CONTINGENT VALUATION OF RIVER POLLUTION CONTROL AND DOMESTIC WATER SUPPLY IN KENYA

by

WILSON S. K. WASIKE

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"Even when we consider such simple organisms as one-celled protozoa, it certainly makes perfectly good sense to speak of what benefits or harms them, what environmental changes are to their advantage or disadvantage, and what physical circumstances are favourable or unfavourable to them "

Taylor (1986), *Respect for Nature*, p 66

"Many people . will leave their spouses for a month to do a job they do not like in order to earn some money And yet they will not agree to leave the spouse for the same month for an offer of money, even a significantly larger sum of money They will feel indignant that someone supposes they are willing to trade the company of their spouses for money from a stranger The explanation of such reactions is familiar First people are sensitive to the motives behind various offers, and to their symbolic significance They may, for example, accept money if they believe that it is offered out of genuine willing friendship, but not otherwise Second, certain actions have a symbolic significance . . *what has symbolic significance is the very judgement that companionship is incommensurable with money* "

Raz (1986), *The Morality of Freedom*, p 348f

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ABSTRACT

The basic theme of this study is that determination of the economic value of water resources is a necessary condition for rational decision-making and management of these environmental assets, and their associated public goods, in developing countries The research particularly evaluates the contingent valuation (CV) method as a technique for evaluating increments and decrements in environmental and natural resource service flows, and estimates households' evaluations for improvements in river water quality and connections to piped water supply for domestic uses

The study objectives were to (a) estimate the economic value of piped water supply and improved water quality in the Nzoia River Basin, Kenya, (b) evaluate the feasibility of using the CV technique to value an environmental amenity and its related quasi-public service in rural settings where respondents have limited education and monetary resources, (c) examine the role of temporal dimensions of bid payments (i e , frequency of payments) in contingent values for environmental commodities, (d) empirically investigate embedding effect bias in contingent valuation of improvements in river water quality improvement in a less developed economy, and (e) evaluate the role of water connection charges in households' willingness to hook onto piped water supply in Webuye Division, Kenya

Empirical analysis and estimates of the non-market value which local people assign to water quality in the Nzoia River and a private household water connection is based on a detailed survey of a representative sample of 311 households in Webuye Division of Bungoma District, Kenya In an on-site survey carried out in May through September 1995, contingent markets were developed for the two goods (1) improved river water quality, and (2) provision of a private connection to water supply The corresponding willingness to pay (WTP) values are explained using Ordinary Least Square regression models Whatever the good, the WTP is seen to increase with income However, the effects of other factors are more specific to the contingent good In order of strength, the other determinants of WTP "quality" are sex, age, household ranking of status of domestic water source, distance from river to household residence, the other factors affecting WTP "connections" are existing source of water supply, household size, ranking of river water quality, and age of household head On the whole, residents accepted the exercise of contingent valuation and were willing to pay important amounts (Ksh 459 and Ksh 386 on average per household per year, respectively, for goods 1 and 2)

Discussion issues include policy significance of the resulting WTPs in terms of the demand for river pollution control and individual household water connections, the effect of the goods upon the CV evaluation process, the "Third World" impacts of frequency of payments in contingent valuation, including perceived-frequency and income-smoothing routes, the embedding effect in WTP values for water pollution abatement in the Nzoia River basin, the importance of pricing influences, specially payment profiles for initial connection charges, on household decisions to connect to piped water systems, and limitations of the study

CHAPTER I

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 INTRODUCTION

Information on the value of water availability, quality and application in alternative uses is relevant to both public and private decision making (Saliba *et al*, 1987, Colby, 1989) Examples of situations in which estimates of water value may be useful include a famer deciding whether to sell water rights or to continue to use them for irrigation, a city or unit of local government evaluating whether to buy senior appropriative rights to firm up their supplies, a court assessing the monetary damages associated with impairment of a surface water right and an environmental organisation seeking to purchase water rights for instream flow protection

Indeed, comparison of water's value in various uses (i e, instream, agricultural, municipal and industrial uses) and locations assists public water agencies in making decisions about the management and allocation of publicly supplied water, and can contribute to the comprehensive evaluations of benefits and costs of water-related projects and policies In the absence of such water value estimates, insufficient resources would be allocated by society to (a) conservation of environmental assets (such as water quality) which development activities may degrade, and (b) judicious and integrated management of improved environment-related infrastructure (such as access to potable domestic water) for the betterment of human life

In the last two decades or so, there has been a lot of discussion on how to employ economic analysis to value environmental benefits and costs of development programmes and projects This discourse has been particularly intense owing to the unique aspects that characterise environmental assets like water resources features which render a smooth operation of a conventional market futile The failure of markets to achieve efficient allocation of environmental resources is often attributed to the existence of externalities, the publicness of environmental and ecological goods, difficulties in enforcing property rights[1], and difficulty in valuing future entitlements owing to the absence of intergenerational markets

We can see the failure of markets to allocate environmental resources efficiently as a result of the impossibility of pricing these resources on markets properly Consequently, prices of goods and services bought and sold on markets may not reflect true social costs Hence the basic problem is the failure of the market incentive system to take environmental aspects into account[2]

Environmental valuation for decision making is challenging for three reasons First, many environmental goods (for example, improved domestic water supply) and bads (for instance, coastal flooding or erosion such as loss of a beach) have no market prices that can be used to put a value on each of the many consequences Secondly, whilst economic theory argues that all changes can be valued (Pearce and Markandya, 1989, Pearce *et al*, 1989, Hanley and Spash, 1993), environmentalists have explicitly rejected economic approaches to valuation of some environmental changes (Bowers, 1990, Friends of the Earth, 1990, Hopkinson *et al*, 1990, Holland, 1995) Equally,

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[1]Hardin (1968) has superbly described the tragedy of the commons which is based on the lack of well defined and enforceable property rights When a property right cannot be enforced, an overuse of that property can be expected In the case of ecological and natural property, this is partly the cause of environmental problems like pollution, soil erosion, and extinction of species of fauna and flora Hardin's arguments have recently been considerably developed by authors like Bromley (1990) and Ostrom (1990)

[2]For a deeper discussion on this issue see Maler (1985), chapter 1

basic economic theory has itself been subject to increasingly critical review (Sen, 1977, 1987, Lutz and Lux, 1988, Saggoff, 1988, Daly and Cobb, 1990) Thirdly, choices are difficult because the issues themselves are complex These reasons indicate that economic analysis should always be used critically as an aid to decision making, rather than as a substitute for thought

Environmental economics research in the last two decades has greatly extended the range of techniques available for the monetary evaluation of environmental damages and benefits The main techniques that have been used in the estimation of the economic value of ecological and natural resource services are travel costs, hedonic pricing and the contingent valuation (CV) approach[3]

This study is a developing country application of the CV approach to assess willingness to pay for improvements in water resources management CV is seen as the most suitable methodology for three reasons First of all, people do not travel away *en masse* from areas where river pollution is occurring or where there is no water thus ruling out the travel cost approach (costs of dispersion away from a public 'bad' are always likely to be more difficult to measure than travel costs towards a public good)

In addition, it is felt that the level of river pollution and poverty of domestic water supply are not significant arguments in house prices, thus eliminating hedonic pricing from consideration Lastly, CV is itself is under investigation owing to the fact

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[3]Even though this dissertation selectively discusses aspects of the theory, practice and complexities involved in nonmarket valuation in Chapter 3, a fuller discourse is beyond the scope of this chapter However, it can be found in Cummings *et al* (1986), Mitchell and Carson (1989), Cambridge Economics (1993), and Hanley and Spash (1993) Surveys specific to particular environmental media are found in Smith and Desvousges (1986) and Feenberg and Mills (1980) for water quality, and Halvorsen and Ruby (1981) for air pollution

that its accuracy is a matter of substantial importance in cost-benefit assessments and litigation over liability and damages Hedonic pricing and travel costs are inferential valuation approaches often used when a defensible case can be made that expenditures for market goods, such as homes and travel-related items, are linked to the value of the nonmarket amenity being valued[4]

1.2 THE MANAGEMENT OF WATER RESOURCES IN KENYA

Hirji (1990), in chapter 2, and Wasike (1993) provide a comprehensive discussion of the overall management of the environment and natural resources in Kenya since political Independence, this section is restricted to social, legal and institutional contexts in which water as a natural resource is managed and conserved Lack of potable water services for rural and urban households as well as water pollution from industrial development are undoubtedly two key issues that epitomize the planning-management problem in Kenya's water resource sector (e g Thitai, 1981)

The responsibility for managing and developing natural resources after Independence followed sectoral lines Water, agriculture, and energy developments, for instance, are each the responsibilities of individual Government ministries The creation of ministries is accomplished in a variety of ways ranging from Presidential decrees to Acts of Parliament It is important to note here that the mooting of ministries concerned with particular environmental resources has been a principal

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[4]For instance, statistical analysis of sale prices for similar homes with and without lake front access provides information on the additional amount home buyers are willing to pay for lake front amenities Such information would then be useful to developers, real estate professionals, and policymakers in evaluating the benefits of preserving lakeside environments

factor in the prevalence of sectoral legislation in Kenya This has been so because legislation governing the natural resources has grown out of perceived needs within each sector Laws have been used to establish binding policies and standards, to provide a basis for substantive and precedural regulations, and to create institutions to complement policies and enforce rules (Tolentino, 1986)

There are 15 laws in Kenya relating to the conservation of natural resources[5], and 15 others relating to pollution control[6] Most laws are statutory instruments that support individual sectoral units (e g , The Water Act, The Agricultural Act, etc) Only a few emanate from common law doctrine Typically, these laws narrowly define what should be done, rather than provide broad based programmes to address the degradation of the environment (Kinyanjui and Baker, 1979) The discussion below introduces the Ministry and organizations that share water resources management responsibilities in Kenya Hirji (1990) and UNEP (1987) provide a detailed account of the institutional framework within which the environment and natural resources are managed in Kenya

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[5]Laws relating to resources conservation include The Water Act, The Agriculture Act, The Forests Act, The Land Planning Act, The Fish Industry Act, The Plant Protection Act, The Local Governnment Act, The Government Fisheries Protection Act, The Lakes and Rivers Act, The Town Planning Act, The Kerio Valley Development Development Authority Act, The Lake Basin Development Authority Act, The Tana and Athi River Development Authority Act, The Wildlife Conservation and Management Act, and The Grass Fires Act (UNEP, 1987 76)

[6]Laws concerning pollution control include The Water Act, The Public Health Act, The Factories Act, The Food, Drugs and Chemical Substances Act, The Pharmacy and Poisons Act, The Fertilizers and Animal Foodstuffs Act, The Use of Poisonous Substances Act, The Cattle Cleansing Act, The Agricultural Produce Act, The Pest Control Products Act, The Radiation Act, The Traffic Act, The Penal Code, The Merchant Shipping Act, and The Kenya Bureau of Standards Act (UNEP, 1987 76f) Note that the Water Act deals with both conservation and pollution control

The Ministry of Water Development (MWD) was created in 1974 by a Presidential decree Prior to 1974, water management was carried out by the Ministry of Agriculture The revised Water Act of 1972 provides the Ministry of Water Development the legal authority to enforce its provisions, and it gives the Minister total responsibility for controlling the use of Kenya's water resources The Ministry of Water Development also oversees water withdrawals and water quality protection The MWD does not, however, implement all water projects, only those involving national sanitation and water supply Projects for irrigation or power generation are implemented by specialized agencies, such as the National Irrigation Board and the river basin authorities

The Ministry of Water Development's Water Pollution Control Department reviews the water quality aspects of industry applications that are referred to it by the Ministry of Industry The Water Pollution Control Department is responsible for protecting water quality in Kenya It monitors and enforces regulations for industrial and domestic wastewater treatment The Water Pollution Control Department also reviews the applications for industrial water permits submitted to the Water Apportionment Board of the Ministry of Water Development[7].

[7]See Thitai (1981) for a complete list of the information requirements of the Water Pollution Control Department for new industries

1.3 THE STUDY AREA

This section is an overview of background information to a recent contingent valuation survey undertaken in western Kenya Location, and demographic information are presented before an outline of the area's socio-economic data Following this section is Section 1 4 whose focus is on "Webuye Water Resources, Pollution and Services"

1.3.1 LOCATION

The study area, Webuye Division, is situated in Bungoma District of Kenya's Western Province Kenya covers an area of 582,000 square kilometres and borders Ethiopia in the north, Sudan in the northwest, Uganda on the west, Tanzania in the south and Somalia in the east It has 400 km of Indian Ocean shoreline Lying between 3^0 north and 5^0S latitude and between 34^0E and 41^0E longitude, it is entirely within the equatorial zone The country is almost bisected by the equator

Administratively, Kenya is divided into eight provinces each of which is sub-divided into districts Bungoma District is one of 48 districts, seven of which were recently delineated The District, itself divided into 10 administrative Divisions and 5 political constituencies, occupies an area of 3,074 km^2 Besides Webuye, the other Divisions are Kanduyi, Cheptais, Sirisia, Kapsokwany, Kimilili, Tongaren, Central, Bumula, and Kapsiro whilst the constituencies are Kanduyi, Sirisia, Mt Elgon and Kimilili (Republic of Kenya, 1994) Webuye is both a Division and a political constituency Kanduyi Constituency covers Kanduyi and Bumula Divisions, Sirisia Constituency includes Sirisia and Central Divisions, Kimilili Constituency comprises Kimilili and Tongaren Divisions and Mt Elgon Constituency embraces Kapsakwony, Kopsiro and Cheptais Divisions

The Webuye Division consists of six locations and 16 sub-locations, two of the locations, Lugusi and Sitikho, are yet to be gazetted (meaning, official recognition) The rest of the locations are Bokoli, Misikhu, Ndivisi, and Webuye The Division is bordered by Kakamega District on the East and South, Tongaren and Kimilili Divisions in the North and North-West respectively, and Kanduyi Division in the West and South-West (see Figure 1 1) The Nzoia River lies to the East and demarcates the Webuye's divisional boundary with Kakamega District

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Figure 1 1 Goes Here

1.3.2 HUMAN POPULATION

On the basis of census statistics, Kenya's population increased from 5 4 million in 1948 to 15 3 million in 1979 and to 21 4 million in 1989 (NCPD-CBS-MI, 1994) (see Table 1 1) Results of the 1989 census indicate that the intercensal population growth rate of Kenya is 3 4 percent per annum This represents a modest decline from the growth rate of 3 8 percent per annum estimated from the 1979 population census (National Council for Population and Development, 1989, Robinson, 1992, Dow, Jr *et al*, 1994) If the population continues to grow at this rate, it is estimated that Kenya's population will increase to 30 million by the year 2000 (NCPD-CBS-MI, 1994)

Table 1 1 Demographic Indicators of Kenya

Indicator	Population Census 1969	1979	1989
Population (millions)	10 9	15 3	21 4
Density (pop /sq km)	19	27	37
Percent urban	9 9	15 1	17 5
Crude birth rate (per 1000)	50	52	46
Crude death rate (per 1000)	17	14	10
Total fertility rate (per 1000)	7 6	7 9	6 7
Infant mortality rate (per 1000)	119	104	69
Life expectancy at birth	50	54	59

Source NCPD-CBS-MI, 1994, p 2

At the size of 397 km^2 and a projected total population of 200,000 persons by the year 2000 AD (Table 1 2), Webuye will have the highest population density of 503 people per km^2 in the region The Division's current population density of 341 $ppkm^2$ is the second highest in the District after Kimilili's 495 $ppkm^2$

Table 1 2 Population Data for Webuye Division, 1989 Census

Location and Sub-location	Female	Male	Total
Bokoli Location	8,943	9,616	18,559
Misikhu Location	12,058	12,685	24,743
Ndivisi Location	22,247	24,212	46,459
Webuye Location	23,312	23,488	46,800
Maraka Sub-	11,913	12,309	24,222
Muchi-Milo Sub-	5,817	5,507	11,324
Khalumuli Sub-	5,758	5,496	11,254
Divisional Total	66,560	70,001	136,561(17 2)#
Divisional Projection for 2000 AD	200,000		

Note # percent of the total District population

Source Webuye Divisional Office

A large majority of households in Kenya are headed by males (67 percent), with only one-third (33 percent) headed by women (NCPD-CBS-MI, 1994, see Table 1 3) Female-headed households are more common in rural than in urban areas (35 vs 22 percent) The average household size in Kenya is 4 8 people (including children), but this figure is 5 89 persons for Bungoma District The summary of household composition in Western Province presented in Table 1 3 is, by and large, representative of the situation in Webuye

Table 1 3 Summary of Household Composition in Western Province[1] [2], Percentages

Characteristic	Western Province	Total for Kenya	Residence in Kenya Urban	Rural
Household headship				
Male	65 9	67 3	78 5	64 7
Female	34 1	32 7	21 5	35 3
Household size				
1	7 0	14 6	29 1	11 1
2	7 4	11 3	18 0	9 8
3	11 3	11 7	13 6	11 2
4	12 8	12 1	11 8	12 2
5	17 6	13 1	10 2	13 8
6	10 8	11 2	6 1	12 4
7	10 4	8 9	4 4	10 0
8	6 6	6 5	2 8	7 4
9+	16 0	10 5	3 9	12 1
Mean size	5 5	4 8	3 4	5 1
Educational Level[3]				
None[4]	22 9 (25 2)	17 5 (28 1)	8 3 (14 2)	19 1 (30 1)
Primary incomplete	43 3 (47 7)	46 8 (44 9)	27 8 (31 8)	50 3 (46 8)
Primary complete	23 0 (14 5)	18 2 (15 3)	19 9 (21 1)	17 8 (14 4)
Secondary and above	10 8 (12 5)	17 5 (11 8)	43 9 (32 8)	12 8 (8 7)

Notes

1 Percernt distribution by sex of head of household, household size and educational level, according to urban-rural residence and region, Kenya, 1993

2 This Table is based on *de jure* members, i e , usual residents

3 Figures within and outwith parentheses are for females and males respectively

4 Includes missing values in the Kenya Demographic and Health Survey sample

Source Adapted from NCPD-CBS-MI (1994) p 10ff

1.3.3 SOCIOECONOMIC PROFILE

Like in the rest of Kenya, agriculture is the mainstay of Webuye's economy Rural areas are characterized by small-scale mixed farming which includes subsistence and cash crops as well as livestock Maize, being the staple food of the Kenyan people, is both a subsistence and a cash crop The other cash crops are coffee, sugar-cane, sunflower, horticultural crops and cotton Apart from maize, sorghum, beans, millet, potatoes, and cassava are other food crops grown to varying degrees

Sugarcane, like tobacco in the other divisions of Bungoma District (Wasike, 1992), are grown in the Division under contract farming with direct integration with processing It is the most important cash crop in the Division Cane production is organized under the Nzoia Sugar Company in the form of a nucleus plantation of 3,500 ha and an outgrowers scheme consisting of small holdings which add up to 14,115 ha in the District The average extent under sugarcane per holding is 0 88 ha (Republic of Kenya, 1994 43, Webuye Municipal Council, 1994)

Besides the Nzoia Sugar factory and the PanAfrican Paper Mills, the other sources of cash income are small-scale industrial and commercial concerns, and informal sector activities as well as Government administration and public service employment Small-scale industrial enterprises range from engineering works, metal fabrication and motor-vehicle repairs to maize-milling, furnitute making, tailoring, and vegetable vending The current five-year Bungoma District Development Plan (Republic of Kenya, 1994) notes (p 52) "The number [of informal sector ventures] has increased due to the increasing number of people failing to obtain wage employment"

1.4 Webuye Water Resources, Pollution, and Services

1.4.1 The Nzoia River Basin Description

The Nzoia River Basin, a main drainage area of Lake Victoria Basin Development Authority, spreads across three provinces of Western Kenya Kibisi, Kuywa, Kimilili and Lwakhakha are the other rivers that drain Lake Victoria Basin It comprises the area drained by the Nzoia River and its tributaries before discharging into the Lake Victoria The key tributaries of the River include Koitobos, Kipkaren, Kibisi, Kuywa, and Lusumu (Figure 1 2)

Figure 1 2 Goes Here

The Basin is the only one amongst Kenya river basins[8] that does not arise from Mt Elgon, its origin is in the Cherangani Hills But still, the Basin has a varied topography rising from slightly above sea-level (in Yala Swamp area) to about 4200 metres above sea-level The location of the Nzoia River Basin and Webuye Division on the slopes of Mt Elgon influences rainfall and moderates temperatures The mean annual temperatures in the southern parts, away from the mountain, are about 21°C to 22°C while the mean annual temperatures in the northern areas close to Mt Elgon are in the lower range of 5°C to 10°C because of the altitude Webuye Division, and indeed the whole of Bungoma District, is a high agricultural potential area It experiences two rainy seasons, the long and the short rain seasons The long rains normally start in March and continue into June or July, while short rains starts in

[8]As noted under legislation for managing natural resources, the river basin development authorities in Kenya are The Kerio Valley Development Development Authority, The Lake Victoria Basin Development Authority, and The Tana and Athi River Development Authority

August and continue into October The total rainfall ranges between 1,250mm to over 1,800mm per annum This allows rain-fed sugarcane cultivation

Geologically, the Nzoia Basin can be divided into five formations the tertiary volcanics, granites, the Kavirodian system, the Basement system, the Nyanzian system A number of young faultlines have been found within the catchment area The relief and land forms affect the climate and the general development of the Division and the District

1.4.2 SOURCES OF WATER POLLUTION

Unlike other water catchment areas and river basins in Kenya, the Nzoia River ecosystem have received dispropotionately less focus of scientific investigation (Amuka, 1995) The inattention is surprising because, during the last 25 years or so, anthropogenic alterations or stresses related to non-point pollution from sugarcane agriculture, municipal water use, and to pollution by toxic substances from industries, have been applied to the Nzoia River with ever-increasing frequency. The broad suite of environmental questions that have arisen as a consequence of these stresses has not been matched by scientific investigations to search for answers

Non-point pollution from agricultural farms and point sources such as industries (mainly effluents from paper and sugar processing industries, and the East African Heavy Chemicals factory) and municipalities are the principal sources of water pollution in Webuye Division (Webuye Municipal Council, 1994) and its surrounding areas Non-point pollution often poses a series of problems for policy-makers, primarily because such pollution cannot easily be traced to, for example, a single waste pipe Shortle and Dunn identify some of the difficult planning problems that arise from the nature of this non-point pollution, these include "determining which water bodies require protection, establishing the particular activities that are responsible and identifying appropriate policies to achieve the desired changes in producer behaviour" (1991 p 30) They convincingly argue that an appropriate mix of voluntary controls, standards, economic incentives, and research and development are the best policy options for the problem

In Webuye area, the major source of non-point water pollution is sediment transported from land through soil erosion Other non-point sources are chemical fertilizers, manure, pesticides, and salts from agricultural lands Increased use of chemical fertilizers and pesticides in sugarcane agriculture results in residual inputs transported by water to endanger stream and groundwater supplies, groundwater contamination by NO_3 and pesticides is of particular concern in areas characterized by shallow water tables (Kallqvist and Meadows, 1977, Willis *et al*, 1991, Southwick *et al*, 1995) It also encourages and allows intensified row-crop farming of maize, which is accompanied by silt exports and the degradation of water supplies The severity of the situation is compounded by the fact that Webuye Municipality and many others within the Basin discharge raw waste into the water body

The herbicides used in sugarcane growing in Kenya are ioxynl, Diuron, 2,4-D and Ametryne There is no standard amount of herbicides to be applied in sugarcane plantantions (say per acreage) and thence most farmers resort to the broadcasting application method External costs of these herbicides in Kenya's sugarcane environments are yet to be evaluated, but one literature review on 2,4-D concludes "There is a considerable body of evidence which indicates that the phenoxy herbicides in general, and 2,4-D specifically, pose a substantial threat to environmental and thus human health Extensive research on the effects of 2,4-D on test animals indicates that the herbicide is teratogenic, carcinogenic and very likely mutagenic" (Warnock and Lewis, 1978)

Amuka (1995) observes that although the acreage under sugarcane has reduced over time, application of herbicides has marginally increased The increased application of the herbicides can be partly attributed to development of resistance in weed population due to repeated use on sugarcane fields (Paoletti and Pimentel, 1995) During the dry season (incidentally the fish breeding season), the concentration of excess herbicides in rivers and streams within the sugarbelt is higher The increased toxicity leads to fish kills, deltas and estuaries of rivers and streams on Lake Victoria constitute breeding grounds for most fish species from the Lake Indeed Foxall, Litterick and Njuguna observe that

> " The upland water sheds are generally well protected from erosion but the erosion hazard increases considerably in the low land plains east of the [Winam Gulf of Lake Victoria] and river sediment loads increase accordingly To this sediment load is added the organic wastes and nutrients from agricultural, domestic and agrobased industrial sources, especially sugar refineries These wastes are transported and deposited at the eastern end of the Winam Gulf along with the treated and untreated effluents from Kisumu Municipality and increasingly also with the pollutants from the oil storage installation in Kisumu port
>
> " [Hence the] increasing local concern for the apparent deterioration of water quality in the Winam gulf, especially its eutrophication, as evidenced by the extensive blooms of blue-green algae, frequent fish kills, and a steady decline in fish landings during recent years" (1987 616)

Apart from non-point pollution from agricultural farms, air and water pollutants within the Nzoia River Basin emanate from manufacturing/processing industries (Foxall *et al*, 1987) Key amongst them are sugar industries (the Nzoia Sugar Companies and the Mumias Sugar Company), as well as the PanAfrican Paper Mill and East African Heavy Chemicals factory in Webuye Township Save for the ongoing research work by Amuka (1995), no published studies are available on effects of industrial effluents on the physical, chemical and biological characteristics of the Nzoia River However, work done elsewhere shows that effluents from these type of industries adversely impact on aquatic environments

Wastewaters from sugar cane processing are not toxic but harmful to the environment because of the presence of organic substances, in particular carbohydrates in the form of alcohols and sugars Consequently, biochemical oxygen demand (BOD), total suspended solids (TSS), and pH are major pollution parameters of sugar industry wastewaters (Train *et al*, 1975, Forsyth, 1977) Organic substances discharged into a river are decomposed by micro-organisms which use substantial quantities of oxygen The effects of organic effluents with high BOD are well known (e g Hynes, 1960) but mostly from temperate zones, and studies on organic pollution in the tropics (e g Campbell, 1978) are limited However, the discharge of organic effluent from a sugar mill into tropical streams has been proved to have similar effects on macro-invertebrate fauna to those found in temperate areas (Pearson and Penridge, 1987)

In a study on the effects of pollution by organic sugar mill effluent on macro-invertebrates on a tropical stream, Pearson and Penridge (1987) show that increased pollution led to decreased diversity, and, in heavily polluted situations, the fauna was dominated by Oligochaeta and one species of Chironomidae, or in most severe conditions by that chironomid alone The effects of pollution became apparent as dissolved oxygen concentration fell below 6 5 mgl^{-1}, and were most severe below 3 5 mgl^{-1} This author's speculation is that dissolved oxygen (DO) concentration is below the acceptable limit of 3 5mgl^{-1} in most sections of the river close to the sugar industries as well as the PanAfrican Paper Mills at Webuye

It is well-known that the Webuye Pulp and Paper industry is an important part of both the Kenyan and regional economies However, while providing welcome employment and income opportunities for the population, the pulp and paper industry provides a heavy burden on the environment The fact that the mill is located along the Nzoia River means that the discharge of suspended solids (fibre) affects both the behaviour of fish and their ability to grow and breathe It can also create mud banks which change the structure of the River bed and, thereby, affect fish and other fauna in the River When oxygen demanding substances, exerting a BOD and COD (chemical oxygen demand), are discharged into water, the level of oxygen is reduced Some of these effluents also affect photosynthesis How fast these substances break down depends on the temperature and on the amount of oxygen in water The warmer the water is, the faster these substances break down BOD and COD are measures of how much oxygen is needed to break down the substances

The firms use chlorine in the bleaching process which are latter discharged into the River It takes a long time for these substances to break down and when they do so, some may become even more poisonous than before[1] Since the composition of bleached pulp mill effluents is very complex, it is almost impossible to characterise the impact of every substance on the environment It is clear, though, that the effects are greater close to the factory, but effects can appear far away as up to 50 km from the source (Leslie *et al*, 1972, Brannlund *et al*, 1995) The biological effects of the discharge of chlorine are injurious to fish spines and changes in their vertebrae There are also serious physiological effects, such as damage to fish livers and immune systems Some of these effects, especially lowered reproduction capability, constitute a serious threat to the survival of the population of some species

1.4.5 DOMESTIC WATER SUPPLY AND SANITATION

Many Webuye residents, like other Kenyans and people in developing countries, face daily problems in obtaining water for domestic purposes Recognizing the harm to health, economic productivity, and quality of life that can result from inadequate water supplies, the Government and nongovernmental organisations (including international donor agencies) have mounted numerous efforts to correct the problem Figure 1 3 shows the piped water schemes in Webuye The Webuye-Nabuyole Water Supply is the main water facility in the Division, but it serves only 25 km^2 So, like in the rest of Western Province (Table 1 4), the vast majority of the population obtain their domestic water from unprotected boreholes, shallow wells, springs, streams and ponds Many of these sources fail at the end of the dry season and water then has to be carried for long distances In drought, both urban and rural households draw untreated water from the Nzoia River and its tributaries

Figure 1 3 Goes Here

Table 1 4 Percent Distribution of Households by Some Household Characteristics, According to Urban and Rural Residence, Kenya 1993

Characteristic	Western Province	Residence in Kenya Rural	Urban	Total for Kenya
Electricity:				
Yes	7 6	42 5	3 4	10 9
No	92 4	57 5	96 6	89 1
Source of Drinking Water:				
Piped into residence	14 4	19 4	55 8	10 7
Public tap	5 3	13 2	31 4	8 9
Well with hand pump	31 2	8 9	0 9	10 8
Well without hand pump	21 7	12 2	2 1	14 6
Lake/pond	2 5	7 1	0 1	8 7
River/stream	23 2	33 6	1 6	41 2
Rainwater	1 1	2 2	0 6	2 6
Other	0 7	3 4	7 4	2 4
Sanitation Facility:				
Own flush toilet	7 2	5 4	23 5	1 1
Shared flush toilet	0 7	4 5	21 4	0 5
Traditional pit toilet	80 2	65 8	42 3	71 4
Vent impr pit latrine	4 1	6 1	6 9	5 9
No facility/bush	7 6	16 8	2 1	20 3
Other	0 3	1 4	3 9	0 8
Mean Persons Per Room:	3 2	2 8	2 4	2 9

Source Adapted from NCPD-CBS-MI (1994) p 14

Furthermore, the almost universally inadequate sanitary arrangements in rural areas cause unprotected water sources to be very liable to pollution During dry season feacal and non-feacal pollutions are washed into water springs, wells and streams Springs near all villages are covered with stones but dogs and livestock can easily reach such places The villagers are not careful about the use of streams and often wash and bathe upstream from the collection of points of drinking and cooking water Evidence of this pollution of sources of domestic water supply may be seen in the high incidence of water-borne diseases Though historical data on disease incidence were not available for the purpose of establishing a trend in cases of illnesses, hospital attendances for most illnesses is increasing Skin diseases (especially scabbies and ulcers) and diarrhoea, the second and third most common diseases, represented 8 94% and 5 47% of reported cases of diseases in 1992, the indisputably most common malaria accounted for 52 53% of the 537,763 reported cases (Republic of Kenya, 1994 91f) Other cases included, *inter alia*, cholera, typhoid, and intestinal worms Epidemiological literature indicates that these infectious diseases, as well as others like gastroenteritis and shigellosis, can be contracted by human contact with contaminated water (Rosenberg *et al*, 1976, Feachem *et al*, 1983, Holmes, 1990)

As is common in developing country practice (Porter and Walsh, 1978, Roth, 1987, The World Bank Water Demand Research Team, 1993), technical criteria have been laid down in Government blueprints for water resources Each water supply should be technically as simple as possible and consist only of an intake or source system, the minimum ammount of storage to ensure continuity of supply, and basic distribution systems Designs are based on a per capita per day consumption The Webuye-Nabuyole Water Supply (WWS) began operation in 1974 with a service capacity of 10 km^2 Even though the water facility now serves 25 km^2, it falls well below demand, the station's total water production of 1600m^3 serves only 2,106 households whilst the regional demand is estimated at 4500m^3 Of the households that were receiving water from WWS at the time of this survey, 381 (18%) paid a flat rate of Ksh 90 00 per month Charges for the rest of the households (including licenced retailers and institutions such as schools) were functions of consumption levels as read on water meters The cost of water supply at WWS are in Table 1 5

Table 1 5 Cost of Water Supply for Webuye-Nabuyole Water Supply Station

Cost element		Amount in Kshs
1 Operation and maintenance (O & M)		
a Salaries for operators and supporting staff		37,845 00
b Transport utilities including telephone and stationery		10,564 75
c Repairs, spares, workshop, uniform and replacement of plants and equipment		9,334 30
Sub-total	Kshs 57,744 05	
2 Water Treatment		
a Expenditure on aluminium sulphate		85,200 70
b Expenditure on chlorine		9,671 60
c Expenditure on electricity		55,388 80
Sub-total	Kshs 150,261 10	
MONTHLY GRAND TOTAL COST OF WATER SUPPLY		Kshs 208,005 15
AVERAGE ANNUAL COST OF WATER SUPPLY		Kshs 2,496,061 80

Source Ministry of Water Development, Bungoma District and Webuye Divisional Offices

1.5 Statement of the Problem

Valuation of changes in water availability and quality is an important issue in Kenya as agriculture, industry, and population growth exert increasing pressure on limited water resources The Government of Kenya (specially units of local authorities, relevant ministries, and river basin management authorities), and non-governmental organisations (like Kenya Water and Health Organisation, KWAHO) have an active interest in strategies for both regional pollution abatement and domestic supply augmentation

The Fifth National Development Plan and other blueprints confirm the Government's commitment to improve access to water supply and sanitation Like most sub-Saharan Africa, Kenya embraced the United Nations' Water Decade's (1981-90) notion of "Clean water and sanitation for all by 1990" (ROK, 1983) The euphoria that accompanied the declaration and passage of the Decade notwithstanding, most rural and urban households in Kenya are still characterised by poor conditions of water supply and sanitation And in the Sixth Plan, The Government opines "A sessional paper on environmental management will be prepared during the Plan period as a basis for the promulgation of a *National Environment Enhancement and Management Act (NEEMA)* which will provide a provision for *an arbitration tribunal for environmental disputes*" (ROK, 1989 170 Italics original)

Generally, control of pollution of water courses (rivers, streams, lakes, estuaries, and coastal waters), and improved provision of domestic water supply represent two integral, essential parts of a strategy towards sustainable development of water resources in Kenya Yet an apparent limited tax base for provision of water supply on social welfare basis coupled with the austerity measures recommended by the international donor community have led to inability of the governmental institutions in providing clean potable water to most residential areas/estates These also appear to have a constraining effect on public expenditure on environmental quality improvement and towards pollution control on most water bodies

This investigation is motivated by both methodological and empirical observations The methodological inspiration is the need to apply and assess the CV technique on issues pertaining to environmental policy and resources management in Kenya As noted, the accuracy of CV estimates is a matter of substantial practical importance in (a) cost-benefit assessments (CBA), and (b) litigation over liability and damages Consequently, the validity of this technique is of crucial significance to environmental cases that may be brought under the envisaged NEEMA, or indeed many other Kenya laws concerning pollution

With regard to CBA, a recent study by Wasike (1993) shows that market forces, through an economic incentives approach, have not been adequately harnessed and marshalled towards a more pragmatic system of environmental policy in Kenya Instead, Kenya has followed a regulative command-and-control model So, therefore, there appears to be untapped scope for using market mechanisms in environmental pollution control and natural resources management In the case of domestic water supply, past approaches to alleviation of the problem of insufficient clean drinking water and sanitation have tended to overemphasise the supply side of the problem to the neglect of demand imperatives

This research, therefore, is predicated on the thinking that water policy and planning, like other sectors of environmental and public utility management, should be built on a comprehension of what quality and service improvements people really want and are willing to pay for This recent approach has the merit of being able to (a) mobilise a community's own resources, both financial and non-financial, and (b) assure that the community is truly in control, that systems remain operating, and that the limited funds available to governments are directed to wherever they are needed most Determinants of households demand and willingness to pay for improved water services and river quality are vital to future decisions on technical and financial planes of public policy in Kenya Technical decisions include the choice of appropriate technology or level of service whilst financial decisions may comprise the monthly tariffs and connection fees to be charged for private household connections to the piped water system There is, in addition, the thorny issue of pollution of traditional household water sources (springs, wells, rivers, and streams) by industrial and agricultural activities? Who pays for cleaning up the associated pollutants?

