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Water as an economic good and water tariff design Comparison between IBT-con and IRT-cap

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Abstract

Although the proclamation of "water as an economic good" has been generally accepted among water resources managers, there are still some debates on the explanation of this topic. In this paper it is argued that different water forms or uses have different kinds of economic value. Even for the same form or use, water economic value can be transferred from one kind to another by interventions.

If water is an economic good, water pricing should be recognized as one of the important incentive measures for water demand management. Although the increased block tariffs (IBTs) have become the tariff structure of choice in many developing countries, it still deserves more careful examination. The traditional IBT-con cannot achieve the initial objectives of IBTs for its incorrect designed structure.

This paper is intent to critically examine the use of IBT-con and to strongly promote a new tariff structure, IRT-cap. The case study of Weinan City shows that IRT-cap is an effective tariff to achieve the objectives of equity, simplicity, transparency and implement as well. Also IRT-cap seems easier to achieve cost recovery than the traditional IBT-con taking the ability to pay of water consumers into account. Pilot projects are necessary to be formulated for verification of this new tariff.

Keywords: Economic good; Water tariff; Increasing block tariffs; Increasing rate tariffs

1. Explanation of water as an economic good

The now famous proclamation that water should be treated as an economic good originated in the Dublin Conference (ICWE, 1992). Eight years later although this proclamation has been generally accepted among water resources managers, there are still some debates on the explanation of this topic. The focus of the argument is often on the question whether allocation can reasonably be left to free market forces, or it requires some amount of extra-market management to effective and efficiently serve social objectives.

Water is an economic good considering the definition of economics which is "the science which studies human behavior as a relationship between ends and scarce means which have alternative uses" (Robbins, 1935). Water serves a multiplicity of ends, which range from domestic water demand, agriculture water demand and industrial water demand, through aesthetic value, recreational use and environmental use, to waste disposal, and thus satisfies the condition of "alternative uses". In many cases, water is scarce in the sense that it cannot fully satisfy its entire alternative uses simultaneously.

Although water has been generally considered as an economic good, what kind of economic good does water mean? Public or private? Here the distinction between public good and private good is closely related to the nature of the goods and services produced in terms of excludability (E) (the degree to which users can be excluded) (World Bank, 1993) and subtractability (S) (the degree to which consumption by one user reduces the possibility for consumption by others). Public goods have a low subtractability and a low excludability, while private goods have a high market potential because of their high levels of excludability and subtractability.

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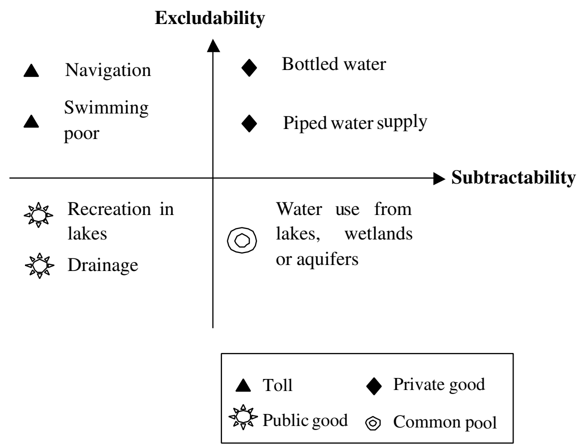


Fig. 1. Samples of the nature of water uses.

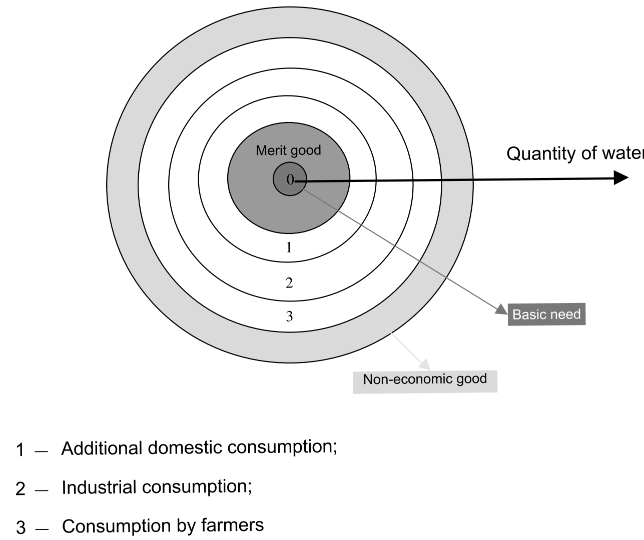


Fig. 2. Water characteristic and water quantity relationship.

