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A Methodical Approach to Multi Criteria Sustainability Assessment of Water Pricing in Urban Areas[1]

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1. Introduction

Drastic changes in water pricing policies are likely to occur in the coming years in particular in the fast growing urban areas all over the world. Urban populations are growing as never before. While today 45% of the worlds population live in urban areas those population is likely to increase to 61% by 2025. (GWP 2000)

Large financial resources will be required for maintaining and renewing the existing water service infrastructure or to construct new infrastructure at all to comply with the environmental needs, but also with the needs of the urban poor.

To expand privatisation of water supply and of water and wastewater treatment facilities is often seen as a need to ensure their appropriate, adequate, development and modernization through increased reliance on private capital. The World Bank recently adopted a policy of water privatisation and Full-Cost water pricing. Many developing countries now fear that than water will not be affordable anymore. To pay for water became a common objective even among the critics and opponents of privatisation. Water has an economic value.

Water pricing itself has an direct impact on water use[2] and pollution and therefore on water resources. A sustainable water pricing policy can lead to a reduction of pressure on water resources by reduction of over-abstraction of groundwater resources and a recharge of aquifers, the increase of flows in rivers and the restoration of ecological status of rivers or wetlands. Efficient water pricing also ensures that water infrastructure is adequately designed and that sufficient resources for operating and maintenance are collected. Water pricing, that builds on sustainable principles and therefore influencing local and socio – economic conditions can provide strong incentives for a more sustainable use of water.

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[1] The research was funded by Klaus Tschira Foundation, Germany, Heinrich-Böll-Foundation, Germany, BMBF, Germany and MOS, Israel.

[2] To measure the influence of water pricing on water demand is rather difficult. An important factor in being able to manage metered water effectively is knowledge of its price elasticity of demand. Price elasticity of demand measures the respond of customers to changes in price of demand (E= percentage change in quantity demanded/percentage change in price) In international case studies the residential price elasticity (short run) of demand for total water usage range from -0.1 to -0.26. To measure price elasticity of demand needs to take into account several factors influencing the water demand, which are not only directly related to water pricing but also to altering social and economic condition. For an overview of studies and values of price elasticity of water demand for domestic users see Bartoszczuk, P. and Nakamori, Y. (2002). "Modeling sustainable water prices". Handbook of Sustainable Development Planning: Studies in Modelling and Decision Support. M. Quaddus and A. Siddique. Cheltenham UK; Northamton, MA, USA, Edward Elgar Publishers (to appear).

2. Minimum elements of a sustainable water pricing[3] concept: Multiple and competing policy goals

Sustainable development has many definitions but the perhaps most commonly quoted within the science community is the description given in the report "Our Common Future", known as the Brundtland Report:(WCED 1987)

"Development that meets the needs of current generations without compromising the ability of future generations to meet their needs and aspirations"

Sustainable development is classical portrayed as the interface between environment, economic and social sustainability, but the detail of what this implies in practice of water use and especial of water pricing and tariff setting has been open to much debate.

The concept of sustainable development is used in the management of renewable water resources to ensure that the rate of harvesting a resource is smaller than the rate of its renewal. The availability of water in adequate quantity and quality is a necessary condition for sustainable development. Water, the basic element, is indispensable to sustain any form of life and virtually every human activity. The need of constraining human activities within the carrying capacity of the Earth system has been widely accepted and is written down in the "UN action program for sustainable development" (Agenda 21), which contains a full chapter only devoted to freshwater resources. Dealing with urban water issues the program area "Water and sustainable urban development" was proposed. It clearly states that a better management of urban water resources, including the elimination of unsustainable consumption patterns, can make a substantial contribution to the alleviation of poverty and improvement of the health and quality of life of the urban and rural poor. Furthermore a continued supply of affordable water for present and future needs and to reverse current trends of resource degradation and depletion are mentioned as the most important targets. (UNCED 1993)

Following the approach described above minimum elements of a sustainable water pricing system have been identified to meet the challenge of the water needs of the recent and future generation: [4]

1. Resource use efficiency including ground waters and surface waters;
2. Full Cost Recovery, including Supply Costs, Opportunity Costs and Economic Externalities;
3. Economic viability of the water utility;
4. Equity and fairness for different uses and users.

Obviously, these criteria describe partly competing water policy goals. A sustainable water pricing system aims to achieve a balance among these competing goals reflected by a consent between several different stakeholder groups.