1.6 The Research Thesis, Objectives, and Questions

The thesis of this study is that determination of the economic value of water resources is a necessary condition for rational decision-making and management of these environmental assets, and their associated public goods, in Kenya This is especially true for improved river water quality and piped domestic water supply since the pricing procedure would help grant proper weight to the benefits of the improvements to environmental sustainability, and human quality of life respectively

The research has a dual objective, to evaluate properties of the contingent valuation (CV) method as a technique of economic valuation for increments and decrements in environmental and natural resource service flows, as well as to estimate households' evaluations for improvements in the water quality in the River Nzoia, Kenya and connections to piped water supply in Webuye Division, Kenya Contingent valuation is one approach to measuring benefits of environmental improvements that has gained currency in environmental economics literature The CV methodological concerns in this dissertation are nature of the good under valuation, effects of frequency of payments, the embedding effect, and influence of connection charge profiles on evaluation of piped water supply for domestic uses

More specifically, the study set out (a) to estimate the economic value of piped water supply and improved water quality in the Nzoia River Basin, (b) to evaluate the feasibility of using the contingent valuation (CV) technique to value an environmental amenity and its related quasi-public service in rural settings where respondents have limited education and monetary resources, (c) to examine the role of temporal dimensions of bid payments (i e , frequency of payments) in contingent values for environmental commodities, (d) to empirically investigate embedding effect bias in contingent valuation of improvements in river water quality improvement in a less developed economy, and (e) to evaluate the role of water connection charges in households' willingness to hook onto a piped water system

This open-ended CV survey has no component value questions Component value questions are often presented in CVM surveys which are designed to "breakdown" the value bids into four possible components Actual User Value, Option of Use Value, Existence Value and Bequest Value The key research questions, and hence hypotheses, that this study set up to investigate are fourfold (1) Does the Nature of the Good Matter? (2) Do Average WTP Measures Vary with Temporal Dimension (or Frequency) of Payments in CV Design? (3) Embedding in WTP Values for Water Pollution Abatement in the Nzoia River Basin (4) Does Nature of

Connection Charges Influence WTP for Domestic Water Supply? We presently deal with each of these hypotheses, in turn

1.7 THE SIGNIFICANCE OF THE STUDY

This research has methodological significance and policy relevance The overlapping literatures on water resources, domestic water supply, and environmental economics stress the need for values to attach to largely nonmarket interactions of people and the environment, such as recreation boating, fishing and swiming (e g , Meyer, 1979, Vaughan and Russell, 1982) So the process of pricing nonmarketed commodities is crucial As far as methodological issues are concerned, the study findings provide direct evidence on the performance of CV in deriving economic values for water resources management In particular, the evaluation of the impacts of nature of good on WTP estimates, and frequency of payments, as well as the embedding effect in WTP for river pollution control and impact of connection charge profiles on WTP for piped water supply are pertinent for future economic valuation of nonmarket goods in Kenya and elsewhere

Of late, the quality (reliability) and affordability aspects of water supply systems are receiving mounting public concern in developing countries (in the case of domestic water supply), general ignorance is being fed by a mixture of scientific concern and media hype On the whole, two lines of the debate can be delineated Most local government authorities and the central government of Kenya perceive potable and disease-free water as an environmental and public "good" that should be subsized for the benefit of all and sundry due to its welfare implications On the other hand, most foreign donor organizations (especially the World Bank and the

International Monetary Fund) would like water consumers to pay for the commodity so as to reduce market distortions that have been blamed for the sorry state of affairs in government's management of the public sector in LDCs The argument in the latter viewpoint, as a matter of fact, ties in well with the Kenya Government's current budget rationalisation policy which is one of the conditionalities under the IMF-World Bank Structural Adjustment Programmes Once the determinants of household's economic valuation of improved water service and the potential biases are taken into account, the study results provide meaningful indications for formulation of policies regarding water supply and its pricing

All in all, current received economic wisdom is that pricing water to reflect the full financial, environmental, and economic costs of supply is necessary for generating funds to expand services and for promoting efficient and sustainable use (Winpenny, 1994) Investigations on the accuracy of CV and generation of people's values of environmental and public goods (like river water quality and deomestic water supply) in Kenya are useful exercises for understanding the potential for employing "market-based" policy instruments in the economy which relies mainly on a "command-and-control" policy framework (*albeit* with lucklustre enforcement ability)

1.8 DEFINING "THE ENVIRONMENT" AND "THE HOUSEHOLD"

1.8.1 DEFINITION OF "THE ENVIRONMENT"

In seeking to value water in nature and social uses, this survey adopts the broad definition for the environment Inherently, "the environment" is a broad, potentially all-encompassing concept Although for analytical and practical reasons it can be treated as having different dimensions, such as an ecological (ecosystems) dimension, an economic (resource management) dimension, and a social (quality of life) dimension, it should be recognized that human activities with regard to one aspect of the environment (such as air pollution) may have repercussions in many other aspects (such as forests, soil fertility, buildings, and human well-being) Such impacts may not always be direct and immediately visible (there may be threshold, sleeper, and synergistic effects), and they may be cumulative, adding to the complexity of environmental phenomena

Threshold effects occur only when an activity or influence reaches a certain level (such as in the case of the eutrophication of lakes because of excessive nutrient enrichment), sleeper effects become apparent only after a considerable lapse of time (for instance, the effect of asbestos or many carcinogenic substances on human health), synergistic effects result from the interaction of different substances or phenomena (for example, acid rain) (Ehrlich, Ehrlich and Holdren, 1977 119) Another operational definition regards what constitutes a "household"

1.8.2 DEFINING "THE HOUSEHOLD"

Throughout this dissertation, I rely on an intuitive understanding of what a household actually is a group of individuals who reside together, pool all or most of their income, and basically share the same water supply This is intentional since the definition of the household is an intractable theoretical problem (Rogers and Schlossman, 1990) Given the varied and complex nature of human society, no definition of the household, however general completely fits all circumstances[9] One can identify a variety of functions usually associated with the household co-residence, joint production, shared consumption, kinship links (Bender, 1967)

Yet these functions often define different sets of individuals In many places, the unit of joint production consists of a different set of individuals from the food consumption unit Moreover, co-residence may not always be associated with shared production or shared consumption (White, 1980) The definition of co-residence itself may not be clear where many dwelling units form a single compound Migration of household members also creates ambiguities, a person may leave the household for most of the year but return to contribute labour in certain seasons, share in the product and even drink water of the household of origin, and contribute remittances for the support of resident household members

Despite the aforementioned complexities of the household which make any

[9]Current economic modelling of the household follows two schools of thought One school assumes the existence of a joint household utility function (Pitt and Rosenzweig, 1985, Strauss, 1986) Earlier contributions to this approach by Becker (e g, Becker, 1981) demonstrate the conditions under which a multiperson household can be treated as an individual utility maximizer The other school allows preferences to vary among household members and proposes a bargaining theory to reconcile the differences (Manser and Brown, 1980, McElroy and Horney, 1981, Jones, 1983) The bargaining theory model draws heavily on the work on co-operative games by Nash (1953)

fixed denotation arbitrary and possibly misleading, two aspects are possibly true of the Kenya household These are

1 It is not an equivalent of the Western concept of the household In Kenya, and indeed most developing countries, the boundary separating the household from the community of which it is a part is more fluid than in Western Europe and USA Essentially then, a Kenya household is unlikely to coincide with the notion of a nuclear family composed of a husband and wife and their children

2 Regardless of how it is defined, the Kenyan household or any country's household for that matter, is definitely not a homogeneous unit in which all members share a common set of preferences It can better be seen as a group of people bound by an implicit contract which specifies the rights and obligations of each member As in conventional contracts, the balance of rights and obligations is determined in part by the alternatives available for each member and in part by their relative power

1.9 STRUCTURE OF THE DISSERTATION

In Chapter 2, I explore aspects of economic analysis of environmental improvements at the household level These theoretical considerations are of particular relevance to economic valuation of non-market goods and household decisions to hook on to a piped water system, since economic pricing of river water quality and private water connections present opportunities for the simultaneous pursuit of economic, financial and environmental objectives (including that of sustainable use) of water resources management both in nature and social uses Two elements that particularly guide the CV application throughout the dissertation regard the theoretical basis for contingent bids derived utilizing survey instruments and discrete choice modelling on how a household decides which water source to use for different purposes

In chapters 3 and 4 an examination of related literature and methodological aspects of this study's estimation of benefits of river pollution abatement and domestic water supply improvement in Kenya is, respectively, presented The issues discussed in Chapter 3 include, amongst others, Cost-Benefit Analysis (CBA) as an aid in decisionmaking and the problem of non-market goods, methodological issues within the valuation (CV) technique, and CV applications in evaluating river water quality improvements Regarding the fact that the project is a developing country CV application and assessment, the chapter devotes considerable attention to both "Third World" contingent values of environmental impacts and potential effects of frequency of payments in CV designs The former includes CV studies on water resources issues in developing countries, where most of the work in the field of environmental valuation has been undertaken, whilst the latter is a part of a larger presentation on frequency information as a dimension in decision making

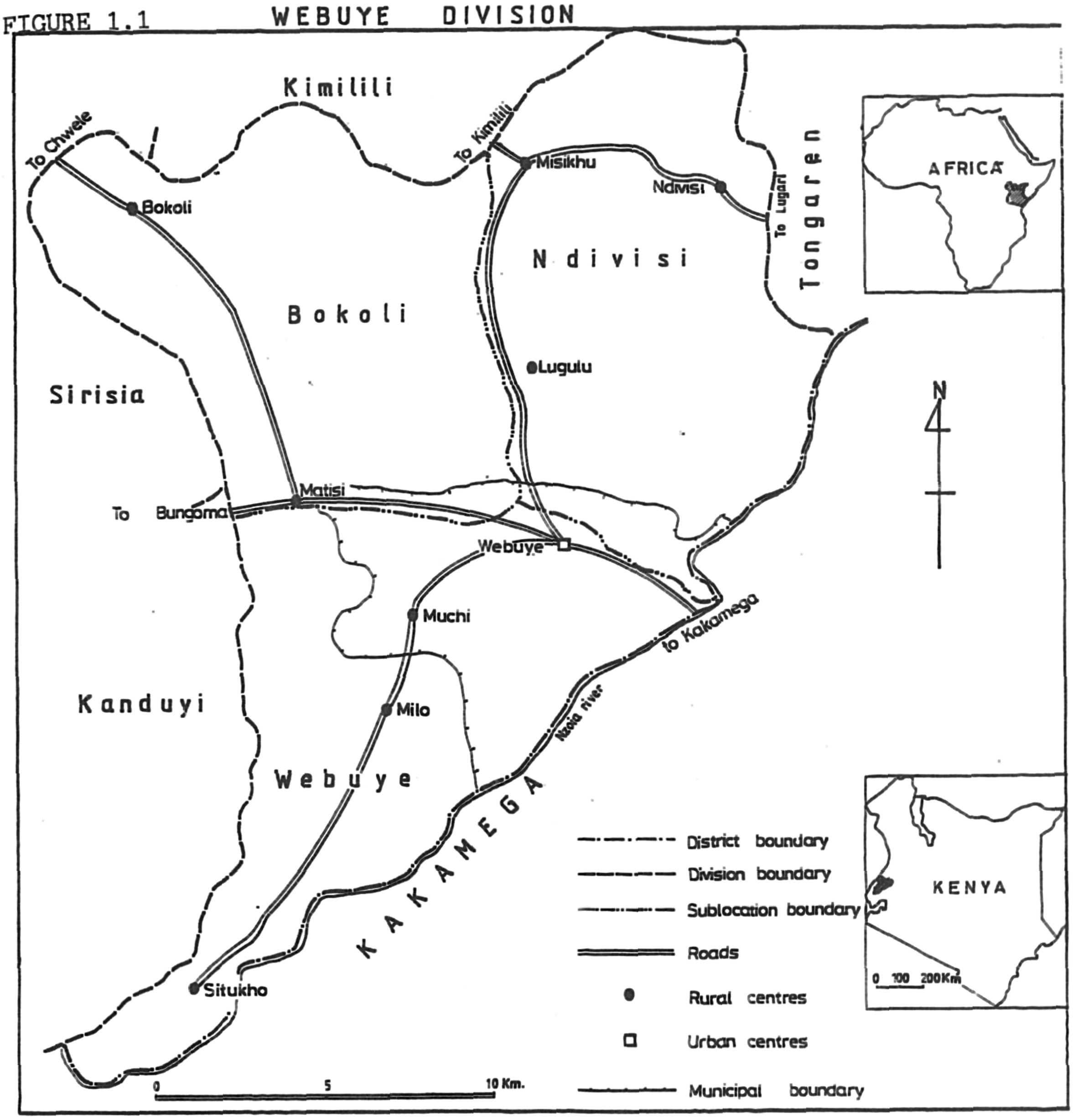
The literature review shows that few CBA studies have been undertaken in LDCs particularly those aimed at comprehending potential 'Third World' influences on CV estimates of benefits of environment and development projects An additional finding from the evaluation is the paucity of CV surveys on issues that directly relate to the 'publicness proper' of the natural environment (such as water and air quality) in developing economies, the few surveys on nonmarket environmental commodities are largely restricted to forestry and wildlife conservation In all, the review shows the Contingent Valuation (CV) approach as a widely accepted method for valuing both natural resource damages, and nonmarketed benefits of environmental resources and improvements The CV method is capable of not only measuring use values but is the only methodology currently available to measure other components of total economic value such as option, existence, and bequest value

Chapter 4 presents the four study hypotheses whose research rationale is demonstrated in Chapter 3 (that is, effect of the nature of the good in CV, impacts of temporal dimension of payments, sensitivity to scope or (embedding effect) in the contingent valuation scenario, and influence of utility-pricing decisions (mainly through initial connection charges) on WTP for individual household water connections) Additionally, details of the questionnaire and survey structure, as well as a description of the survey pre-test, administration, sample design, and fieldwork procedure then follow, in that order

Chapter 5 presents empirical analysis and results, including household perception of the probems studied, nonmonetary measures of relative importance of benefits, and socio-economic and demographic data Further still, the chapter focuses on descriptive statistics and frequency distributions of willingness to pay (WTP) values, as well as WTP estimation models and tests of differences for various WTPs from different questionnaire versions (or samples) In relation to the tests of differences for various WTP estimates, this chapter particularly matches the statistical tests with the four study hypotheses before presenting aggregates benefits of improvements in river pollution control and a household water connection at Divisional, District, and National Levels

Chapter 6 discusses the CV survey results Essentially, the Nzoia River Basin and domestic water supply are integral parts of the natural and human environment of residents of Webuye Division, Kenya Indeed, residents of the study area are well informed on the twin problems of river pollution and inadequate water supply for domestic purposes This fact explains the relatively good acceptance of this contingent valuation (CV) exercise for Webuye Division dwellers The chapter focuses first on the demand for river pollution control and individual household water faucets It then moves on to discuss each of the four research hypotheses Effect of Nature of Good on Contingent Values, Impacts of Frequency of Payments, Embedding Effect, and Effect of Connection Charge Profiles on Evaluation of Household Water Connections Limitations of the study close the chapter Finally, chapter 7 presents a review of the study objectives, conclusions and implications of this CV application for the technique and for policy

FIGURE 1.1 WEBUYE DIVISION



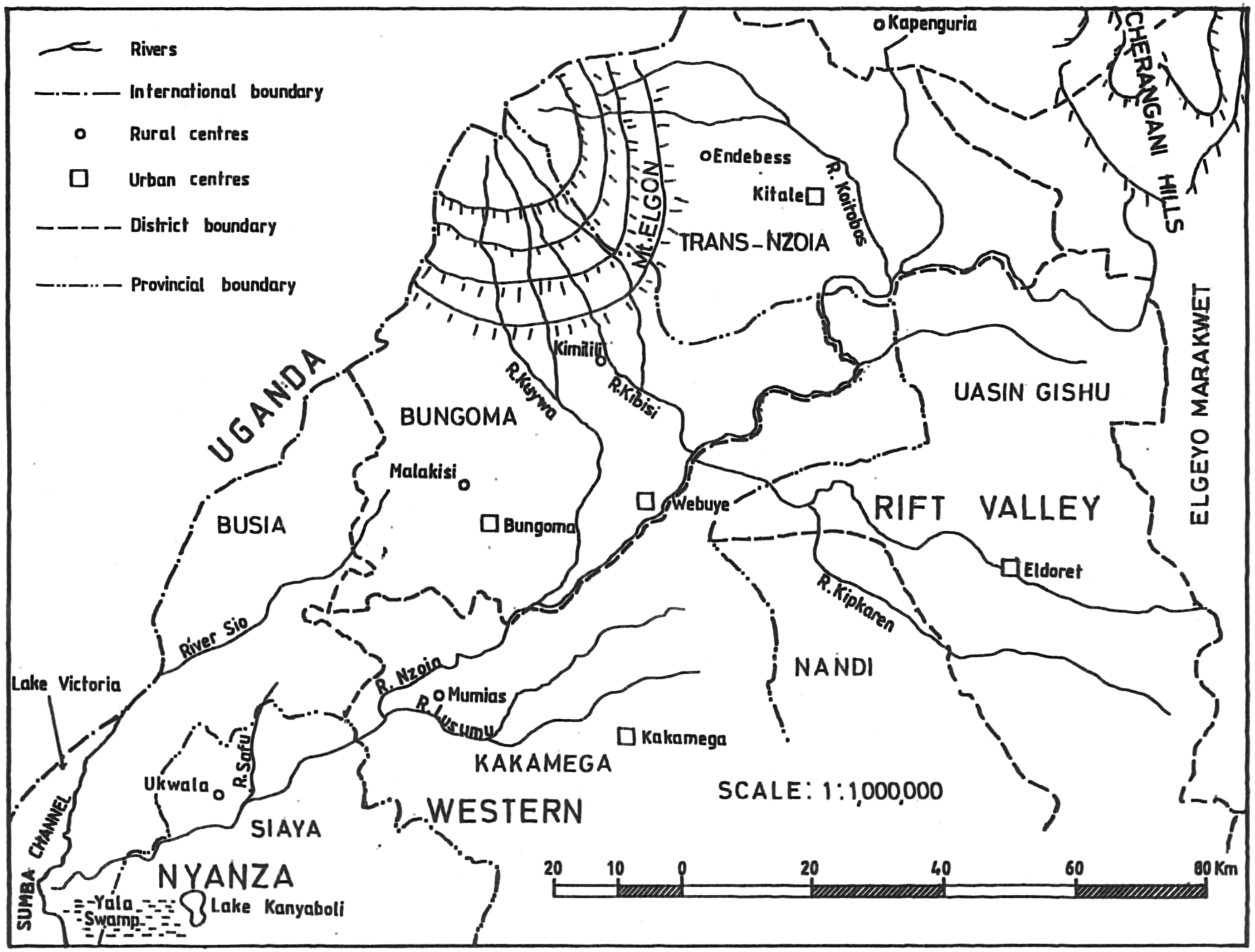


FIGURE 1.2

NZOIA RIVER BASIN

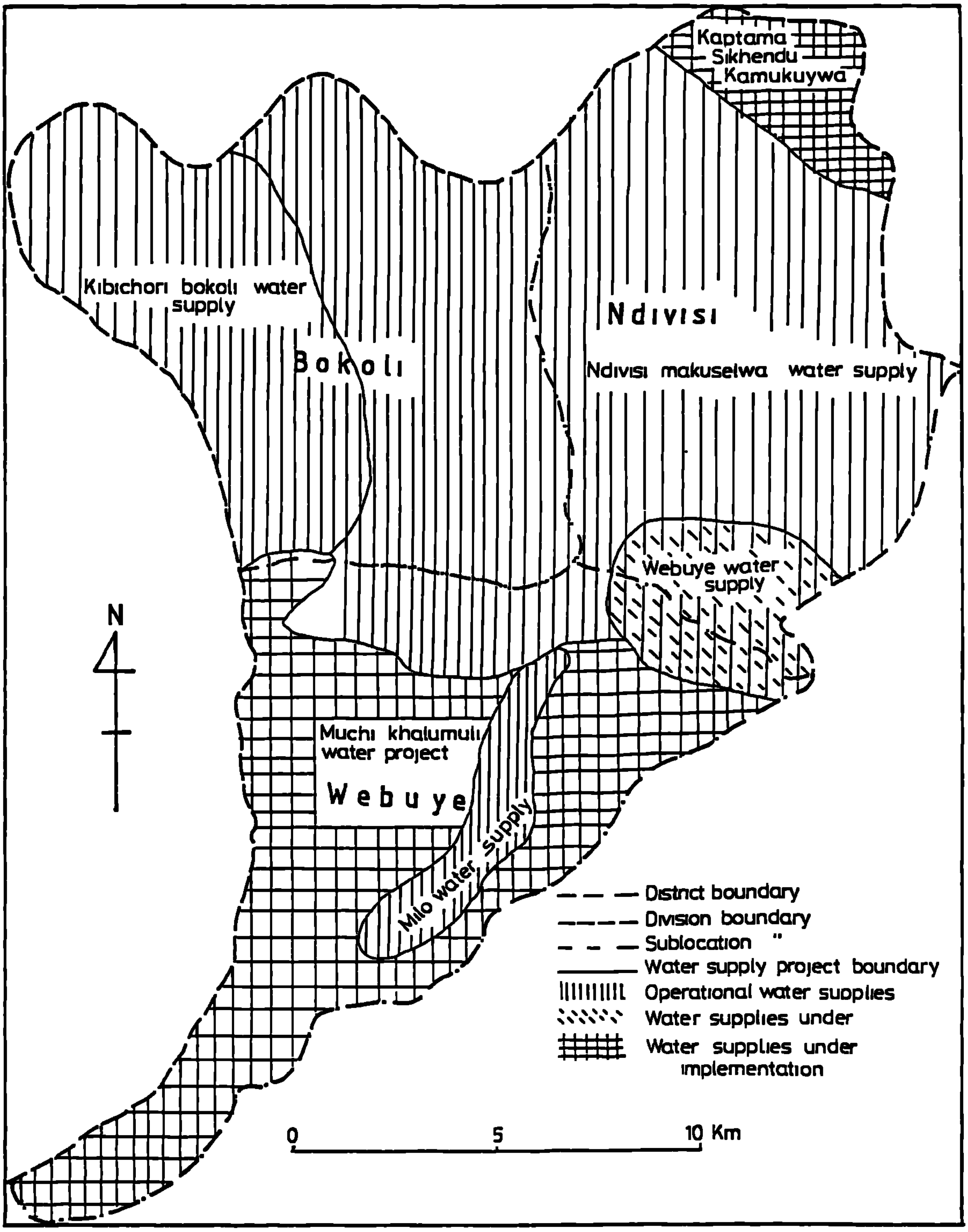


FIGURE 1.3 WATER SUPPLY DISTRIBUTION IN WEBUYE DIVISION

CHAPTER II

THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter explores aspects of economic analysis of environmental improvements at the household level These theoretical considerations are of particular relevance to economic valuation of non-market goods and household decisions to hook on to a piped water system, since economic pricing of river water quality and private water connections present opportunities for the simultaneous pursuit of economic, financial and environmental objectives (including that of sustainable use) of water resources management both in nature and social uses

The variety of empirical approaches used to value environmental goods, whether examining contingent or actual behaviour or market prices, have typically been based on a particular ad hoc theoretical structure However, Freeman (1979a, b), Maler (1974), as well as Schulze and co-workers (1981), provide a consistent theoretical perspective for the different approaches The second Section of this Chapter concerns about the theoretical basis for contingent bids derived utilizing survey instruments whilst Section 2 3 presents a discrete choice model on how a household decides which water source to use for different purposes

2.2 ECONOMIC BENEFITS OF ENVIRONMENTAL AND PUBLIC GOODS

Lack of a detailed and coherent model specifying how people will respond to contingent valuation (CV) questions has led to spirited research efforts towards understanding what determines responses to contingent scenarios Even though Hoehn and Randall's (1987) analysis of CV estimates of Hicksian consumer surplus appears to be the first systematic theoretical evaluation of how information and time affect CV responses, it is Bradford's (1970) aggregate bid function that provides a useful way of explaining the theoretical antecedent of CV In fact Hanley (1989), following Bradford, lucidly presents a geometric outline of CV's utility-theoretic foundation

The utility individuals receive from a good can be determined by measuring their willingness to pay (WTP) for the good WTP was thus adopted to measure the benefits from both improved water quality in the Nzoia River and private water supply connections[10] Where individuals do not have the right to a given quality level of a public good, Mitchell and Carson (1989) argue that a Hicksian compensating surplus WTP measure is the correct approach to determining both the value of increased quality provision as well as the value of avoiding any proposed reduction in the quality level compared with that currently available

[10]This avoids the controversy about whether WTP or willingness-to-accept (WTA) is the most appropriate measure to elicit consumer surplus values The choice between WTA and WTP is a question of property rights do individuals have the right to a certain water quality in a river and thus have the right to sell further pollution/use by manufacturing firms, or if individuals wish to enjoy an enhanced river water quality, do they have to buy it? To improve water quality in the Nzoia River, manufacturing industries operating within the Basin have to invest in waste-water purification plants, involving higher prices for their customers, whilst the Lake Victoria Basin Development Authority (LBDA) may need to invest in other water pollution control measures necessitating higher tax payments from the general public Thus WTP is appropriate both as a measure of benefits from enhancing water quality in the Nzoia River, by investing in alternative waste-water treatment technologies and undertaking water pollution abatement/control measures on the Nzoia to improve the present water quality levels, and as a measure of benefits from a private water connection for domestic water requirements

$$CpS = [e(P_0, Q_0, U_0) = Y_0] - [e(P_0, Q_1, U_0) = Y_1] \qquad (2.1)$$

$$CpS = Y_0 - Y_1 \qquad (2.2)$$

where CpS is the compensating surplus WTP, P_0, Q_0, U_0, Y_0, represent initial quality level price, quality level, utility and income, and Q_1 and Y_1 subsequent levels If CpS is positive, then Q_1 is preferred to Q_0 and the consumer would be WTP to the point where his/her utility level was the same as it was before the change If Q_1 level of quality is preferred to Q_0, then an individual will be WTP CpS for the change, i e Y_1 will be less than Y_0 Note also that in this study these measures are also ***ex ante*** measures they are the individual's expected value of the state of the world after the change in river water quality or level of domestic water service

The value of environmental and other public goods (such as a piped water connection) is often derived from the demand for related goods (such as recreation and housing) using a simple utility function of the form

$$u = u(X, RH, L) \qquad (2\ 3)$$

where utility (u) depends on the consumption of private goods (X), on-site use (RH), and on the enhanced environmental quality or amenity (L)

In the case of river pollution control (and even water connections, albeit arguably), this theoretical treatment can be expanded to measure the bundle of off-site satisfactions for improved water quality in the Nzoia River These passive or non-use benefits are assumed to include option, existence and bequest demands A more general form of the utility function is (as suggested by Willis and Garrod, 1995), therefore,

$$u = u\ [f_1(\ ..) + f_2\ (O,\ E,\ B)] \qquad (2.4)$$

where individuals also derive benefit from off-site consumption of enhanced flows by way of option value (O) to guarantee the opportunity of future benefits from the Nzoia under conditions of uncertain demand or supply, existence value (E) from the satisfaction an individual derives from knowledge that the water quality of the river or section of the river is protected, and bequest value (B) from the knowledge that other individuals will benefit from the environmental acceptable river water quality This total economic value (TEV) concept was adopted to measure the benefits of both the Nzoia river pollution control and private water connections in Webuye, Kenya

This research particularly uses the following conceptual framework to describes a household's[11] decision on whether or not to agree to pay for river pollution control and a private water supply connection Let the representative household's indirect utility function be

$$U\ (Y,\ P,\ SDE,\ Q) \qquad (2.5)$$

where Y is the monetary income, vector P represents the prices of all other goods and services, SDE refers to other socio-demographic and economic factors that might influence the household's ability to pay or constrain its behaviour, and finally Q is the

[11]At this point I ignore the possibility that households are not homogeneous decision making units Thus I assume that consumption behaviour either reflects household preferences or the preferences of the dictator in the household

character of the commodity of interest (in this case it is improved water quality in the Nzoia and a household connection to piped water)

Equation (2 6) the household's WTP for changes in the nature of the commodity (either river water quality of water supply system) from say Q_0 to Q_1 (i e, Hicksian compensating surplus)

$$U(Y_0 - WTP, P_0, SDE, Q_1) = U(Y_0, P_0, SDE, Q_0) \quad (2\ 6)$$

Equation (6) implies that WTP is a function of the proposed change in Q and all the other factors hypothesized to influence a person's value for a change in Q Thus,

$$WTP = f(Q_0, Q_1, Y_0, P_0, SDE_0) \quad (2.7)$$

2.3 Household Decisions on Water Supply Source

The typical approach utilized to characterize how a household decides which water source to use for different purposes is a discrete choice model (Briscoe et al , 1990, Mu et al , 1990, Whittington and Swarna, 1994) Suppose that an individual (or household) faces a choice among J water sources, and will select only one source for a particular water use Assume that this individual makes his water source selection(s) on the basis of the attributes of the water sources available and his socio-economic characteristics Each individual attaches a marginal value (or utility) to each attribute of a water source (such as price, quality, and reliability) A utility-maximizing individual is assumed to aggregate the utility obtained for all attributes of each source and then select the source that yields maximum utility (Lancaster, 1965, McFadden, 1981, Bockstael et al , 1987) Thus if q_h is the quantity of water demanded by household h for specific use, the quantity of water demanded by household h from source j for that use, q_{jh}, will be

$$q_{jh} = q_h \qquad \text{if source } j \text{ is chosen} \quad j \in J$$

$$q_{jh} = 0 \qquad \text{otherwise.} \qquad (2\,8)$$

From among the set of possible water sources, household h is assumed to choose alternative j if any only if

$$u_{jh} \geq u_{ih} \qquad i, j \in J \qquad i \neq j, \qquad (2\,9)$$

where u_{jh} and u_{ih} are "well behaved" indirect utility functions conditioned on the source choice Let I be a dichotomous variable such that

$$I_{jh} = 1 \qquad \text{if } u_{jh} \geq u_{ih} \quad i, j \in J \qquad i \neq j$$

$I_{jh} = 0$ otherwise (2.10)

A planner needs to understand why a household selects water source(s) and the quantity of water it uses, but the indirect utility function is unique to each household and cannot be known to the analyst To approximate the "true" utility function, the analyst assumes a known function based on economic theory and attempts to use it to describe households' water source selection decisions Doing this requires data on households' water source selection decisions as well as data on attributes of the alternative sources and socioeconomic characteristics of the households involved

It is impractical for the analyst to collect such data for each household in a community Instead, data are conventionally collected for a representative sample of households The behaviour of some households in the sample may appear inconsistent to the analyst in terms of his assumed model of behaviour Such observed inconsistencies in water source choice behaviour are assumed to result from random disturbances (Ben-Akiva and Lerma, 1985) The indirect utility function is thus typically assumed to have two components a random term and a systematic (or observed) term The addition of this random term results in "a random utility function", and the utility a household derives from a water source selection decision becomes a random variable For example, let V be the systematic term, and e be the random term The random utility function associated with source i is given by

$$u_{ih} = V_{ih} + e_{ih} \qquad (2.11)$$

Consequently, the source choice decision becomes

$$I_{jh} = 1 \text{ if } V_{jh} + e_{jh} \geq V_{ih} + e_{ih} \quad i, j \in J \quad i \neq j$$

$$I_{jh} = 0 \qquad \text{otherwise} \tag{2.12}$$

This can be rewritten in probability terms as

$$\text{Prob } [I_{jh} = 1] = \text{Prob } [(V_{jh} + e_{jh}) \geq (V_{ih} + e_{ih})] \quad i, j \in J \quad i \neq j \tag{2.13}$$

In other words, the probability that household h will choose water source j equals the probability that the utility derived from using water source j is no less than the utility derived from using any alternative source