Some samples of the nature of different water uses are shown in Fig. 1.

As shown in Fig. 1, different water forms/uses have the different excludability and subtractability, which leads to different kinds of economic value of water such as public or private water. However, it should be notified that for the same form/use of the water, water economic value can be transferred from one kind to another by interventions. For example, suppose a lake has a low excludability initially. If subsequently it is limited to water supply for a certain region by the government, this regulation will exclude people from other regions to use it. The excludability will become higher than before which results in a change of nature of water from common pool to a more private good (a little or a lot, depends on the governmental regulation). The water supply processes in fact change water forms from lake water to piped water and consequently translate economic value of water from common pool to private good.

Also, the available quantity of water is vital to determine what kind of economic good it is! Depending on the quantities supplied to individuals, water can be a basic human need, merit good, or an ordinary economic good (as shown in Fig. 2). A case can be made that in extreme instances, water, as other basic human needs, ceases to be an economic good. Since there is only one end to which all of the resource (and all other resources) would be applied under conditions of extreme scarcity, there is only one option and only one choice to be made, which is to get the water to the thirsty, which closes all options. In this case, water is no more an economic good but a basic need for people to survive! When there is just enough for the thirsty, water also fulfils the criteria for being considered a merit good: good that has a high societal function but are generally not expressed in monetary terms, such as the importance of having clean rivers and a beautiful scenery. It is obligation of human societies to assure reasonable levels of water to meet the basic human needs and merit goods. But it is not reasonable to assist individuals or families in the acquisition of goods beyond this level. It means that the same goods should be treated differently at different levels of consumption. At a higher level of supply when human thirst and basic needs have been satisfied, water can be

Table 1
Aspects of water and how they apply to other goods (Savenije, 2001)

	Water	Air	Land	Fuel	Food
Essential, vital	+	+	+	+	+
Scarce, finite	+		+	+	+
Fugitive	+				
Indivisible	+				
Bulky	+	+			
Non-substitutable	+	+	+		
Public good	+	+			
Location bound	+		+		
High mobilization costs	+				
Non-homogeneous market	+	+	+		
Prone to market failure	+				
Merit value	+		+		

considered an economic good. On the other extreme where water is abundant, it ceases to be an economic good.

Water has an economic value and should be recognized as an economic good. However, Water is not a normal economic good; it is too special to be considered compared with other economic goods. Water has a combination of characteristics that make it different from any other good and should be dealt with in a very special way although individually these characteristics are maybe not so restrictive (as shown in Table 1) (Savenije, 2001). We cannot define water to be a public good or a private good separately. Water serves many different objectives and has properties that make it both a private and a public good. The appropriate blend of values and facts in proper policy formulation for water requires a much more sophisticated form of analysis than that allowed by the simpleminded dogmatism of proponents, either of basic needs or of free markets (Perry et al., 1999). Water policy must be formulated in terms of multi-objective decision making, recognizing that the relevance and importance of various values and facts will vary substantially over different conditions of time and place.

