of some bioethical issues of the principle of utility and its relationship with the residential consumption of drinking water in Colombia.

The need to complement the principle of utility with the bioethics of protection, the moral hazards derived from information asymmetries, and the priority of universalizing the water service in Colombia are discussed and identified. The conclusions are articulated to the objectives proposed by this work.

#### 4. RESULTS

The Political Constitution of 1991 and Law 142 of 1994, known as the Residential Public Services Law, which allows private participation in the provision of water services and defines that the State has the obligation to guarantee universal coverage of water services under efficient conditions. Concern arises about giving an economic value to water to avoid indiscriminate use and the risk of depletion of the water resource. During this period, the expression 'domiciliary public service' was used for the first time, which included aqueduct, sewerage, electricity, fuel gas distribution, basic public landline telephony, local mobile telephony in the rural sector, and urban sanitation services.

In this context, the public home drinking water service has the following characteristics: (a) it satisfies the basic needs of users through a system of physical or human networks with terminal points in homes and workplaces, (b) objective efficiency and quality controls are carried out, (c) its provision is based on a tariff regime or price charged by the company to the user in exchange for the provision of the service, that is, the provision of the service is not free, and (d) it is considered a fundamental human right, for which reason certain minimum amounts of consumption are required that must be provided to its inhabitants in a mandatory manner.

The economic foundations of service provision recognize that the water industry is characterized as a natural monopoly because economies of scale are high in relation to demand, since water for human consumption is transported from collection centers to the home through physical networks and, therefore, only the presence of a single company in the market is efficient and financially viable (CRA, 2001). This analysis applies to the public drinking water service in Colombia, as evidenced by Nauges & Van den Berg (2007) who verify the existence of economies of scale and therefore the presence of natural monopolies. From this perspective, in Colombia, the Drinking Water and Basic Sanitation Regulatory Commission (CRA) was created to regulate natural monopolies and promote competition between operators to avoid situations of abuse of dominant position and encourage the provision of quality services.

The first regulatory stage began in 1995, from which methodologies and formulas for calculating water service rates were developed to facilitate investment resources and improve the quality of services, eradicating the tradition of setting rates based on political criteria independently of technical and economic considerations (CRA, 2001).

This is supported by Law 142 of 1994, where the public drinking water service adopted a non-linear tariff system based on long-term average cost, with a two-part tariff: a fixed part charged per user (\$/user) where fixed costs are divided by the number of users and costs for service availability are recognized; and, a variable part for consumption, which is fixed per cubic meter (\$/m<sup>3</sup>) calculating the long-term average variable cost.

The regulations applicable throughout the country establish a structure of three consumption blocks with simple billing: the limit of the first block (basic consumption) is determined by the thermal floor (height above sea level) of the locality; the second block rises to double the basic consumption and this, in turn, is the lower limit of the third block.

There is a system of subsidies and contributions to demand, where users with greater ability to pay quote (surcharge) above the average cost of the service and subsidize less favored users with solidarity criteria. The tool for



targeting subsidies is the classification of households according to the physical condition of their homes into six strata, with stratum 1 being the homes inhabited by the poorest and stratum 6 being the homes of the richest. The maximum subsidy for basic consumption is 70% for stratum 1, 40% for stratum 2, and 15% for stratum 3. The maximum contribution to total consumption for strata 5 and 6 and non-residential users is 20%. In this sense, the criterion of solidarity and income redistribution is normatively assimilated to criteria of social equity.

This stage was based on the regulation of the rate of return, that is, financial sufficiency is prioritized over considerations of efficiency and equity. The following aspects of this regulatory stage can be identified: (a) control of monopolies to prevent abuse of dominant position, (b) competition for the market through the free concurrence of bidders, (c) regulatory measures to improve the financial condition of the service providers, (d) regulatory signs for the dismantling of subsidies not contemplated in the law, (e) the tariffs recognized a non-revenue water index (IANC) of 30%, when the sector had a loss rate that exceeded 50%, however, (f) there were high levels of coverage in large cities but high levels of water losses, that is, there were incentives to invest but not to maintain the system because operators had access to low-cost financing for investments, but high-cost money for maintenance, and (g) the tariff regime did not generate incentives to increase coverage in areas of low population density.

In the second regulatory stage, the dismantling of subsidies that did not correspond to the requirements of the law continued, while the main concern was to avoid the transfer of inefficiencies from the companies to the users and to consolidate the financial sufficiency of the companies (the main concern of the first regulatory stage). In this sense, the tariff scheme was based on the comparative efficiency model applying the Data Envelopment Analysis (DEA) methodology in the calculation of administrative and operating costs, which sought to encourage virtual competition between providers of a monopolistic service (CRA, 2004).