The distribution of u_i will depend on the distribution of the error term, and different assumptions about the distribution of the error term will lead to different mathematical specifications of the discrete choice model A common assumption is that the error term follows a Gumbel distribution with mean equal to zero and the scale parameter of 1, in which case Equation (13) may be written as a multinomial logit model

$$\text{Prob } (j) = \exp (V_j) / \Sigma_i \exp (V_i) \quad i, j \in J \quad i \neq j, \tag{2.14}$$

where Prob (j) is the probability that the household chooses water source j (Ben-

Akiva and Lerman, 1985, Whittington and Swarna, 1994) This multinomial logit model has been widely used to model household decisions with discrete choices (Amemiya, 1981)

The independent variables in the indirect utility function include two groups (1) attributes of an alternative, which vary across sources, and (2) socioeconomic characteristics of the households, which do not vary across sources The second group of variables are intended to explain variations in tastes among households that choose different water sources To estimate the probability of choosing a specific alternative and the taste variation simultaneously, McFadden (1973, 1981) developed a conditional logit model Let X be a vector of water source characteristics, and Z be a vector of household characteristics that includes income and a set of socioeconomic variables Assuming the utility function is additive (that is, $V_{ih} = BX_{ih} + a_i Z_h$), the conditional logit model can be written as

$$P_h(j) = \exp(BX_{jh} + a_j Z_h) / \textstyle\sum_i \exp(BX_{ih} + a_i Z_h) \qquad i, j \in J \qquad i \neq j \tag{2.15}$$

As an approach to better understanding of household water source decisions, this discrete choice model has recently been applied by a number of investigators (e g , Briscoe et al , 1990, Mu et al , 1990) Most studies estimating the discrete-continuous water demand model have, however, used the indirect approaches to estimating households' WTP for improved water service (Whittington and Swarna, 1994 33)

Of several important advantages over indirect approaches, the direct estimation method of CV was used in this study due to one principal advantage it can be used to value services that are impossible to assess with indirect approaches For example, it can be used to evaluate the benefits of increased reliability of existing water systems (e g , Howe and Smith, 1994), or the reaction of households to prices or technologies beyond the range of past experience One component of this study specially used CV to evaluate the reaction of households to prices beyond the range of past experience (that is, WTP for a private water faucet when initial charges to connect to the piped system are SPREAD over time or paid for UPFRONT, the former payment profile is non-existent in practice)

CHAPTER III

REVIEW OF THE LITERATURE

3.1 INTRODUCTION

In an effort to shed light on the central themes of the study, this chapter reviews related literature on the topic Cost-Benefit Analysis as an aid in decisionmaking and the problem of non-market goods is the subject of Section 3 2 This naturally leads to the consideration of the methodological issues within the valuation (CV) technique, with particular emphasis on structural biases, WTP/WTA disparity, and embedding effect (Section 3 3) In Section 3 4, the focus is on CV applications in evaluating river water quality improvements

As the CV study reported in this dissertation is set in Kenya, Section 3 5 presents developing country applications of the CV method whilst Section 3 6 is on frequency information as a dimension in decision making Section 3 6 specially deals with potential "Third World" effects of frequency of payments in CV designs Section 3 7 not only reviews further CV studies on water resources issues in developing countries, but also discusses elements of pricing water services in such economies The last section is a brief appraisal of the whole chapter

3.2 Cost-Benefit Analysis as a Decision-Aid and the Problem of Non-Market Goods

> "It is expensive to quantify all benefits and costs There are differences of opinion about how the value of certain items should be treated We cannot expect benefit-cost analysis to give us a definitive answer about the desired level of environmental quality What it can do is to eliminate policy options that are clearly outside the range of economic acceptability" (Downing, 1984 110)

Cost-benefit analysis is probably the most widely known procedure for the analysis of economic efficiency in the public sector Its historical development is characterized by two fundamental influences On the one hand, CBA is an application of welfare theory The benefit concept in its classical form was prepared by Dupuit (1844), founded by Marshall (1907), and completely rejected by Paretian welfare economics It was rehabilitated by Hicks (1941), and debased by Little (1965) as a "theoretical toy" On the other hand, CBA is the very prototype of an applied science In the USA, it initially came into its own as early as the 1930s The main objective at that time was to assess water-management projects according to a criterion for macro-economic efficiency Barde and Pearce (1991), and Hanley and Spash (1993) clearly trace the Anglo-American as well as European historical roots of CBA

Recent environmental economics literature nearly always points out that CBA can be employed as a useful aid in environmental policy decision making Most frequently mentioned are five basic arguments which lend support to the method of monetizing environmental protection benefits with respect to environmental damage (McAllister, 1980, Barde and Pearce, 1991 21, Hanley and Spash, 1993)

1 *The clarity argument* Monetary cost estimates demonstrate unequivocally to the public eye the socio-political importance of environmental damage

2 *The objectification argument* Rational environmental policy requires a

careful weighing of the advantages against the disadvantages of environmental protection Those who advocate less environmental protection do so by heaping staggeringly high costs on to one side of the scale On the other side, however, champions of more environmental protection often have only verbal arguments at their disposal, these scarcely provide a good counterbalance to offset the burgeoning costs cited by opponents of increased environmental protection

3 The dosage argument Available funds for environmental protection should be applied (dosed) in such a way as to ensure that the greatest amount of surpluses (benefits minus costs) will be achieved However, these surpluses can be calculated only when the amount of the environmental damage costs avoided is known

4 The internalizability argument Insofar as an economically optimal internalization of external effects via environmental charges is desirable, then extensive information is required on the reported net amount in monetary terms of environmental damage caused

5 Correcting the gross national product (GNP) It is increasingly argued that the GNP, traditionally the measure of societal affluence and economic growth, should be supplemented with additional data In keeping with this aim, an expanded system of national accounting is envisaged which would include environmental as well as human health damage This kind of national income accounting is only reliable however if, for instance, environmental damages can be measured in monetary terms

As noted, environmental economics and particularly CBA has recently been shown to play a seminal role in incorporating environmental imperatives into decision making and in facilitating more efficient management of natural resources as a stepping-stone on the path to sustainable development (Munasinghe, 1993, Cropper and Oates, 1992, Lutz and Young, 1992) This is so in so far as the field has developed techniques for valuing nonmarketed goods, inputs and outputs, and externalities (especially environmental impacts) Despite this, the extensive theoretical and empirical literature on economic valuation of environmental programmes and projects in industrial nations of Western Europe and the USA (e g Hanley and Spash, 1993, Barde and Pearce, 1991) compares very unfavourably with the few studies on developing nations (LDCs)

The studies by Bojo (1991) and Peters *et al* (1989) in Lesotho and on the Amazonian rainforests of Brazil, respectively, involved the implementation of general Cost-Benefit Analysis (CBA) principles to environmental management However, in an apparent support for van Pelt (1993), Meier and Munasinghe (1992) use a multicriteria analysis (MCA) to incorporate nonvalued environmental considerations into energy decision making in Sri Lanka Van Pelt (1993) shows that although CBA has been used most frequently, its usefulness in sustainability-oriented project appraisal in LDCs is limited As MCA can utilize qualitative data (such as knowing whether a project's impact will be environmentally "good" or "bad"), the author rightly contends that it (that is, MCA), is a more appropriate alternative or complementary project appraisal tool in LDCs where data base on environmental impacts is weak, economic activities are directly dependent on natural resources, and distribution concerns are strong Operationally, MCA involves adopting a number of criteria for project selection, which might include efficiency, equity and meeting a sustainability constraint

It is difficult to disagree with van Pelt given the well-known environmental limits to CBA, namely, valuation of nonmarket goods, institutional capture, ecosystem complexity as well as discounting, uncertainty and irreversibility of environmental effects (Pearce, 1976, Hanley, 1992, Hanley and Spash, 1993 p 261-74) Nonetheless, current efforts to refine approaches for estimating costs and benefits related to consumption or production of environmental/public commodities (such as the travel cost method, hedonic property method, and contingent valuation, CV) are of vital importance and should be encouraged Unlike MCA and Environmental Impact Assessment (EIA) which have often been presented as the alternatives[12], CBA is a useful filter in public decision-making machine since it enables the analyst to delineate both the opportunity cost and the most efficient way of undertaking a particular course of action Furthermore, the CBA programme offers a formal methodology of laying out the pros and cons of undertaking a project CBA critiques should take cognisance of the on-going developments in resolving some of its problem areas The CV method in particular, is regarded as an aid to the policy process rather than a replacement for it altogether[13], its loose purpose is to make the process more participative by drawing in the 'valuations', 'opinions' and even 'feelings' of a relatively large number of individuals

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[12]The other alternative frameworks for generating and presenting information for policy making in development and environmental management are risk-benefit analysis, impact assessment (involving environmental impact analysis and economic impact analysis), cost effectiveness analysis, multicriteria analysis, and national and environmentally adjusted economic accounts

[13]Critics of CV might believe I have conceded too much here if 'methodological pluralism' holds sway and CV is competing with other inputs to the policy process, then the final decision will be indeterminate But if CV was the unique, determinate decision process then it would be (rightly) labelled 'imperialistic' by the same critics For policy purposes, it would be pointless to propose the grafting of a decision procedure onto existing structures which ignores the inevitable political cloudiness surrounding final policy choices This cloudiness is presumably the reason why no sensible alternative proposed to CV provides a determinate decision either

3.3 METHODOLOGICAL ISSUES WITH THE CONTINGENT VALUATION TECHNIQUE

3.3.1 LINKING CONTINGENT VALUATION THEORY WITH EXPERIMENTAL FRAMEWORKS

If one considers the relationship between Chapter 2 and the massive contingent valuation (CV) literature, one is likely to see that evaluations of estimates of willingness to pay (WTP) fall into five experimental frameworks[14] These are

(a) the descriptions used to characterise the change from Q_0 to Q_1 (Brookshire *et al*, 1980, Bergstrom *et al*, 1989, for instance),

(b) the consistency over time in WTP values reported by similar individuals for a given change in Q (e g , Loomis, 1989, 1990, Kealy *et al*, 1990, Whittington *et al*, 1992),

(c) the procedure used to elicit WTP, such as bidding game, direct question, use of payment card, etc , or in the case of CV formulations and quantity change, discrete choice, ranking, or conjoint matching procedures for contingent behaviour questions (Desvousges *et al*, 1987, Smith *et al*, 1986 as examples),

(d) the other conditions (e g , values for P or SDE) that might influence an individual's WTP for a change in Q (like Smith and Desvousges, 1987), and

(e) the temporal dimensions of the valuation (or payments), whether daily, weekly,

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[14]CV evaluations usually involve one or more of the following seven research protocols (Smith, 1993 8f) (a) comparison of indirect and CV estimates of the value of some change in an environmental resource, (b) use of constructed markets in which commodities not usually sold are offered for sale and the results compared with CV estimates for the same commodity, (c) evaluation of CV for measuring the demand for actual marketed commodities of programmes in comparison with actual demands, (d) test-retest comparisons of the stability of CV estimates from the same sample over time, (e) creation of laboratory experiments in which hypothetical and actual sales of commodities are undertaken, (f) surveys of purchase intentions and actual sales of commodities, and (g) nonparametric "tests" of the consistency of CV and travel cost estimates with the strong axioms of revealed preference theory It is on the basis of these criteria that the performance of CV in eliciting satisfactory estimates of public and environmental goods has shown the methodology to be a progressive scientific research programme in the sense of Lakatos (1970)

monthly, or annually (Schulze, 1992)

As the last variation has received little attention in CV research, this study's experimental design explicitly considers its effects on CV estimates of household WTP Note that the definitions of the terms here are equivalent to those in Chapter 2 $Q_0$and Q_1 represent initial and subsequent quality levels, vector P represents the prices of all other goods and services, SDE refers to other socio-demographic and economic factors that might influence the household's ability to pay or constrain its behaviour, and finally Q is the character of the commodity of interest (in this case it is improved water quality in the Nzoia and a household connection to piped water) The next Sub-Sections survey structural biases, WTP/WTA disparity and embedding effect as special CV research questions

3.3.2 Structural Biases and the WTA/WTP Disparity

Structural biases and the disparity between WTP and willingness to accept (WTA) or demand compensation as measures of valuation are two key areas in CV research There are four types of structural biases which have been of primary pre-occupation for researchers involved with experimental studies related to the development of the CV method The biases have been argued to emanate from such aspects as starting points, choice of payment vehicles, strategic behaviour and information Consequently, the potential structural biases in CV-derived value measures are strategic and hypothetical bias, bias due to choice of starting point and valuation question format, and influence of variations in information sets and nature of payment vehicle See Freeman (1979), Cummings *et al* (1986), Mitchell and Carson (1989), Cambridge Economics (1992), Hanley and Spash (1993), and Hausman (1993) for details and original research papers

Besides bias due to the structure of CV surveys, much of the earlier criticism of CV (through the 1970s and 1980s) focused on the disparity between willingness-to-pay (WTP) and willingness-to-accept (WTA) values in survey instruments involving the same good In seeking economic valuations or welfare measures, individuals may be asked to state the maximum they would be willing to pay (WTP) for a particular good or service Alternatively, they could be asked to state the minimum amount they would require in compensation (WTA) if the good or service was removed[15]

A common interpretation of economic theory suggest that WTP and WTA, in response to a price or quantity change, should only differ by an income effect Otherwise, the two measures of welfare change should be similar in magnitude for most goods (e g , Willig, 1976, Just *et al*, 1982, Freeman, 1979) But, repeated experimentation has shown that values of WTP and WTA for the same commodity can be vastly different In fact, WTA values of three to five times WTP values have become a rule rather than the exception This view has become established from experimentation using hypothetical goods, actual market transactions, goods which are known to the consumer and priced in a market, and goods which are not traditionally priced in a market

A variety of possible explanations for the apparent anomaly, between this interpretation of economic theory and CV empirical results, have been presented in the literature These range from those which support traditional economic theory and claim

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[15]WTA requires an individual to accept compensation for giving up a good, while for the same good, WTP requires the individual to decide on a sum that they are willing to pay to acquire the good Adamowicz *et al* (1993) and Shogren *et al* (1994) provide satisfactory starting points for the discussion on WTP/WTA disparity upon which this dissertation just mentions

that the difference is a function of the empirical procedures involved in eliciting WTP and WTA, to those which accept the empirical findings and then consider explanations from psychological research For a detailed discussion on the explanations see Adamowicz *et al* (1993) and Shogren *et al* (1994) Briefly however, four groups of explanations can be discerned

One explanation for the WTP-WTA disparity appeals to problems in data collection, interviewing technique, or questionnaire design used in administering the CV method In particular, respondents of CV surveys may not have enough incentives to give truthful answers A second group of explanations suggests that the WTA measure is faulty due to two possible explanations One, consumers make cautious valuations (Hoehn and Randall, 1987) Two, many respondents reject the property right thesis implied by WTA-type questions on ethical grounds The idea that WTA is often justified on the proportionately high number of protest bids and/or outliers that normally characterise empirical work based on its format

The third group of reasons for the observed WTP-WTA differences resides in the psychology-economics literature (Kahneman and Tversky, 1979, Kahneman *et al*, 1986) This mainly refers to the prospect theory The Kahneman and Tversky's hypothesis involves the often observed condition that people may have different values for losses and gains of the same magnitude "This would suggest, for example, the separate indifference maps to illustrate acquisition and disposal decisions" (Knetsch and Sinden, 1984 519f) The additional value attached to possession may be considered an "instant endowment effect" (Kahneman *et al*, 1990) In other words, the numerous protest bids and outliers in WTA formats are indicative of economists being confronted with a problem that is beyond the conventional utilitarian framework.

The substitution-good hypothesis is yet another explanation According to this theory, the existence of the WTP-WTA disparity can be attributed to lack of substitutes for the commodity being valued Hanemann (1991 635) argues that "for quantity changes, there is no presumption that WTP and WTA must be close in value and, unlike price changes, the difference between WTP and WTA depends not only on an income effect" He shows that where there is a perfect substitute for the good being valued, WTP and WTA will be equal in the absence of an income effect Conversely, when there are zero substitutes for the good, the difference between WTP and WTA can be large Thus the difference depends on a parameter reflecting the degree of substitutability of the good under valuation In this way, Hanemann demonstrates that the bounds on compensating and equivalent variation developed by Randall and Stoll (1980) are "consistent with substantial divergencies between WTP and WTA" (Hanemann, 1991 636)[16]

In sum, there exist a number of competing theories which attempt to "explain" the difference between WTP and WTA Some hold to economic arguments and criticize the CV approach while others suggest that the phenomenon is a true expression of valuation Fisher, McClelland and Schulze (1988) suggest that the disparity is a function of both strategic behaviour and "loss aversion", although they provide no rigorous empirical backing for this thesis Their argument is that individuals value a given reduction in entitlements more highly than an equivalent increase in entitlements As noted in Chapter One, this study uses WTP measure and

[16]Hanemann's model attempts to deal with the observed WTP-WTA disparity through a line of inquiry that is well rooted in economics (i.e , substitute relationships) Although this does not necessarily make Hanemann's theory superior over the competing theories, it certainly makes it more amenable to testing within an economic methodology (as in Adamovicz *et al* 1993)

not WTA

3.3.3 Embedding and the Validity of Contingent Valuation Estimates

Embedding relates to tests of the validity of CV estimates, namely, to what extent does the CV method produce different values in situations for which economic theory suggests different values. For instance, economic theory predicts that respondents, when valuing environmental goods, will respond to the neoclassical axiom of 'more will always be better' a larger environmental good will be regarded more valuable than a smaller one That is, under normal conditions it can be expected that respondents are willing to pay more to clean up all the nation's lakes than to clean up one specific lake Besides this, economic theory postulates that for environmental goods which are substitutes and valued sequentially, the value of a good will be larger, the earlier it appears in the sequence (Randall and Hoehn, 1989)

Whereas tests of the former assumption are usually labelled 'perfect embedding', the influence of substitute goods are generally tested under the heading of 'regular embedding' (Kahneman and Knetsch, 1992b, Hoevenagel, 1995) Carson and Mitchell (1995) propose an alternative nomenclature that would separate true embedding effects from other biases that nesting and sequencing appear to cause They also argue for a set of standards to ensure that amenity mis-specification does not occur when developing the CV survey instrument, thus reducing the possibility of rendering the data collected to the embedding effect

The embedding proposition was first put forth by Kahneman (in Cummings *et al*, 1986), who found respondents in a telephone survey were WTP essentially the same amount for all lakes in Ontario as for lakes in a small area of Ontario It is important to note the distinction between part-whole bias as defined by Mitchell and Carson (1989) and the embedding problem considered by Kahneman and Knetsch (1992) Part-whole bias occurs when a respondent values a larger or smaller entity (e g , geographic location, range of benefits, policy package) than that intended by the researcher Part-whole bias is a common but avoidable obstacle in designing a CV survey, and its avoidance is seen by Mitchell and Carson (1989) as a key element in a survey designer's primary task, ensuring that the respondent is valuing the good intended

In contrast, Kahneman and Knetsch (1992) seem to see embedding as an indicator of the inevitable inability of respondents to rationally value public goods It will be useful to state their definition of embedding "the same good is assigned a lower value if WTP for it is inferred from WTP for a more inclusive good than if the particular good is evaluated on its own" This definition is problematic because the sequence in which goods are valued, substitution effects, and changes in the composition of the choice set should make a difference in the agent's valuation Thus embedding can only be seen as a distinct problem with CV if this so-called embedding effect is much larger than that which can be explained by reference to plausible economic effects, i e , the CV technique produces the effect while it is not seen in the actual behaviour of consumers or voters[17] The recent survey of empirical work on the

[17] Because it is difficult to judge what the exact magnitude of these economic effects should be, a statistical test of either part-whole bias or embedding often sets out as its null hypothesis that two related goods (where one encompasses the other) are valued identically by the respondents against the alternative that the good which encompasses the other is valued more highly (See research hypotheses in Chapter IV) Note however, the Mitchell and Carson (1989) framework suggests that while the null hypothesis may be accepted in a poorly designed CV study, it should be rejected by a well-designed CV survey The Kahneman and Knetsch framework, because it views the phenomena as "inevitable", suggests that the null postulate should always be accepted The difference between the two frameworks is that accepting the null hypothesis under Mitchell-Carson framework implies a rejection of a

issue of scope in CV studies by Carson and Mitchell (1993) shows that sensitivity to scope of CV estimates is a matter of survey design and administration

When referring to wilderness areas, perfect embedding is said to occur when respondents' WTP values for preserving area A, are the same as their WTP values for preserving areas A and B together, and areas A, B and C together (see Harrison, 1992, Owen and Hanley, 1993) In a recent study,[18] Diamond *et al* (1992) sought to obtain WTP values for 3 wilderness areas, 1 and 2 together, and 1, 2, 3 together, and individually Respondents were told that in order to lower the deficit, selective logging rights were to be sold in over 50 wilderness areas, resulting in requisite roading and the presence of heavy machinery The Government was considering adding the three named areas to this list The stated alternative was to impose a Federal income tax surcharge (implies broad acceptance of the distribution of taxes) designated for wilderness preservation They test the hypothesis that, "Stated WTP is the same for preserving one, two or three wilderness areas" Neither parametric nor non-parametric mean tests rejected this hypothesis

Using data gathered for the same wilderness areas McFadden and Leonard (1992) test the embedding hypothesis using a double referendum elicitation method, in which respondents are offered a second bid, conditioned on the response to the first bid, a number of valuation questions are asked Valuation question DR1 seeks household WTP regarding a 1 3 million acre area, DR2 seeks household WTP regarding 57 wilderness areas including the 1 3 million acres, and DR3 seeks a

particular study whilst under the Kahneman and Knetsch framework it implies rejection of the CV methodology in its entirety

[18]The next three studies cited were financed by Exxon

valuation regarding the 1 3 million acres and 2 other similarly large areas The authors could not reject the hypothesis that the value of the three areas was the same

Desvousges *et al* (1992) also found that the level of natural resource damage appeared to have no significant effect on open-ended or dichotomous choice WTP values The hypothetical scenario involved WTP for preventing 2,000, 20,000 and 200,000 migratory waterfowl from dying in waste-oil holding ponds scattered over the south-western United States[19] However, as respondents were told that 2000 birds was much less than 1% of the migratory bird population, and 200,000 birds was about 2%, it may have lead them to consider the programmes to be essentially the same (Arrow *et al*, 1993)

Besides the studies in Cambridge Economics (1992), Owen and Hanley (1994) test for embedding in the contingent valuation of biodiversity through UK Sites of Special Scientific Interest (SSSIs) In their case study of Greenham Common SSSI in Newbury district, the two goods that represent quantitative nesting are Greenham Common and its unique species/habitat structure being one subset of all local SSSIs and local biodiversity By comparing the bids for the two goods, A and B, A being the biodiversity provision of all local SSSIs including the single SSSI and B being the biodiversity provision of the single SSSI, an external test of component sensitivity is

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[19]Kahneman and Knetsch (1992) also test for and claim to find an embedding effect However, Harrison (1992) convincingly argues that their work fails to properly differentiate between more and less inclusive levels of environmental protection such that K and K's less inclusive good may well have been considered as identical by respondents to the more inclusive good

Harrison's own characterisation of how a rational agent would not increase the value of a more inclusive good over her/his WTP for the less inclusive good does not seem to be at all likely He says, Assume X and Y are virtually perfect substitutes for each other, that X+Y = Z and my WTP for 1 unit of Z=$10, 1 unit of X=$10 and 1 unit of Y=$10 "[I]f you asked me to value one unit of Y *after* asking me to value one unit of X, then I would value Y at $0" Does this not imply that 1 unit of either X or Y satiates?

conducted In conclusion, the CV method "fails the test of component sensitivity Respondents' valuations of the value of preserving one SSSI were insignificantly different from valuations of the value of preserving all local SSSIs on the evidence of both paired tests (parametric and non-parametric), and a bid curve estimated using a Tobit ML procedure" (p 19)

The evidence of embedding presented in Cambridge Economics (1992) and in Owen and Hanley (1994) is the most damaging to CV in the recent past As noted, it clashes with the fundamental proposition of economics, that more of a good is preferred to less To critics the embedding effect implies that the CV method does not measure economic preferences and therefore should not be used in natural resource damage assessments (e g , Desvousges *et al* , 1992, 1993, Diamond *et al* , 1992, 1993, Kemp and Maxwell, 1993, Binger *et al* , 1995) Several explanations have been put forward to explain these findings and three hypotheses can be distinguished Mental Accounting/Good Causes Dump Hypothesis (attributed to Kahneman and Tversky, 1984), Moral Satisfaction Hypothesis, Misperception Hypothesis Detailed explanations of these reasons can be found elsewhere (especially in Hanley and Spash, 1993, Hoevenagel, 1996 or the original articles) Nevertheless, a brief outline of the explanations follows

1 Mental Accounting-Good Causes Dump Hypothesis According to this postulate, people have a set of 'mental accounts', one of which may be for environmental issues or, more generally, for good causes, this explanation stems from some researchers interpretation of Kahneman and Tversky's (1984) findings Therefore, respondents, when asked to value a specific environmental good, will dump everything in their 'good causes account' or 'environmental account' into the required WTP value irrespective of the description of the environmental good of interest

2 *Moral Satisfaction Hypothesis* This hypothesis has been put forward by Kahneman and Knetsch (1992) in a way to explain their perfect embedding results According to these authors, responses in CV surveys represent a willingness to get a sense of moral satisfaction through the hypothetical payment to the provision of environmental goods, rather than a measure of economic value As claimed by these authors, an interesting feature of this hypothesis is that the moral satisfaction related to payments to an inclusive cause, for example, saving all endangered species, extends with little loss to any significant subset of that cause, for example saving the Chinese Panda

3 *Misperception Hypothesis* Mitchell and Carson (1989) explained perfect embedding on the basis of respondents' misperception of important aspects of the constructed market and the environmental good to be valued According to these authors there is a considerable potential for respondents to ignore (important) details in a CV scenario because they lack articulated values for many of the goods valued and because they have "a natural inclination [to] think of a CV survey as an ordinary public opinion survey" (Mitchell and Carson, 1989 p 250) Only through careful design, which includes the use of focus groups and pretesting, they argue could such important misperception biases be overcome

There is a clear difference between the hypotheses defined above whereas the mental accounting and moral satisfaction hypothesis imply that, because of the hypothetical character of the CV method, respondents will always express similar WTP values across related (embedded and inclusive) goods, the misperception hypothesis claims that perfect embedding can be overcome by improved design

Proponents of the CV method generally disregard the studies that have reported perfect embedding (such as those in Cambridge Economics, 1992) on the basis of improper design (Smith, 1992, Arrow, 1993, Carson and Mitchell, 1993)

For example, Arrow *et al* (1993) note that the survey used by Desvousges et al (1992) and Diamond *et al* (1992), may not have adequately differentiated between the goods being valued The survey related to migratory birds dying in oil filled ponds In this study respondents were told that 2,000 birds was much less than 1% of the migratory bird population, and 200,000 birds was about 2% This could have resulted in respondents considering both goods to be roughly the same Likewise in the Diamond *et al* (1992), the three wilderness areas constituted 1 in 57 areas individually and 3 in 57 together To the extent that respondents saw the survey from this perspective, they may have seen very little difference between the value of 1, 2, or 3 areas, i e. in each case it is a very small part of the whole

3.4 Applying Contingent Valuation to River Water Quality

Proponents of Cost-benefit analysis (CBA) believe it constitutes a valid decision support tool for gauging the performance of water policies CBA, they argue, facilitates decisions that account for economic and political effects through identifying the value of a policy or expenditure to both direct, intended audience and to any indirect audiences (Peskin and Seskin, 1975, Dasgupta and Pearce, 1978, Campen, 1986, Hanley and Spash, 1993)

In water resource management, the United States River and Habor Act of 1902 was one of the first impositions of cost-benefit criteria on public water projects The Act required the Army's Corps of Engineers to evaluate navigation projects in a way that identified both commercial benefits and their costs The Flood Control Act of 1926 took the River and Harbor Act further by stating explicitly the criteria that benefits must exceed costs for public projects

However, until the publication of the *Proposed Practices for Economic Analysis of River Basin Projects* (the "Green Book") in 1950 by the US Federal Inter-Agency River basin Committee subcommittee on benefits and costs, the technical and theoretical development of CBA had followed an intuitive and political course The outcome of CBA was not so much aimed at discovering those projects that best served the affected public, but rather at discovering the approach to a politically desirable project that was justifiable Identification of costs and benefits and their treatment was largely a seat-of-the-pants process The Green Book was the first codification of the economic principles relevant to proper CBA It was superseded by Budget Circular A-47 in 1952 and later by the US President's Water Resources Council's *Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for*

Use and Development of Water and Related Land Resources in 1962

3.4.1 Perceptions, Values, and Benefits of Improvements

As noted, the fundamental role of CBA is to establish principles by which the costs and benefits of any public programme are measured However, many of the components of costs and benefits are not exchanged in markets and thus have no well-defined prices In addition, many markets contain distortions -- taxes, subsidies, quotas, monopoly, monopsony -- that make the prices misrepresentative of the resource-scarcity or shadow price of the commodities exchanged

In the field of CBA application in environmental quality, there are many studies on the problems of measuring abatement costs (e g , Peskin and Seskin, 1975) On the other hand, measuring benefits from improving environmental quality is difficult because most of these benefits must be *imputed* by CBA techniques Some benefits routinely evaluated for cost benefit studies of pollution are the value of life (mortality and morbidity), the value of intangibles such as the quality of life, the value of the natural environment (air and water quality), and property values

The parameters that have been used to measure water quality include the oxygen demand of organic wastes as they are decomposed, suspended solids, toxic chemicals, and temperature It is in the relationship between a change in environmental services and change in economic welfare or benefits of abatement that economic valuation becomes important (e g , Trihey and Stalnaker, 1985, Cavendish and Duncan, 1986, Priscoli, 1987) For instance, Trihey and Stalnaker (1985) state that the results of their studies on the value of fisheries resources ultimately will need to be compared with results of other studies on the value of instream and out-of-stream uses

Through its capacity to measure *total economic value*, the Contingent Valuation (CV) method provides a versatile approach to underpinning such values as well as enhancing an inter-disciplinary discourse on managing environmental and public goods Benefits from a change in water quality depend on an individual's utility function[20] Table 3 1 shows the types of benefits which might accrue from improved water quality In the presence of uncertainty, CV obtains an estimate of the difference between two planned expenditure functions, an ex ante welfare measure which is referred to as option price (Smith, 1987) Several benefit categories, particularly those making up the nonuse (i e , existence) class of benefits, may show no traces in marketplace transactions There are reasons to believe that this class of benefits may comprise a sizable portion of total water quality benefits (Fisher and Raucher, 1984) Among benefit measurement methods, the CV technique is uniquely able to measure nonuse benefits since it can elicit values from both users and nonusers of a given amenity

[20]The utility function, as usual, includes all sorts of things, but economists assume it includes some measure of water quality, and option and preservation values Option and preservation values arise when an environmental asset, say a particular wilderness area, has alternative uses Preservation values include bequest and existence values Bequest values are the willingness to pay for the satisfaction derived from having one's heirs and future generations in general enjoy environmental services Existence values are what people are willing to pay just to know that the environmental asset is preserved, even if they do not intend ever to directly consume those services

Table 3 1 A Typology of Benefits From an Improvement in Freshwater Quality

Use	Instream	Recreational (water skiing, fishing, swimming, boating)
		Commercial (fishing, navigation)
	Withdrawal	Municipal (drinking water, waste disposal)
		Agriculture (irrigation)
		Industrial/commercial (process treatment, waste disposal)
	Aesthetic	Enhanced near water recreation (hiking, picnicking, photography)
		Enhanced routine viewing (commuting, office/home views)
	Ecosystem	Enhanced recreation support (duck hunting)
		Enhanced general ecosystem support (food chain)
Nonuse	Vicarious consumption	Significant others (relatives, close friends)
		Diffuse others (American public)
	Stewardship	Inherent (preserving remote wetlands)
		Bequest (family, future generations)

Source Carson and Mitchell (1993) p 2446 Table 1

Recreational use of water has significant economic value Freeman (1992), for example, implies that movement from 1972 U S water quality baseline to the level attainable using best available technology for reducing water pollution would provide annual benefits of $20 1 billion, with lower and upper bounds of $8 2 and $39 1 billion Freeman's estimates include benefits from commercial use and marine recreation They are based on a careful synthesis of prior studies (e g , Freeman, 1979), with some key recreation data dating from 1972

Should technical measures such as biological oxygen demand, suspended solids, and toxic chemicals be used in the analysis of water use? It is most unlikely that most recreational users will be able to evaluate these measures But does this matter? People may not know the precise pollution components of the water but their perceptions of whatever it is that determines water quality may correspond to the technical measures David (1971) surveyed individuals in Wisconsin to find their perception of water quality People tended to look at characteristics such as algae content (green scum), murkiness, odour, and debris in the water But when people's perceptions of what constituted "polluted water" (and variations in polluted water) were matched with scientific determination of degrees of polluted water using objective criteria, a close correlation resulted Other studies have not had such positive results

How has water quality and option value been estimated? The CV study by Greenley *et al* (1981) contains measures of people's willingness to pay for improvements in water quality *and* the option and preservation values associated with a choice of use of a particular recreational site The site is the South Platte River Basin in Colorado In this case, a hypothetical decision was to be made about whether to continue to use the basin for recreation or to allow mineral and energy development to occur Mineral development would irreversibly degrade the water quality of the river

The authors first measure the implicit benefits of water quality improvements along the basin and then measure option and preservation values The technique used in each case is sampling of people's willingness to pay A random sample of 202 households in two cities in Colorado were interviewed in the summer of 1976 There was little evidence of sample bias or any strategic behaviour on the part of the individuals questioned People were asked what they would be WTP for incremental improvements in water quality and for the option of maintaining the river at the highest quality attainable, rather than allowing mineral development to proceed immediately They were told that the decision to start mining could be made in the future two types of payment were proposed -- incremental increases in sales taxes for the state, or an increase in the water and sewer fees paid by all residences The funds collected were to go improving water quality These fees were chosen because they were familiar to individuals and seen as a practical means of financing improvements

To determine different levels of water quality, people were shown colour photographs of three sites that represented the range of quality They were also given technical information about the pollutants (heavy metals) present in the three sites The photos allowed people subjectively to evaluate certain aspects of water quality (algae, debris), but not others (odour) They were asked what they would be WTP to increase quality to the highest level shown in the photographs by 1983 Eighty percent of those sampled were willing to pay to increase water quality On average, these people were willing to incur an additional $57 per year through an increase in the rate of the state sales tax to have water quality at the highest attainable level The amount they were WTP through an increase in water and sewer fees was much smaller