2. Water pricing and increasing block tariffs

Water pricing is recognized as one of the most important non-structural incentive measures for demand management to achieve the objective of efficiency and sustainability of scare water resources. Water pricing aims at achieving financial sustainability rather than an instrument for water allocation. Only if the financial costs are recovered can an activity remain sustainable. If water is free, water provider does not receive sufficient payment for its services. Consequently, the provider is not able to maintain the system adequately and, hence, the quality of services will deteriorate. Eventually the system collapses, people have to drink unsafe water or pay excessive amounts of money to water vendors, while wealthy and influential people receive piped water directly into their houses, at subsidized rates. Thus the water-for-free policy often results in powerful and rich people getting water cheaply while poor people buy water at excessive rates or drink unsafe water. To maintain the water supply system, help the poor to drink safe water and keep the society secure, the government has to give subsidy to many sectors. But subsidy is really not a good way to solve this "free water dilemma". Because of the long-time subsidy, people cannot realize the fact that water should be recognized as an economic good. Also, because of the low price of the water, large quantity of water is consumed easily with large quantity of waste produced by the consumers, which will worsen water scarcity in their life. The most important instrument to break this vicious cycle is to make reasonable water pricing to recovery the cost and to obtain financial sustainability. If the cost is recovered, the government does not need to subsidy any sector (even the poor, the rich can subsidy the poor if reasonable water pricing is made). Government does not need to be involved in the production of water (as a producer); it could only need to make reasonable policy to supply and allocate water equally and efficiently (as a caretaker). For the People, they will rethink their behavior because of the implement of water pricing, water conservancy technique may be taken compared with the high charge for large quantity water. The demand for water will be directly influenced if this reasonable water pricing is implemented.

Water pricing is very important for water demand management to achieve efficient and sustainable use of water. But how high should the price be? To answer this question, it is necessary to look at the economic analysis of different values of a good. Briscoe (1996) presents the basic economics needed in a clear and simple way as follows:

> The idea of "water as an economic good" is simple. Like any other good, water has a value to users, who are willing to pay for it. Like any other good, consumers will use water so long as the benefits from the use of an additional cubic meter exceed the costs so incurred. This is illustrated graphically in Fig. 3(a). Which shows that the optimal consumption is X^*. Fig. 3(b) shows that if a consumer is charged a price p', which is different from the marginal cost of supply, then the consumer will not consumer X^* but X'. The increase in costs (the area under the cost curve) exceeds the increase in benefits (the area under the benefit curve) and there is a corresponding loss of net benefits (called the "deadweight loss").
>
> But what about groups of users, and how is welfare maximized for the group (or society) as a whole? The simple logic of Fig. 3 applies in the aggregate—for society as a whole, and welfare is maximized when:
>
> - Water is priced at its marginal cost, and
> - water is used until the marginal cost is equal to the marginal benefit.
>
> So far so good, but what actually do we mean by "benefits" and "costs", how are these dealt with in different water-using sectors, and what are the implication?

The value of water to a user is the maximum amount the user would be willing to pay for the use of the resource (Briscoe, 1996). However, willingness to pay depends largely on the ability to pay, even with the same basic need or value of water, the rich will get more and the poor less. Thus the people between X^* and X' are priced out of the market for water, if not completely,

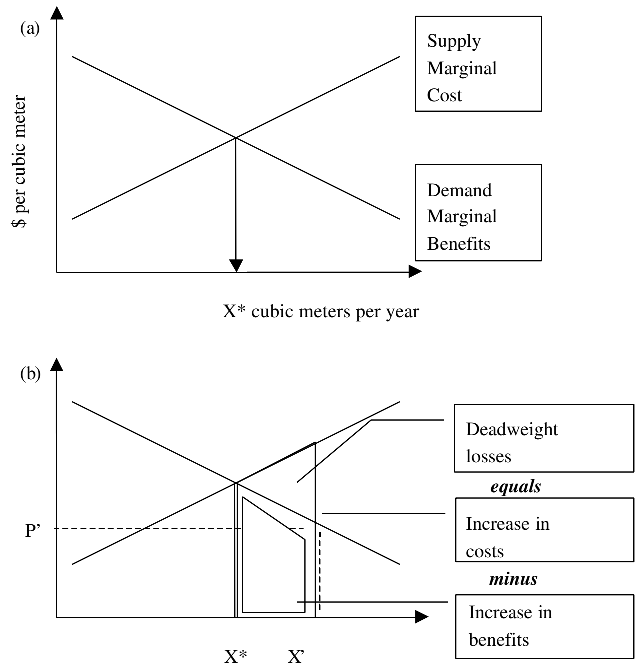


Fig. 3. Optimal consumption and "deadweight losses" is water is underpriced.

then in terms of marginal reductions in the amount they can afford.