2.1. Resource use efficiency

Water is a scarce resource in both quality and quantity. Efficient use of the water resource is not an end itself but an enabling mechanism to promote a more sustainable use of water. It refers at once to a reduction of total resources costs and a way to

[3] Please note that the term "water pricing" refers to both price level and tariff structure

[4] The scientific literature knows other concepts of sustainable water pricing, but all of them comprise at least the following criteria: viability, efficiency, equity, optimality, see: Dalhuisen, J. M., et al. (2001). "Thematic Report on the Economics of Water in Metropolitan Areas". Metron Project Report. Vrije Universiteit Amsterdam, the Netherlands., Beecher, J. A. and Shanaghan, P. E. (undated). "Sustainable water pricing". http://www.uwin.siu.edu/ucowr/updates/pdf/V114_A4.pdf., Boland, J. J. (1993). "Pricing urban water: Principles and compromises". Water Resources Update. 92(summer).

contribute to an improvement of water quality and quantity, supply reliability and the quality of service and environment. Key attribute is the level of water resource exploitation: Only as much water might be used as naturally recharge within a defined short time horizon.

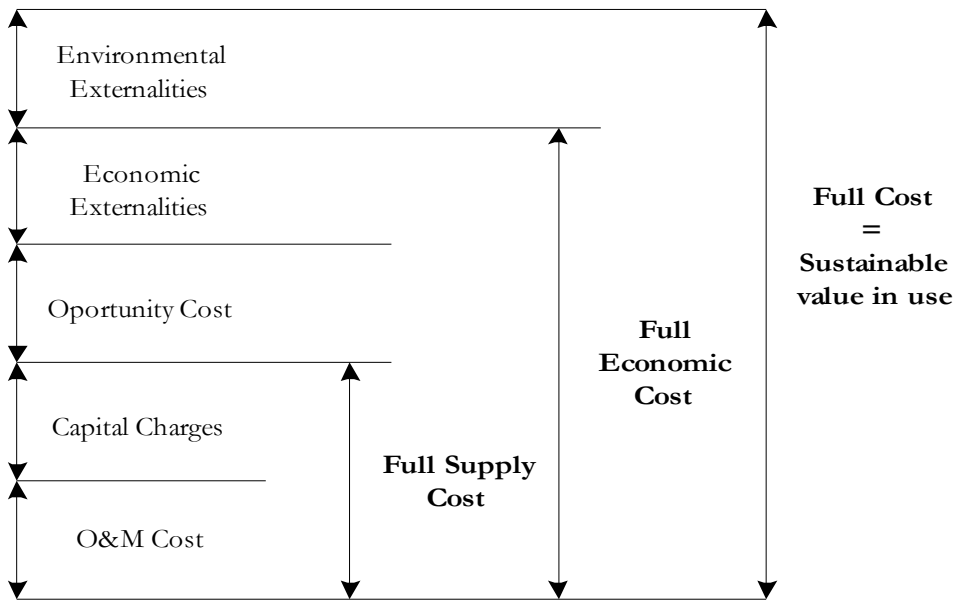
2.2. Full Cost recovery

Regardless of the method of estimation, the ideal for the sustainable use of water requires that the sustainable value of water and the Full Costs should balance each other. Various components have to be added to make the Full Costs of water: The Full Supply Costs and the Full Economic Costs, to which Environmental Externalities have to be added.

Each of these is composed of separate elements: The Full Supply Costs include the costs associated with the supply of water to a consumer without consideration of either externalities nor alternate uses of water. They are composed of Operation and Maintenance Costs and Capital related Costs. The Full Economic Costs of water are the sum of the Full Supply Costs, the Opportunity Costs associated with the alternative use of the same water resource and the Economic Externalities[5] imposed upon others due to the consumption of water by an specific sector. Opportunity Costs address the fact that by consuming water the user is depriving another user of water. If that user has a higher value of water, then there are some opportunity costs experienced by society due to this misallocation of resources.

To the Full Economic Costs the Environmental Externalities have to be added. These costs have to be determined based on the damages caused or as additional costs of treatment to return the water to its original quality.(Rogers et al. 1998)

Figure 1: General principles of Full Cost of water, modified (Rogers et al. 1998)



[5] The most common externalities are: The impact of an upstream diversion of water or the release of pollution on downstream users and over-extraction from or contamination of common pool resources

2.3. Economic viability of the water utility

In general the economic theory serve guiding principles to calculate Full Costs grounded in Marginal Cost Pricing theory. An important issue in estimating the marginal cost of water service is where the next increment of supply comes from and the cost of this supply increment. Marginal cost estimation is a forward looking process, involving forecasts of future costs and future use. Marginal costs can vary within time and location. Unfortunately they may not always generate revenues that match the utility revenue requirements due the fact that long run Marginal Costs typically exceed embedded costs. (AWWA 2000)

At least the Full Supply Cost of water must be covered to guarantee the economic long time financial, managerial and technical capacity of the water utility. (Bhatia et al. 1999), (OECD 1999)

2.4. Equity and Fairness

Most economists assert that economic efficient solutions are equitable[6]. The political definition of equity also takes into account justness, fairness and affordability of water. As far as water is a minimum element of life every human being must be able to access a reliable and affordable minimum of water in quality and quantity. The criteria of affordability does not necessarily undermine efficiency goals or the viability criteria and the criteria of full costs recovery. Efficiency is a necessarily but not a sufficient criteria of sustainability.