Efficiency is measured by the distance between the observed practice and the efficient frontier of the activity, that is, those companies that stray further from the best practices that the frontier marks will be more inefficient. Greater controls are carried out on the investment reported by the companies, inefficient administrative costs are eliminated, and environmental taxes are included, such as the tax on the use of water for the use of a natural source and a retributive tax for specific discharges.

The third regulatory stage began in 2014, continuing with the comparative efficiency model through the DEA, guaranteeing in any case the financial sufficiency of the companies. The new framework aims to ensure that companies meet certain annual targets through efficiency improvements and gradually reach certain service standards. In the event that companies do not meet the objectives, users may receive financial compensation according to a quality and discount system. The objective is to increase the coverage, continuity, and quality of service provision. It is assumed that there is an association between rates and degree of coverage, whose goal is to reach 100% (CRA, 2014).

The main elements arising from the regulatory experience and the behavior of companies in the drinking water sector were the following:

- (a) Regulation by the rate of return has been an important instrument to increase service coverage; however, this has not prevented large companies from obtaining monopoly rents that have been partially used in wage overruns and high pension debts (CRA, 2007). The regulation has been permissive regarding the incorporation of acceptable efficiency parameters, and they are too far from those presented by large companies in conditions of efficiency in the international context. In contrast, in small companies the staff have low technical and administrative capacity, preventing the provision of a good quality service.
- (b) High inefficiencies were introduced due to the waste of economies of scale in the water industry, since in 1995 there were 953 companies providing the service and in 2020 there were 2,861; this proliferation of companies currently exceeds the total number of municipalities in Colombia (1,102). The average density in



Colombia is 3,883 users/operator, while studies for Colombia show a minimum efficient scale of 149,000 clients per service provider to achieve gains in business efficiency (Ferro & Lentini, 2010; Revollo & Londoño, 2010).

The wastage of economies of scale and scope through spin-off or business merger operations has not occurred due to the high atomization of the provision of public services as a result of the decentralization processes initiated in the 1980s in Colombia and the few competitive incentives in the drinking water market in large markets.

In rural areas, with a dispersed population and low income, the strategy of cross-subsidies and economies of scale that provide financial closure, do not work well in these territories. In these markets, the distribution costs of the expanding areas have lower population densities and are higher than the distribution costs in the areas already in service. The insufficiency or poor quality of the water supplied is mainly caused by an ineffective supply and not by a resource deficit. However, there were notable increases in rural coverage, for 1993 it was 44% and for 2020 it increased to 74.5% (Departamento Nacional de Planeación [DNP], 1995; CRA, 1997).

- (c) The tariff policy has focused on eliminating tariff gaps that allow the tariffs to reflect the costs of providing the service and has not transferred part of the efficiency gains from the companies to the users through significant reductions in the value of the invoice. Some studies suggest that the drinking water bill should represent a maximum of 3% of household spending, which for Colombia would seem to be in line with the average payment for drinking water supply in household spending, in 2019 it was 1.83% (CRA, 2020; Fernández *et al.*, 2021).

However, Colombia is the second most unequal country in the OECD and this average does not show some significant deviations. When reviewing the participation that the water bill has in the family basket of households according to income level, it is found that it was 2.14% in vulnerable, 1.98% in poor, 1.91% in middle class and 1.45% in high income (CRA, 2020). In this sense, there is some evidence that the rate policy promoted by the regulator has been regressive in Colombia, since as the level of income increases, households make less effort in percentage terms to pay the bill.

The tariff policy has allowed a rationalization of basic water consumption expressed in that until 2015 lower-income households were subsidized in the monthly consumption of the first 20 cubic meters, after this date through a transition process it seeks to subsidize a home, in the first 11, 13, and 16 cubic meters, whether in a cold, temperate, or warm climate, respectively. This policy is consistent with the monthly average residential consumption, which for 2020 was 10.89 m<sup>3</sup>/month/user (Superintendencia de Servicios Públicos Domiciliarios, 2021a).

The rationalization of water consumption has decreased not only due to the increase in rates but also due to regulatory incentives for basic consumption and greater citizen care for the use of water. Efficiency conditions in the use of water resources have been improved, but social equity considerations have been negatively affected because the tariff policy has been regressive.