But water is so special that it cannot be merely recognized as an economic good but also a social good. In an enlightened humane society, well-to-do taxpayers want to help the poor obtain basic needs. Thus, in terms of Fig. 3, tax-payers are willing to subsidize water, effectively shifting the supply curve down to the point where it intersects the demand curve ant P', X', and many more poor people get water.

Marginal value could reflect the economic value of water. But it is very difficult to be implemented as a tariff structure. An alternative for marginal value is increasing block tariffs (IBTs). An IBT is based on the volumetric component. In this tariff structure, water use per billing period is divided into a number of discrete blocks for which separate prices can be set. A water user in a particular category, such as domestic water consumption, is charged a relatively low per unit price for consumption up to a specified amount. This amount defines the end of the initial or first block. A user who consumes more water faces a higher per unit price for this additional consumption until reaching the end of the second block, and then a still higher price until reaching the end of the top block in the increasing block structure (Boland and Whittington, 2000).

Increasing block tariffs (IBTs) appears to be a popular tariff structure in many developing countries. In a survey of urban water utilities in Asia, the Asian Development Bank (1993) found that the majority of utilities in their samples (20 out of 32) used an IBT structure.

Many utility officials and experts have shown their strong interest in increasing block tariffs because it seems to have a lot of advantages.

First, *easier cost recovery*. Only if the cost is recovered can water activity remain sustainable. IBTs are easier to achieve this aim compared with the traditional uniform tariff. Assume that both uniform tariff and IBT are initially designed to recover the same total revenue. In uniform tariff, water is sold at the same price for each household. Poor people may have no ability to pay for the piped water, which may result in the incapability of cost recovery for water. However, the increasing block design, then, contains one or more prices which are higher than the uniform design, and one or more which are lower. It is assumed that the poor consume less water than the rich do. This consumption will lead to the lower average price for the poor and higher for the rich in IBT and will certainly result in the easier cost recovery.

Second, *equity*. In this paper, equity has the same meaning as fairness. Equity should be considered when water pricing is implemented. The human rights issue means that if water is to be provided to all, then it must be marketed at affordable rates, which vary considerably. It therefore appears that some form of differential tariff system would be required whereby the richer subsidized the poor. One way to gain full financial control over the subsidies is to finance them by putting a surcharge on the consumption of high-income customers. Such a subsidy within the tariff structure is called a *cross subsidy*. Another way is the implementation of "lifeline" policy. The lifeline is a part of the tariffs that is not cost-of-service-based block. This is a policy part of the tariffs structure to provide a benefit to lower water-using customers. The lifeline block of consumption provided to all customers specifically benefits low water use customers or customers with the majority of their consumption within the lifeline allotment. This lifeline could ensure the poor to obtain water for their basic needs considering their low income.

Third, *demand management*. Increasing block tariffs can be used to impose conservation incentives on some target group of large users. The impact on conservation of an increasing block tariffs design is best illustrated by comparing it to the simplest alternatives uniform tariffs. Customers facing the higher prices at the margin will, in theory, use less water than they would under the uniform design; customers facing lower prices at the margin will use more. The increasing block design will conserve water if the sum of decreases in use exceeds the sum of increases (Metropolitan Water District of Southern California, 1991). The expectation is that demand in the high blocks will be more elastic than demand in the low blocks, resulting in a net decrease in water use.

Although there is widespread consensus that increasing block tariffs have many advantages, this type of tariff still deserves more careful examination. Personally, the author appreciates the idea of the IBTs. However, an incorrect structure of the IBTs leads to several shortcomings as argued by Boland and Whittington (2000), such as difficulties to set the initial block, mismatch between prices and marginal costs, conflict between revenue sufficiency and economic efficiency, absence of simplicity, transparency and implementation, incapacity of solving shared connections, etc. To illustrate this statement, some important concepts to be used later are defined as follows:

Income refers to the annual average per capita household income with a unit of Y/cap.a. For example, if the total household income is 20,000 Y/year, and the household size is four persons, Income is equal to 5000 Y/cap/year. (The currency unit is Chinese Yuan (Y) in this paper. The exchange rate in January 2000 was 1 US$ = 8.279 Y.)

IBTs: increasing block tariffs.