This concept of sustainability raises the issue of subsidies, often the only possibility to make water affordable to the urban or rural poor. Subsidies can be paid as internal subsidies amid different users and uses within a water supply system and to a supply system as extern subsidies. External subsidies can be paid as financial assistance to the water system by the government or payment assistance to individuals by governmental or charitable organizations. Most common subsidies are those amid different uses: the urban sector subsidies the agricultural sector, the industrial sector subsidies the urban households. Subsidies between users comprise payments from the economical viable customers to the rural or urban poor. Main target of subsidies should be to make the crucial amount of water for everyday life affordable for everybody, even the very poor:

- The average person needs a minimum of 50 litres of water per day, with 5 litres for drinking, 10 litres for cooking, 15 litres for bathing and 20 litres spent on sanitation needs. (Gleick 2000)
- The water expenditures of a family should not exceed 2 % of the family income. (AWWA 2000)

That also might indicate that external subsidies would have to be paid to the water system by a government or charitable organization to cover Full Supply Costs.[7]

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[6] For competitive goods and services, the concept of economic efficiency encompasses equity in terms of willingness to pay. The equilibrium price reconciles supply and demand, which in turn reflects the producers willingness to produce and the costumers willingness to pay for a good or service.

[7] For a contrary position see Beecher, J. A. and Shanaghan, P. E. (undated). "Sustainable water pricing". http://www.uwin.siu.edu/ucowr/updates/pdf/V114_A4.pdf.

3. Measuring the immeasurable: Indicators for sustainable water pricing

Based on the sustainability criteria mentioned above appropriate indicators for the assessment of water pricing policy were selected.

The use of indicators has many potential benefits and uses:

- Provision of key information related with water pricing;
- Monitoring of the effects of water pricing management decisions;
- Highlight of strength and weakness of water pricing policy and support for the formulation of policies;
- Assistance in assessing investment priorities, project selection and follow-up:
- Providing of an appropriate framework for identifying the main asymmetries between different urban areas.

The indicator system incorporates 3 thematic groups of indicators. Integrated pricing management, water pricing policy and Full Cost recovery. Each of these is composed of separate elements.

The assessment of a water pricing policy cannot be done without taking into account the context information of the water supply system, as well as the characteristics of the region. Therefore, in additional context information indicators were defined to collect all necessary information needed for the assessment indicators which partly derive from. The indicators proposed take into account the actual experience working with indicators in the water sector[8] by analysing case studies.

To describe each indicator and its relation to the comprehensive system the following indicator characteristics are defined:

- The concept to give a definition of the indicator with a concise meaning and unique interpretation;
- The unit of measure;
- The reference value to define a sustainability range by meaning that, if the indicator lies within the value the sustainability criteria are met;
- The critical value to mark a limit value of sustainability;
- The sustainability criteria to identify to which extent the indicator contributes to value of sustainability[9];
- The sustainability weight to represent how important the indicator is to achieve sustainable water pricing[10].

Indicators needs to refer to a well defined time period and geographical area. The model uses one year as the basic assessment period and the urban area as the geographical assessment area. Latter attributes to the political boundaries of urban administration.[11]

For a list of the assessment indicators and their characteristics see the Appendix.

4. Sustainability assessment and decision making: A strategic approach

The model shows that the basic principles of sustainability assessment are being applied to other than purely environmental or purely economic issues. The demand

[8] One of the most developed indicator systems for water supply services was developed by IWA, see: Alegre, H., et al. (1999). "Performance indicators for water supply services". Manual of best practice. IWA.

[9] ++ -high contribution, + - low contribution, 0 - no contribution

[10] 6 - high effect, 3 - average effect, 1 - low effect

[11] In contrary to the urban area the metropolitan area refers to a conglomerate of small urban areas gathered around a large urban area.

for sustainability assessment at higher levels of planning and policy making and strategic planning has given rise to a discussion about the need for an appropriate assessment method or reference framework. This discussion is linked to the question of how sustainable development principles can be introduced in the decision making process.

4.1. Sustainability assessment

Applying the model to a real world water pricing policy for each indicator an evaluation can be made, whether the parameter falls within the reference value or exceed the limit value of sustainability. Once the process has been performed

- a classification can be given for each indicator and as percentage output for each (sub) thematic group;
- fields of needful activity can be identified;
- a first appraisal of for which field urgent actions are needed can be done by taking into account the sustainability weights.