- (d) In the different regulatory stages, the average execution index of investments in large cities of the country such as Bogotá, Medellín, and Cali, has barely approached 60%; therefore, the companies would be collecting resources for activities that they have not carried out as scheduled, without having returned those resources to the users through rate reductions. Additionally, several companies advanced production investments that exceed and are not necessary for the system.

Current regulations require that the rates be updated every 5 years by the companies in accordance with the calculation methodologies defined by the CRA. In these updating processes, companies take advantage of

information asymmetries. For example, the regulator's inability to have detailed knowledge of costs has led to cases such as that of the Bogotá Water and Sewerage Company (EAAB), which has registered many investments in equipment and network rehabilitation twice, that is, users were charged the same investments in two tariff periods (Betancur *et al.*, 2006).

- (e) In the Colombian case, there is an inverse relationship between investment and maintenance requirements. Service providers have financed their investments with low-cost resources, while maintenance has been financed with expensive resources. This is explained because the central government transfers resources for drinking water systems, excluding maintenance expenses and giving special incentives to projects that increase service coverage. The municipality has strong incentives to increase the coverage of the service at a low cost due to the transfer of resources from the central government and few incentives to carry out maintenance expenses that affect water losses and the quality and continuity of the service.
- (f) There were notable increases in the coverage of the domestic water service, but some indicators of quality and continuity show significant deficiencies, which are listed below:
- By 1993, the total household coverage was 79.7% distributed in 82.6% urban coverage and 44% rural coverage (Departamento Nacional de Planeación [DNP], 1995; CRA, 1997). By 2020, the water coverage in Colombia was close to 92.8% distributed in 97.7% coverage in urban areas and 74.5% in rural areas.
  - In 2020, 74.2% of the companies guaranteed a continuity of service close to 24 hours/day, while 25.8% of the service operators did not exceed an average of 18 hours/day (Superintendencia de Servicios Públicos Domiciliarios. Superservicios, 2021b). By 1993, the average continuity was only 15.36 hours/day (Domínguez & Uribe, 2005).
  - By 2020, it was found that 62% of the municipalities supplied water suitable for human consumption, 21% with significant risk, and 17% with low risk (Superintendencia de Servicios Públicos Domiciliarios, 2021b). It must be considered that at the end of 1993 only 62% of urban inhabitants and 10% of the rural population had water services suitable for human consumption (Domínguez *et al.* 2005).
- (g) Regulatory efforts have focused on recognizing a non-revenue water index (IANC) of 30% in the first and second tariff regulatory periods and 25% in the third period; however, the incentives have been insufficient because the companies registered a non-revenue water index of 40.5% for the year 2020. This indicator shows that the prices charged by the companies do not fully recover the long-term costs (Departamento Nacional de Planeación [DNP], 1995; Superintendencia de Servicios Públicos Domiciliarios. Superservicios, 2021b).

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There are few incentives for companies to reduce their water losses (IANC) to the levels set by the regulator and there are even no business incentives to have levels of losses below the limits established by the regulation. Exceptions have been made, such as the case of the company responsible for the water service in the municipality of Cali (Colombia) which, pressured by its difficult financial situation, managed to reduce losses from 57.3% (2016) to 47.5% (2022), reducing the supply in 2 m<sup>3</sup>/s equivalent to the water production of the second most important plant in Cali (EMCALI, 2023).

#### 4.1. Bioethical issues related to the utility principle for the case of residential drinking water

The logic of water management in Colombia has a utilitarian predominance since the main interest is to maximize social benefit, harmonize economic efficiency, financial sufficiency, equity, and comprehensive service with universal coverage and quality. Companies seek to maximize economic benefits and increase the return on invested capital. Users hope to maximize their utility through the continuous availability of the service in quality and quantity at efficient prices (Salamanca, 2015).

The principle of utility in the Colombian context has supported moral decisions in conditions of scarcity of resources to choose between several alternatives that have allowed the massification of the drinking water service. These choices are determined through the balance between costs and benefits that seek the best consequences, that is, the maximization of utility includes benefiting most households, guaranteeing the efficient allocation of investment resources with notable increases in the aggregate welfare of the society. The increases in service coverage assume that investment resources are prioritized in areas with higher population density and higher incomes with respect to areas with dispersed markets and low incomes. In practice, this ends up supplying the water needs to most homes, but the universalization of the service is not achieved.