The authors feel the divergence between the two forms of payment may be due to considerations of equity (or spreading the payments over a broader group of people) The sales tax would be paid by residents of the state and by out-of-state tourists who visited the site Only residents pay the water and sewer fees There had also been a recent increase in the water and sewer fees, and people were perhaps more sensitive to that form of financing What is important to note is that the method of financing changes in water quality will influence WTP for the improvements

To determine option values, people were asked if they preferred preserving the river basin at the highest quality or permitting mineral development They were told that if mineral development occurred recreational use of the basin would end If they chose to preserve the site, they were asked how many additional cents per dollar of sales tax they would be WTP to postpone any development decision to the future

Eighty percent of the sample expected to use the site for recreation, 60 percent of the total sample had a positive option value Twenty percent had zero option value because, although they intended to use the site for recreation, they did not believe that the pollution would affect their use The remaining 20 percent also had a zero option value because they did not intend to visit the site for recreation The average option value for the 80 percent who intended to use the site came to $23 per year Preservation values were calculated at an average of $42 per year per household increase in sales taxes when the 20 percent who did not intend to use the site for recreation were included These people were WTP for the option of having the site preserved for future generations and simply to have the site there When the preservation values for only those using the site are averaged, the increase in the sales tax comes to $67 per year per household

When these values are applied to all households near the river basin, the total benefits of an improvement in water quality came to $61 million per year, of which $26 4 million represented direct improvements in water quality, $10 5 million the option values, $14 4 million existence value, and $9 8 million bequest value These benefits suggest a strong WTP for improvements One can criticize the techniques used to obtain the numbers, but the numbers provide a basis with which to compare the actual costs of abatement Table 3 2 shows examples of CV studies on river quality improvements

Table 3 2 Examples of Contingent Valuation Surveys on River Quality Improvements

Reference	Contingent Commodity	Research Details
Mitchell and Carson (1985), interpretation of Greenley, Walsh, and Young (1983)	Option price of water quality in Platte River Basin	Sample size 161 (water bill), 177 (sewer tax), selected by random sampling of households in Denver and Fort Collins, no starting points used but the authors show different implied starting values by the alternative payment vehicles, Some disagreement about exact commodity measured (Desvousges, Smith, and McGivney 1983, Mitchell and Carson 1985)
Boyle, Bishop and Welsh (1985)	Scenic beauty on lower Winsconsin River	Sample size 176, selected by random sampling of recreationists on site, Starting points used \$10 to \$120 randomly chosen, found statistically significant and positive relationship between starting bid and willingness-to-pay (WTP), commodity is somewhat abstract, detailed examination of starting points with ample sample size and a wide range of starting values, found statistically significant and positive relationship between starting bid and wtp
Desvousges, Smith and McGivney (1983)	Option price for water quality and improvement in the Monongahela River basin	Sample size 150, selected by stratified random sampling amongst 5 counties in the basin, Starting points used \$25 and \$125, some evidence of starting point bias especially in comparison results, high starting point corresponded with 19 of 30 outlying bids making statistical results suggestive but not conclusive, Most detailed sampling and survey plan, trained professional interviewers, ample sample size and wide range of starting bias
Green and Tunstall (1991)	Recreational benefits resulting from improvements in river water quality in the UK	Sample size 823, selected by random sampling of recreationists at 12 sites, the willingness-to-pay question was an iterative bidding procedure, potential effect of temporal dimension of payments in the valuation process mentioned, but not fully addressed
Willis and Garrod (1995)	Alleviating low flows in rivers in England and Wales	Sample survey covered three groups (i) 325 residents along the River Darent, (ii) 335 visitors to the Darent, and (iii) 758 households randomly sampled from the general public, open-ended questioning format, presents the first UK project appraisal of a low-flow alleviation scheme, Overall, the study suggests that, for the River Darent, preventing further deterioration in river flow will result in greater benefits than costs

3.4.2 National Benefits and Costs

Until recently estimates were unavailable on how much planned investments would improve river water quality in ecological or other terms and on the economic valuation that a nation would place on such improvements Those who would estimate the economic benefits of national water pollution control programmes face a dilemma On the one hand, data at the national level have thus far been lacking or are untrustworthy (Dorfman, 1977, Feenberg and Mills, 1980, Freeman, 1982)

On the other hand, studies that have valued "local" water bodies such as river basins or lakes, while more numerous (e g , Greenley *et al*, 1982) are at best, of limited use in determining the benefits of national water quality policy changes Theoretical work by Hoehn and Randall (1989) demonstrates that independently derived benefit estimates for geographic locations or categories of benefits which are potential substitutes or complements for each other can not be aggregated to obtain national benefits in a straightforward manner Hoehn (1991) provides additional theoretical discussion on this issue and provides empirical evidence that performing such an aggregation may result in a significant overestimate of total benefits

However, one approach used by national studies[21] (e g , Carson and Mitchell, 1991, 1993) considers a 10-step water quality ladder which relates physical characteristics of water quality to approximate changes in typical uses that are

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[21]The approach of national CV studies has a number of merits Firstly, it avoids the geographical aggregation problem by using a survey in which a countrywide probability sample of (say, U S , UK or Kenya) households are asked to value a national set of water quality improvements In terms of the Carson and Mitchell (1991, 1993) study, it avoids the problem of benefit category (e g , fishing aesthetics) aggregation by asking the same sample to give the total value of all benefits of for American households for three progressively higher levels of water quality In addition to directly measuring national water quality benefits, the national CV approach also makes it possible to estimate a valuation function which predicts willingness to pay as a function of the level of water quality, income, water-based recreational use, and environmental attitudes

meaningful to people interviewed in these studies For instance, step 2 5 represents boatable water, step 5 fishable water, step 7 swimmable water, and step 9 5 drinkable water

Carson and Mitchell (1991, 1993) conducted a nationwide CV study involving careful in-person interviews with 813 randomly selected adults Experienced personnel conducted the interviews, which averaged 40 minutes each Respondents were asked how much they would be willing to pay through higher taxes or prices for movements of all U S freshwater from one step on the ladder to another The survey was conducted in 1983 Their analysis related WTP for water quality improvements to survey respondents' household incomes, attitudes toward the environment, and participation in outdoor recreation

Carson and Mitchell's methodology included pretests of the survey instrument and other checks to help ensure meaningful responses by survey participants The exact factors considered by the respondents are unknown but could include recreational, aesthetic, wildlife, and other benefits Mean values for environmental attitudes and participation in freshwater recreation were also found by Carson and Mitchell to affect WTP Carson and Mitchell (1991 p 24, 1993) propose that two-thirds of household WTP reflects water quality within respondents' states, with the remaining third reflecting out-of-state waters

A major share of the benefits of clean water programmes is expected to be received directly by households In a study by Lyon and Farrow (1995), household WTP for freshwater benefits is estimated using an econometric relationship determined by Carson and Mitchell (1991 p 20, 1993) Lyon and Farrow (1995) present an economic analysis of the incremental benefits and costs of clean water programmes

In the paper, benefit estimates are principally based on CV research on WTP for clean freshwater The data are supplemented with estimated benefits for municipal and industrial water withdrawals and saltwater fishing Cost estimates are largely based on the US Environmental Protection Agency (1991) "needs" data and on studies of nonpoint source pollution control practices (specially, Gianessi *et al*, 1985) The authors rightly contend that "[a]llocating all benefits within states tends to raise the net benefits of states with high populations (or reduce their net losses, as these states also tend to have high estimated costs)" (p 215)

The Lyon-Farrow (1995) analysis suggests that US Clean Water Act programmes, as currently planned, may have incremental costs that exceed their incremental benefits as measured by WTP Secondly, the analysis suggests that untargeted construction of municipal treatment facilities is unlikely to be cost effective as a national strategy in terms of aggregate removal levels and will not address the most prevalent sources of impairments and discharges agricultural nonpoint sources Municipal facilities may have advantages, however, in terms of addressing certain pollutants or water quality in heavily populated areas The study also suggests that the concept of "needs" has limitations when viewed in a benefit-cost context

Finally, the United States EPA (1994) in a recent analysis of President Clinton's Clean Water Initiative, concluded that the undiscounted monetized benefits of the initiative in urban areas would be of the order of $0 8 to $6 0 billion annually If benefits are discounted to reflect phased-in controls, they would be somewhat lower Urban areas are estimated by EPA (1994 p D-8) to have three-quarters of the total U S population Like the study by Lyon and Farrow (1995), EPA's analysis relies heavily on the Carson and Mitchell (1991, 1993) research[22].

3.5 Developing Country Applications of the Contingent Valuation Method

No matter what views one holds about the desirability of cost-benefit analysis, the extent to which it is used both in developed and less developed countries has increased and many advocate for its more widespread use (or that of closely related techniques) as a means to decide whether to commit resources to particular projects or of choosing between competing projects when resources are scarce Unlike in developed countries where application of the method to evaluate water-resource projects dates back to the 1950s, efforts to extend its use to project evaluation in LDCs were made in the 1970s (Tisdell, 1986, Munasinghe, 1993) Indeed, application of techniques for taking account of environmental factors, and other unpriced or 'inadequately' priced commodities, is still in its infancy

It is only in the last decade or so that environmental effects of projects have become important considerations in foreign aid and loans to LDCs The World Bank and U S AID now undertake environmental assessments in supporting Third World projects This has helped to stimulate interest in the art of environmental assessment of projects in the LDCs, environmental assessment, of necessity, includes economic valuation of natural resources and the environmental impacts

Indeed, studies employing specific valuation techniques have recently began

[22]EPA estimates the annual costs of the initiative for these areas to be $9 9 to $14 billion About two-thirds of these costs ($6 6 to $8 6 billion) would fall on municipalities, mostly for storm water controls EPA (1994 p ES-1) correctly notes that there can be good reasons for pursuing the initiative despite the benefit-cost estimates These reasons include the uncertainties in the analysis, the distributional effects of the policy, including the public's right to enjoy clean waters, and the strong public support for clean water policies

to address aspects of environmental policy and resource management in LDCs (Munasinghe, 1993, see Table 3 3) For instance, Tobias and Mendelsohm (1991) measured the value of ecotourism at a tropical rainforest site in Costa Rica using the travel cost method while Brown and Henry (1989) utilised both travel costing and contingent valuation (CV) to estimate the demand function for viewing elephants on safaris[23] in Kenya The travel cost approach has also been utilised in Nigeria to place monetary values on recreational centres (Duroyaiye and Ikpi, 1988)

Durojaiye and Ikpi (1988) report a study aimed at quantifying monetary benefits associated with three recreation centres in Nigeria (the Agodi Gardens, Ibadan, the University of Ibadan Zoological Garden, Ibadan, and the Luna Amusement Park, Lagos) Two measures of monetary value were employed -- the total benefit value and the nondiscriminating monopilist or the maximum collectable gate taking value Total benefits of the respective centres were N57,297, N479,906, and N1,146,643 The nondisriminating monopolist values were N13,248, N177,212, and N382,458, respectively Because these values were not considered insignificant to the economies of Ibadan and Lagos cities, the authors concluded that there was no economic justification for the then Nigerian governments "little orphan" attitude to recreation

Most CV research applications in LDCs, as will be seen shortly, involves determination of household willingness to pay for improved domestic water Nevertheless, the CV method has been applied in developing countries to evaluate quality of electricity services (Munasinghe, 1990), as well as to the problem of

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[23]"Safari" is a Kiswahili -- Kenya's national language -- word for "tours" "Safari" is the singular equivalent for "tour"

financing education (Thobani, 1983, Tan *et al*, 1984, Jimenez, 1987) and health (Jimenez, 1987, Birdstall, 1987) Also, Kramer and co-workers (1995), in a World Bank project on environmental valuation of forestry development and conservation, apply CV to determine nonuse values of tropical forests in Madagascar

Table 3.3 Examples of Environmental Valuation Research in Developing Countries

Reference	Country, Environmental Commodity, and Valuation Technique
Adger *et al.* (1994)	Mexico, apply both contingent valuation (CV) and travel cost (TC) surveys to estimating total economic value of Mexican forests
Duroyaiye and Ikpi (1988)	Nigeria, apply the TC technique to value three recreational facilities i.e., the Agodi Gardens Ibadan, the University of Ibadan Zoological Garden Ibadan and the Luna Amusement Park Lagos
Jimenez (1983)	Philippines, uses hedonic property (HP) value modelling to explain changes in housing prices in a Manila slum area, upgraded partly due to water and sanitation service improvements
Maille and Mendelsohn (1993)	Madagascar, use the travel cost (TC) technique to estimate the value of ecotourism from visitors' observed behaviour
Navrud and Mungatana (1994)	Kenya, employ both the TC and the contingent valuation (CV) methods to estimate the recreational value of wildlife viewing in Lake Nakuru National Park
Peters, Gentry and Mendelson (1989)	Brazil, determine the value of an Amazonian rainforest through both CV and TC methods
Swallow and Wouldyalew (1994)	Ethiopia, determine willingness to contribute towards tsetse fly control by a CV survey.

The many potential problems in applying CV in developing and transition economies have been noted by several authors (e g , Tisdell, 1986, Thomas *et al* , 1991, Boadu, 1992, Krupnick *et al*, 1993, Munasinghe, 1993, Paulsen, 1993, Shyamsundar and Kramer, 1993, Whittington and Swarna, 1994, Swallow and Wouldyalew, 1994) These problems include very low income levels and their impact on stated WTP, and the emphasis of CV on individual preferences as a guide to decision-making

Moreover, attempts have been made to discern contextual impacts upon CV estimates A variable designed to test the effect of the presence of listeners was included in Whittington *et al*'s (1993a, b) multivariate analyses of WTP bids for improved sanitation services in Ghana The results are mixed and depend on the estimator used The effect of listeners is never statistically significant in the ordered probit models and is statistically significant in only two of the OLS models (both cases are for water and WC[24] with sewer connection) The effect of listeners shows up most strongly in the Stewart maximum likelihood models The direction of the effect is not consistent In the models of willingness to pay for KVIP, for WC with sewer, and for sewer, it is positive, but in the models for water and for water and WC with sewer, it is negative" (*Ibid* 1553) However, because the parameter estimates are generally small, the authors interpret the results to mean that the presence of listeners

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[24]WC and KVIP stand for water closets and Kumasi ventilated improved pit latrines respectively A KVIP is a private, sanitary means of waste disposal It is a dry system which does not use any water A KVIP can be built in different sizes to accommodate various members of households Each toilet room (or module) has two holes (only one of which is in use at a time) and can be built as a free-standing structure with its own roof, or it can be built into an existing room in a building The excrement falls into one of two adjacent pits When one pit is full, the users switch to the other A pit is not emptied immediately after it becomes full Rather the users wait for about two years until the excreta is decomposed and is fully safe to handle At this point the stabilized waste can be safely used for fertilizer For details on KVIPs including diagrams see Whittington *et al* (1993a,b)

had little, if any, effect on the WTP bids Overall, the results suggest that willingness-to-pay bids are "not easily manipulated or influenced by contextual issues" (Whittington *et al*, 1993 1553)

An even more distinctive feature of the applications has been the researchers' hawk-eyedness for possibilities of using (or complementing money with) a different "item" for evaluating household willingness to "contribute" towards an environmental improvement rather than just cash as is normal in CV studies of American and western Europe persuasion Note that Swallow and Woudyalew (1994) asked respondents if they were willing to contribute money to a fund for replacing materials and/or labour time for constructing, monitoring and maintaining tsetsefly control targets Their results indicate that more people would be willing to contribute labour than money With respect to the overall purpose of the Ethiopian case study of evaluating the distributional benefits of tsetse fly control to reduce illness in humans and livestock, the authors clearly demonstrate the importance of decentralized participation in ecological management

Another study where a non-monetary unit of value is used due to a limited cash economy is that by Shyamsundar and Kramer (1993) In their estimation of welfare losses resulting from land-use restrictions associated with a newly established national park in rural Madagascar, the researchers denominate contingent valuation questions in baskets of rice In measuring individuals' WTP for reduced mortality risks (or WTP for reductions in health or environmental risks or effects) in developing and emerging economies, Krupnick and co-workers (Krupnick, 1992, Krupnick *et al*, 1993) at the Quality of the Environment Division of Resources for the Future suggest that WTP questions in CV surveys be framed in terms of time rather than money

However, they rightly note that for use in a cost-benefit analysis the analyst will still face the task of valuing time or whatever unit of account is employed in contingent valuation

As far as the applicability of the CV approach to LDCs is concerned, the reviewed research, including that evaluated in Section 3 7 below, suggests (a) that CV can be applied in such economies albeit with modifications and (b) new insights into sources of bias Thus one can read

> "The results of this study suggest that it is possible to do a contingent valuation survey among a very poor, illiterate population and obtain reasonable, consistent answers There does not appear to be a major problem with either starting point or hypothetical bias The evidence with regard to strategic bias is less conclusive, but neither the admittedly limited test for strategic bias nor the experience of the enumerators indicated that it was a problem" (Whittington *et al*, 1990 p 307-308)

> This research provides additional evidence that [CV] surveys can be successfully conducted in cities in developing countries and that useful information can be obtained on household demand for public services such as sanitation From a methodological perspective, however, there was an interesting aspect about the evidence of starting point bias The results revealed a potential problem with the use of "abbreviated bidding procedure with follow-up" as an elicitation method When a respondent was offered an improved service at a specified price, he could answer "yes" or "no" In this study, if answered "yes", he was not likely to raise his bid above this specified price in response to an open-ended follow-up question In this case the open-ended follow-up question did not provide any additional information on the household's preferences On the other hand, if the respondent answered "no" when offered the service at a given price, an open-ended follow-up question elicited a wide range of answers below the specified price The apparent reluctance of respondents to offer a bid above the specified price will likely result in a downward bias in the mean of the [WTP] responses to the open-ended questions' (Whittington *et al*,1993 p 1555-7)

> ' the "translation" of a CV study into the Korean context was more than a matter of translating a suitable English questionnaire Creating a sampling frame and choosing a target respondent, both key parts of a study required significant adjustment to the realities of Seoul Focus groups and local technical assistance became especially important in a such a more general "translation" exercise While we believe the adjustments we made to the Korean situation described above "worked", we emphasize that all such adjustments will be country and culture specific In particular, it does not seem feasible at this time to create a generally applicable cookbook of recipes for doing c v studies in countries around the globe Each effort in a new

country will turn up a new lesson" (Kwak and Russell, 1994 p 524)

Apart from the above, the applicability or otherwise of CV in developing and emerging economies can be discerned from modifications and innovations undertaken by the researchers The need for focus groups and local technical assistance has been given emphasis

3.6 FREQUENCY INFORMATION AS A DIMENSION IN DECISION MAKING

> How many movies have you seen this year? If the answer is more than one, which did you see most recently? Where did you sit the last time you were at your favourite restaurant? Do more people in the United States die of botulism or of emphysema? Are there more tailors or more lawyers? Which word occurs more frequently in English -*bacon* or *pastrami*? These questions are directed at how often events occur, in what temporal order, and in what spatial contexts (Hasher and Zacks, 1984 1372, original italics)

3.6.1 FREQUENCY DEFINED

The term "frequency" denotes the number of times an event or category of events occurs For consumers, there are several types of events relevant to decision making that may be subject to "counting" (Hasher and Zacks, 1984, Alba and Marmorstein, 1986) Of particular relevance are three forms of frequency

a) frequency of purchase or average interpurchase time interval (Winer, 1986, Meghir and Robin, 1992, Kalyanaram and Little, 1994, Moffat, 1995)

b) number of positive or negative attributes possessed by a brand or number of dimensions on which one brand outperforms another (Bordley, 1985, Alba and Marmorstein, 1987)

c) frequency of price advantage/promotion or number of items on which a firm enjoys lower prices over its competitors (Krishna, 1991, Alba et al , 1994)

However, it is as well to note that until recently use of frequency knowledge as a decision heuristic received little attention in consumer research One reason may be that decision making is often studied under conditions that suppress frequency effects (e g , Wright, 1975, Bettman and Park, 1980, Petty and Cacioppo, 1984, Kisielius and Sternthal, 1986, Moore *et al* , 1986, Alba and Marmorstein, 1987)

This section starts by reviewing recent literature on consumer sensitivity to frequency of information The section then moves on to extrapolate implications of such behavioural and social understanding of purchasing behaviour for temporal dimensions of payments in contingent valuation (CV) of environmental improvements CV work often presents subjects (mainly households or individuals) with a fourth form of frequency information This is because the methodology involves constructing hypothetical market scenarios with a view to eliciting weekly, monthly, annual or once-off single payments as willingness to pay (to accept in compensation) for a welfare gain (loss) due to a given environmental improvement (deterioration)

Temporal dimensions of payments in CV studies are apt to provide cues to respondents, but this area has received little attention (save for Green and Tunstall, 1991) In the Green and Tunstall's (1991) study on evaluation of river water quality improvements in UK, respondents were randomly assigned to one of three CV questionnaire versions Two used payment by month with starting points respectively of 50p and £1, the third asked for willingness to pay per year with a starting point of £6 The findings were as follows " those respondents who replied to the version of the question where the starting point was £6 00 a year, gave bids which were higher but on average these were less than twelve times either of the two monthly bids So, defining the question in terms of a year and a starting point of £6, depressed bids What is not clear is whether it is the use of a single annual payment or the higher starting point which apparently had this effect" (Green and Tunstall, 1991 p 1139f) As noted by the authors, the results fail to isolate the effect of payment frequency on WTP bids because the experiment employed different starting points across the payment frequencies Furthermore, the survey results do not provide any tests of the significance of the frequency effect in the monthly/yearly WTP disparity

3.6.2 Overview of Frequency Knowledge in Consumer Research

The utility of frequency information is multifaceted Broadly speaking, however, such information has a role (a) in mediating memory for events, (b) as a device for organizing existing knowledge, (c) in decision making, and (d) in both cognitive and social development This section does not detail all the four categories of uses for frequency data as such a treatment can be found elsewhere (Hasher and Zacks, 1984 and references cited therein) In a nutshell though, the Hasher and Zacks (1984) review shows that people from all ages and abilities are sensitive to frequency of occurrence information, and that encoding of frequency information[25] is uninfluenced by most task and individual difference variables Indeed, frequency knowledge seems only unimportant for neurologically impaired individuals

The role of frequency information in decision making is our main concern People often must make decisions in the face of incomplete, equivocal, or probabilistic data To do this, individuals rely on preferences and subjective probabilities, all of which depend to some extent on the encoding of frequency information So the first way in which frequency information can influence decisions involves affective responses, including preferences, an example being the assessment of neighbourhood

[25]Until recently, responses to frequency questions relied upon a Sudman-Bradburn memory model (see Burton and Blair, 1991) The model presumes that respondents answer frequency questions via episode enumeration, in which behavioural episodes are recalled and counted, and that response errors are the result of episode omission and/or episode misplacement (telescoping) during the process Recent studies (see Burton and Blair, 1991 and references therein), however, have shown that survey respondents use a variety of content- and procedure-defined cognitive processes in formulating answers to frequency questions Possible processes include (1) episode enumeration, in which respondents recall episodes from the relevant time frame and count them, (2) rule-based estimation, in which respondents recall or construct an occurrence rule and apply it to the relevant time frame, (3) estimation from an availability heuristic (Tversky and Kahneman, 1982), in which frequency is estimated according to the ease of recalling sample episodes, (4) automatic estimation (Hasher and Zacks, 1984), in which estimates are drawn from some innate sense of relative or absolute frequency, (5) use of other heuristics, and (6) various combinations of these processes

safety in a choice of the "best" place to buy a house These are known to be affected by event frequency Research on the "mere exposure effect" (e g , Zajonc, 1968) has shown that alternatives to which a person has been frequently exposed are more important that those to which the person has been infrequently exposed

The second way in which frequency information can influence decision making has to do with a person's belief in the validity or truth of whatever information is available (Hasher and Zacks, 1984 1383) Information about event frequency also plays a crucial role in probabilistic environments, such as predictions of election outcomes or of gambling events Decisions in such situations are often said to be determined by an individual's "subjective probabilities". Although there is an extensive literature on subjective probabilities, recent work (reported in Hasher and Zacks, 1984) leads to the conclusion that probabilities are not stored directly but are derived from the more basic knowledge of frequency

Similarly, it has been shown that subjects perceive a change in the incidence of a probabilistic phenomenon (e g , illness among friends), when simple frequency changes even if the rate (i e , probability) has remained constant (Hasher and Zacks, 1984) Insofar as people base decisions about the rates of events on frequency rather than on probability[26], this creates a potentially serious problem for decision makers

[26]There is a difference between frequency and probability Whereas the former refers to absolute repetitiveness of events, the latter is a rate measure of the likelihood that a given event will occur These two terms are easily confused in decision-making Yet, frequency knowledge is more easily encoded (on the criterion of sensitivity without intention) regardless of people's individual differences, such as in age, in motivation, in intelligence, and in educational attainment, than probability data. For instance, children are able to respond appropriately to differences on probability, although this ability increases with age (e g , Brainerd, 1981) This increase is not, however, due to age differences in the encoding of frequency information In agreement with other research, Brainerd found that even the youngest children tested (4-year-olds) had excellent knowledge of relevant frequencies There were, however, developmental differences in the likelihood of retrieving stored frequency information to make probabilistic predictions When retrieval of the relevant frequencies was

It must be emphasized, nonetheless, that this does not conflict with demonstrations of the importance of the Tversky and Kahneman (1973) availability heuristic in making decisions about frequency In this view, subjects are biased towards judging frequency on the basis of the availability of events in memory In most instances, frequency and availability (like frequency and probability) are highly correlated more frequent events are, *ceteris paribus*, more recallable or "available" than less frequent events In such situations, any biasing effects of the availability heuristic will not be seen Use of availability will bias frequency estimates most clearly when the retrieval cue (i e , the event to be judged) is a weak one

A growing body of literature attests to the importance of consumer knowledge in consumer decision making The same literature, however, also suggests that consumer knowledge is extremely complex and that traditional measures may tap only a small part of its richness Accordingly, we now examine what attention consumer researchers have afforded the "frequency" aspect of consumer knowledge Until recently there were few investigations on consumer sensitivity to frequency of occurrence information But, of late, there is increasing evidence that this situation is being remedied (Alba and Marmorstein, 1987, Krishna, 1991, Alba et al , 1994, Kalyanaram and Little, 1994, Moffat, 1995)

Essentially, emerging investigations can be classified into those that glean frequency effects from secondary data (the revealed preference type), and those that seek to understand the effects as well as underlying reasons for such consumer behaviour through experimental methods Using 1987 UK National Food Survey data

maximized, appropriate predictions occurred at higher levels for all ages Brainerd's research thus showed that the early onset of the ability to encode frequency provides the basis for the early development of probability judgment skills

Moffat (1995) constructs and estimates a model of household purchase behaviour with time between purchases or "purchase interval" as the variable of interest His results suggest that the purchase frequency decision is the result of an optimisation problem in which considerations such as the value of time are important Like other models of purchase frequency decisions (e g , Meghir and Robin, 1992), this suggests that "households with facilities for storage (e g a freezer), with a high value of time and for whom purchasing is an inconvenience (e g those living in a rural area), have a higher interval between purchases, ceteris paribus, than households of other types" (Moffat, 1995 14) This finding notwithstanding, the analysis' assumption that the interval between purchases is fixed for a given household and a given good is questionable Although this assumption is justifiable on economic theoretical grounds, it blocks vision of the whole spectrum of frequency effects on consumer decision making For instance, it is impossible to see why frequency matters or, more aptly, how frequency of payments may influence willingness to pay (WTP) for a product We must hasten to add, however, that this criticism is directed not just at models of purchase frequency, but also at revealed preference studies, not much can be seen beyond the records

Consumer experimental research, on the other hand, provides further insight into the frequency question Through a set of experiments, Alba and Marmorstein (1987) examine use of the frequency heuristic as a function of an individual's motivation and ability to encode, comprehend, and remember decision-relevant information In each case, frequency is pitted against attribute importance or the size of the differences between brands on common features Their findings show that frequency knowledge, being an important component of a consumer's information structure, can influence judgement and choice, particularly when other types of information have been poorly encoded, poorly remembered, or poorly understood

In a more recent study Alba and co-workers (1994) investigate the relative effect of prior beliefs, frequency cues, and magnitude cues on consumers' perceptions of comparative price data The researchers conducted a series of experiments to explore the relative persuasiveness of these factors Alba et al 's (1994) series of experiments indicate that prior beliefs affected price perceptions but that the frequency cue exerted a dominating influence Of all 164 responses, 67 percent were identified as frequency related This represented 87 percent of all identifiable, nonguessing responses

Another experiment that comes close to broaching the issue of how payment frequency may affect willingness to pay (WTP) is that in Krishna's (1991) paper on the effect of dealing patterns (i e , patterns in price promotions) on consumer perceptions of deal frequency and WTP The paper's attempt to explore the frequency-WTP link is evidently predicated on Munroe's (1973) work Krishna's hypothesis is, when consumers perceive a lower deal frequency for a brand, they are WTP a higher price for that brand Munroe (1973) had earlier suggested that the extent to which buyers are conscious of the prices that they pay influences the role that price plays in buyers' choice process, and that buyers consider past prices as a basis for a product's fair price The author shows that the prices consumers are WTP for a brand is correlated more highly with perceived deal frequency (that is, frequency with which the brand is promoted) than with actual deal frequency Thus WTP is affected by the accuracy of consumer perceptions of deal frequency and by whether the perceptions are biased upward or downward

3.6.3 Implications for Temporal Dimension of Payments in Contingent Valuation

Students of preferences differ considerably in the core assumptions they make about the nature of values (especially nonuse value) that are available for elicitation for unfamiliar environmental goods At one extreme is what Fischoff (1991) calls the "philosophy of articulated values", which assumes that people have well-formed preferences about any relevant topic and can directly retrieve an appropriate response to an elicitation question Adopting this view leads to a focus in finding the correct methodology for eliciting values, as has been the emphasis in CV literature (e g , Hanley, 1989, Mitchell and Carson, 1989, Hanley and Spash, 1993)

At the other extreme is the "philosophy of basic values", which assume that people have well-defined values only for very familiar topics Given this presumption, people must derive specific valuations for less familiar topics through some inferential process This view leads to the conclusion that in many if not most cases, people must *construct* their responses at the time they are asked an elicitation question, rather than *retrieve* a previously formed value (Slovic et al , 1990) A key implication of a more constructive view of preferences is severe context dependence of the elicited values

The constructiveness of preferences and beliefs has been attributed to the limited information processing capacity of humans (Simon, 1955, Kahneman, 1973, Hasher and Zacks, 1984) According to March "human beings have unstable, inconsistent, incompletely evoked, and imprecise goals at least in part because human abilities limit preference orderliness" (1978 598) Several authors have suggested that the construction of preferences may be common in CV studies (Fischoff and Furby, 1988, Gregory et al , 1993) Mitchell and Carson (1989 249) acknowledge that "people tend not to have previously well-defined values for many of the goods valued in CV studies" However, they go on to argue that improvements in the method can overcome the potential biases resulting from this lack of well-defined values

The idea of constructive preferences goes beyond a mere denial that observed preferences result from retrieving the appropriate value from a mental master list in memory It also means that preferences are not necessarily generated by some consistent and invariant algorithm, such as an expected utility calculation (Tversky et al, 1988, Fischoff, 1991) It appears that people have a repertoire of methods or strategies, resulting from both experience and training (e g, Larrick et al, 1980), for identifying their preferences and developing their beliefs

The overview of consumer research in the preceding section has indicated two aspects The central interest of behavioural decision researchers (especially psychologists) is in the encoding of information into memory Two fundamental ideas underlie their framework The first is the concept of encoding itself, which derives from the view that memory of an event consists of a collection of attributes (e g, space, time, meaning, mood etc) regarding that event The second is the concept of automaticity, which derives from the view that the individual's momentary capacity for cognitive activity is limited (e g, Kahneman, 1973)

Hard on the heels of the first interest is the role that frequency information plays in decision making amongst consumers Frequency information presents a unique type of decision heuristic (rule of thumb), it is a simplifying heuristic in decision-making (Wright, 1975, Kahneman et al, 1982) Many consumer decisions are simplified by eliminating brands and/or attributes from careful consideration and concentrating on the remainder Unlike other types of learned information, frequency knowledge does not contain specific facts about brands and attributes Rather, frequency knowledge is a tally of the number of positive and negative attributes associated with a brand, irrespective of their meaning or importance Thus, the frequency heuristic differs from other decision rules that require the decision-maker to evaluate the performance of a brand(s) on at least one substantive dimension As a result the frequency heuristic can be applied irrespective of the consumer's product class knowledge, making it a potentially universal rule

Second, the process by which frequency information is acquired may differ significantly from other types of information Specifically, evidence suggests that frequency counts of some classes of information may be acquired with very little effort, and perhaps unconsciously (Hasher and Zacks, 1984) The significance of this point is that consumers may learn and remember the frequency aspects of a message at times when involvement, information load, or other factors inhibit the learning of its semantic details Thus, frequency knowledge may provide a reasonable basis for decision making when other data are lacking

The implication of the foregoing review of behavioural decision research for the impact of temporal dimension of payments in CV is the need for careful design of hypothetical scenarios with regard to payment frequency As research on the "mere exposure effect" (e g , Zajonc, 1968) has shown that alternatives to which a person has been frequently exposed are preferred over those to which the person has been infrequently exposed, respondents engaged in CV tasks are likely to anchor their WTP on the extent to which they are comfortable with the temporal dimension of payment in the value elicitation question

A collorary to this is that WTP values will not only depend on income as stipulated in demand analysis, in accordance with micro-economic theory, WTP rises with income But they will also be closely associated with the periodicity of respondents' wages or salaries Given a choice on the payment frequency participants in a CV survey are apt to prefer a scheme that is closely associated with the way they transact most key expenditure items For instance, if interviewees receive income, or pay most of their bills, on monthly basis they may prefer 12 payments in a year than a yearly payment format To obtain "true" WTP values, the CV researcher ought to appropriately peg the temporal dimension of payment in the often unfamiliar "markets" for environmental goods on ubiquitous household expenditure-income patterns These patterns may vary considerably between developing and developed countries