The theoretical aim is to alter the actual water pricing policy in that way that each indicator falls within the sustainability value. The practise will be rather difficult. There is no solution optimising all criteria at the same time. A decision has to be made by finding a compromise solution taking into account the different sustainability weights of each indicator.

4.2. The decision making process

The norm in policy making is that a single criterion is not sufficient. A large number of multi-criteria evaluation methods have been developed and applied for different policy purposes in different contexts. In general, a multi-criteria model presents the following aspects:(Paruccini et al. 1997)

- There is no solution optimising all the criteria at the same time and therefore the decision maker has to find compromise solutions.
- The relations of preference and indifference are not enough in this approach, because when an action is better than another one for some criteria, it is usually worse for others, so that many pairs of actions remain incomparable with respect to a dominance relation.

With a multiple criteria decision aid the principal aim is not to discover a perfect solution, but to create a basic agreement between different stakeholder groups taking part in the decision making process.

Once the fields of activity are identified outranking methods can be used to decide which alternative results in the best compromise. The outranking methods have been recommended for situations with a finite number of discrete alternatives to be chosen among. The number of decision criteria and decision makers may be large. An important advantage of outranking methods, when compared to other decision support techniques is the ability to deal with ordinal and more or less descriptive information on the alternative plans to be evaluated. Furthermore, the uncertainty concerning the values of the criterion variables can be taken into account using fuzzy relations, determined by indifference and preference thresholds. The difficult interpretation of the results, on the other hand, is the main drawback of the outranking methods.(Kangas et al. 2001)

4.3. Moderating conflicting policy goals of different stakeholder groups

Conflicting policy goals have been identified and therefore procedures for consensus building and conflict management are central to a successful sustainable water pricing policy. In general conflicts can occur for many reasons including independence of people and responsibilities, jurisdictional ambiguities, functional overlap, competition on scarce resources, differences in organizational status and influence, incompatible objectives and methods, differences in behavioural style, difference in information, distortions in communication, unmet expectations, unmet needs or interests, unequal power or authority, misperceptions and other. (GWP 2002)

Gaining a shared version of a sustainable water price of different stakeholder groups a moderating process were initiated. The identified indicators of the sustainability assessment model were assessed by different stakeholder groups by appraising the sustainability criteria and the general sustainability weight for each indicator.

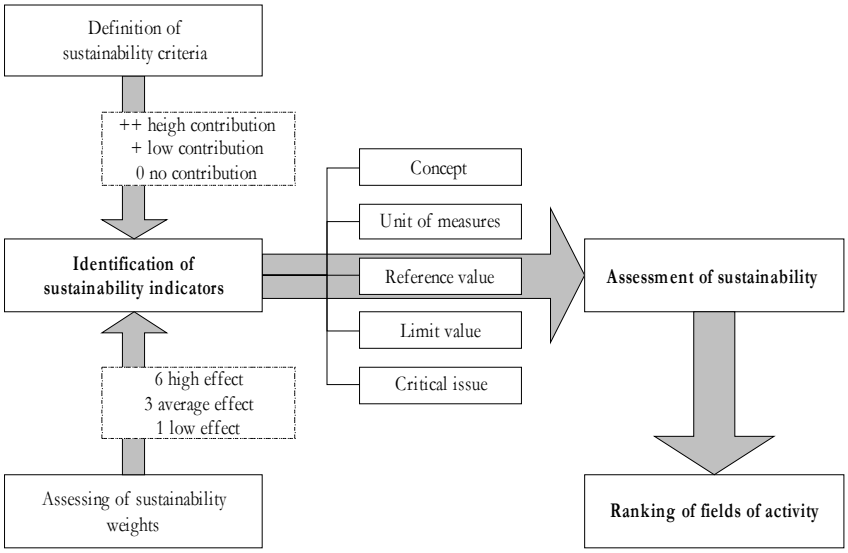
Out of the four identified sustainability criteria for water pricing the following areas for potential conflicts have been identified: [12]

- Full cost recovery;
- Economic viability of water utility
- In assessing the general sustainability weight for each indicator differences occurred within the following indicator fields:
- Analysis and demand of water;
- Use of subsidies and incentives;
- Full economic cost.

Differences in objectives are seen as the main reason. Managing these conflicts means for all stakeholders to move beyond possible bargaining and the claim/counter claim process. By identifying differences and possible conflict areas it becomes possible to understand which interests lie behind each sides position. Furthermore, win-win situations can be identified, that meet as much as possible of the interests of all the stakeholder groups. It has to be stressed, that especially in the field of water pricing issues, not all situations can be resolved with win-win situations in a short term. Trade off and compromises are often a necessary outcome.