IRTs: increasing rate tariffs. They are another way to provide a price, which is progressive with respect to water use. In this kind of tariffs, a user pays the same price for all water used in the billing period, but the price increases with increasing use (UNDTCD, 1991).

IBT-con: increasing block tariff based on water consumption per connection. It means that for this tariff, water price is dependent on the total water consumption by a household, no matter how large the family is.

IRT-cap: increasing rate tariff based on water consumption per capita. It means that for this tariff, the water price is dependent on both the total household water consumption and the household size.

Water fee percentage: water fee percentage = (water fee per year/income) × 100%. The major reason for the incorrect use is that the water price is dependent on the water consumption per connection (m^3/month/connection).

For a tariff design, it should be easy to explain and easy to understand. It should be possible for most users to know what price that they are paying for water (Boland and Whittington, 2000). Taking *Simplicity* and *Transparency* into account, in this paper, water tariffs are designed in a different way compared to the traditional IBTs. The difference between them is shown in Appendix A. It can be seen that for the traditional IBTs (see Appendix A.1), the water bill is equal to the integration of the water price over the consumption. However in the proposed IRTs (see Appendix A.2), the water price is determined by the maximum water consumption of a water user. The water bill for a household is equal to this price multiplied by the water consumption. Consequently, the proposed IRTs are simple to be implemented and also they can contribute

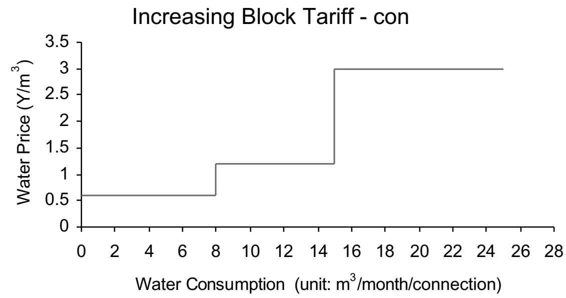


Fig. 4. Increasing block tariffs based on water consumption per connection.

to explain the difference between IBT-con and IRT-cap easily.

The following is an example for IBT-con:

Example. The increasing block tariffs are shown in Fig. 4. The following questions arise:

1. Assume that user 1 has a household size of six people. The income per capita is very low (only 800 Y/cap/year). The water demand is 3 m^3/cap/month. Based on Fig. 4, what is the water price for this user?
2. Assume that user 2 has a household size of two people. The income per capita is high (30,000 Y/cap/year). The water demand is 3.9 m^3/cap/month. Based on Fig. 4, what is the water price for this user?

The above questions are not difficult to answer. But the results make us very confused on the increasing block tariffs. The poor with an income of 800 Y/cap/year has to pay the water fee with a price of 3 Y/m^3; while the rich with an income of 30,000 Y/cap/year only needs to pay it with a price of 0.6 Y/m^3.

The above dilemma results from the incorrect assumption in IBTs: the poor can consume less water than the rich. In several developing countries, this assumption is not right if the household size is taken into account. Consequently, family size should be considered when the price policy is made. The reasons are given as follows:

- Large families in which many children are born often consume large quantity of water. However, the people are often poor. In large families, increasing block tariffs might mean charging much more money from the poor but less money from the rich.
- The water price for small families is lower than for large families. The rich people in small families will use more water because of the low price. In this case, this tariff structure is not useful to conserve water, especially for the rich.
- Water is also recognized as a social good. The rich should subsidize the poor for the objective of equity. But if increasing block tariffs are not correctly

adopted in domestic use, this objective cannot be implemented.

3. IBT-con and IRT-cap, a case study in Weinan City in China

Weinan City is situated in the east of Guanzhong Plain of Shaanxi Province in China. It has a total area of about 126 km^2 with a population of approximately 230,000 people, which means a population density of 1830 people/km^2. Among the whole people, 67% of them are living in urban area.