The rate of return regulation applies to countries that require investments to increase service coverage and welfare gains are achieved by prioritizing financial sufficiency over social equity considerations. The principle of utility has been implicitly incorporated into the decisions of the CRA, in the regulation scheme of the rate of return as an ethical instrument to rapidly increase the coverage of the water service in Colombia since the mid-1990s, with the objective to universalize the drinking water service. This is explained to the extent that the regulator ensures a minimum return on the investments made by the service providers, due to their condition of natural monopoly and the need to reduce the coverage lag. The regulation of natural monopoly does not resolve the conflict between allocative efficiency and productive efficiency, because evidence has shown that companies that serve large markets have achieved monopoly rents, including the transfer of inefficiencies in administration and operating cost overruns to users.

A related ethical criterion that makes it possible to realize the universal declaration of bioethics and human rights in terms of adequate water consumption is affordability, that is, households must have access to a supply of water with the best standards at an affordable price. In the case of Colombia, the affordability of residential water consumption is affected by having a regressive rate policy because home subsidies are granted according to the physical considerations of the home without considering the per capita income of the home, this prevents a direct subsidy to the water bill and grant a higher percentage to the poorest and move towards a progressive rate regime. Such behavior is consistent with the principle of utility, because in Law 142 of 1994 the considerations of financial sufficiency and efficiency predominate over social equity.

However, the principle of utility is partially explained by the criterion that an economic system is efficient if it does not waste resources (production) and maximizes the welfare of individuals (distribution). Several elements that are indicated below show that the Colombian service delivery system is highly inefficient:

- (a) The high IANC shows the economic inefficiency of the tariff policy and the lack of incentive systems to reduce tariffs. Thus, with a high level of accepted technical efficiency losses, the problem lies in the high value of the tariffs to the detriment of the poorest and most vulnerable population. Therefore, it affects bioethical issues related to the principle of dignity and human rights, including a bioethical principle, which approved by the Universal Declaration on Bioethics and Human Rights. These efficiency problems are fueled by government incentives to boost investment in coverage and discourage maintenance and replacement of companies' home networks.
- (b) The dispersion of water supply companies entails a waste of economies of scale, scope, and density.
- (c) Information asymmetries have led many companies to pass on cost overruns to users.
- (d) Many municipalities supply water that is not suitable for human consumption, that is, it poses a significant risk to human health.

In the Colombian case, the predominance of the utility principle is supported by cost-benefit analysis for decision making. The application of the cost-benefit analysis ignores ethical aspects related to equity, since the subsidies to be granted to lower-income households end up being the last variable to be determined in the

tariff policy, since the amount of the subsidies depends on the magnitude from premiums charged to higher-income households, commercial and industrial users, and from government contributions. Therefore, through cost-benefit analysis, equity considerations are subordinated to the financial stability of companies, and the availability of government resources.

It is evident that the cost-benefit ratio of investments to achieve universal access to drinking water and sanitation provides a significant positive return in Colombia and in most of the regions studied. The benefits are in human health, in many cases with low costs in additional infrastructure (UNESCO, 2021).

For Colombia, the cost-benefit analysis of the projects and policies carried out by the public water services takes into account the following projected variables in a long-term scenario: (a) the average cost of the long-term service that reflects the service efficiency costs avoiding transferring cost overruns to users, (b) future projections of service demand in a long-term horizon, (c) rates that incorporate subsidies, contributions, and state contributions that guarantee long-term economic balance (total income equal to total costs with a regulated minimum return), (d) the regulated discount rate that remunerates the investments, (e) the regulated maximum price, and (f) political decisions have a future impact that often involve scenarios of climate change that show a tendency to increase the average temperature and decrease rainfall in some regions of Colombia by up to 30% (Lizcano *et al.*, 2019).

## 5. DISCUSSION

**Q8** The principle of utility must be complemented with bioethics of protection (Schramm & Kottow, 2001), since the objectives of the universalization of water become mandatory because they are indispensable, and the water supply programs are accepted as necessary and reasonable because they control problems of poverty and exclusion in vulnerable communities and the programs cannot be discarded for secondary reasons because they contribute to basic collective needs.

The political interests of the officials of the Regulation Commission and of the companies cannot be ignored. It is clear that in Colombia, the greatest regulatory developments have focused on regulation in the public interest, which means that the regulatory body looks after the interests of society. However, the regulator was caught in some aspects such as the setting of high rates of unaccounted for water for the calculation of consumption and service rates.

For its part, the ethical conflict between efficiency and equity has been persistent and leads to a mistaken perception of the regulator's capture, in terms of attributing to the commissioners the absolute responsibility for the regressiveness of the rates, when the solution depends on a great extent on the issuance of norms by the Congress of the Republic, which allows moving towards progressive price schemes.