[12] The following method has been applied in practise: In a structured email interview for each indicator the influence of the identified sustainability criterion had to be assessed and a general sustainability weight had to be named by different stakeholders summarized in two main groups: Lobby group of economics and lobby group of environment. Please note that out of 50 stakeholder asked only approx. 40 % answered were received and evaluated. The evaluation doesn't claim to be a universal categorization, but shows a possible method of stakeholder participation and conflict resolution by managing disputes

Figure 2: Strategic approach



5. Putting the model to a practical use – first steps

5.1. Overview about water pricing in urban Israel – the case of Tel Aviv-Jaffa

5.1.1 The water tariff: Increasing Block Rates

All fresh water served in Israel by the national water supplier MEKOROT is paid by Increasing Block Rates charging Increasing Volumetric Rates for increasing consumption. Increasing Block Rates require metering. By law all water served in Israel is metered. Increasing Block Rates need to define consumption blocks over which rates increase. The rates usually are designed by costumer classes (residential, agricultural, industrial). Theoretically, properly designed Increasing Block Rates recover class specific cost of service while sending a more conservation oriented price signal to the classes. Therefore Increasing Block Rates have been favored in relatively water scarce regions.

But the price signal of Increasing Block Rates will only be sent, if the water price is calculated in economic terms, not by administrative policy decisions as it is still the situation in Israel

5.1.2 The water prices: Volume rates per administrative sectors

In Israel two water price types have to be distinguished: The water price the municipality has to pay to MEKOROT getting water from the national water supplier and the water price consumers have to pay for their uses. Water prices for urban water uses for the different administrative sector of the last years are represented in .

If there is no residential consumption at all but a water meter is installed a very small Minimum Charge of NIS 16.20 per billing period is requested. Large families have a discount (Levi 2002).

Table 1: Tel Aviv – Jaffa urban water prices, 1997-2002, in NIS[13]

MEKOROT water price, which the municipality has to pay					
				2000	2002
Residential				1.474	1.53
Industrial				1.436	1.492
Agricultural				0.89	0.857
	1997	1998	1999	2000	2002
Residential customer water price, 2 month billing period					
0-16 m³	2.32	2.35	2.54	2.69	2.69
16-30 m³	3.42	3.47	3.76	3.99	3.99
>30 m³	4.97	5.04	5.45	5.78	5.78
Industrial					
Per quota	1.20	1.39	1.40		
Agricultural (urban)					
Per quota	0.85	0.88	0.92		

The difference between what the municipality of Tel Aviv–Jaffa has to pay to MEKOROT is supposed to be used for operating and maintenance expenses, taxes and capital related costs of the water system, but in reality most of the municipalities deserve a certain income used for general purposes of the municipality. So the additional income is used similar to a general tax income. In 2000 the additional income of the municipality of Tel Aviv-Jaffa amounted to NIS 1.924 Mio. Therefore in general every municipality has no economic interest that its customer saves water, but on the other hand the possibility to make some profit also engages the municipality to operate efficiently.

5.1.3 Supply and consumption behaviour and affordability of the water price

The supply network of Tel Aviv - Jaffa today is asked to meet the need of about 350,000 inhabitants and some 700,000 commuters working in the city or coming as a tourists daily. All water for institutional, public, commercial and industrial purposes has to be added. Following the overall water policy of Israel the actual urban water policy of Tel Aviv-Jaffa is supply oriented.

Water in Israel is defined per law as a public property. So far every municipality in Israel gets as much water as the municipality asks for water from the governmental supply company MEKOROT [14].

The general level of the total urban water consumption[15] in Tel Aviv-Jaffa is much higher compared with the consumption in other developed countries. The same picture can be drawn for residential water consumption only. But assessing the data one has to take into account the large number of commuters and illegal workers, which redoubles the number of urban consumers. In 2000 the residential water consumption amounted for 201.61 Litre/capita/d.

Providing water to all customers at an affordable price is a basic requirement in every society. Less affluent households have less flexibility in their budgets to absorb water bill increases. Due to the fact that there are no substitutes for portable water the customer can not choose a lower priced alternative. When customers have difficulties paying their bills, the cost to the utility is raising, too due to late payments, disconnec-

[13] Due to the economic situation the Israeli currency varies strongly: Annual Exchange Rate for US$ 1: 1999: NIS 4.14; 2000: NIS 4.0773; 2001: NIS 4.2056; 2002: NIS 4.8867, Source: http://www.bankisrael.gov.il/deptdata/mth/average/averge.htm

[14] Water for agriculture and industry is served by means of quotas.

[15] The urban consumption is here defined as the total water consumption in the urban area (residential, industrial, agricultural, public, trade and commercial) for a specific year, divided by the number of residents in the city in that year.

tion notices and service terminations etc. This associated collection costs and bad debt write-offs increase all other costumer bills.