Water consumption in Weinan City (urban areas) was analyzed to get more insights on the incorrect use of IBT-con. In this city, the uniform rates were employed with the water price of 0.8 Y/m^3 in 2000. This low water price has resulted in high water consumption. The domestic water consumption as recorded by the Weinan Housing Office was averagely 4.2 m^3/cap/month. The relation between water demand and income for household is shown in Fig. 5. In the investigation, a sample of fifty households with different household size and household income was chosen stochastically. The total population in the sample was 166. In the sample, the household size distribution was as following: for one-people household, 6%; for two-people household, 16%; for three-people household, 32%; for four-household, 32%; and for five-people household, 14%. The household income distribution was as following: less than or equal 2000 Y/cap/year, 30%; between 2000 and 10,000 Y/cap/year, 64%; and more than 10,000 Y/cap/year, 6%. The sample was representative compared to the present situation in Weinan City.

Assume the IBT-con shown in Fig. 4 is to be employed in this city. Because of the higher price, water consumption will be affected. But for the poor, even in the low price, they cannot consume much more than their basic needs because of their low income. After increase of the water price, water consumption will not be influenced much because the basic needs mean that low level of water consumption cannot decrease any more. So, water consumption by poor households with an income less than 2000 Y/cap/year is assumed to be the same as before. For the rich, water consumption also will not change too much because water fee only accounts for a small part of their total incomes. So, water consumption by the rich with an income more than 10,000 Y/cap/year is also assumed unchanged. For the households with an income between 2000 and 10,000 Y/cap/year, water consumption is assumed to decrease by 10%.

Base on the above assumption, the IBT-con is analyzed. The results are shown in Figs. 6 and 7. From these two graphs, conclusions can be drawn as follows:

- For the rich, they only need to pay for water with a low price, say 0.6 or 1.2 Y/m^3.
- For the poor whose annual income is less than 2000 Y/cap/year, about 15% of households have to pay water fee with a high water price as much as 3 Y/m^3; nearly half households need to pay the water with a price of 1.2 Y/m^3; the left 35% households pay with a low water price.
- For many poor households, water fee accounts for much more than 4% of their total income, which is not recognized as a reasonable fee; but for the rich, water fee only accounts for a little part of their incomes.

So, this kind of increasing block tariff is not reasonable. It's not equitable for the poor. Although this kind

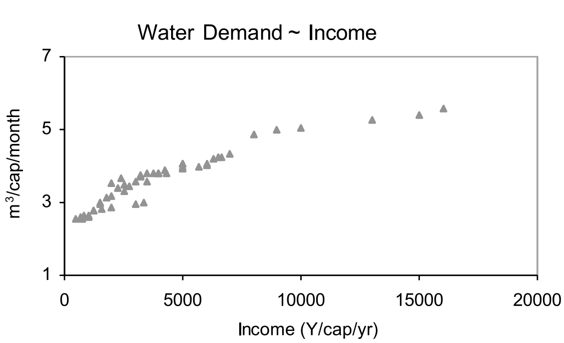


Fig. 5. Water demand and income relation.

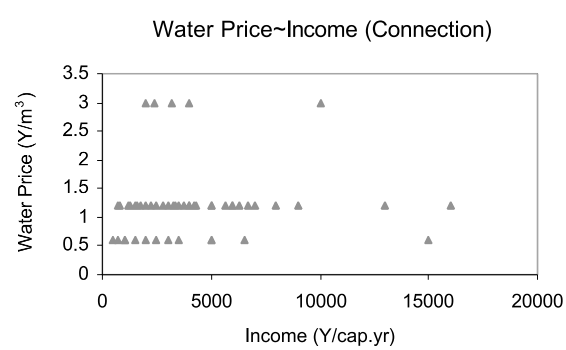


Fig. 6. Water price and income relation in IBT-con.

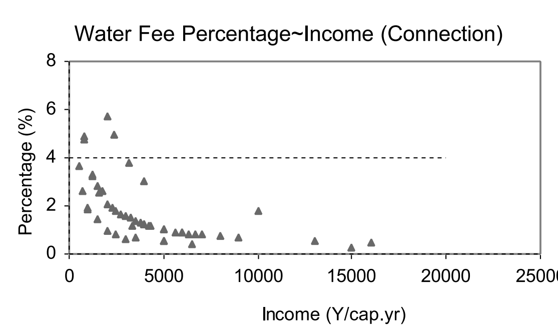


Fig. 7. Water fee percentage and income relation in IBT-con.

of tariff design reflects the economic theory that a high price may decrease water consumption, equity should be considered as well. How to solve the conflict between water conservation and equity? The author suggests that water pricing should be based on the water consumption per capita instead of per connection. The following water price–water consumption relation is suggested for adoption.