The potential effect of timing-of-income on willingness to pay was suggested by Boadu (1992) Although households were requested to report the amount of money they would be WTP for water per month, a billing procedure used by most water authorities, "farmers do not earn monthly incomes Rather, a farmer may harvest a few bushels of crops when needed to pay for immediate needs (funerals, medical, travel, gifts), or to pay off major debts and obligations at harvest time Since the survey was conducted off-season, it is possible that bids were lower than they would have been if the survey was conducted at harvest time" (Boadu, 1992 465)[27] We contend that

[27]Roughly 75 percent of the 1 5 billion workers in low-income countries are employed in agriculture Incomes of these farmers are volatile, determined in large part by weather conditions and international crop prices These factors are beyond the control of individual farmers, which leaves their households exposed to risk (Case in *Journal of Economic Perspectives*, 1995 81) A recent symposium reported in *Journal of Economic Perspectives*, 1995, hereafter JEP) explored ways in which households in LDCs, even without access to formal credit and insurance markets, find avenues to smooth their consumption in the face of large shocks to their income In the symposium, Robert Townsend (JEP, 1995 83-102) tests the extent of consumption smoothing He examines the extent to which household consumption in low-income countries moves with household income and the extent to which household consumptions move with village income In all, low-income farm households may choose a somewhat lower level of expected income in exchange for reducing the risk of devastating swings in income (Jonathan Morduch in JEP, 1995 103-114) In certain areas where credit markets are especially poor, households are more likely to choose lower mean,

the timing-of-income and consumption-smoothing argument, when invoked to explain influences of payment frequency in contingent valuation of environmental goods, predicts that households in developing economies are not only likely to choose fewer payments in a year, but that lower WTP values are expected as well

Clearly, this raises two issues The first concerns a potential validity problem which might arise for the CV method if different temporal dimensions of payment in design result in different images of the good, and consequently different values The second is concerned with how much information on payment schedules should be supplied in CV surveys (e g , Hanley et al , 1995) Simply referring to an attribute may increase its importance on decisionmaking under conditions of uncertainty (Kahneman et al , 1982, Keller and Staelin, 1987, van der Plight et al , 1988) The next section discusses domestic water supply in terms of its linkage with river water quality, developing country CV studies, and its pricing in developing countries

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lower variance production methods

3.7 Domestic Water Supply and Pricing in Developing Countries

Existing literature on water resources management shows that the field is replete with weaknesses which include *inter alia* underpricing of water and lack of cost recovery, neglect of public health, water quality and the environment, and inadequate service delivery to the poor (Feder and Moigne, 1994, Winpenny, 1994) Underpricing water below its economic value is in fact prevalent worldwide because of either cultural and religious reasons and/or political expediency For instance farmers in both industrialised and developing countries often pay little for their publicly supplied irrigation water and so have few incentives for water conservation Similarly industries and other investment projects, faced with low charges for authorised discharges into water sources often discharge untreated wastewater into rivers, lakes, and coastal waters

A key point, however, is that water source quality and domestic water supply are two of many water resource management sub-sectors that epitomise an important linkage in humankind's quest for sustainable development The reason for this is simple, water quality and supply plays just as critical a role in biogeochemical cycles as it does to the sustenance of both animal and plant life Basically, water resources management sits on the interface of ecosystems and sociosystems The rest of this section is devoted to showing the connection between river water quality and domestic water supply (Sub-Section 3 7 1), reviewing developing country CV studies on water resources issues (Sub-Section 3 7 2), and overviewing the pricing of water services in developing countries (Sub-Section 3 7 3)

3.7.1. The Linkage With River Water Quality

Pollution adversely affects numerous urban and rural water users of water courses such as rivers, streams, lakes, estuaries and coastal waters Consequently, various public policy initiatives have been researched and proposed as possible avenues through which polluters can be induced to reduce discharges of nonpoint pollution Key amongst these are taxes on water, water conservation subsidies[28], as well as land and water rights purchases through, for instance, transferable discharge permit programmes (Baumol and Oates, 1988, Letson, 1992, Hanley, 1993) The other water pollution control practice, which has tended to dominate environmental quality management in industrial economies, is regulation by "consents" given by specific environmental-resource authorities Consents specify both the quantity and composition of discharges, and are enforced by monitoring and, if necessary, fines through the courts

Most research in the field of water pollution control economics has centred on, *inter alia* (a) modelling optimal enforcement of firm behaviour (i) under imperfectly enforceable pollution standards and taxes, and (ii) when firms are noncompliant, (b) analysing the efficiency of the policy instruments in point and nonpoint pollution situations, as well as in local, regional and international scenarios, and (c) estimating economic damages of water sources due to contamination by pollutants Although early research on these issues was essentially theoretical, with only passing references to empirical-policy applications, environmental economics has recently began to see more evidence of applied work (e g , Shechter, 1985, Edwards, 1988)

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[28]A water conservation subsidy can, in theory, yield the same pollution reduction as a tax on effluent Applying this idea to inputs, a subsidy paid to reduce irrigation water application rates would likely encourage reduced salt discharges This conservation subsidy is analogous to a water rental market, it confronts the user with an opportunity cost for water use at the margin

As noted in Chapter 1, this study not only measures the economic benefits of improved river quality, but also derives a WTP function for improved domestic water supply The need to do this was occasioned by three reasons These are

1 As rivers in LDCs, and indeed in the entire human civilisation right from Mesopotamia, were original lines of settlement and the main water sources for many years, it is plausible to investigate the link between household's value of the quality of this source and that of the artificial domestic water supplies subsequently introduced

2 Anecdotal evidence, and even empirical assignments (such as Ludwig and Browder, 1992 on South-East Asia, Nyaoro, 1992 on Kenya, and Sangodoyin, 1993 on Nigeria), reveal the fact that most households in LDCs still rely on rivers for water for (i) gardens and washing clothes, (ii) their livestock, and (iii) even bathing All these categories of water use fall in the purview of domestic activities

3 More pollution of surface and ground water sources, *ceteris paribus*, leads to high costs of water purification by domestic water supply utilities McPhail (1994) refers to this issue when he names initial down-water payment a constraint to household's decisions to hook up to piped water systems This issue is elaborated upon below, in Sub-Sections 3 7 2 and 3 7 3

Recently appearing amongst policy statements is the recognition of the need to see water supply provision in a wider context of resource management For example, the United Nations Development Programme (1990) states that "Safe water and proper means of waste disposal are essential for environmental sustainability, and better human health, and must be at the centre of integrated water resources management" This sentence points to the possibility of placing "domestic water" within the context of common property resource management, a body of theory which, when it has dealt with water, has concentrated on "productive" water for irrigation or for livestock production The approach is essentially concerned with "the recognition that land and related resources in the rural sector are characterised by a whole complex institutional arrangements that will vary across resources and through seasons of the year" (Bromley, 1989 871)

Many people in the Third World, especially those living in the rural areas and fringes of towns and cities, face daily problems in obtaining water for domestic purposes In recognition of the harm to health, economic productivity, and quality of life that can result from inadequate water supplies, international donors (such as the World Bank and the World Health Organisation) and the governments of developing nations have mounted numerous efforts to correct the problem The international community affirmed its commitment to improving water supplies by declaring the 1980s the United Nations' International Drinking Water Supply and Sanitation Decade, that commitment had been hinted at in the 1972 UN Conference on the Environment in Stockholm and in the 1976 Habitat Conference in Toronto The devotion to the cause was later reaffirmed at the 1990 New Delhi Global Conference on Safe Water and Sanitation

There are two cardinal formulae according to which the water problem has been addressed by international initiatives The first one is the "first standard" paradigm which is based on a dual premise that "government must subsidize rural water supplies because many rural households are too poor to pay for improved water systems, but that, to achieve equity, those government funds must be spread thinly because public resources are also limited This [is the] policy of 'some for all rather than more for some'" (World Bank Water Demand Research Team, 1993 48) The "second standard" paradigm, which has been strongly advocated by the World Bank and the International Monetary Fund owing to the rather unpalatable "welfare state" implications inherent in the first approach, contends that as long as the financial requirements of the chosen technology do not exceed 3% to 5% of household income, low income communities will choose to abandon their existing water supply in favour of a new improved system In other words, households can and will pay at least 3 to 5 percent of their disposable income for better services

However, neither of the two methodologies have successfully solved the problem[29] Besides the statistical data in the foregoing footnote, the literature in this field contains many illustrative testimonies First of all, empirical evidence shows that many of the water systems established in accordance to these paradigms are either not functioning at all or not being used For example, McPhail (1993) has shown that the behavioural response that the "second standard" model assumes is not correct in Morocco

Secondly, Franceys and Pickford (1989 33) posit "In many communities either the level of service is too low (that is, the community does not value the improved service and therefore refuses to pay for it) or the level of service is too high (that is, the people want service but not at the price that has to be charged) 'Willingness to pay' must therefore be determined so that the community receives the service at the standard they desire and at the price they (and the government) can afford" This

[29]By the mid-point of the Water and Sanitation Decade there were nearly as many people without good water and sanitation as there had been in 1980 Only 16% of the rural population of the developing countries had adequate sanitation (WHO, 1987) More recently, over 1 0 billion and 1 8 billion people were reported as lacking access to safe water and proper sanitation respectively (World Bank, 1992)

observation is supported by many authorities in economics of water utility management (e g , Pickford, 1987, Briscoe and de Ferranti, 1988)

A third illustrative testimony to the inability of the two paradigms in solving the water supply problem in developing countries relates to surveys on water vending (e g , Whittington *et al* , 1990, 1991 and other studies in Sub-Section 3 7 2) which shown that poor households actually pay more than prices charged by water utilities According to the World Bank (1994 49) "During the mid-1970s to the early 1980s, people in seventeen cities surveyed were paying private water vendors an average of twenty-five times the prices charged by the utility. In Nouakchott, Mauritania and Port-au-Prince, Haiti vendors were charging upto a hundred times the public utility price".

The complex evidence given above is a manifestation of the intractable nature of the domestic water supply problem in LDCs Items one and three tend to suggest that expanding public utility networks so as to give poor households access to piped water is the way forward, but then item two ostensibly discounts such a course of action The second aspect one reads from the evidence is the difference between water management issues in LDCs from those of developed economies, the issues in the former cohort are clearly unique (Brookshire and Whittington, 1993)

The economics of water utility management in an industrial country is quite simple (a) all potential users will connect to the system and all will have multiple taps in their yards and houses, and (b) because the quantity of water used is relatively inelastic with respect to price, future needs and revenues for a given tariff can be projected with some confidence[30] In a developing country the situation is fairly complicated The number of potential users who will choose to connect to a system is heavily dependent on exogenous factors (such as the family's socioeconomic situation, and the cost and perceived quality of their existing sources, including accessibility, reliability, and aesthetic characteristics), as well as on factors controlled by the utility (such as the level of service offered, the connection cost, and the tariff charged)

Recent studies (Altaf *et al*, 1992, 1993, McPhail, 1994) conclude that the cash portion of the connection cost poses the major deterrent to household decisions to connect to piped water systems and not the monthly commodity bill So the importance of a utility-required cash down payment and cost recovery to ensure reliability of provision of water services should be underlined The empirical question that lies at the heart of institutional management of water utilities[31] is How significant is the payment profile of initial cash connection charge in household WTP bids for individual water connections? This study sheds light on this issue by comparing WTP for water connections across SPREAD and UPFRONT connection charges Sub-Section 3 7 3 locates this issue in the existing literature on the pricing of water

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[30]These two points vividly undermine the majority of investigations of water demand in developing countries which have been modeled on industrial-country literature (Katzman, 1977, Hubbell, 1977 *et cetera*) Many of the studies on water demand in industrial countries (e g, Jones *et al*, 1984) focus on estimation of income and price elasticities of demand for single-family residences

[31]Like environmental management, institutional frameworks for managing environment-related infrastructure can be typed into four broad categories (a) public ownership and public operation, (b) public ownership and private operation, (c) private ownership and private operation, and (d) community and user provision (World Bank, 1994) It is the principal-agent model that often informs discussions on the first three institutional options whilst the theory of common property resource management provides the formal framework of issues relating to the last alternative

services in developing countries

3.7.2 Review of Contingent Valuation Studies on Water Resources Issues

The problems associated with water development in developing countries are many fold Generally speaking, a significant number of the populations in the LDCs do not have access to satisfactory water supplies The planning process that is utilized for developing water projects is typically inadequate and results in failed projects In many cases the results are "monuments" Often the institutional frameworks employed in the management of the projects, especially in the case of irrigation projects, are flawed In choosing which projects to pursue, there is no serious quantification of benefits and thus appropriate tradeoffs between alternative projects are not made Typically, the lack of quantification of benefits is justified on the basis that water is essential so that any project must be justifiable Finally, financial, equity, and health issue are often not carefully considered in the planning process

Understanding the number of people in LDCs without adequate water and sanitation facilities can be difficult First, different countries use different definitions of what constitutes "improved" or "adequate" service, and often use different data collection methods for preparing the estimates One could envision incentives by reporting countries to inflate or deflate their reported estimates This would tend to distort the planning process Second, estimates of coverage are typically based on the assumption that people are covered if they are provided access to improved facilities However, many improved facilities are underutilized, for a variety of reasons households may choose to continue to use their traditional water sources even after an improved water source is available (Mu *et al*, 1990) This would suggest that estimates of coverage are inflated Third, such estimates rarely account for the fact that millions of people in LDCs purchase water from water vendors (Zaroff and Okun, 1984, Fass, 1988, Whittington *et al*, 1989, Whittington *et al*, 1991, Katko, 1991) Although water purchased from vendors is always very expensive, for households using vendors, vended water represents an improvement over traditional sources If water vendors are counted as an improved water source, this would suggest that figures on coverage are underestimates of the people served However, one must question whether such sources truly represent a satisfactory water supply institution

As regards quantification of benefits of water supply projects, it is notable that monetary valuation of environmental and public goods in the developing economies, particularly applications of the contingent valuation (CV) method, can be attributed to the work by research groups sponsored by the World Bank to study the demand for village water supplies and sanitation services in Latin America, Africa, and South Asia (World Bank Water Demand Research Team, 1993) Tables 3 4 and 3 5 show features of some of the CV surveys, including socioeconomic characteristics in resultant willingness-to-pay models

Indeed, the importance of household water services in the developing countries has been underscored by many governments as well as national and international institutions Hence, the increased economic and policy research interest in water as an environmental/public resource is not surprising The interest can also be attributed to the increasing recognition of water as scarce commodity with an economic value (Saliba *et al*, 1987, Winpenny, 1994) The supply of adequate water of the required quality and through an convenient system is a cardinal challenge to Third World governments and authorities since most of the communities have come to depend almost entirely upon governments for the provision of the vital resource

Ever since the Whittington *et al* (1990a) study in the summer of 1986, a number of researchers have applied contingent valuation (CV) to determine household willingness to pay for water services Such studies have been conducted in Brazil, Haiti, India, Nigeria, Ghana, Tunisia, Morocco, Pakistan and Zimbabwe These works shed some light on the efficacy of CV in evaluating household water supplies in developing countries, understandably though, water supply is less 'public' than other environmental amenities such as air and water quality Reliability and accuracy of results, sources of bias, and the "five-percent" rule for provision of water as a socio-economic infrastructure are the key distinguishing features of the above empirical research

Table 3 4 Features of Some Previous CV Studies on Household Water Supply and Sanitation Services in Developing Countries

Study Reference[1]	Characteristics Country/Area, Sample size, Model(s) of analysis[2], CV Design question
Briscoe *et al* (1990)	Brazil,1232, Probit, none
Whittington *et al* (1993)	Ghana, 1633, OLS, Stewart ML, Ordered Probit, starting point, time-to-think and observers listening to the interview
Boadu (1992)	Ghana, rural region, 294, OLS, starting point, hypothetical and strategic bias
Whittington *et al* (1990)	Haiti, southern region, 272, Ordered Probit, starting value, hypothetical and strategic bias
Kwak and Russell (1994)	Korea, 300, OLS, MLE, tobit and STLS models, none
Whittington *et al* (1992)	Nigeria, Anambra state, 421, OLS, Stewart ML, Ordered Probit, N2SLS, none
Whittington *et al* (1991)	Nigeria, Onitsha, 235, OLS, ordered Probit, starting value
McPhail (1993)	Morocco, small cities, 464, OLS, none
McPhail (1994)	Tunisia, Tunis urban areas, 82, no model reported, simple descriptive statistics, none

Notes [1] All the CV surveys employed a bidding game questioning format whilst the sample size refers to households

[2] OLS, Stewart ML, and N2SLS refer to Ordinary Least Squares, Stewart Maximum Likelihood and Nonlinear Two-Stage Least Squares estimation approaches respectively STLS is Powell's (1986) method of symmetrically trimmed (censored) least square estimation

Table 3 5 Determinants of WTP Bids for Water Supply in Previous CV Studies Undertaken in LDCs

Study Reference Country	WSS[1]	Determinants of Willingness to Pay[2]							
		Income	Education	Occupation	Major appliance ownership	Tenancy	Storage capacity	Household size & composition	Distance to existing source
Briscoe et al (1990) Brazil	Private	++	++	++	++	x	x	x	x
Boadu (1992) Ghana	Private	++	_	x	x	x	x	_	++
	Public	++	+	x	x	_	x	+	_
Whittington et al (1990) Haiti	Private	+++	++	++	x	x	x	_	++
	Public	++	++	_	x	x	x	+++	+++
Whittington et al (1992) Nigeria, A	Private	++	++	_	x	x	++	_	x
	Public	++	+	+	x	x	++	_	x
Whittington et al (1991) Nigeria, O	Private	+	_	+++	x	+++	+	x	x
McPhail (1993) Morocco	Private	+++	_	x	x	++	++	_	x

Notes
[1] Private and Public Water Systems refer to yard/personal water connections and public water standposts respectively
[2] +, ++, and +++ indicate statistical significance at 10%, 5%, and 1% levels for a one-tailed test, _ stands for non significance of the explanatory variables, and x means variable not measured in a particular survey

Whittington *et al* (1990a) determine households' value of time spent on collecting water in Ukunda region of Kenya Using revealed preference and random utility approaches, the authors find that households in the coastal village place as high a value on the time they spend hauling water as the wage rate for unskilled labour This suggests that the economic benefits of improved water services in developing countries may be higher that commonly realized

The research reports by Whittington *et al* (1991) and Boadu (1992) on the structure of water vending and WTP for water in the Nigerian town of Onitsha and on WTP for water in rural Ghana, respectively, have shortcomings The former study does not consider household size as an explanatory variable for household WTP whilst the latter's construction of the hypothetical scenario is not divulged Moreover, both documents do not report any tests for validity and reliability of the survey instruments[32] This is contrary to the recent consensus among economists that these aspects accompany published work for purposes of facilitating replication and ironing of any rough methodological edges

Most across-the-board assessments (e g Cummings *et al*, 1986, Mitchell and Carson, 1989, Smith, 1993) unequivocally support the fact that CV estimates are "comparable" in performance to alternative approaches However, CV application in determining economic value of residential water services inevitably begs two questions Does the fact that household water is not a conventional environmental

[32]The question of reliability and accuracy of any CV findings cannot be answered with certainty without performing controlled experiments Additionally, the ability to exercise the control limits, in turn, curtails the types of commodities and decisions that can be included in a CV analysis Therefore, there always remains the possibility of asking oneself whether the results are relevant to those situations that could not be considered Consequently, CV research has focused on evaluating a wide range of indirect gauges of the validity and reliability of findings

amenity in the sense of air and water quality matter? Would resultant WTP estimates possess predictive validity?

Changing the commodity under valuation from environmental amenities like air and water quality to quasi-private goods such as water does not alter the general point. Of course, it will influence how assumptions affect outcomes. For instance, a study of strawberry sales by Dickie, Fisher, and Gerking (1987) found that demand curves based on hypothetical sales did not differ significantly from models using actual sales. *But*, this conclusion was somewhat sensitive to how the analysis treated interviewer effects and one outlier. Again, if the criteria were changed to the predicted demands for strawberries from the two models, the conclusions would depend on the treatment of outliers. Their analysis does not mention that the relevant variance in the random variables being considered also changes, so large numerical differences in predicted quantities may not indicate statistically significant differences. All these issues are not the result of the design (i.e., asking quantities) or the specific commodity used (i.e., pints of strawberries). They illustrate the role of judgement in the analysis.

To reduce influence of judgement in analysis, Whittington and several coauthors (1991b) used the need to value public drinking water supplies in rural Pakistan to compare the results derived from experience with past connection decisions for earlier systems versus that derived from a double-bounded CV survey designed to elicit maximum annual tariffs for the water system. After developing economic models relevant to each type of data, they estimated the implied values for comparable water systems and evaluated their correspondences. Estimates based on CV were closely related to those from the indirect model (in this case a random utility model, RUM, descnbing connections) However, the CV estimates were 1 71 times the values denved with the RUM framework when alternative water supplies were good and 2 97 when they were poor This difference, however, may be seen as part and parcel of market behaviour where markedly different prices can persist for long periods

To determine predictive validity and temporal reliability of WTP models it has become customary to design test-retest comparisons of the stability of CV evaluations from the same sample over time The papers by Loomis (1989, 1990), Kealy *et al* (1990) and Whittington *et al* (1992) reveal that length of time between elicitation of respondents' valuations is critical Loomis considered two samples, interviewed both groups twice (asking the same valuation or discrete choice question in two rounds of questionnaires mailed 6 months apart), and tested whether the valuation responses differed for each group between the first and the second responses Kealy and co-researchers (1990) compare CV values for a private and public good after about 2 weeks Whittington *et al* (1992), on their part elicited no values in the initial interview from those respondents who were given a one-day duration of time to think The regression models by Whittington *et al* (1992) showed the time-to-think variable to be exceptionally robust across estimators, type of water connection, and model specification The implication of this result is that giving people time to think consistently reduces their bids, their implied ratings, and their likelihood of agreeing to purchase the improved water source in comparison to bids from those who respond immediately at the time of the interview This finding differs from what Hoehn and Randall's (1987) analysis would suggest --- that stated WTP should be "nondecreasing" with time or other informational resources devoted to respondent decision making So there is no consensus on impact of time-to-think in CV studies for either a type of commodity or socio-economic and cultural setting

Besides tests of CV performance in developing countries, recent benefit measurement exercises have employed the CV technique to address unique problems in the water sector Before presenting the relevant studies, however, one non-CV study on estimation of benefits of water supply is worth mentioning as it deals with a pertinent developing country issue in water resources research North and Griffin (1993) focus on a region of the Philippines and utilize the hedonic price method Their interest lies in the relative valuation households place on differing types of water sources Thus they attempt to value alternative types of infrastructure for providing water supply As part of the effort, they investigate the role that distance to a public or communal source has on households willingness to pay They find that a piped in source is valued high relative to other characteristics of the home They suggest that the development of more communal sources should be second priority relative to in-house piping

Let us now examine the CV applications to some policy aspects in water supply Singh *et al* (1993) address the issue of how to get better service and more yard taps The CV method is used to evaluate the possibility of improving the overall performance of the systems The setting is three areas of Kerla, India Specifically, they examine the WTP for yard taps and/or house connections They show that consumers' welfare, based on responses to the CV question, rises with the increase in connections and monthly tariff Further, they argue that a critical element is the nature of the financing process for new connections focusing on the quality of the service

Altaf *et al* (1993) use estimates of households' WTP for piped water supplies (also obtained using the CV method) to explore ways to improve rural water policy in the Punjab, Pakistan They describe communities caught in a kind of "low-level equilibrium trap" In the Punjab government-provided water systems have been designed to accommodate an estimated water use of 40 litres per capita per day Because water connections are not metered, people demand more water than the existing piped water systems can provide To ration available supplies, the water authority must reduce the number of hours of service The systems thus become unreliable, and people are not WTP much for such poor service Because households are not willing to pay, the water authority cannot charge realistic prices and thus does not collect sufficient revenues to manage the system properly Without adequate funds for operation and maintenance, reliability deteriorates further

Altaf and co-workers (1993) show that the way out of this trap is to install meters and charge higher prices for water Their results indicate that households' WTP for reliable water supplies is much higher than is commonly assumed, and that full cost recovery is quite feasible in many areas of the Punjab They recommend that the rural water sector be reorganized to reflect a decentralized, demand-driven philosophy toward the provision of new infrastructure

Bohm (1993) address the financial viability of water systems in rural Philippines They address two questions First, what are the necessary conditions for a rural water system to cover costs? Second, if such a system does not generate sufficient revenues to cover costs, what must be the subsidy level? The CV mechanism is utilized to address these issues They conclude that rural systems such as the one they studied are unlikely to generate sufficient revenues in order to be sustainable

On direct relevance of WTP estimates to public policy, McPhail (1993) carried out household WTP survey in five small Moroccan cities with the prime object of testing the "Five Percent Rule" for improved water service often advanced by most water utilities and international donors, specially the World Bank The paradigm states that as long as the cost of portable water to the household falls below 5% of household income, then it is "affordable" and the household will make a connection to the system and be able to pay the subsequent recurrent expenditure The results from his 460 sample size revealed that households, even though they had free and reliable standpoint water service, were willing to spend well in excess of 5% of total household expenditures to finance an individual metered water connection and the subsequent monthly commodity charges

While still on the issue of the percentage of its income that a household is WTP for use of an improved water source, it is important to stress that the evidence varies widely For example, in the Chihota District in Zimbabwe, where water is relatively easily available from traditional wells, households are prepared to pay less than 0 5 percent of their income for an improved well with a handpump (Robinson, 1988) In rural Haiti, households are WTP only about 1 percent of their income for access to public taps in their villages (Whittington *et al* , 1990a)

In the sweetwater zones of the Punjab in Pakistan, almost every household has its own private handpump in its compound These handpumps, manufactured by private-sector firms, have been installed and maintained without government involvement Here, despite the relative prosperity of the villages, households are on average WTP only about 1 percent of their income for a private water connection (Altaf *et al* , 1993)

On the other hand, in some places households are WTP an extraordinarily high percentage of their income for improved water service In the Newala District of

Tanzania, households are extremely poor and spend several hours a day collecting water during the dry season They are WTP about 8 percent of their meagre income for access to water from public taps located in their village (Whittington *et al* , 1988) In Ukunda, Kenya, a small market town south of Mombasa, the majority of households are already spending more than 10 percent of their income purchasing water from water vendors (Whittington *et al* , 1989b) Fass (1988) found that during times of drought the poor in Port au Prince, Haiti sometimes pay more than 20 percent of their income to water vendors Similar results have been found in Sudan (Cairncross and Kinnear, undated), Honduras (Whittington *et al* , 1989b), Mozambique (Katko, 1990), Jakarta in Indonesia (Lovei and Whittington, 1991), and Nigeria (Whittington *et al* , 1990b, 1991) It is thus clear that under some conditions people will pay a very high percentage of their income for water, and in other circumstances very little The immediate implication of these statistics is that measures of household WTP reflect much more than simply a household's income (World Bank Water Demand Research Team, 1993, Whittington and Swarna, 1994), however, the entire second part of this section illustrates how CV has recently been applied to water resources issues in the developing world

3.7.3 The Pricing of Water Services in Developing Countries

Different water resource pricing principles exist in developing countries due to the co-existence of the market and non-market sector, the multiple institutions involved in water supply and, most important, a trade-off between economic, social and environmental criteria (e g , Arntzen, 1995, Herrington, 1996) Yet traditionally water supply pricing policy in most countries has been determined on the basis of financial or accounting criteria, such as raising sufficient sales revenues to meet operating expenses and debt service requirements while providing a reasonable contribution towards the capital required for future system expansion

However, in the recent times several new factors have arisen, including the rapid growth of demand, increases in supply costs, dwindling availability of cheap water resources, and the expansion of water supply services into regions of lower consumer density (especially rural areas) at relatively high unit costs These developments have led to increasing emphasis being placed on the use of economic principles in order to produce and consume water efficiently, while conserving scarce resources and meeting various national objectives[33] Attention has particularly been paid to the use of marginal cost pricing policies (mainly long-run marginal costs, LRMC) in the water and sewerage sectors

Recent evidence shows that price is an effective long-run technique of demand

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[33]The modem approach to water pricing recognizes the existence of several policy objectives or criteria, not all of which are mutually consistent First, national economic resources must be allocated efficiently not only among different sectors of the economy, but within the water sector itself Second, certain principles relating to fairness and equity must be satisfied Third, water prices should raise sufficient revenues, to meet the financial needs of the sector Fourth, the water tariff structure must be simple enough to facilitate metering and billing customers Finally, other economic and political requirements must also be considered, such as subsidized water supply to certain sectors to enhance growth or to certain geographic areas for regional development See Munasinghe (1990b) and Whittington (1992)

management (e g , Crew and Kleindorfer, 1979, Postel, 1992, Winpenny, 1994, Herrington, 1996) As the theory of marginal cost pricing is well known (Hotelling, 1938, Ruggles, 1959a, b, Crew and Kleindorfer, 1979, Gestler, 1985, Lund, 1988) and its role in water supply detailed by the Organisation for Economic Cooperation and Development (1987) and Munasinghe (1988a, 1988b, 1990a, 1990b), this section only overviews three related methods of improving cost recovery in the water sector subsidized prices and connection charges (starting with common tariff forms), cross-subsidization, and metering decision and price complexity

3.7.3.1 Common Tariffs, Subsidized Prices, and Connection Charges

Probably the most common form of tariff is the unit charge based on the consumer's consumption over a given period of time, typically one month Unit charges may also be varied according to the volume of water consumed, yielding two basic types of block structure The use of increasing block water tariffs is widespread throughout developing countries An increasing block tariff (IBT) is a price structure in which a commodity is priced at a low initial rate up to a specified volume of use (block), then at a higher or several increasingly higher rates for additional blocks used The ordinary household municipal water bill in developing countries is often calculated on some sort of IBT structure, and donor organisations and consultants continue to recommend this practice for town and city water systems The majority of World Bank-sponsored water tariff studies conducted in 1970, for example, have recommended the use of increasing block water tariffs (Whittington, 1992)

Besides the IBT structure, there is also a decreasing block tariff, for a discussion on the incorporation of increasing block structure in applying the LRMC-based methodology and arguments for and against decreasing block tariffs see Munasinghe (1990b) and Whittington (1992) Decreasing block tariff, in which the initial slab of consumption has the highest price followed by successively cheaper blocks has been widely used especially for households and small consumers with simple metering

Fixed charges are most often related to consumer costs In particular, a lump-sum payment may be levied to cover the initial cost of providing the service connection, or the repayment period may be spread over several years to provide credit relief to customers Recurrent fixed costs are often charged to meet the costs of meter reading, billing, and other repetitive expenses In some cases, the charge based on the capacity of a consumer's connection is also called a fixed charge, but this is usually a proxy for the capacity cost which should be included in the variable charge Lastly, surcharges or adjustment clauses are also becoming increasingly common, this permits the utility to pass on to the consumer quickly any unforeseen increases in operating costs[34]

Socio-political or equity arguments are often advanced in favour of subsidization or lifeline rates for potable water supply, especially where the costs of consumption are high in comparison to the relevant income levels In practice, the magnitude of minimum water consumption block should be based on acceptable criteria for identifying low income groups and reasonable estimates of their minimum consumption levels (for instance, sufficient to supply basic requirements for washing,

[34]Ideally, any changes in relative input would require re-estimation of strict LRMC followed by changes in the tariff structure, but the legislative procedure to achieve the latter may take a long time A convenient short-run adjustment clause can, meanwhile, provide much needed financial relief when cost inflation is significant

drinking, cooking and so on) Such tariff structuring is possible when water utilities act as discriminating monopolists (e g , Munasinghe, 1988b)

3.7.3.2 CROSS-SUBSIDIZATION

The issue of subsidization between different customer groups within a class arises because urban customers often subsidize rural customers by paying more than the LRMC of water In this manner, a uniform national tariff can be implemented to help accomplish certain specific policy goals, based on socio-political reasons such as maintaining a viable regional, industrial or agricultural base, stemming rural to urban migration, or alleviating local political discontent For example, in November 1985 Algeria instituted a uniform national water tariff despite the fact that the estimated average cost of water varied across the country between US$0 23 and $0 58 (in 1987 dollars) (World Bank, 1987) While the national tariff recovered the costs of the sector as a whole, it also resulted in local water companies having widely varying profits and losses In Tunisia, the national water company, SONEDE, charges a uniform tariff that "implies cross-subsidization between centers to avoid prohibitive charges in high-cost systems" (World Bank, 1992) Meanwhile, in the Hashemite Kingdom of Jordan, the government provides free water to nomadic populations at a cost up to ten times the cost in the country's large cities (World Bank, 1986)

While the full economic benefits of such a course of action may be greater than efficiency costs which arise from any divergence between actual price and strict LRMC, the rationale for such deviation from efficient prices needs further study For example, one advantage of cross-subsidization versus, say, taxation, is that rate structures can be used to develop a direct scheme for transfers among customer groups Tariffs which perform this cross-subsidization within a customer class are highly useful in redistributing income, provided higher incomes and greater water consumption are positively correlated Such a tariff is equivalent to a tax on consumption which can be collected in a discriminatory fashion, with little possibility of evasion

Pressures to subsidize water supply are likely to be more significant in a developing country than a developed one because of the high cost of water relative to incomes in the former Also, the available administrative and fiscal machinery to redistribute incomes, or achieve regional and industrial development objectives by other means, is frequently ineffective in developing countries

For the same reasons, it is particularly difficult to reform pricing policy where low incomes and a tradition of subsidized water supply combine to create extreme socio-political difficulties in raising prices to anywhere near marginal costs In practice, price changes have to be gradual, in view of the costs which may be imposed on those who have already incurred expenditures on equipment and made other decisions, while expecting little or no change in traditional water pricing policies Munasinghe (1990b) rights notes "The efficiency costs of gradualism can be seen as an implicit shadow value placed upon the social benefits that result from that policy The macroeconomic type argument that water price increases may be inflationary is rarely valid because the costs of water use are usually a small proportion of household expenses and of industrial production costs In contrast, the overstimulation of demand and lack of funds to expand supply, resulting from low water prices are potentially much more serious long-run problems which should not be ignored"