Compared to other developed countries the water price in Tel Aviv-Jaffa is moderate. But to assess the affordability of water one has to take into account the income of the customers, the general consumption expenditures and the consumption behaviour, too.

In 1999 only 0.19 % of the average monthly consumption expenditures were used for water, but e.g. 18.6 % for transportation.

Assessing a water price needs to orientate towards affordability issues. For the group of households, whose family head is employed only 1.31 % of the minimum wage has to paid for water. (Tal 2000) As mentioned above special assistance to households is only needed, where the water bill exceeds 2% of the average income (AWWA 2000).

In the group of family whose head is unemployed are approx. 16,800 families (out of 349,045 in urban total) The cost of water represent in this group amounts to 2.6% of their income.

As shown above the water price not only accounts for a minimum of consumption expenditures, but also represents an easy affordable percentage of the average income. Rising the water price could send an important signal to reduce the urban water consumption. Special assistance is needed for low income families on the basis of their real income (e.g. low income affordability rates).

5.1.4 Use of subsidies and incentives

Every water supplier is asked to charge its costumers to cover the Extraction Levy. The municipality of Tel Aviv – Jaffa on whom an Extraction Levy has been imposed is entitled to collect the same amount of money per water unit supplied from the water consumer, but at the same time the municipality is only allowed to charge prices posted by the government. Furthermore it is questionable if the municipality charges their consumer cost recovery fees at least for the water produced from their own wells.

The water prices of MEKOROT, calculated on an average cost basis, are very low and don't reflect the scarcity of water at the present time. The first step was done with the recently introduced Extraction Levy. But, if the Extraction Levy is collected at all, the amount of money received is simply entering the general national budget and is not used for environmental purposes. Hopefully it will cover at least the 20% the government is paying to MEKOROT to fill up the public company's deficit. Today the public company only covers approx. 80-85% of its costs, the difference is covered by the state by general taxes (Kislev 2002). In 1994 the Cost Plus method used by MEKOROT to calculate water costs was replaced by a more Supply Cost oriented method in which the fixed and variable costs were defined, and a 2.5% efficiency factor was imposed on the company's performance. An increase in water prices coupled with improved performance (saving in energy costs and other variable and fixed costs) have resulted in a significant reduction in the Government's subsidy from 40% to 20% over the last years. Under the current water price and tariff structure, water supplied to the most urban and industrial consumers covers the Supply Cost, while water supplied to agriculture and urban costumers in remote and hilly areas is partially subsidized. Since the agricultural price is much lower the urban consumers subsidize the water for agricultural purposes. The costs of water which is being supplied over long distances or to hilly costumers are much higher than municipalities have to pay for it. The intention to subsidize water for certain administrative sectors was and still is to serve national policy goals. Nearly self-sufficiency in food production is still an important national target although the number of imported products has been raising

permanently over the last years. The foundation of new settlements far away from urban centres or in the dessert is still an important goal. Both examples require the transport of high values of water over long distances. But at present time the national agricultural policy goals are changing resulting in smaller water quotas for the agriculture sector and higher prices.

To reduce leakages every municipality will be punished with a fine if it has more than 12% water losses a year. A special water administration was set up to monitor and collect the contributions to the Water Networks Rehabilitation Fund, which is managed by the Municipal Waterworks Association The money is used to assist municipalities in investments and renewals of their water networks. In 2000 water losses in Tel Aviv-Jaffa amounted to 11.9 % of the system input volume. The average water loss in Israel accounts for 10%.

5.2. Is the current water price sustainable? An application of the assessment model to the water pricing policy of Tel Aviv-Jaffa

In a large number of personal interviews and by a comprehensive literature survey data for all indicators were collected to evaluate the current water pricing concept of the urban area of Tel Aviv-Jaffa. It has to be mentioned that, as far as every urban area in Israel can get as much water as it wants to get from the national water supplier MEKOROT, for an assessment of the availability and use of water resources national resources and use were taken into account.

By applying the model different fields of activities have been identified. Several indicators exceed the critical sustainability value: (see Appendix: yellow marked indicators)

Table 2: Selection of indicators with a critical sustainability value (Tel Aviv-Jaffa, year 2000, sustainability weight: 5 and 6)

Critical indicator	Critical sustainability value
Use of natural water resources	Recently Israel utilize more natural water than naturally recharged (103%)
Level of water bill in relation to consumption expenditures per household	Only a very small interest of consumption expenditures (0.19%) is used for covering the water bill. The water price is to low.
Level of water bill in relation to average family wage	Only 0.48% of the average family wage has to be paid for water. The water price is to low.
Marginal Cost pricing in use	Due to the fact that no marginal cost pricing is in use no accurate price signal is send to the customer.
Full supply cost coverage	Supply costs of water are not fully covered. Economic viability of the water utility is questionable.
Operating cost coverage	No operating costs are covered. Economic viability and efficiency of the water utility is debatable.