The same assumptions are considered for water consumption when IRT-cap is analyzed in this study.

Fig. 9 shows the water price–income relation based on IRT-cap as shown in Fig. 8. The poor with low income only need to pay for the water with a low price, while the rich have to pay more for one unit of water. This is more reasonable for water demand management to achieve sustainable water use, especially for the social equity.

Figs. 7 and 10 shows the water fee percentage–income relation based on IBT-con and IRT-cap separately. When IBT-cap is employed, Water Fee Percentage for the poor will be lower than in the case of IBT-con while for the rich will be higher. It means that the rich have to pay more to subsidy the poor. Also for all of the households it is not more than 4%. All these results show that IRT-cap is much more reasonable compared to IBT-con and other tariff rates. IRT-cap should be recognized as an ideal tariffs to be employed by water resources managers for water demand management.

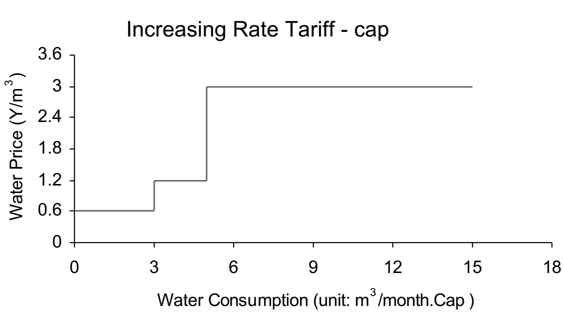


Fig. 8. IRT-cap to be used.

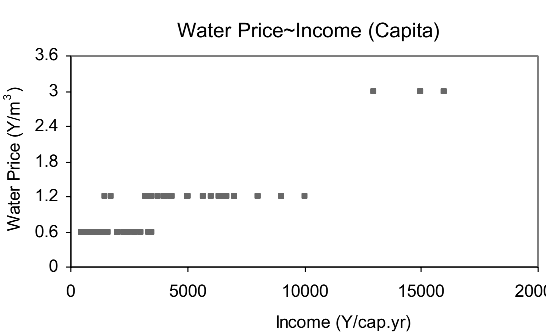


Fig. 9. Water price–income relation in IRT-cap.

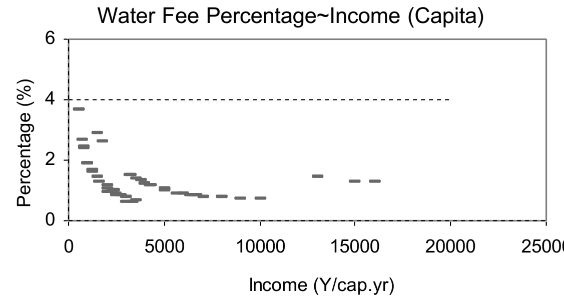


Fig. 10. Water fee percentage and income relation in IRT-cap.

IRT-cap can make up most of the disadvantages in IRT-con. The initial block price is easier to be set because household size is considered in IRT-cap. It can avoid the dilemma argued by Boland and Whittington (2000) that a suitable volume for a household of five, say, 4–5 m/month, does not meet the essential need of a household with 10 members in IBT-con. But this does not means that the first block will certainly be set to the internationally cited standards for basic water needs of 25–30 l/cap/day (WHO, 1997; United Nations, 1993; Gleick, 1996). Local situation is still needed to analysis for the setting of the first block.

IRT-cap seems easier to achieve the objective of cost recovery. By analyzing, the total water fee paid by the household in the sample is 760 Y/month based on IRT-cap while it is only 575 Y/month based on IBT-con. Also for IRT-cap, because the water price is higher for the rich and lower for the poor in this tariff, it can reflect the ability to poor for different people. Due to the cross-subsidy between the rich and the poor, equity can be realized. Poor people with low income can have the access to water for the basic needs, which should not be recognized as an economic good. For the simplicity, it is possible for most users to know what price that they are paying for water. This will lead to the easy implement for this tariff. The proposed statement of water bill is as shown as in Appendix B.