3.7.3.3 METERING DECISIONS AND PRICE COMPLEXITY

The degree of sophistication of metering depends on the practical problems of installation and maintenance, and the net benefit of metering based on a cost-benefit analysis that compares the lower supply costs of reduced consumption with the cost of metering plus the decrease in net consumption benefits (Gestler, 1985, Lund, 1988, Munasinghe, 1990a)[35] Currently, advanced solid-state technology (including use of microprocessors) is being examined as a means to implement sophisticated metering, automatic meter reading, demand management techniques and pricing structure (Gestler,1985) In contrast, some developing countries may lack technically skilled labour for installation and maintenance of sophisticated meters, or even reliable meter readers Therefore choice of appropriate metering is usually very country specific, and is likely to involve many practical considerations

Despite these country-specific requirements, for urban water systems in developing countries it is always preferable to meter at both ends of the distribution system This is because historically the amount of unaccounted for water in those systems greatly exceeds that found in comparable systems in industrialized countries Thus, metering provides a reliable method to compare the amount of water produced to the amount actually delivered to the customers and, thereby, losses can be estimated and steps taken to reduce them when they exceed a predetermined level It is also often postulated that metering water use discourages waste, even at standposts where

[35]Owing to both practical difficulties and the economics of metering and billing, the tariff structure may have to be simplified Another crucial factor is that the tariff structure must be comprehensible to the average customer Otherwise individuals will not be able to adjust their consumption according to the price signals Therefore, the number of customer categories, consumption blocks, and fixed charges will have to be limited On the other hand, more detailed price structures could indicate price signals to consumers more efficiently

money is charged, which in this way acts as a powerful psychological agent to promote efficient use of resources (Sims, 1978) The next section provides an overall appraisal of this chapter on literature related to the CV study undertaken in Kenya

3.8 ASSESSMENT OF THE LITERATURE SURVEY

The above literature review as well as that in Bateman (1993), Barbier (1993) and Walsh *et al* (1989) points out three related issues First, few CBA studies have been undertaken in LDCs particularly those aimed at comprehending potential 'Third World' influences on CV estimates of benefits of environment and development projects The many potential problems in applying CV in developing and transition economies have been noted by several authors (e g , Tisdell, 1986, Thomas *et al* , 1991, Boadu, 1992, Krupnick *et al* , 1993, Munasinghe, 1993, Paulsen, 1993, Shyamsundar and Kramer, 1993, Whittington and Swarna, 1994, Swallow and Wouldyalew, 1994) These problems include very low income levels and their impact on stated WTP, and the emphasis of CV on individual preferences as a guide to decision-making

Secondly, CV surveys on issues that directly relate to the 'publicness proper' of the natural environment (such as water and air quality) in developing economies are few and largely restricted to forestry and wildlife conservation. The diversity in environmental and public goods in whose valuation the CV method has been employed in developing countries compares disproportionately to existing literature on developed countries (e g , those in Cummings *et al* , 1986, Mitchell and Carson, 1989, Barde and Pearce, 1991, Hanley and Knight, 1992, Hanley and Spash, 1993, Hausman, 1993) The *total economic value* approach has been employed in the USA and the UK to assess the WTP for a diverse range of public goods from visibility

(Schulze *et al*, 1981), grizzly bears and bighorn sheep (Brookshire *et al*, 1983), endangered species such as the golden eagle and striped shiner (Boyle and Bishop, 1987), water quality (Smith and Desvousges, 1986), to wilderness areas (Walsh *et al*, 1984), and wildlife habitats (Willis, 1990) The list of developing country CV studies, on the other hand, is shorter and restricted to provision of domestic water supply and sanitation

Finally, apart from the Ukunda study, no other applied work has been undertaken with a view to understanding household behaviour in respect of valuation of improved water services in Kenya This investigation is, therefore, an attempt to redress this situation by applying and assessing the contingent valuation (CV) method in determining the value that households attach to private water supply and river water quality in Kenya The measure of welfare change is willingness to pay (WTP) Indeed, the reference operating conditions (ROCs)[36] for CV studies recommend avoiding a WTA format So the WTP measure for an improved water service and river water quality will, on the whole, be utilised with the understanding that it is a probable conservative approximation of households' WTA compensation for a denial of a similar service and quality of water in most circumstances

[36]ROCs essentially define restrictions, warnings or caveats on use of the CV technique to value environmental and public non-market goods The Cummings *et al* (1986) ROCs are (ROC 1) Subjects or participants in CV must understand, and be familiar with the commodity to be valued, (ROC 2) Subjects must have had or be allowed to obtain prior valuation and choice experience with respect to consumption levels of the commodity, (ROC 3) There must be little uncertainty, and (ROC 4) WTP, not WTA, measures are elicited In his comments in the Palo Alto Conference, Prof Daniel Kahneman (see Cummings *et al*, 1986 185-194) adds three more conditions (ROC 5) The CV method should be used only for problems that have a "purchase structure", (ROC 6) The use of CV should be restricted to user values, rather than to ideological values, and (ROC 7) Accurate description of payment mode is essential to CV Although ROCs do not translate directly into testable hypotheses, they do suggest research questions that may generate testable postulates This viewpoint has guided the immense WTP-WTA research (e g, Boyle, Welsh and Bishop, 1993)

Measurement of benefits of river water pollution control and domestic water supply is crucial if we are to evaluate the tremendous costs of reducing pollution (as well as providing portable water) and make informed judgements about the social value of improving river water quality or supply clean water for domestic uses Effect of the nature of the good in CV, sensitivity to scope or (embedding effect) in the contingent valuation scenario, effect of temporal dimension of payments, and impact of initial connection charges on WTP for individual household water connections are the research concerns in this work

Periodicity of payments in the valuation function for environmental goods is likely to be crucial in Third World economies due to existence of large subsistence and informal sectors (Miracle *et al*, 1980, Gregory, 1980)[37] As Boadu (1992) notes, CV results are apt to be sensitive to the amount of money respondents have at the time the survey is conducted It has to be noted that this has to do with periodic income flow of the interviewees and not simply the general question of the income constraint which is implicitly addressed by the choice of WTP in preference for WTA as a welfare measure For instance, the study by Briscoe and co-workers (1990) shows that being employed in the formal sector raises the probability of hooking up to a yard water tap by 7 per cent The next chapter, Chapter IV, presents the research methodology

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[37] The informal sector principally comprises people who are either self-employed or are in unpaid-family worker capacity

CHAPTER IV

METHODOLOGY

4.1 INTRODUCTION

As shown in the review of the literature related to this study, in Chapter 3, the Contingent Valuation (CV) approach is a widely accepted method for valuing both natural resource damages, and nonmarketed benefits of environmental resources and improvements The CV method is capable of not only measuring use values but is the only methodology currently available to measure other components of total economic value such as option, existence, and bequest value

Questionnaire design is the most critical task in a contingent valuation study This paper describes and presents salient methodological aspects of this study's estimation of benefits of river pollution abatement and domestic water supply improvement in Kenya There are four sections to the Chapter First, the four study hypotheses are presented in Section 4 2 This naturally leads to the questionnaire and survey structure (Section 4 3) which, in turn, is succeeded by a description of the survey pre-test, administration, sample design, and fieldwork procedure (Section 4 4)

4.2 THE FOUR STUDY HYPOTHESES

The purpose of this Chapter is to link study hypotheses to the survey instrument and structure that was utilised in the application and assessment of the contingent valuation (CV) to estimate the economic value of improved river quality and domestic water supply in Kenya Tables 4 1A and 4 2B briefly describe each of the six CV questionnaire versions used in this survey and indicates sizes of the sub-samples Respondents were randomly assigned one of the six versions See Appendices 4 A and 4 B for the actual questionnaire versions

Before presenting the study hypotheses, however, we need to restate the purpose of the research The study was designed to serve five objectives (a) to estimate the economic value of piped water supply and improved water quality in the Nzoia River Basin, (b) to evaluate the feasibility of using CV to value an environmental amenity and its related quasi-public service in rural settings where respondents have limited education and monetary resources, (c) to examine the role of temporal dimensions of bid payments in contingent values for environmental commodities, (d) to empirically investigate embedding effect bias in contingent valuation of improvements in river water quality, and (e) to evaluate the role of water connection charges in households' willingness to hook onto a piped water system

Table 4 1A Differences in CV Questionnaire Versions and Sizes of River Pollution Control Sub-Samples

Version	Contingent Commodity, Temporal Dimension of Payments in the Valuation, and Size of Sub-Sample (n)
A1 BS*-sm	monthly wtp for improving water quality in the part of the river in Webuye Division under a questionnaire version (A1, n = 38) eliciting for values for both the section and the entire basin
A1 TBS-bm	total amount of monthly wtp for improved river water quality in the entire basin upto Lake Victoria, essentially the sum of BS*-sm and an additional amount elicited for within the same questionnaire version, A1
A2 BS*-sy	annual wtp to improve river water quality in only the part within Webuye area under a questionnaire version (A2, n = 39) eliciting for values for both section and entire basin
A2 TBS-by	total amount of annual wtp for improved water quality in the entire river basin upto Lake Victoria, essentially the sum of BS*-sy and an additional amount elicited for within the same questionnaire version, A2
A3 Sect-sm	monthly wtp for improved river quality in the part within Webuye Area in the questionnaire version (A3, n = 40) asking for "sectional values" only
A4 Sect-sy	yearly wtp for improved water quality in the section within Webuye area under the questionnaire version (A4, n = 37) asking for "sectional values" only

Note n stands for realized sub-samples Planned sub-samples were as follows 45 households for each of the four river pollution control questionnaire versions (total 180 households) and 85 households for each of the two domestic water supply questionnaire versions (total 170) (cf Table 4 1B) Consequently, 350 respondents was the planned sample size for the entire study

Table 4 1B Differences in CV Questionnaire Versions and Sizes of Domestic Water Supply Sub-Samples

Version	Contingent Commodity, Temporal Dimension of Payments in the Valuation, and Size of Sub-Sample (n)
B1 M*Spread	monthly wtp for a private domestic water supply (dws) "connection" when connection charges are spread over time elicited for under questionnaire version B1, n = 79
B1 M*Front	monthly wtp for a private dws "connection" when connection charges are to be paid up-front elicited for within the same questionnaire version, B1
B2 Y*Spread	Annual wtp for a private dws "connection" when connection charges are spread over time asked for under questionnaire B2, n = 78
B2 Y*Front	Annual wtp for a private dws "connection" when connection charges are to be paid up-front within the same questionnaire version B2

Note n stands for realized sub-samples Planned sub-samples were as follows 45 households for each of the four river pollution control questionnaire versions (total 180 households) (cf Table 4 1A), and 85 households for each of the two domestic water supply questionnaire versions (total 170) Consequently, 350 respondents was the planned sample size for the entire study

All questions in the survey instrument were designed to address four research hypotheses effect of temporal dimension of payments, evaluation of river pollution control over diverse geographical extents (a form of embedding effect), and impact of nature of payment profiles for connection charges in household decisions to hook onto a piped water supply system The fourth study hypothesis on whether the nature of the good under valuation matters in hypothetical evaluations should be apparent Following is a brief exposition of the hypotheses

4.2.1 Nature of Good Hypothesis

The first hypothesis is that contingent values for river quality would be less reliable and less accurate predictors of actual willingness-to-pay than those of domestic water supply because one, piped water is more well defined and concrete, and two, because respondents are more familiar with domestic water The amorphous nature of environmental amenities has bred scepticism over the performance of the CV method Although this doubt was perhaps dispelled by Kealy and her co-workers (1990), it still lives on in developing country applications since CV surveys there have not involved environmental amenities proper Hence the two sets of questionnaire versions, **A** for river pollution control in the Nzoia Basin and **B** for domestic water supply

4.2.2 TEMPORAL DIMENSION OF VALUATION HYPOTHESIS

This hypothesis is basically about whether specifying payments on monthly or annual basis makes a significant difference to the contingent valuation process The postulate is that the nature of periodic payment scheme does not affect a household's willingness-to-pay for improved river water quality and domestic water supply services The test is on

$$WTP_m = (1/12)WTP_a \quad \text{versus} \quad WTP_m \neq (1/12)WTP_a \tag{4 1}$$

where **m** and **a** stand for monthly and annual payment systems

The CV application detailed in this thesis is concerned with the effect on WTP values of two temporal dimensions of payment, namely monthly and yearly contributions The contingent valuation markets were those of improved river water quality in the Nzoia Basin, Kenya and private water connections for residents in Webuye, Kenya In each of the hypothetical markets, the question arises as to whether it matters which payment frequency is chosen Do different temporal dimensions of paying for an environmental improvement result in the same representation of that good, or will these frequencies result in different images of the good and consequently in different values? In the latter case a validity problem arises for the CV method as the same object leads to different WTP values

As noted in Chapter 3, Third World CV results are apt to be sensitive to the amount of money respondents have at the time the survey is conducted, we saw that this has to do with periodic income flow of the interviewees (partly due to existence of large subsistence and informal sectors) and not simply the general question of the income constraint which is implicitly addressed by the choice of WTP in preference for WTA as a welfare measure

4.2.3 EMBEDDING HYPOTHESIS

In terms of this study, embedding will occur if the average WTP value for pollution control in the entire Nzoia River Basin upto Lake Victoria is the same as the WTP value for pollution control in the section of the Nzoia River Basin within Webuye Division only In particular, tests for embedding effect relate to statistical equivalence of average WTP for pollution control over geographic extents of the Nzoia River Basin (a form of part-whole bias) Hence the four questionnaire versions on river pollution control, asking for "sectional" evaluation over nested/paired (Versions A1 and A2) and nonnested/unpaired response modes (Versions A3 and A4)

4.2.4 CONNECTION CHARGE HYPOTHESIS

It is expected that in a socio-economic setting of low levels of education and income the nature of initial connection charges for a household water faucet would influence willingness to pay for the good This is the hypothesis under test here Does the nature of initial connection charges affect household willingness-to-pay bids for an individual connection to the piped water system?

Essentially, the postulate on whether or not average wtp measures for domestic water supply improvement would vary across profiles of initial connection charges can be shown as follows

Null hypothesis $$H_0 \quad WTP[SPREAD]_{(m,y)} = WTP[UPFRONT]_{(m,y)} \qquad (4\,2)$$

Alternative hypothesis H_a $WTP[SPREAD]_{(m,y)} > WTP[UPFRONT]_{(m,y)}$ (4 3)

where (m,y) denote the temporal dimension of payments in the valuation process (that is monthly or yearly), and SPREAD and UPFRONT represent the two payment profiles of initial charges for piped water connection

4.3 QUESTIONNAIRE AND SURVEY STRUCTURE

4.3.1 FEATURES OF THE HYPOTHETICAL MARKETS

The basic notion of the CV method is that a realistic but hypothetical market for "buying" use and/or preservation of a nonmarket natural resource or public good is described to an individual Then the individual is told to use the market to express his or her valuation of the good Key features of the market include (1) description of the good under valuation, (2) means of payment (often called payment vehicle), and (3) the value elicitation procedure

The two goods to be valued were river pollution control in the Nzoia Basin, Kenya and household piped water connections for Webuye residents, Kenya The problems of water pollution in the Nzoia River Basin as well as lack of access to clean, safe, potable, and convenient water supply for domestic purposes were both familiar to residents of Webuye Division, Kenya To emphasize the geographical stretch of the river, however, a map was shown to respondents

The payment vehicle must be realistic and emotionally neutral for the respondent To improve realism, the payment vehicle should be appropriate for the resource and market constructed The payment vehicle used in this study's contingent market of the Nzoia River quality was a council charge[38]/sewage fees and that for improved water service (that is, household piped water connections) was a water charge Although a *prima facie* look at a council charges shows a simplification of the economic activities that involve water use owing to its apparent disregard for the conventional method through which people pay for improved river quality as taxpayers and consumers of industrial products, it is a familiar method of payment for most public services in Kenya In the case of piped water connections, the water bill a very realistic and familiar means of paying for water for most homeowners and persons renting houses Renters, in general, are aware of payment for water because many do pay for their water separately and those that do not are often aware that water is a service paid for in their rent Landlords make use of "utilities included" when attracting rentors and as a reason for periodically raising the rent when electricity or water rates increase

The value elicitation procedure can be one of three types, iterative bidding, open-ended, and closed-ended or dichotomous choice[39] Open-ended (or continuous) willingness to pay (WTP) questions (sometimes aided with a payment card listing alternative amounts) simply ask the respondent to state their maximum WTP without any prompts concerning possible answers In the close-ended "iterative bidding" type question, the interviewer states a monetary (shilling, in this case) amount and the

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[38]These are basically user-charges Use of the term "charge" rather than "price" recognises the administrative, rather than market, determination of payments More specifically, use of "user-charge" recognises the necessity to exclude internal recharges in order to avoid multiple counting For a detailed international comparison of user-charges for urban services see Bailey (1994)

[39]For more details on these approaches see Cummings *et al* (1986), Hanley (1989), Mitchell and Carson (1989) and Hanley and Spash (1993)

respondent answers "yes" they would pay or "no" they will not pay If a yes is elicited, the amount is raised and this process is repeated until a no is recorded Dichotomous Choice (which is also known as "take-or-leave-it", close-ended, discrete, or referendum[40] style bidding) value elicitation approach is where the respondent answers yes or no to one randomly assigned monetary amount chosen by the interviewer. Many intermediate questioning formats are also possible, e g bidding games, bidding games with a budget constraint, and ranked choice

The history of the CV method reveals use of bidding techniques (now called iterative bidding) in personal interviews (such as Davis, 1961/81) and the use of open-ended (OE) willingness to pay (WTP) questions in mail surveys (for example, Randall *et al*, 1974) and Cummings *et al* (1986) prefer iterative bidding over the open-ended question format due to iterative bidding's more market-like approach and the fact that the repetition provides the respondent greater opportunity to "research his preferences" However, the iterative approach is impractical in mail surveys and the OE approach found much use in such surveys

When Bishop and Herberlein (1979) first explored the use of closed-ended or dichotomous choice (DC) WTP questions in their validation work, it became apparent this question format could provide a more market-like setting and yet be performed in a mail survey With the utility-theoretic foundation established by Hanemann (1984), the DC question format was quickly adopted as the preferred approach in a large number of surveys (Loomis, 1990 78)

[40]The referendum format is a dichotomous-choice question with the payment vehicle posed as a referendum vote

4.3.2 Open-Ended Contingent Valuation Model

Currently, open-ended and dichotomous-choice questions appear to be the most popular formats Open-ended questions were one of the earliest questioning formats (Hammack and Brown, 1974) Dichotomous-choice questions were developed later in the evolution of contingent valuation (Bishop and Heberlein, 1979) and are the most commonly employed questions in the literature today

Although there has been growing enthusiasm in the CV literature for using discrete choice (DC) over open-ended questions due to the NOAA panel's endorsement of the DC strategy (NOAA, 1993)[41], one should not be indifferent in the choice of a questioning format In fact, the debate on whether or not the two approaches yield different results continues Kealy *et al* (1988) indicate that DC and open-ended questions yield similar average estimates of consumer surplus There is also little evidence suggesting differences in accuracy Kealy *et al* (1988) and Boyle and Bishop (1988) found the precision of both their CV estimates to be similar, but Seller *et al* (1985) found the open-ended CV estimates were tighter

Unless OE responses are highly skewed toward high values, open-ended data are likely to yield lower estimates of central tendency and smaller standard errors Thus, the choice of questioning format can influence the absolute magnitute of welfare estimates and, perhaps, the outcome of cost-benefit analyses The differences in standard deviations also can lead to different conclusions from statistical tests of means

[41]Like many others, the NOAA panelists are attracted by the referendum approach - where people are asked whether or not they accept to pay a contribution of a given amount - since this approach lacks an obvious strategic bias All right, but this approach opens up a Pandora's box of other problems related to a worsening of the hypothetical status of the questions

An open-ended WTP question format was chosen in this survey for the main reason that WTP is directly elicited and inference is not required, Olsen *et al* (1991) and Sanders *et al* (1990) are two recent studies that also used an OE WTP question However, from the respondent's viewpoint, stating a specific WTP amount is a mentally more difficult task, often resulting in item-nonresponse or underestimates (Hoehn and Randall, 1987) This well known disadvantage was partly countered by using personal interviews as opposed to mail surveys

Secondly, as valid and reliable estimates of WTP can be obtained using either OE or DC CV models (Boyle and Bishop, 1985, Kealy *et al*, 1988, Loomis, 1990, Kristrom, 1993), preference for the former was resource-driven, given the four study hypotheses, a DC question format would have required a larger sample size While DC has many advantages[42], these advantages are not without costs One cost is that WTP must be inferred, and the resulting estimates may be sensitive to the assumptions made about the specific utility function, distribution of the error term, and associated functional form of the estimated logit equation (Hanley, 1989, Loomis, 1990, Kanninen, 1995)

Several recent papers focus on showing that point estimates of willingness to pay (WTP) are sensitive to seemingly innocuous changes in the statistical model estimated when discrete response CV is used Cooper and Loomis (1992) show empirically that point estimates of WTP depend systematically on the length of the bid

[42]The merits of a DC CV model include the following (1) fewer mental demands are placed on the respondent, resulting in lower item nonresponse, (2) there is a question format matching that of a market setting, in which the price is stated and the individual engages in "price-taking" behaviour of buying or not buying at that price, and (3) the DC format is an incentive compatible device for respondents to reveal their true preferences about provision of the good (Hanemann, 1984, Sellar *et al*, 1986, Hoehn and Randall, 1987, Loomis, 1987, Shultz and Lindsay, 1990 1870)

vector used They conclude that it is essential to include bid values in the tails of the WTP distribution in order to obtain an unbiased point estimate of WTP Similarly, McFadden and Leonard (1992) find that their point estimates of WTP is sensitive to the inclusion or exclusion of a bid value in the upper tail of the WTP distribution Boyle *et al* (quoted in Kanninen, 1995) find that their point estimates of WTP, estimated using "synthetic" discrete response CV data created by comparing open-ended responses to a set of bid values, are significantly different from the point estimates of WTP estimated using the actual open-ended data More recently, Kanninen (1995) shows that DC responses or yea-saying could inflate a CV study's "best estimate"

4.3.3 STRUCTURE OF THE QUESTIONNAIRE

The design of the questionnaire (see Appendices 4 1A and 4 1B) centred on two primary objectives, *one*, to collect data required for analysis of the research objectives above, and *two*, to collect data in a such a way that reliability and validity are enhanced In meeting these objectives, I reviewed the water quality questionnaire of Smith and Desvousges (1986) and Green and Tunstall (1991) as well as questionnaires from early research on improved water supply and sanitation services (e g , McPhail, 1994, Whittington *et al* , 1992, Whittington *et al* , 1993) With these as background and other literature (reviewed in Chapter 3), draft questionnaire versions were developed The drafts were, of necessity, revised a number of times before the actual survey

4.3.3.1 PART A -- SURVEY BACKGROUND AND INTRODUCTION

A key ingredient in successful CVM research is establishing credibility for the survey objectives In particular, "[t]he first component of the questionnaire has to achieve this objective without biasing or offending the respondent" (Smith and Desvousges, 1986 p 82) Therefore, Part A in both versions of the questionnaire attempted to realise these goals by inquiring about water pollution in the Nzoia River and the respondents's water supply situation

As for version **A** (i e , on water quality in the Nzoia River Basin), the first three questions relate to use or non-use of the River, knowledge of on-going pollution, and a list of benefits from improved water quality in the River The purpose of this was, *inter alia*, to determine if the respondent has used or enjoyed the River in the past one year and his/her ranking of the various benefits

In version **B** (i e , domestic water supply connection), the first three questions pertain to existing water supply system and activities that involve water use as well as amount of household water storage capacity Recent CVM researches (see developing country application in Chapter 3) have found household perception of reliability and quality of water from an existing source and amount of storage capacity to be significant factors in attitudes on improved water supply situation in developing economies. Following the existing water source question, a list of activities that involve water use was presented and a question on water storage was asked The interviewee was required to state, by "yes/no" answers which of the operations apply to them

The data collected in Part A achieved two twin sub-objectives, it (a) completed River use/non-use and water supply profiles of the respondent that were later used in the analysis phase, and (b) established a rapport with him/her without influencing the main objective -- benefit estimation Part A also reinforced the notion that a wide range of activities are influenced by river water quality and household water supply Before this part, however, there was the Identification Information section which contained two key contextual issues rural and urban settings as well as presence of people listening to the interview Due to crowded housing conditions in urban areas and the general behaviour of rural Kenyans (especially the extended family system), the ideal situation of interviewing a respondent without other people listening is largely not possible Enumerators, therefore, noted the presence of other adults listening to the interviews It is possible for the presence of listeners to bias a respondent's WTP bids, but the direction of the potential bias is unclear Respondents may be reluctant to indicate their ability to pay a large amount and thus bid low Alternatively, they may want to demonstrate their ability to pay to their neighbours and thus bid high in an attempt to gain status

4.3.3.2 PART B -- BENEFIT MEASURES

Between basic questions of putting the respondent in the mood (Part I) and asking a series of questions on the household's socioeconomic composition and its physical structure (Part III, see next section 4 2 3 3), all questionnaire versions elicited for responses relating to the economic value of river pollution control and a household water faucet in Part II Part II focused on what households would be willing to pay (WTP) for improved water quality in the Nzoia Basin, Kenya and an individual water connection in Webuye Division, Kenya

Willingness-to-pay parts or sections of CV questionnaires often begin with a query on whether the respondent would be willing to pay (WTP) anything for the environmental good in the contingent market The approach in this study was not dissimilar As noted in Chapters 2 and 3, people's total WTP for increments or decrements in a natural resource can include current personal use values, possible use values (option values), and future generation use values (bequest values) Total WTP can also include nonuse (or existence) values which involve gains people obtain from the good for various reasons other than their person use (for instance, Brookshire *et al*, 1986)

The objective of this research, however, was to estimate the **total** WTP for both river pollution abatement and water supply improvement without separating the benefits into individual components Nonetheless, the fact that individuals will be asked to express a WTP bid for improved water quality in the entire Nzoia river basin means that they will be expressing expected use values, some option value (associated with uncertain future use), and existence value This is especially so because Webuye residents do not conceive of using the entire Nzoia river from its source to the mouth, it must be assumed that only the section of the river in the Webuye area is part of the set actually used or planned for future use

Part B of the questionnaire versions established the framework for the contingent commodities In other words, this part described the hypothetical market, the commodity to be valued, the payment vehicle and elicits the valuation amounts The first paragraph of this section introduced the setting for the hypothetical markets Following the introduction, the interviewee was asked, through an open-ended CV model, to state their valuations of the two-related contingent commodities Each Question 5 of the questionnaire variants introduce and address key elements in the "as if" market the distinction between values of a section and an entire environmental resource in the case of river water quality, and the importance of utility-required down payment in piped water systems In the former situation respondents were asked a separate valuation bid for water pollution control in the whole River basin while in the latter case, as will be seen presently, respondents were asked for WTP bids when the payment profiles for connection charges are paid for upfront (as opposed to being spread over time)

As noted, the payment vehicle used in the contingent market of the Nzoia River quality was a council charge/sewage fees and that for improved water service was a water charge The questions concerning household's WTP were carefully designed in an open-ended format to address the research hypotheses To study the influence of temporal dimensions of payments on contingent values, a field experiment was conducted with the two commonly used frequencies, *one (yearly payments)* and *twelve (monthly payments)* Equal sharing of six questionnaire versions between the two frequencies meant that two variants and one version of river water quality and domestic water supply questionnaires, respectively, asked for yearly WTP

In all questionnaire versions the question asking for respondents' choice of payment frequency was succeeded by

"(a) Now suppose the payments are to be made [monthly/yearly] and the payment would mean that you need to spend less on other items, would you be willing to pay any charge to [clean the Nzoia River/have a private water connection to your house]? Yes/No

(b) SHOW CARD If NO, which of the following reasons best describes why you are not willing to pay any money to [clean the Nzoia River/have a private water connection to your house]?

[ ] Not enough information
[ ] I do not want to place a shilling value on the water quality in the Nzoia River [applies to good1 only]
[ ] Improving the Nzoia river water quality has no value to me [also applies to good1 only]

[ ] I do not want to participate in this survey
[ ] I cannot afford to pay

(c) If YES, what is the most you as a household would be willing to pay per [month/year] in [payment vehicle] in order to [contingent good]?"[43]

As far as the hypothesis on influence of nature of connection charges upon WTP for household piped water connections is concerned, the SPREAD format was presented first before the UPFRONT one Naturally, this point relates only to the CV questionnaire versions on domestic water supply The exact wording (in the case of the questionnaire version eliciting for monthly WTP) was as follows

" Now I would like to ask you some questions about how much your household would be willing to pay for a piped water connection to your house

5 Suppose that you have the option to have a water faucet installed in your house This installation is considered a privilege Your family would have access to safe, reliable water 24 hours per day, all year round

However you would be responsible to pay the monthly or annually water bill for the consumption of water from your faucet The amount of the bill is based on the quantity of water used You do not have to pay anything additional to cover the cost of the water standposts (kiosks) in the street Your family also does not have to immediately pay for making the private connection from the main water pipe to your house because Webuye Municipal Council pays these costs now and then you would repay it via your water bill for several years The cost of installing the pipes and plumbing accessories in your house is about Ksh 2,000 (approx £ 25 00)

If you were asked how frequently you would like to pay water charges for the private water connection to your house, which of these two frequencies would you prefer? Monthly/Yearly

6 (a) Now suppose the payments are made monthly, and that the payment would mean that you need to spend less on other items, would you be willing to pay any charge for having a private water connection in your house? Yes/No

(b) SHOW CARD If NO, which of the following reasons best describes why you are not willing to pay anything to have a private water connection to your house?

[ ] Not enough information
[ ] I do not want to place a shilling value on a private water connection

[43]The use of [ ] is specific to this dissertation It has no bearing to the original questionnaire versions (see Appendices 4 1A and 4 1B)

[ ] A private water connection has no value to me
[ ] I don't want to participate in this survey
[ ] I can't afford it

(c) If YES, what is the most you as a household would be willing to pay per month in water charges for a private water connection to your house?"

This was followed by another question eliciting for WTP when connection charges are to be paid for upfront The exact wording was

"7 Upto now we have talked about piped water supply based on the assumption that the Municipal Council makes the private connection to your home and then charges you for the installation costs through the water charges over several years An alternative approach would be for the Municipal Council to insist that each household meets the cost of installing the pipes and plumbing accessories in advance Given this condition, what is the most your household would be willing to pay per month in water charges to have a private water connection ?"