The regulations have not prevented the moral hazards derived from information asymmetries from becoming a reality: (i) the regulated companies have taken advantage of the greater information about the costs of providing the service and once they ensured the income during a tariff period, operated with costs lower than those reported without sharing those profits of the operator with the users through reductions in tariffs, (ii) the collection of investments not made, without having returned those resources to the users, (iii) excess production investments not required by the system, (iv) the collection during two tariff periods for the same investments, and (v) the extraordinary gains due to the scarce update of the discount rates and the absence of regulations regarding the correspondence between the weighted average cost of capital real and regulated.

Colombian regulation introduces the single sectoral indicator as a mechanism for disclosure of information, measurement of company management, and classification of the level of business risk. Regarding quality, the regulator takes into account the discount to the fixed charge through the indicator of complaints and claims (IQR)

and the discount to the charge for consumption through the indicator of technical quality of service (ICTS), which in turn it is built based on the indicators of water quality (ICAP) and continuity (ICON).

To improve the performance of the water industry and translate into benefits for users, competition in large markets is encouraged through the sale of water in bulk and competition for expansion. To streamline these processes, it is necessary to have clear rules of the game at the level of interconnection, coverage, and access to subsidies.

In rural and low-income markets, it is preferable for Colombia that these markets are served by community organizations that for decades have assumed the informal role of supplying the communities, in places where the state's capacity is low and there is no possibility of applying economies of scale by providing the conventional service.

## 6. CONCLUSIONS

The bioethical aspects related to the residential consumption of drinking water in Colombia are the following.

The bioethics of the second best supported by the principle of utility has been applied, due to the fact that decisions are made with high budgetary and temporary restrictions that have led the coverage of the urban service to figures close to universalization, while the coverage in rural areas it barely exceeded 74%. The lag in rural coverage reflects the predominance of rate of return regulation that sacrifices levels of efficiency and social equity.

The price is an element of the principle of utility and is set at the level of the average cost of the service due to the strong natural monopoly features of the water industry ('second best'). However, the use of the service operators of information asymmetries led to the service providers appropriating monopoly rents. The regulatory signals that the rates reflect the costs of the service, the removal of extra-legal subsidies, and the reduction of subsidizable basic consumption have led to a rationalization of consumption with regressive rates.

Efficiency as an essential axis of the utility principle has not been met because many regulated companies operate with costs below those reported, charge unrealized investments without returning those resources to users, apply investments that oversize the system and charge during two tariff periods for the same investments. The incentive of coverage increases seeking to universalize the service has caused the resources directed to maintenance to be very expensive with respect to the application of investment resources; therefore, there is great neglect of maintenance expenses, which translates, in high levels of unaccounted for water losses. The regulator was captured in some discretionary aspects such as the setting of the non-revenue water efficiency index for the calculation of service rates, transferring inefficiencies to users.

Cost-benefit analysis adds a moral dimension to the utility principle because its cost-benefit methodology produces positive returns by adding new users. Therefore, it is a basic instrument to achieve rapid increases in coverage aimed at universalizing the service in contexts of high-density economies. However, for low-income and rural markets, it produces negative returns because the analysis is one-dimensional in nature and uses purely economic criteria.

An important reference to defend care for vulnerable groups is the bioethics of protection due to its orientation towards universalization, the recognition that it satisfies urgent collective needs and has direct impacts on increasing the well-being of the poorest communities. From this bioethical perspective, it is a good complement to the utility principle, since the latter prioritizes accessibility to the greatest number of households with the available budget and in the shortest time.

The utility principle for drinking water is insufficient because it does not satisfactorily resolve the tensions between efficiency and equity universalizing the service, progressive tariff policies in terms of quality, and continuity of service, among others. Drinking water regulation has focused on regulation by maximum price and rate



of return, but the incentives have been insufficient to guarantee quality standards and continuity of service, as well as to build a serious regulation in defense of users.

In general, there is a strong technical and economic bias in the management and supply of drinking water to households in Colombia, leaving aside ethical and bioethical considerations (with water for all, in adequate conditions of accessibility and affordability, including solidarity and redistribution of income) that affect aspects of coverage, quality, and continuity of service to users.

## DATA AVAILABILITY STATEMENT

**Q9** All relevant data are available from an online repository or repositories.

## CONFLICT OF INTEREST

The authors declare there is no conflict.

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