Certainly, No country has employed this IRT-cap up to now because it is proposed for the first time. Pilot projects are necessary to be formulated for verification of this new tariff.

4. Conclusion

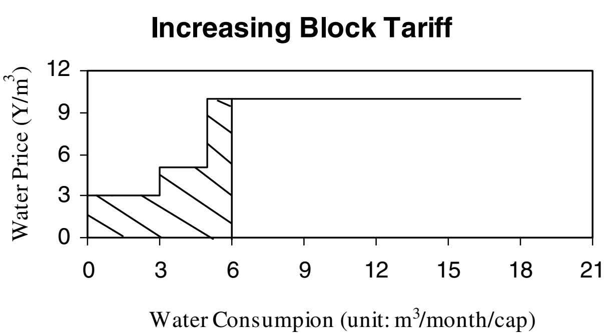
The argument of "Water as an economic good" often focus on the question whether allocation can reasonably be left to free market forces, or it requires some amount of extra-market management. It is found that different water forms/uses have different excludability and subtractability, which will lead to different kinds of economic value of water such as public or private good.

Also water quantity that could be attained in an area determines what kind of good water is.

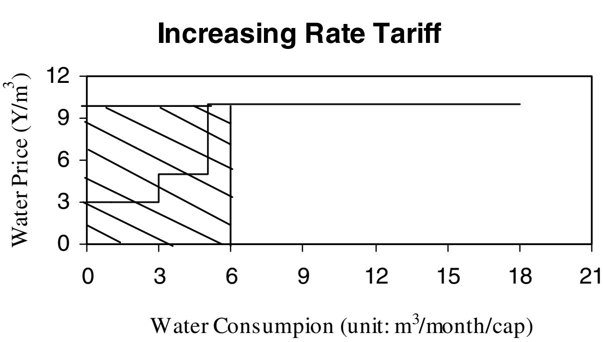
Increasing block tariffs seems to provide an effective tariff structure to achieve the objective of cost recovery and to maintain the equity of the society. But this tariff rate has not been designed well in most developing countries. This paper has discussed the difference between IBT-con and IRT-cap. The case study of Weinan City shows the effectiveness of IRT-cap: It can really achieve the objective of equity. IRT-cap can avoid most of the shortages in IBT-con, such as the difficulties to setting the first block, cost recovery, simplicity, transparency and implementation. This new design of water tariff should be formulated in some pilot projects for verification.

Appendix A. Traditional IBTs and proposed IRTs

A.1. Traditional increasing block tariffs



A.2. Proposed increasing rate tariffs

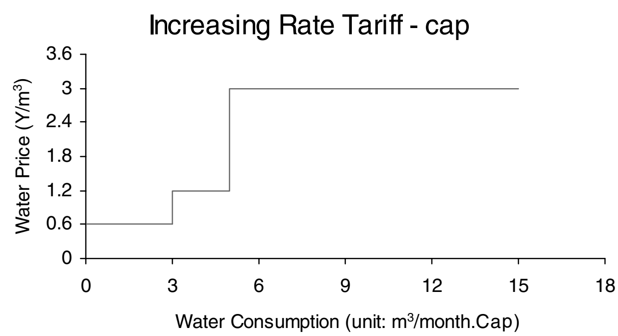


Appendix B. Proposed statement of water bill

Statement of Water Bill by ABC Water Company

User: Liu Junguo
Address: Locker 345, IHE Delft, P.O. Box 3015, 2601 DA Delft, The Netherlands
Tel.: +31(0)618048285
Household Size: 3
Water Consumption
From: Jan 1, 2002 *Water Meter*: 320 m^3
To: Feb 1, 2002 *Water Meter*: 338 m^3
Household water consumption: 18 m^3
Water consumption per capita: 6 m^3/cap/month
Water Price: 3 Y/m^3
Water Bill: **48** Y

Signature:
N.B.: 1. Water Bill should be paid before Feb 15, 2002;
2. The increasing block tariff-cap is shown as follows:



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