4.3.3.3 PART C -- BACKGROUND AND SOCIOECONOMIC DATA

This section of the CVM questionnaire versions aimed at collecting basic socio-economic and demographic information that may influence households' WTP for benefits of water pollution abatement on the Nzoia River and improvement in domestic water supply The key characteristics asked for here included sex, age, level of education, occupation, knowledge about river pollution, and status of existing water supply in terms of quantity, quality, and convenience The other variable sought for was total monthly income Respondents were not asked to specify precisely the gross monthly income of family members, but rather to indicate the category into which their household income fell

Findings from studies on impact of attitudes on WTP for environmental assets have had a direct influence on the specific socio-economic features that are included in this CVM study's questions A note on some of the studies is definitely apt at this stage In a study on public attitudes towards water and other environmental issues, Hamilton (1985a, b) concluded that concern over water contamination was highest among young respondents, women, and persons with children living at home It has also been shown that more highly educated people are often more concerned about protection of the environment (Butel, 1979, Lowe *et al*, 1980) and that those people who have greater knowledge of an environmental problem are more likely to be actively involved in it (van Liere and Dunlap, 1980) Finally, in a recent WTP experiment in a Third World country, Whittington *et al* (1992) found that income had a strong positive effect on the probability of residents WTP for improved water supplies Chapter 5 details, among other aspects of empirical analysis and results, the expected signs (that is, directions of influence) of the various variables on WTP for river pollution control and improved domestic water supply

Besides the conventional background data mentioned above, Questions 12 and 13 of the survey questionnaires on Nzoia River pollution abatement and water supply improvement asks for household perception on water supply and water quality on the Nzoia River respectively The aim here is to examine the effect of a respondent's water supply status on valuation of benefits of river pollution control and *vice versa*, the impact of a household's perception of river quality on the value of water supply improvement

4.4 SURVEY PRE-TEST, ADMINISTRATION, SAMPLE DESIGN, AND FIELD PROCEDURE

This CV questionnaire was extensively pre-tested with this author as the principal researcher and three field assistants, all students at Kenya's public universities One pre-test was conducted by the principal researcher alone using African students at the University of Stirling as mock-respondents and another was conducted at the study location over the second half of May 1995 The pre-tests showed the need to modify some part of the text which flowed badly, to change some of the skip patterns, and to provide additional cards containing response choices for some questions A number of minor language changes were made to the contingent scenarios to improve their understandability The correct income group brackets based on the high-medium-low income cohorts employed in the Kenya Government surveys were incorporated in consultation with the Bungoma District Statistical Officer Moreover, since one main purpose of training for interviewers and pretest was to check language translations, we practised with interpretations of the English questionnaire versions into Kiswahili and Luhya languages

The CV survey was administered in June 1995 through August 1995 by this author and three field assistants Interviews with 311 respondents were completed out of a target of 350 households Given the Divisional population of 135,561 and the average household size of 5 89 (this is a Bungoma District figure), the completed interviews represent 1 4 per cent of the entire population of about 23,015 households The survey was conducted in-person with one person interviewed in each household Respondents were selected using a household-based multi-sub-location stratified random sample of persons 18 years or older Stratification was done at Locational level, metropolitan/non-metropolitan level and upper/lower levels, upper/lower levels respectively refer to the areas north/south of the Pan Paper Mills (see Figure 1 1 in Chapter 1) Within strata, census enumeration blocks were randomly chosen and households in the blocks were physically listed "linearly on a line as we walked along paths in the study area" Respondents were randomly assigned one of six versions of the CV questionnaire Versions contained either RWQ or DWS good combined with one of the two temporal dimension of payments and/or embedding scenarios [that is, part (section) or part and the whole (entire) basin of the Nzioa River]

Interviewers received extensive training by attending 10 full-day training sessions held in different locations throughout Webuye Division, Kenya (Khalumuli, Maraka, Matulo, Muchi-Milo, Nabuyole Falls, and Webuye Township) The training emphasized the use of visual aids (SHOW CARDS), need for neutrality, the nature of the quota selection, and translation of English questionnaire versions into Kiswahili and Luhya (Bukusu and Tachoni dialects) languages The survey instrument took on average 30 minutes to complete In an effort to obtain completed interviews, interviewers occasionally called back to respondents homes in the evenings and weekends An 88 percent response rate was achieved An interviewer debriefing after the CV survey suggested that the survey had gone well and had been taken seriously by interviewers "Empirical Analysis and Results" is the subject of Chapter 5

CHAPTER V

EMPIRICAL ANALYSIS AND RESULTS

5.1 INTRODUCTION

The contingent valuation (CV) method offers a direct, intuitively appealing means of estimating economic benefits of environmental improvements e g , river pollution control and improved domestic water supply Rather than attempting to infer from behavioural information how much an individual is willing to pay (WTP) for improved service or resource (as in revealed preference methods like hedonic property value approach), the evaluator simply asks outright how much the individual or household would be willing to pay This Chapter reports empirical results of the Kenya CV survey undertaken, on river pollution control and improved domestic water supply, over the period between May 1995 through to September 1995

There are five sections to the Chapter Section 5 2 presents preliminary results, including household perception of the problems studied, nonmonetary measures of relative importance of benefits, and socio-economic and demographic data Section 5 3 is on the descriptive statistics and frequency distributions of willingness to pay values, as well as the analytical framework for WTP findings from open-ended CV design However, the section starts with a presentation of responses to the value elicitation question

Estimation models and tests of differences for various WTPs from different questionnaire versions (or samples) are given in Section 5 4 and Section 5 5 respectively Section 5 5 particularly matches the statistical tests with the four study hypotheses presented in Chapter 4 Finally, Section 5 6 aggregates benefits of improvements in river pollution control and a household water connection at Divisional, District, and National Levels

5.2 PRELIMINARY EMPIRICAL RESULTS

The significance of household recognition of environmental and socio-economic problems has been greatly underscored in the literature on water resources management (Lichtenberg and Lessley, 1992, Smith and Desvousges, 1986, Whittington *et al*, 1990a, 1990b, 1991, 1993, Winpenny, 1994) This section presents preliminary results, from Kenya, on perceptions of the severity of river pollution and inadequate domestic water supplies (Sub-Section 5 1 1) Nonmonetary measures of relative importance of benefits of river pollution control and improved domestic water supply are in Sub-Section 5 1 2 Sub-Section 5 1 2 shows that the socio-economic and demographic statistics of households in the contingent valuation survey correspond closely to the characteristics of the underlying population in the Nzoia River Basin within Webuye Division

5.2.1 HOUSEHOLD PERCEPTIONS OF THE STUDY PROBLEMS

Before directly asking how much respondents would pay for improvements in river water quality and domestic water supply, it is important to allow them an opportunity to reflect on why they might care about the river and a private water supply connection Cummings, Brookshire and Schulze (1986) call this "researching their preferences", or in other words, permitting respondents to collect their thoughts on the topic

The first set of questions therefore asked about the relative gravity of river pollution and domestic water supply problems countrywide and the study location, and the relative importance of the Nzoia River for, *inter alia*, residential water supply, for use by future generations and as habitat for plants and wildlife A five-point Likert scale allow individuals to rate the relative seriousness of the problems (Table 5 1), as well as importance of various reasons for valuing the Nzoia River (explained in Sub-Section 5 2 2) The neutral response format, preceding the shilling valuation questions, may aid in understanding the willingness to pay responses that people provide later in the survey Table 5 1 shows that while Webuye residents recognized the existence of water quality and supply problems, they tended to believe those problems occur away from their local area

Table 5 1 Perceptions of Severity of River Pollution and Water Supply Problems

The Water Resource Issue	Area and Rating of Severity of the Water Resource Problem[1]		
	Likert scale	Countrywide	In Webuye Division
		count (%)	count (%)
River Water Quality			
	scale, 1	59 (38 31)	42 (27 27)
	2	53 (34 42)	45 (29 22)
	3	25 (16 23)	32 (20 78)
	4	17 (11 04)	35 (22 73)
	5	0 (0 00)	0 (0 00)
	Mean (SD)	**2.00 (0.99)**	**2.39 (1.12)**
Domestic Water Supply			
	scale, 1	27 (17 20)	37 (23 57)
	2	88 (56 05)	29 (18 47)
	3	31 (19 75)	53 (33 76)
	4	11 (7 01)	32 (20 38)
	5	0 (0 00)	6 (3 82)
	Mean (SD)	**2.17 (0.79)**	**2.62 (1.16)**

Notes Scale 1 - 5 (1 = serious problem, 5 = no problem), SD figures represent standard deviations, total counts for river water quality and domestic water supply samples are 154 and 157 households respectively

Webuye households' perceptions on river water quality and domestic water supply problems suggest that they may not recognize fully either the extent or location of the issues in the sources of pollution, including their own contribution to the destruction, and/or Government policy on industry-environment relations While the households recognize that the two issues are problems, they tend to associate it more with other areas of Kenya This may be explained by the ubiquitous and overarching influence sugarcane agriculture and PPM paper industry has on the local economy Most sugarcane farmers in the rural areas pointed accusing fingers at the paper factory and municipal sewage while urbanites employed at the manufacturing concern aimed theirs at agricultural sources of surface and ground water damages All in all, respondents in more urbanized sub-locations exhibited more concern about pollution of the Nzoia River than those in the rural parts of Webuye

These ratings are in contrast with the actual water quality and water supply problems in the Division, as already been painted in the background to the study The most plausible speculation for these responses are twofold Firstly, the households might have strategically underrated the problems with the view to preempt the purposes of the research with regard to investment or policy decision This reason is, however, unlikely since most well-structured experiments undertaken in the United States and Western Europe (Bohm, 1972, Mitchell and Carson, 1989, Hanley and Spash, 1993) and in developing countries (Whittington *et al*, 1990b, 1993) fail to support the hypothesis that individuals will act strategically in answering contingent valuation questions Surveys to estimate strategic bias are often structured such that one group of respondents is told one set of factors about a situation that minimizes their incentive for strategic behaviour, and another group receives a different set that maximizes their incentive for behaving strategically (e g , Bohm, 1972, Whittington *et al* , 1990b, Grossman and Pirozzi, 1993) Assuming there is no strategic behaviour, one particular implication emerges from this result, most ruralfolk lack knowledge on environmentally deleterious effects of the agrochemicals that are applied on their sugarcane fields

The second speculation is that the households put more emphasis on the user benefits than other categories of economic value of water in nature This fact is seen in the ratings for motivations for river water pollution abatement (see Sub-Section 5 2 2)

5.2.2 Nonmonetary Measures of the Relative Importance of Benefits

People's differences in importance attached to the various economic value categories influences their attitude towards public investment in river water quality improvement This issue is examined further in the section on determinants of willingness to pay The question of "why do they benefit?" in domestic water supplies can be answered by the three attributes of piped systems convenience, reliability and quality, listed in the order of household indications of degree of importance

As noted, a five-point Likert scale allowed respondents in Webuye area to rate the relative seriousness of the problems, as well as importance of various reasons for valuing the Nzoia River Table 5 2 suggests that the main motivation for improved water quality in the Basin for inhabitants of Webuye is use value This is insofar as "Contributes towards a cost-effective water supply for personal use and increase enjoyment by its users" received the higher mean rating as a possible motivation for improving water quality in the Nzoia River Basin *vis-a-vis* existence, option and bequest reasons

Household perceptions on other aspects of Webuye water resources and services were captured through different statements in the CV questionnaire versions Specifically household predispositions regarding water quality in the Nzoia River Basin, distance to existing source of domestic water supply (open-ended, but to the nearest kilometre), time expenditure on hauling water (open-ended, but to the nearest hour), and exiting domestic water supply status with respect to reliability, quality and convenience (on Likert scale) were elicited on the corresponding scales Perceptions of river water quality was based on the Smith-Desvousges (1986) water-quality ladder These psychographic profile information is presented in Tables 5 3 and 5 4 whilst Table 5 5 is a joint frequency distribution of number of water uses and household storage capacity In tandem with expectation, the two variables in Table 5 5 have a positive correlation coefficient of 0 058

Table 5 2 Benefits of River Pollution Control in the Nzoia Basin

Variable		Distribution of Responses (Likert scale) Likert scale	Count (%)	Mean (SD)
I	Contributes towards a cost-effective water supply for personal use and increase enjoyment by its users			3 82 (1 20)
		1	7 (4 9)	
		2	14 (9 9)	
		3	32 (22 7)	
		4	32 (22 7)	
		5	56 (39 7)	
II	Protect the river for use by the future generations			3 10 (1 28)
		1	19 (13 5)	
		2	26 (18 4)	
		3	40 (28 4)	
		4	32 (22 7)	
		5	24 (17 0)	
III	Avoid dirty, unsightly and smelly nature of river			2 56 (1 48)
		1	52 (36 9)	
		2	25 (17 7)	
		3	14 (9 9)	
		4	33 (23 4)	
		5	17 (12 1)	
IV	Contribute towards the improvement of the environment in general			2 62 (1 30)
		1	27 (19 2)	
		2	49 (34 8)	
		3	40 (28 4)	
		4	0 (0 0)	
		5	25 (17 7)	
V	Conserve wildlife and plants			2 88 (1 44)
		1	36 (25 5)	
		2	27 (19 2)	
		3	15 (10 6)	
		4	44 (31 2)	
		5	19 (13 5)	

Notes n = 154
Scale 1 - 5 (1 = not important at all, 5 = very important)
Figures in brackets are standard deviations

In the domestic water supply sub-sample, conscious efforts were made to interview only households who did not have a private water connection However, 12 (7 6%) respondents in the sub-sample had access to 'almost' private water in the neighbourhood or in shared compounds Insofar as the households did not possess an individual water faucet these interviewees were included in the non-market valuation exercise On the other hand, their psychographics are excluded This is the reason for the total domestic water supply sub-sample being less than 157 households on some psychographic items For instance, in reporting an approximate distance to the water source of less than 0 5 kilometres, such respondents are assumed to behave as if in possession of a private tap The distance travelled by Webuyians to fetch water averages at 1 53 km and is positively correlated with time expenditure in hauling water (0 676) and number of water uses (0 070), it has a negative association with water storage capacity (with -0 317 as Pearson's correlation coefficient)

Table 5 3 Perceptions of Other Aspects of Webuye Water Resources and Services, River Water Quality Sample

Aspect of Water Resources and Services		Count	Percent	Mean (SD)	Median
1	Rank score for water quality in the Nzoia River			2 3 (1 5)	2 0
	0	23	14 9		
	1	20	12 9		
	2	45	29 2		
	3	45	29 2		
	4	9	5 8		
	5	7	4 6		
	6	3	1 9		
	7	2	1 3		
2	Distance from residence to the Nzoia River (rounded off to the nearest kilometre)			2 2 (2 1)	2 0
	1	48	31 2		
	2	53	34 4		
	3	39	25 3		
	4	8	5 2		
	5	3	1 9		
	6	0	0 0		
	7	1	0 7		
	8	2	1 3		
3	Current domestic water supply status in terms of reliability, quality, and convenience			4 0 (0 7)	4 0

Notes
1 excludes 12 respondents who had access to a water faucet in their compounds or neighbouring homes
2 scale 1 - 5 (1 = Very good, 2 = Good, 3 = Normal, 4 = Poor, 5 = Very poor)

Table 5 4 Perceptions of Other Aspects of Webuye Water Resources and Services, Domestic Water Supply Sample

Aspect of Water Resources and Services		Count	Percent	Mean (SD)	Median
1	Distance to water source (to the nearest km)[1]			1 5 (0 7)	1 0
	1	81	55 9		
	2	51	35 2		
	3	13	8 9		
2	Time expenditure in hauling water (to the nearest hour)[1]			1 8 (0 9)	2 0
	1	68			
	2	51			
	3	20			
	4	6			
3	Status[2] existing source of domestic water supply with respect to				
	(a) Reliability	3 2 (0 8)		3 0	
	(b) Quality	2 8 (0 7)		3 0	
	(c) Convenience	3 8 (0 8)		4 0	
4	Status of water quality in the Nzoia River	4 2 (0 7)		4 0	

Notes

1 excludes 12 respondents who had access to a water faucet in their compounds or neighbouring homes

2 scale 1 - 5 (1 = Very good, 2 = Good, 3 = Normal, 4 = Poor, 5 = Very poor)

Table 5 5 Joint Frequency Distribution of Number of Water Uses and Household Water Storage Capacity

Water Uses (in groups)[2]	Household Storage Capacity (in jericans)[1]				
	1	2	3	4	TOTALS
1	5	7	1	0	13
2	16	23	5	6	50
3	26	50	11	7	94
TOTALS	47	80	17	13	157

Notes

1 a jerican is local parlance for a volumetric measure of water, one jerican is equivalent to 20 litres In areas near Lake Victoria, it is called *mbuguru*

2 three groups of water uses Group 1 = Drinking/cooking/domestic washing, Group 2 = Watering flowers and irrigating vegetables, Group 3 = Watering livestock

Tables 5 6 and 5 7 show summaries of perceptions of water quality in the Nzoia River by Household Location in the Basin As expected, most residents located in the upper section of the river (after the Webuye Bridge) gave higher scores for the river water's quality than those in the lower section, most of the polluting activities are located in the lower parts of the Basin Of the 90 persons interviewed in the upper section, 21 (24 4%) thought the water quality in the Basin was either at 0 or 1 level, while more than 32% of dwellers of the lower section (sub-sample was 64) agreed with these rankings Although these findings relate to the river sample, the picture is similar for the water sample Perceptions of quality of water in the Nzoia River also varied in accordance with household socio-economic setting In particular, people in urban areas ranked it low compared to rural folks

Unlike developed country scenarios in which a conceptual problem arises with within-basin comparisons because individuals with particular preferences for water quality may locate at specific areas (d'Arge and Shogren, 1989), we submit that this situation is unlikely in the Kenyan case The reason is as follows Most household locations in the Basin, except house renters within Webuye Municipality, are on ancestral lands and therefore peoples' perceptions are well-informed by recent changes in the river water quality due to various polluting activities d'Arge and Shogren concede that their "observed difference in values between the lakes may be partially determined by differences in preferences" (p 254), and not by differences in perceptions on water quality in the lakes under valuation

Table 5 6 Perceived Water Quality in the Nzoia River by Household Location in the Basin, The River Water Quality Sample (n = 154)

Rank on Smith-Desvousges Ladder	Socio-Economic Setting		LOCATION	
	Rural	Urban	Upper	Lower
0	11	12	9	14
1	15	5	13	7
2	22	23	29	16
3	23	22	28	17
4	4	5	5	4
5	5	2	3	4
6	2	1	1	2
7	1	1	2	0
Totals	83	71	90	64

Note Upper and Lower locations refer to the household siting in relation to PanAfrican Paper Mills at Webuye (see Figure 1 1)

Table 5 7 Perceived Water Quality in the Nzoia River by Household Location in the Basin, The Domestic Water Supply Sample (n = 157)

Rank on the Likert Scale	Socio-Economic Setting		Administrative Location					
	Rural	Urban	1	2	3	4	5	6
1	0	0	0	0	0	0	0	0
2	1	2	0	0	1	0	0	2
3	8	8	1	3	1	3	0	8
4	45	39	9	12	9	7	8	39
5	31	23	10	5	4	6	6	23
Totals	85	72	20	20	15	16	14	72

Note The key to the administrative locations follows 1 = Khalumuli, 2 = Maraka, 3 = Matulo, 4 = Milo-Muchi, 5 = Sitikho, 6 = Webuye Town

5.2.3 Response Rate, and Socio-economic and Demographic Profile

Data was collected by ın-person admınıstratıon of CV questıonnaıres to randomly selected households ın Webuye Dıvısıon of Bungoma Dıstrıct, Kenya The survey was conducted over a three-month perıod, June 1995 to September 1995 Usable (approprıately completed) questıonnaıres emerged from 311 respondents, whıch yıelded a response rate of 88 9 per cent, the planned total sample sıze was 350 households Socıo-economıc and demographıc characterıstıcs of the household are shown ın Table 5 8

It should be noted that despıte the relatıvely sımple, but not sımplıstıc, sample selectıon desıgn the sample attrıbutes whıch resulted correspond closely to the characterıstıcs of the underlyıng basın populatıon (NCPD-CBS-MI, 1994, Republıc of Kenya, 1994) The medıan bracket of famıly ıncome ın the sample was Ksh 4,000-5,999 as compared to per capıta earnıngs of Kshs 2,908 from agrıculture and lıvestock products for Bungoma Dıstrıct, and the recent per capıta ıncomes ın wage employment of Kshs 6,643 30 for Webuye Town (Republıc of Kenya, 1994 p 83, 85) The dısjunctıon between ıncomes from agrıculture/lıvestock sector and that of wage employment ıs maınly explaıned by the relatıvely large proportıon of the populatıon engaged ın the former sector Medıan educatıon attaınment for both the sample and the basın was about 8 years (prımary school)[44] Slıghtly less than one half of the sample was male

[44]Kenya's fomal educatıon ıs based on a three-tıer system, known as 8-4-4 system In thıs system prımary educatıon consısts of 8 years and secondary educatıon 4 years Graduates of secondary school may then further theır educatıon by enrolıng at any of the five natıonal unıversıtıes or ın any several prıvate unıversıtıes, or by joınıng colleges or technıcal ınstıtutes to acquıre certaın skılls necessary for natıonal development The 8-4-4 system was adopted ın 1985, replacıng a four-tıer system (7-4-2-3) consıstıng of seven years of prımary school, four of secondary, two of hıgher secondary, and three of unıversıty

Table 5 8 Socio-Economic and Demographic Characteristics of Sample Households

Variable		River water quality n	%	Domestic water supply n	%
1 Sex	Female	89	57 79	90	57 32
	Male	65	42 21	67	42 68
2 Age	Under 20 years	8	5 19	14	8 92
	20-29 years	6	3 90	18	11 46
	30-39 years	52	33 77	60	38 22
	40-49 years	58	37 66	44	28 03
	50-59 years	26	16 88	18	11 46
	Over 60 years	4	2 60	2	0 64
	median age group		4th		3rd
3 Education	No education	25	16 23	24	15 29
	Primary school	69	44 81	68	43 31
	Lower Secondary (O'level)	38	24 68	54	34 39
	Upper secondary (A'level)	11	7 14	8	5 10
	College/University	11	7 14	3	1 91
	Median education bracket		2nd		2nd
4 Household size	3	8	5 19	15	9 55
	4	12	7 79	32	20 38
	5	31	20 13	39	24 84
	6	27	17 53	22	14 01
	7	42	27 27	25	15 92
	8	21	13 64	17	10 83
	9	9	5 84	5	3 18
	10	4	2 60	2	1 27
5 Income	Under Ksh 1,999	41	26 62	24	15 29
	Ksh 2,000 - 3,999	41	26 62	38	24 20
	Ksh 4,000 - 5,999	28	18 18	52	33 12
	Ksh 6,000 - 7,999	22	14 29	29	18 47
	Ksh 8,000 - 9,999	11	7 14	9	5 73
	Over 10,000	11	7 14	5	3 18
	Median income group		2nd		3rd
6 Occupation					
	Public servant[1]	44	28 57	52	33 12
	Farmer	51	33 12	62	39 49
	Informal sector	59	38 31	43	27 39
7 Home ownership					
	Renter	80	51 95	76	48 41
	Owner	74	48 05	81	51 59
Total		154	100 00	157	100 00

Note [1] includes respondents employed in the private sector

5.3 THE CONTINGENT VALUATION MODEL AND RESULTS ON WILLINGNESS TO PAY

Between basic questions of putting the respondent in the mood (Part I) and asking a series of questions on the household's socioeconomic composition and its physical structure (Part III), all questionnaire versions picked up the gauntlet of determining the economic value of river pollution control and a household water faucet in Part II Part II focused on what households would be willing to pay (WTP) for improved water quality in the Nzoia Basin, Kenya and an individual water connection in Webuye Division, Kenya All open-ended bid questions were carefully designed to address four research hypotheses effect of temporal dimension of payments, evaluation of river pollution control over diverse geographical extents (a form of embedding effect), and impact of nature of payment profiles for connection charges in household decisions to hook onto a water supply system The fourth study hypothesis on whether the nature of the good under valuation matters in hypothetical evaluations should be apparent Table 4 1, in Chapter 4, describes each of the six CV questionnaire versions used in this survey and indicates sizes of the sub-samples As noted, respondents were randomly assigned one of the six versions

5.3.1 Response to the Value Elicitation Question and the Screening for Protest Bids

Willingness-to-pay parts or sections of CV questionnaires often begin with a query on whether the respondent would be willing to pay (WTP) anything for the environmental good in the contingent market The approach in this study was not dissimilar Indeed, in all questionnaire versions the question asking for respondents' choice of payment frequency was succeeded by

"(a) Now suppose the payments are to be made [monthly/yearly] and the payment would mean that you need to spend less on other items, would you be willing to pay any charge to [clean the Nzoia River/have a private water connection to your house]? Yes/No

(b) SHOW CARD If NO, which of the following reasons best describes why you are not willing to pay any money to [the contingent good]?

(c) If YES, what is the most you as a *household* would be willing to pay per [month/year] in payment vehicle in order to [contingent good]?"

The response to the elicitation question can only be interpreted as reliable willingness to pay (WTP) if it reflects a true preference for the good being valued Individuals might adopt various attitudes towards a contingent market The open debriefing question reveals large differences especially when offers are null due to bids refusal, or zero due to strategic behaviour or to a strong budgetary constraint

As is typical in CV surveys, numerous individuals stated that they would not pay for the environmental improvements A check question was asked to ascertain if these refusal-to-pay were valid "no" responses or protests to some feature of the hypothetical market As is customary (Mitchell and Carson, 1989), we classified as *non*-protest refusals to pay 30 respondents (16 in river quality questionnaire versions and 14 in drinking water questionnaire versions) who indicated they could not afford to pay and another 9 respondents (all in the river samples of the CV survey) who stated the programme was not worthy anything to them See Table 5 9 The dominant *protest* refusal-to-pay response was "Not enough information" with 15 people in versions I and 5 in versions II stating this reason About equal numbers of each version (on the order of 10 to 8 people) stated they did not want to participate in the exercise These protest refusals-to-pay are normally not included when CV responses are analyzed and the practice is followed here Some of these protests may result from not convincing the respondent that the environmental improvement and response programmes would work

Table 5 9 Willingness to Pay Responses and Nature of Contingent Commodity[1]

Response		Good 1 Count (%)	Good 2 Count (%)	**Total Count (%)**
Willing to pay		96 (62 3)	130 (82 8)	226 (72 7%)
Would not pay				
why not?	1	15	5	20
	2	8	0	8
	3	9	0	9
	4	10	8	18
	5	16	14	30
total		58 (37 7)	27 (17 2)	85 (27 3)
Classification of refusals to pay[2]				
True zero's (0's)[3]		25 (43 1)	14 (51 9)	39 (45 9)
Protests[4]		33 (56 9) (21 4)	13 (48 1) (8 3)	46 (54 1)
(14 8)				
Sample size:		**154**	**157**	**311**

Key to Reasons

1 Not enough information
2 I do not want to place a shilling value on river water quality/a private water connection
3 River water quality/a private water quality has no value to me
4 I do not want to participate in this survey
5 I cannot afford

Notes [1] Good 1, Good 2 represent river water quality and domestic water supply samples respectively

[2] per cent of refusal-to-pay responses within the category

[3] True zero bids includes respondents who gave Nos 3 and 5 as reasons for their refusal to pay

[4] Second percentage refers to protest bids as % of all response for each good, and for the entire study sample in the case of the last column

There appears to be *prıma facıe* evıdence, ın Table 5 9, that Webuye resıdents understood the two goods dıfferently owıng to theır famılıarıty Addıtıonally, Table 5 9 shows that wıllıngness to pay responses were hıgher ın ımproved domestıc water supply than for rıver water qualıty ımprovement Indeed, number of households not wtp for rwq ımprovements was more than double that of those not wtp for a prıvate water connectıon (58 versus 27) A closer scrutıny reveals that more of the refusal-to-pay (rtp) responses ın the latter group (51 9%) are true zeros whılst 56 9 per cent of the former group are protests Second, sınce a hıgher proportıon of those not wtp for dws gave "I cannot afford" reason, there were more protest bıds ın Good 1 valuatıon than ın that for Good 2

Table 5 10 shows responses to questıon (a) above, by socıo-economıc settıng, whılst Table 5 11 cross-tabulates responses to the questıon on whether the respondents' would be wıllıng to pay (WTP) for the contıngent commodıtıes, as well as reasons gıven by those who answered "NO" Clearly, rural areas have more refusals to pay than urban settıngs

Table 5 10 Wıllıngness to Pay Responses and Socıo-Economıc Settıng

Wıllıngness to Pay Response	Socıo-Economıc Settıng Rural (%)	Urban (%)	Total
Wıllıng to pay			
Rıver water qualıty sample	50 (52 1)	46 (47 9)	96
Domestıc water supply sample	67 (51 5)	63 (48 5)	130
Total	117 (51 8)	109 (48 2)	226
Refusals-to-pay			
Rıver water qualıty sample	33 (56 9)	25 (43 1)	58
Domestıc water supply sample	18 (66 7)	9 (33 3)	27
Total	51 (60 0)	34 (40 0)	85

Note Percentages are, accordıngly, ratıos of the group sub-sample

Table 5 11 Relatıonshıp Between Responses to the Wıllıngness to Pay (?) Questıon and Temporal Dımensıon of Payment ın Valuatıon

Response		Temporal Dımensıon of Payment ın Evaluatıon Monthly (%)	Yearly (%)	Total (%)
Wıllıng to pay?				
No	Good 1	27 (17 5)	31 (20 1)	58 (37 7)
	Good 2	15 (9 6)	12 (7 6)	27 (17 2)
Yes	Good 1	51 (33 1)	45 (29 2)	96 (62 3)
	Good 2	64 (40 8)	66 (42 0)	130 (82 8)
Total	Good 1	78 (50 7)	76 (49 4)	154 (100 0)
	Good 2	79 (50 3)	78 (49 7)	157 (100 0)
If Not, Why?				
1	Good 1	6 (10 3)	9 (15 5)	15 (25 9)
	Good 2	2 (7 4)	3 (11 1)	5 (18 5)
2	Good 1	4 (6 9)	4 (6 9)	8 (13 8)
	Good 2	0 (0 0)	0 (0 0)	0 (0 0)
3	Good 1	6 (10 3)	3 (5 2)	9 (15 5)
	Good 2	0 (0 0)	0 (0 0)	0 (0 0)
4	Good 1	3 (5 2)	7 (12 1)	10 (17 2)
	Good 2	5 (18 5)	3 (11 1)	8 (29 6)
5	Good 1	8 (13 8)	8 (13 8)	16 (27 6)
	Good 2	8 (29 6)	6 (22 2)	14 (51 9)
Total	Good 1	27 (46 6)	31 (53 5)	58 (100 0)
	Good 2	15 (55 6)	12 (44 4)	27 (100 0)

Notes Good 1, Good 2 represent rıver water qualıty sample and domestıc water supply respectıvely
Reasons for refusal to pay
1 = Not enough ınformatıon
2 = Do not want to place a shıllıng value on the good
3 = Has no value to me
4 = Do not want to partıcıpate ın the survey
5 = Cannot afford ıt

As seen in Table 5 11 the proportion of refusing to state a WTP amount in both versions are very close, 26 8% compared to 27 9% for monthly and annual versions respectively The picture at the Good level, however, is more confused For Good 1, the percentage of respondents who were not WTP was higher in the annual payment formats (40 8% versus 34 6% in monthly versions) whilst for Good 1 these figures were 15 4% and 18 9% in the annual and monthly version respectively Yet, most of those who "cannot afford to pay" were in the monthly payment formats

We can even go further and specify the proportion of refusals-to-pay per questionnaire version This is done in Tables 5 12 and 5 13 An important observation here concerns the effect of payment profiles of initial water connection charges for a household water faucet Some households that were wtp on "SPREAD" mode changed their mind and said they would not afford a private water connection when they were offered the case of "UPFRONT" connection charges In other words, both rtp and zero bids increased when respondents were asked to state their maximum wtp for a private water connection if the connection costs were to be paid upfront

Table 5 12 Number and Percentage of Willingness to Pay Responses on Improved Water Quality in the Nzoia Basin Across Nature of Temporal Dimension of Payment in Questionnaire Versions, and Extent of Geographic Coverage

Response[1,2] Temporal Dimension and Geographic Coverage in Questionnaire Version[3] Number (Percentage)[4]

	Monthly Payments Versions			Annual Payments Versions		
	BS*-sm	TBS-bm	Sect*-sm	BS*-sy	TBS-by	Sect*-sy
Wtp	26 (68 4)	26 (68 4)	25 (62 5)	22 (56 4)	22 (56 4)	23 (64 9)
Rtp[5]						
0's	7 (18 4)	7 (18 4)	7 (17 5)	6 (15 4)	6 (15 4)	4 (10 8)
Prot	5 (13 2)	5 (13 2)	7 (17 5)	11 (28 2)	11 (28 2)	10 (27 0)
Tot	12 (31 6)	12 (31 6)	14 (35 0)	17 (43 6)	17 (43 6)	14 (37 8)
ñ	33 (86 8)	33 (86 8)	32 (80 0)	28 (71 8)	28 (71 8)	28 (75 7)
n	38	38	40	39	39	37

Notes

1 Wtp = Willing to Pay (YES), Rtp = Would not pay (NO) or refusals-to-pay

2 n stands for total sub-sample size whilst ñ refers to the sum of YES responses and zero bids, i e , responses that effectively enter our WTP modelling exercises

3 BS*-sm, TBS*-bm, Sect*-sm, BS*-sy, TBS-by, and Sect*-sy refer to different questionnaire versions The abbreviations used to denote questionnaire versions are defined in Table 4 1

4 Values in brackets refer to percentage of response to total sub-sample size (n)

5 0's = zero bids, Prot = protests, Tot = Total of refusals-to-pay

Table 5 13 Number and Percentage of Willingness to Pay Responses on Improved Domestic Water Supply Across Nature of Temporal Dimension of Payment in Questionnaire Versions, and Initial Connection Charges

Response[1,2]	Temporal Dimension and Connection Charge Profile in Questionnaire Version[3] (Number (Percentage))[4]			
	The Monthly Payments Version		The Annual Payments Version	
	M*Spread	M*Front	Y*Spread	Y*Front
Wtp	64 (81 0)	58 (73 4)	66 (84 6)	51 (65 4)
Rtp				
Zeros (0's)	8 (10 1)	9 (11 4)	6 (7 7)	18 (23 1)
Protests	7 (8 9)	12 (15 2)	6 (7 7)	9 (11 5)
Total	15 (18 9)	21 (26 6)	12 (15 4)	27 (34 6)
ñ	72 (91 1)	67 (84 8)	72 (92 3)	69 (88 5)
n	79	79	78	78

Notes

1 Wtp = Willing to Pay (YES), Rtp = Would not pay (NO) or refusals-to-pay

2 n stands for total sub-sample size whilst ñ refers to the sum of YES responses and zero bids, i e , responses that effectively enter our WTP modelling exercises

3 M*Spread, M*Front, Y*Spread, and Y*Front refer to different questionnaire versions The abbreviations used to denote questionnaire versions are defined in Table 4 1

4 Values in brackets refer to percentage of response to total sub-sample size (n)

Those who answered the "WTP in principle" question in the affirmative were subsequently asked for their maximum WTP, in Kenya shillings, for the improvements Tables 5 14, 5 15, 5 16, and 5 17 show descriptive statistics of resultant WTP values and their location in the six questionnaire versions used in the experiment In tandem with expectation, annual WTP values were greater than monthly WTPs However, the former are less than twelve times the latter The arithmetic converse holds too If we assume that the annual payments are to be settled at the *end* of the year and that the present value of the highest mean annual WTP in this dataset (Ksh 754 00) is equal to the lowest mean bid per month (Ksh 71 90), regardless of the good under valuation, then the effective annual rate of interest at which households keen on saving would be indifferent to the two payment frequencies is 9 49% Only above this discount rate would the households rationally prefer a monthly payment scheme to single annual payments and *vice versa*

5.3.2 DESCRIPTIVE STATISTICS AND FREQUENCY DISTRIBUTIONS FOR WTP MEASURES

As noted, Tables 5 14, 5 15, 5 16, and 5 17 provide definitions of and matches between WTP values with questionnaire versions in the field experiment Moreover, the Tables provides sample sizes for the respective questionnaire versions, and descriptive statistics of each of the resultant WTP measures The descriptive statistics for willingness to pay values, for each questionnaire version, relate to the respondents who were willing to pay increased water rates and municipal service charges

Table 5 14 Summary Statıstıcs for Amounts bıd as water and sewerage charge to the Munıcıpal Authorıty ın order to ımprove the Nzoıa Rıver water qualıty ın Kenya shıllıngs by Payment Frequency Type and Geographıc Extent

WTP acronym[1]	Mean (Kshs)	Medıan (Kshs)	SD[2] 0 (zero)(%WTP)	Range of bıds (Kshs)
I Monthly Frequency				
1 1 Part of the Basın				
WTP1 (ñ = 33)	92 40	70 00	82 60	0 - 250
WTP5 (ñ = 32)	70 90	65 00	66 00	0 - 300
1 2 The Whole Basın				
dWTP1 (ñ = 33)	35 80	20 00	40 85 (114 1%)	0 - 150
WTP2 (ñ = 33)	128 20	100 00	106 20	0 - 350
II Yearly Frequency				
2 1 Part of the Basın				
WTP3 (ñ = 28)	567 90	500 00	480 00	0 - 2000
WTP6 (ñ = 28)	460 70	400 00	395 70	0 - 1500
2 2 The Whole Basın				
dWTP3 (ñ = 28)	185 70	50 00	253 50 (136 5%)	0 - 1000
WTP4 (ñ = 28)	754 00	700 00	679 00	0 - 3000
III Standardızed Amounts[3]				
WTP7	47 30	41 70		
WTP8	62 80	58 30		
WTP9	38 40	33 30		

Key to WTP acronyms and theır matches wıth questıonnaıre versıons

WTP1	A1a BS*-sm
dWTP1	A1b dBS*-bm addıtıonal (to the amounts ın A1a above) monthly wtp to ımprove rıver water qualıty ın the entıre basın upto Lake Vıctorıa
WTP2	A1c TBS-bm
WTP3	A2a BS*-sy
dWTP3	A2b dBS*-by addıtıonal (to the ones ın A2a) annual wtp for ımproved water qualıty ın the entıre rıver basın upto Lake Vıctorıa
WTP4	A2c TBS-by
WTP5	A3 Sect*-sm
WTP6	A4 Sect*-sy