As far as several indicators weighted with a high effect on sustainability are affected the actual water pricing system can not be named sustainable and urgent actions are needed to improve the urban water pricing system of Tel-Aviv-Jaffa. By using one of the outranking methods mentioned above it can be decided which alternative action would lead to the best compromise.

Appendix: List of Indicators, their characteristics and a first practical application

Indicator	Concept	[Unit of measure]	Reference value	Limit value	Critical issue	Sustainability criterion: Resource use efficien-cy	Full cost recovery	Economic viability of water utility	Equity and Fairness	Sustainability weight	year 2000 Tel Aviv-Jaffa
Integrated Pricing Management											
Analysis of Economic Setting, Development Objectives and Policies											
Metropolitan Water System Profile											
Differentiation of water supply source	Water supplied from different sources	% of the vol. produced from a single source	<50%	<80%	Quantity of drinking water not guarantied in the event of a water supply crisis	++	0	+	0	2	85%
Central water supply	Water supplied by a central system	% of population with access to central water supply	80-100%	<80%	Minimum quantity of drinking water not guarantied	++	0	+	++	3	100%
Full time supply	Reliable full time supply 24h a day	yes/no	yes	no	Minimum quantity of drinking water not guarantied	+	0	0	++	4	yes
Water Resource Assessment											
Availability and Use of Water Resources											
Use of natural water resources	=Real annual water abstraction / Reliable annual yield of natural resource x100	%	<100%	>100	Level of water resource exploitation: A value of more than 100% means that more natural water is being used than naturally recharged.	++	+	+	0	6	103%
Analysis of Demand and Supply of Water											
Water Balance for a Water Supply System											
Inefficiency of use of water resources	=Water losses / System input volume x 100	%	<40%	<60%	Sub-optimal performance and achievement of infrastructure, future level of investment, absence of gua-ranties of water supply	++	+	++	0	3	8%
Revenue water by volume	Value of revenue water as % of system input volume	%	>60	<60%	Absence of guaranties of economic viability of water utility	+	++	++	0	5	88%
Non revenue water by volume	Value of non-revenue water as % of system input volume	%	<40%	>40	Absence of guaranties of economic viability of water utility	+	++	++	0	5	12%
Consumption and De-mand											

Total per capita consumption	=System input volume / Population served/365	l/capita/d	<300	>300	Wastefulness use of water	++	+	+	0	5	373,59
Consumption per type of customer-residential	=Residential consumption / residential customers / 365	l/capita/d	<120	>120	Wastefulnes use of water by residential customers	++	+	+	0	5	196,34
Costumer Analysis, Metering and Billing											
Residential customer meters	as % of Customers for residential use	%	80%-100%	<80%	Management difficulties, sub-optimal tariff setting and billing	++	+	+	++	5	100%
Residential customer meter reading frequency	pre-defined frequency of meter readings per residential customer meter targeted within the water undertaking per year	number/a	6-12	<6	Absence of information and incentive signal to customer	++	+	+	++	4	6
Residential customer billing frequency	pre-defined frequency of billing per residential customer targeted within the water undertaking per year	number/a	6-12	<6	Absence of information and incentive signal to customer	++	+	+	++	4	6
Type of residential customer meter	apartment meters as % of residential customer meters	%	80	<80%	Management difficulties, Limited possibilities to set specific water conservation oriented tariffs	++	0	0	++	3	no data
Industrial/agricultural customer meters	as % of Customers for industrial/agricultural use	%	100%	<80%	Management difficulties, sub-optimal tariff setting and billing	++	+	+	++	5	100%
Industrial/agricultural customer meter reading frequency	pre-defined frequency of meter readings per industrial/agricultural customer meter targeted within the water undertaking per year	number/a	6-12	<6	Absence of information and incentive signal to customer	++	+	+	++	5	6
Industrial/agricultural customer billing frequency	pre-defined frequency of billing per industrial/agricultural customer targeted within the water undertaking per year	number/a	6-12	<6	Absence of information and incentive signal to customer	++	+	+	++	5	6
Public/institutional meters	as % of Customers for public/institutional use	%	100%	<80%	Management difficulties, sub-optimal tariff setting and billing	++	+	+	++	5	100%
Public/institutional customer meter reading frequency	pre-defined frequency of meter readings per public/institutional customer meter targeted within the water undertaking per year	number/a	6-12	<6	Absence of information and incentive signal to customer	++	+	+	++	5	6
Public/institutional customer billing frequency	pre-defined frequency of billing per public/institutional customer targeted within the water undertaking per year	number/a	6-12	<6	Absence of information and incentive signal to customer	++	+	+	++	5	6

Coverage of large volume users	Identification of large volume users	yes/no	yes	no	Absence of information and incentive signal to customer	+	+	+	0	3	yes
Coverage of large pollution users	Identification of large pollution users	yes/no	yes	no	Absence of information and incentive signal to customer	+	+	+	1	3	yes
Social Impact Assessment											
Demographic analysis											
Population with access to safe water	=Resident population within the supply area supplied by the undertaking	% of resident population	95-100%	<85%	Reduced hygienic and sanitary safety, Pricing policy and management difficulties, future level of investment	0	++	0	++	5	100
Population with access to adequate sanitation	=Resident population within the supply area with adequate sanitation	% of resident population	95-100%	<85%	Reduced hygienic and sanitary safety, Pricing policy and management difficulties, future level of investment	1	++	1	++	5	100
Population growth	Forecasted average yearly growth of resident population	%/a	0.5-1%	>2%	Absence of guaranties of capacity of water supply infrastructure	0	++	+	++	2	1
Water Pricing Policy											
Analysis of Tariff Level											
Water price and demand											
Average water price per type of customer-residential	Water price per unit	$/m³	1-2 (given a central supply system)	<1	Level of water price to give a price signal (Please see also Price elasticity)	0	++	++	0	3	0,66
Price elasticity of residential water demand	=Change in use as % of original use level/Change in price as % of original price level	negative ratio	>-1	<-1	Sensitiveness of water use relative to changes in the price of water	+	+	+	0	3	<-1
Level of water bill in relation to consumption expenditures per household	Expenditures for water as % of consumption expenditures	%	10	>10	Level of water price to give a price signal	0	+	+	++	5	0,19
Level of water bill in relation to average family wage	Expenditures for water as % of average family wage	%	<5%	>5%	Affordability of water not guaranteed	0	+	+	++	5	0,48
Analysis of Tariff Setting											
Rate design											
Design by customer class	Rate design by customer class	yes/no	yes	no	Identification of customer classes, customer specific cost allocation	+	+	+	++	5	yes
Fixed charge	Partly fixed payment for water supply service	yes/no	yes	no	Full Supply Cost, Coverage of fixed costs	+	+	++	+	3	no

Water conservation rate in use	Use of rate to motivate to save water	yes/no	yes	no	Water conservation	++	+	0	0	5	yes
Marginal cost pricing in use	Added cost of producing or acquiring incremental supplies or capacity	yes/no	yes	no	Optimal rate to send the accurate price signals to customer, Typical mismatch of revenues to actual costs	++	++	++	0	5	no
Use of Subsidies and Incentives											
Subsidies											
Cross sector subsidies	Subsidies for a specific sector	yes/no	no	yes	Subsidisation of water use by one sector, Accurate price signal, Cost coverage	+	++	+	++	3	yes
Subsidies for the poor	Subsidies for low income families	yes/no	yes	no	Affordability of water use by the poor	0	-	-	++	3	yes
Full Cost Recovery											
Full Economic Cost											
Full Supply Cost											
Full supply cost coverage	=Total revenue/(Total O&M expenses +Total capital related costs +Total taxes)	ratio	1.5	<1	Economic viability of water utility	0	+	++	0	5	1,01
Operating cost coverage	=Total revenue/ Total O&M expenses	ratio	>1	<1	Economic viability of water utility, Efficiency of water utility	0	+	++	0	5	1,24
Level of capital related costs	as % of Total revenue	%	20%-50%	>50%	Economic viability of water utility, limited economic elbowroom	0	+	++	0	3	11,58%
Opportunity Cost											
Coverage of costs due to misallocation of water resource		yes/no	yes	no	Undervaluing of water, Misallocation of water resource, which needs to be shared between different users	0	++	0	++	3	no
Economic Externalities											
Coverage of costs due to the impact of an upstream diversion of water		yes/no	yes	no	Undervaluing of water	0	++	0	++	3	no
Coverage of cost due release of pollution on downstream users		yes/no	yes	no	Undervaluing of water	0	++	0	++	3	no

Coverage of cost due to over-extraction from common pool resources	yes/no	yes	no	Undervaluing of water	0	++	0	++	3	yes
Coverage of cost due to contamination of common pool resources	yes/no	yes	no	Undervaluing of water	0	++	0	++	3	no
Environmental Externalities										
Coverage of costs of public health and ecosystem maintenance	yes/no	yes	no	Up keeping of public health and ecosystem quality	0	++	0	++	3	yes
Sewage treatment charge in use	yes/no	yes	no	Additional costs of treatment to return water to its original quality	0	++	0	0	3	yes

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