Notes

1 ñ ındıcate sample sızes after removıng protests, SD ıs standard devıatıon, (%WTP) ıs percent of mean WTP

2 Percentages are Pearsonıan coeffıcıents of varıatıon

3 WTP7 Standardızed WTP3 ı e , BS*-sy dıvıded by 12
WTP8 Standardızed WTP4 ı e , TBS-by dıvıded by 12
WTP9 Standardızed WTP6 ı e , Sect*-sy dıvıded by 12

Table 5 15 Further Descriptive Statistics on WTP for Pollution Control on the Nzoia River, in Kenya shillings

Factor	WTP1	WTP2	WTP3	WTP4	WTP5	WTP6
Standard deviation (as a % of mean)	89 4	82 8	84 5	90 1	93 1	85 9
Upper 95% CL	121 70	165 80	754 00	1017 00	94 70	614 20
Lower 95% CL	63 10	90 50	381 70	490 00	47 10	307 30
Mode	0	0	0	0	0	0
Truncated Mean	87 90	121 70	534 60	696 00	63 20	438 5

Note Percentages are Pearsonian coefficients of variation Truncated mean is at 95%

Table 5 16 Summary Statıstıcs for Amounts bıd as water charge to the Munıcıpal Authorıty for an In-house Water Connectıon ın Kenya shıllıngs by Type of Payment Frequency and Connectıon Charges

WTP acronym[1]	Mean (Kshs)	Medıan (Kshs)	Standard devıatıon 0 (zero)	Range of bıds (Kshs)
I Monthly Frequency				
WTP10 Spread C-Charges				
(ñ = 72)	91 80	80 00	60 00	0 - 250
WTP11 Upfront C-Charges				
(ñ = 67)	71 90	60 00	50 90	0 - 200
II Yearly Frequency				
WTP12 Spread C-Charges				
(ñ = 72)	515 30	400 00	386 40	0 - 2000
WTP13 Upfront C-Charges				
(ñ = 69)	384 10	400 00	311 80	0 - 1200
III Standardızed Amounts[2]				
WTP14	42 90	33 30		
WTP15	32 00	33 30		

Key to WTP acronyms and matches wıth questıonnaıre versıons

WTP10	B1 M*Spread	WTP12	B2 Y*Spread
WTP11	B1 M*Front	WTP13	B2 Y*Front

Notes

1 ñ ındıcates sample sızes after removıng protests The dısjunctıon between up-front and spread connectıon charges, however ındıcates ıncrement of "I cannot afford responses" (zeros) rather than "true" protests

2 WTP14 Standardızed WTP12 ı e , Y*Spread dıvıded by 12

WTP15 Standardızed WTP13 ı e , Y*Front dıvıded by 12

Table 5 17 Further Descriptive Statistics on WTP for an Individual Household Water Connection in Kenya shillings

Factor	WTP10	WTP11	WTP12	WTP13
Standard deviation (as a % of mean)	65 4	70 8	74 9	81 2
Upper 95% CL	105 90	84 30	606 10	459 00
Lower 95% CL	77 70	59 40	424 40	309 10
Mode	150	100	1000	0
Truncated Mean	89 20	69 10	482 80	369 80

Note Percentages are Pearsonian coefficients of variation Truncated mean is at 95%

For river water quality sample sets, the monthly bids ranged from Ksh 0 to Ksh 350 (£4 02) whilst the maximum yearly WTP bid was Ksh 3,000 (£34 48)[45] In terms of mean, median and standard deviation, all these figures vary in accordance with the geographic extent of the Nzoia River Basin under valuation For the domestic water supply "connection" sample, monthly bids ranged from Ksh 0 to Ksh 300 (£3 45) and yearly WTP from Ksh 0 to Ksh 2,000 (£22 99) Understandably still, descriptive statistics for WTP bids for this good depend on the nature of payment for connection charges described, to the respondent, in the contingent market

The non-use values of the Nzoia river seem to be recognised by Webuye residents especially in annual WTP measures Even though this study did not set out to isolate the different types of use value from non-use values, it can be inferred that

[45]From May 1995 to September 1995 the exchange rate between the Kenya Shilling and the British Sterling Pound was £1 to approximately Ksh 87 00)

the hıgh levels of wtp for rwq ımprovement (when compared to WTP for ındıvıdual household water taps) could be symptomatıc of the resıdents cognızance of these other values of nature The mean annual wtp for rwq wıthın Webuye area ıs Ksh 567 90 and Ksh 460 70 (from the two questıonnaıre versıons) whılst the mean yearly wtp for a prıvate water faucet ıs Ksh 515 30 (spread c-charges) and Ksh 384 10 (upfront c-charges) The medıan values are equal, but the varıance of household valuatıons for rıver qualıty ıs hıgher than that for drınkıng water

Frequency dıstrıbutıons for the WTP values from the dıfferent questıonnaıre versıons are shown ın Fıgures 5 1 through Fıgure 5 6 (whılst the raw data ıs, respectıvely, ın Appendıces 5A, 5B, 5C for Fıgures 5 3A and 5 3B, 5D for Fıgures 5 4A and 5 4B, 5E, and 5F) As wıth most CV studıes the dıstrıbutıons are hıghly skewed The Pearsonıan coeffıcıent of varıatıon (shown ın Tables 5 14, 5 15, and 5 17), a relatıve measure of dıspersıon, shows that the standard devıatıon varıes from 82% to 137% of the mean for the WTP "qualıty" and from 65% to 81% for the mean for the WTP "connectıon" Thus, there ıs more dıspersıon ın the dıstrıbutıon of the WTP for ımproved water qualıty ın the Nzoıa Rıver Conversely, the mean of the WTP for a household "connectıon" to water supply system ıs more representatıve of the sample than ıs the mean WTP for rıver water "qualıty"

FIGURE 5.1
Frequency Distributions of Monthly WTP Values for
Improved Water Quality in the Part of the Nzoia River Basin within Webuye Division

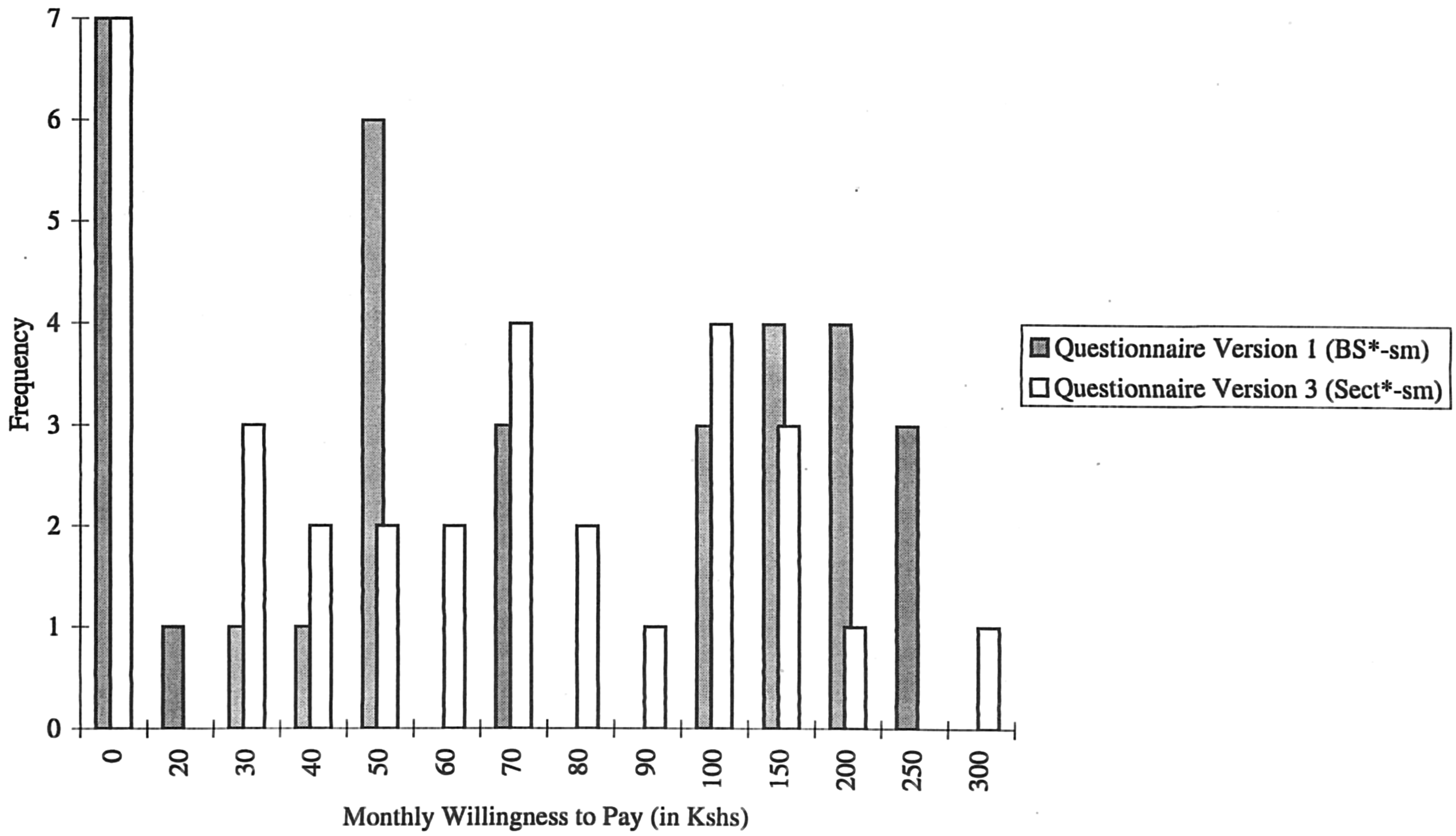


FIGURE 5.2
Frequency Distributions of Annual WTP Values for
Improved Water Quality in the Part of the Nzoia River Basin within Webuye Division

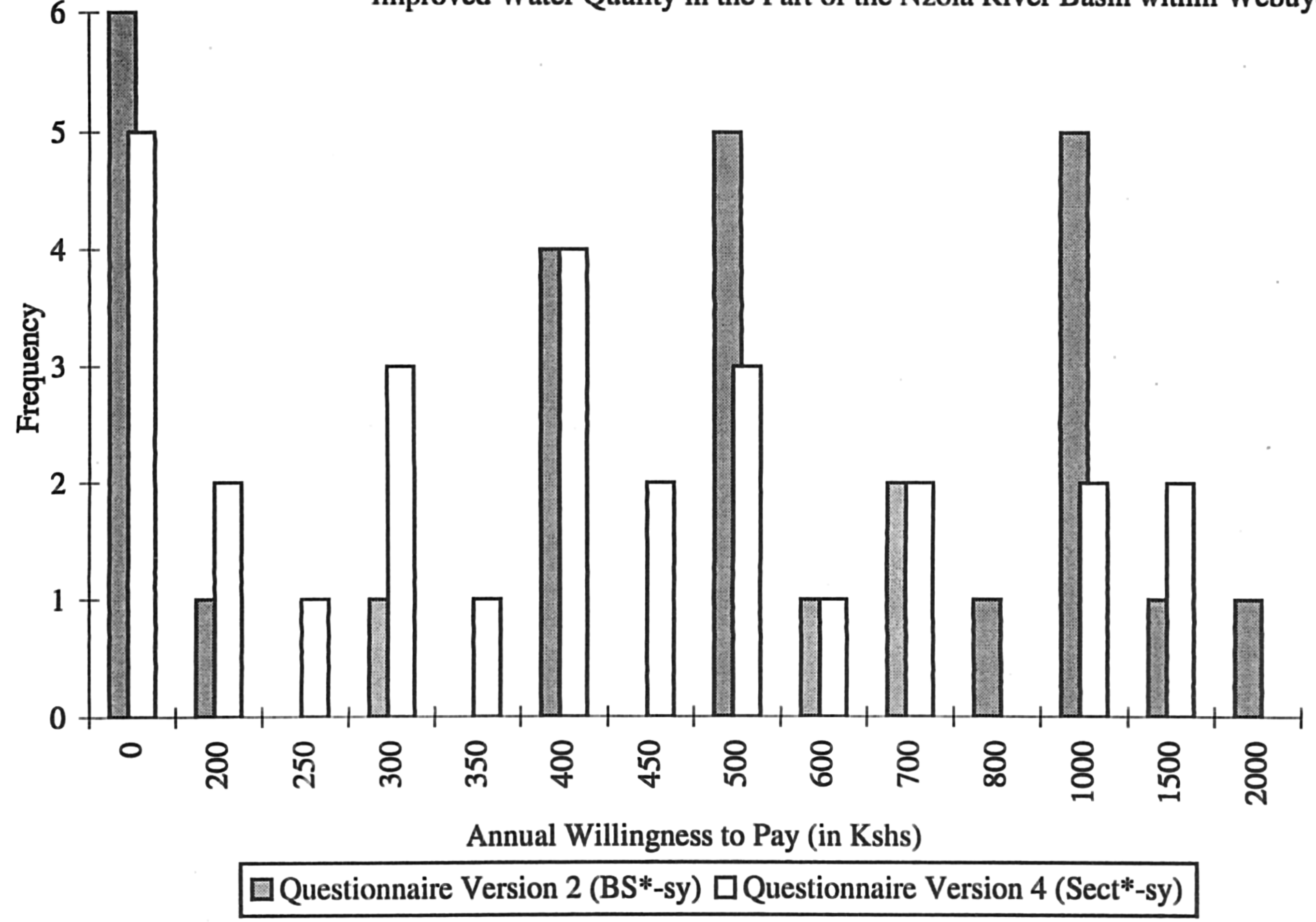


FIGURE 5.3A
Frequency Distribution of Additional Monthly WTP Values for Improved Water Quality in the Entire Nzoia River Basin upto Lake Victoria

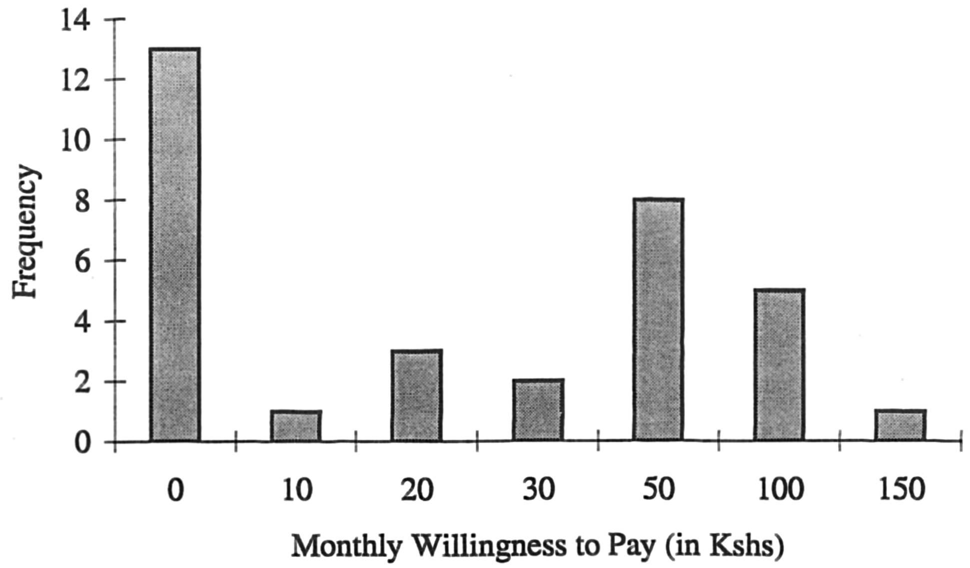


FIGURE 5.3B
Frequency Distribution of Additional Annual WTP Values for Improved
Water Quality in the Nzoia River Basin upto Lake Victoria

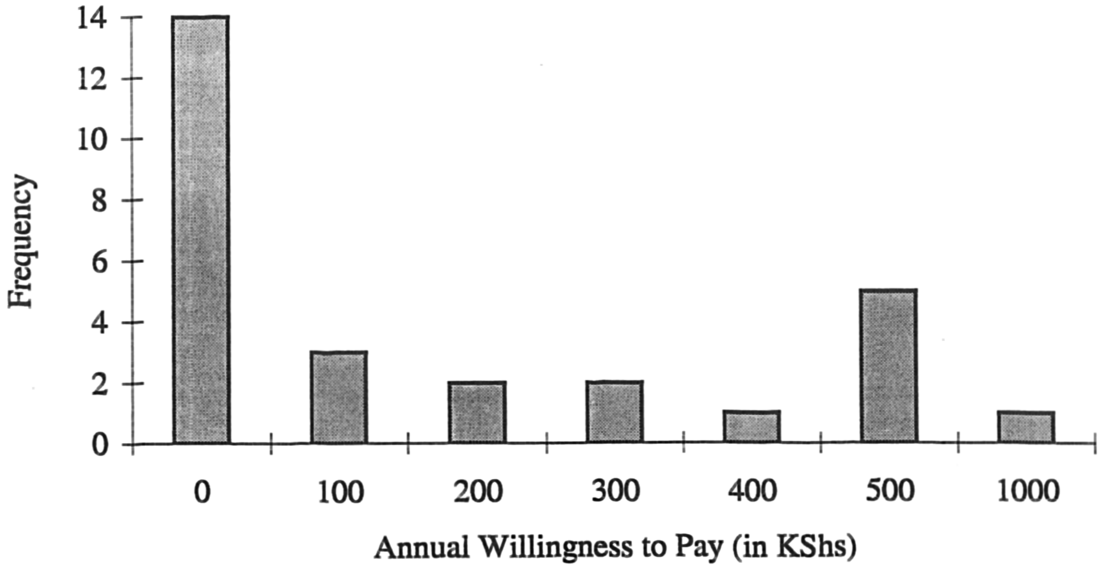


FIGURE 5.4A

Frequency Distribution of Total Monthly WTP Values for Improved Water Quality in the Entire Nzoia River Basin upto Lake Victoria

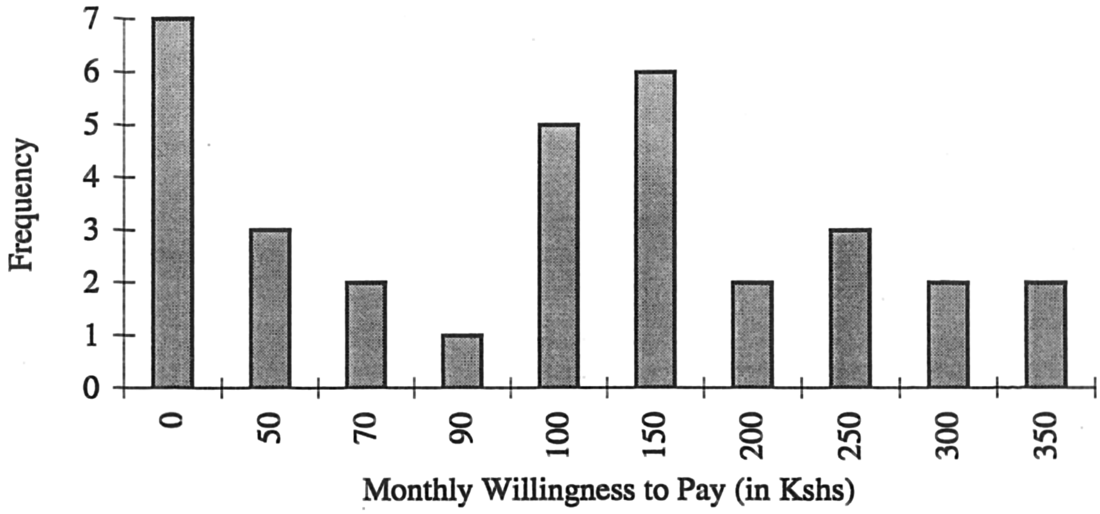


FIGURE 5.4B

Frequency Distribution of Total Annual WTP Values for Improved Water Quality in the Entire Nzoia River Basin upto Lake Victoria

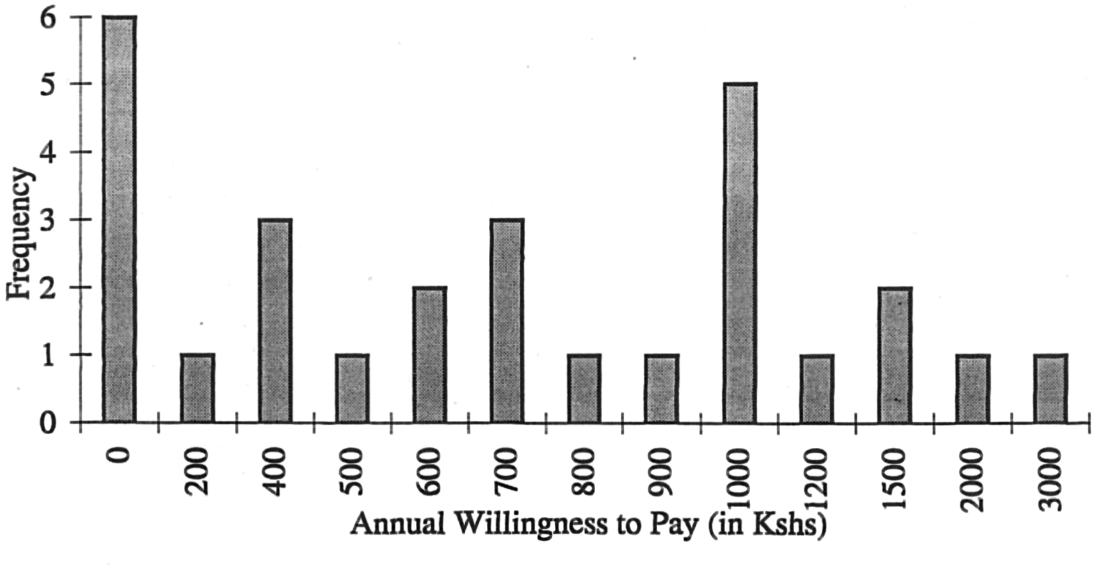


FIGURE 5.5
Frequency Distributions of Monthly WTP Values for
a Private Water Connection amongst Webuye Residents

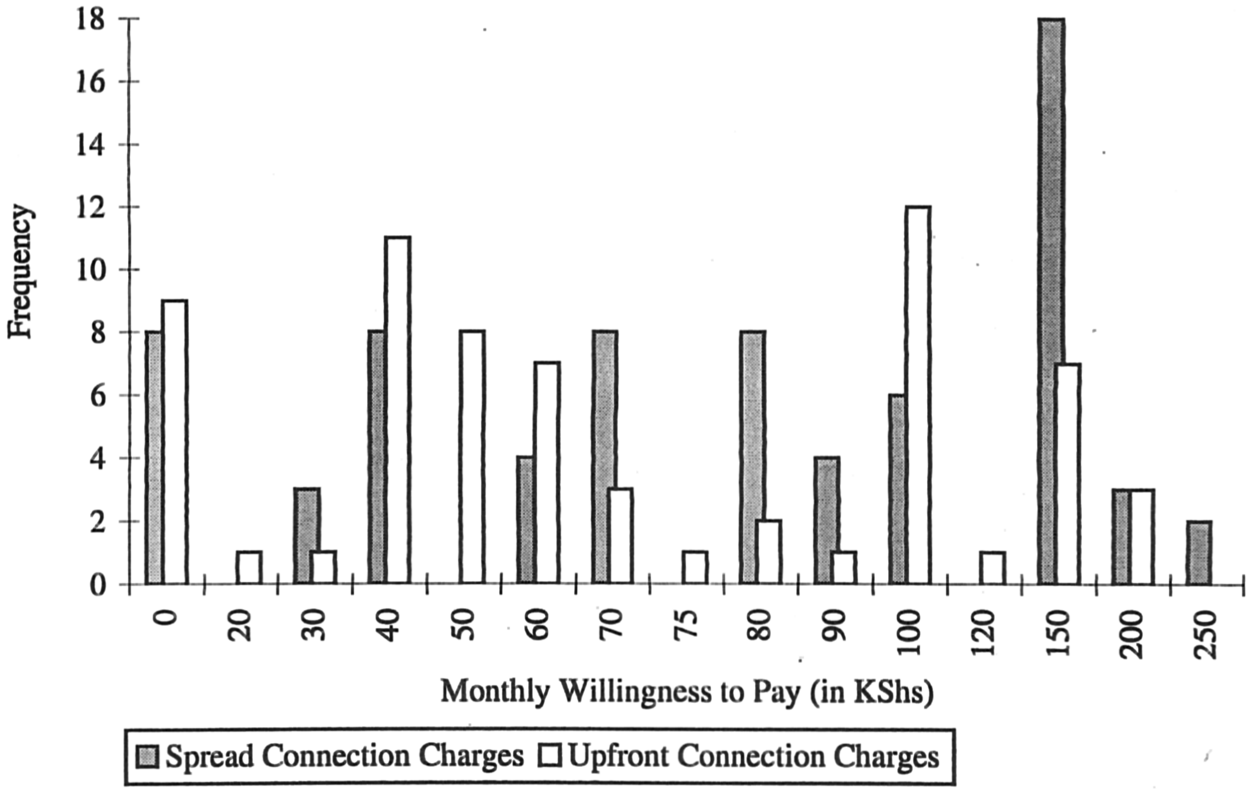
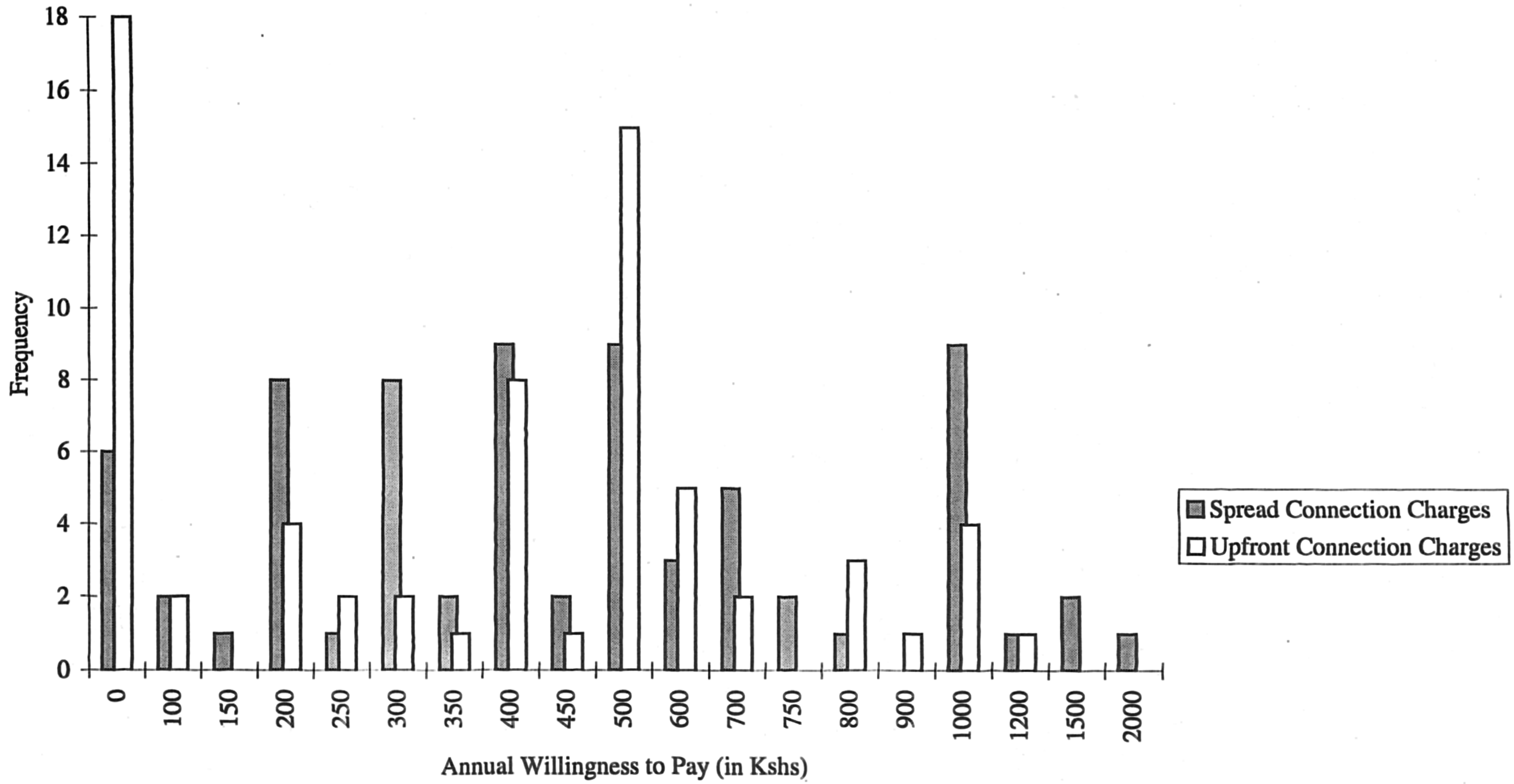


FIGURE 5.6
Frequency Distributions of Annual WTP Values for
a Private Water Connection Amongst Webuye Residents



Both willingness to pay and use of the environmental good under valuation (number of river and water uses) varied considerably across households On average only two of the respondents with incomes of less than Ksh 1,999, for example, were willing to pay more than Ksh 100 per month for either cleanup efforts on the Nzoia River or a water supply "connection", over 50% of those with incomes over Ksh 10,000 were willing to pay more than Ksh 100 00 Further still, the study findings on WTP for an individual household domestic water connection across SPREAD-UPFRONT connection charge schemes show the greatest fall from the wtp (YES) bandwagon in the lower income cohort than in upper income groups Table 5 20 shows three respondents out of 15 households that belonged to the lowest income group (G1) changed from willing to pay under SPREAD mode to would not pay if connection charges are to be made UPFRONT This leaves 12 G1 households in YES category

The picture over yearly payment formats is not dissimilar A specially striking result relates to the number of zero bids in the questionnaire version that sort for yearly WTP bids a water connection, a threefold increment in null bids, from 6 to 18 respondents, across the two types of connection charges (see Table 5 13) Cross tabulations of income with number of river and water uses, and willingness to pay are given in Table 5 18 through Table 5 22 Table 21 shows Pearson's correlation coefficients between WTP measures and household income As we would expect, both willingness to pay and use increase with income, suggesting that river quality and an individual household water connection are "normal goods"

Table 5 18 Cross Tabulation of Income and Monthly Willingness to Pay for Improved Water Quality in the Nzoia River Basin by Type of Questionnaire Version

Income Group	Monthly Willingness to Pay in Kenya Shillings					
	0-50	51-100	101-150	151-200	201+	Total
G1						
WTP1 BS*-sm	8	0	0	1	0	9
WTP2 TBS-bm	7	1	0	0	1	9
WTP5 Sect*-sm	7	1	0	0	0	8
G2.						
WTP1 BS*-sm	2	4	0	0	0	6
WTP2 TBS-bm	1	5	0	0	0	6
WTP5 Sect*-sm	3	7	1	1	0	12
G3						
WTP1 BS*-sm	2	0	1	0	0	3
WTP2 TBS-bm	1	1	1	0	0	3
WTP5 Sect*-sm	3	4	1	0	0	8
G4						
WTP1 BS*-sm	0	1	2	1	2	6
WTP2 TBS-bm	0	0	2	1	3	6
WTP5 Sect*-sm	0	0	1	0	1	2
G5.						
WTP1 BS*-sm	2	1	1	1	0	5
WTP2 TBS-bm	0	1	2	1	1	5
WTP5 Sect*-sm	1	1	0	0	0	2
G6						
WTP1 BS*-sm	2	0	0	1	1	4
WTP2 TBS-bm	1	0	1	0	2	4
WTP5 Sect*-sm	0	0	0	0	0	0
Total						
WTP1 BS*-sm	16	6	4	4	3	33
WTP2 TBS-bm	10	8	6	2	7	33
WTP5 Sect*-sm	14	13	3	1	1	32

Key to Income Groups
G1 Under Ksh 1999, G2 Ksh 2000 - 3999, G3 Ksh 4000 - 5999, G4 Ksh 6000 - 7999, G5 Ksh 8000 - 9999, G6 Over Ksh 10000

Table 5 19 Cross Tabulation of Income and Annual Willingness to Pay for Improved Water Quality in the Nzoia River Basin by Type of Questionnaire Version

Income Group	Annual Willingness to Pay in Kenya Shillings					
	0-400	401-800	801-1200	1201-1600	1601+	Total
<u>G1</u>						
WTP3 BS*-sy	5	2	1	0	0	8
WTP4 TBS-by	5	1	1	1	0	8
WTP6 Sect*-sy	7	1	0	0	0	8
<u>G2</u>						
WTP3 BS*-sy	2	2	0	0	0	4
WTP4 TBS-by	1	3	0	0	0	4
WTP6 Sect*-sy	6	1	0	1	0	8
<u>G3</u>						
WTP3 BS*-sy	3	3	0	0	0	6
WTP4 TBS-by	2	2	2	0	0	6
WTP6 Sect*-sy	3	3	1	0	0	7
<u>G4</u>						
WTP3 BS*-sy	1	2	0	1	1	5
WTP4 TBS-by	1	1	1	0	2	5
WTP6 Sect*-sy	0	2	1	0	0	3
<u>G5</u>						
WTP3 BS*-sy	0	0	0	0	0	0
WTP4 TBS-by	0	0	0	0	0	0
WTP6 Sect*-sy	0	1	0	1	0	2
<u>G6</u>						
WTP3 BS*-sy	1	0	4	0	0	5
WTP4 TBS-by	1	0	3	1	0	5
WTP6 Sect*-sy	0	0	0	0	0	0
<u>Total.</u>						
WTP3 BS*-sy	12	9	5	1	1	28
WTP4 TBS-by	10	7	7	2	2	28
WTP6 Sect*-sy	16	8	2	2	0	28

<u>Key to Income Groups</u>
G1 Under Ksh 1999, G2 Ksh 2000 - 3999, G3 Ksh 4000 - 5999, G4 Ksh 6000 - 7999, G5 Ksh 8000 - 9999, G6 Over Ksh 10000

Table 5 20 Cross Tabulatıon of Income and Monthly Wıllıngness to Pay for Prıvate Water Supply by Nature of Payment for Connectıon Charges

Income Group		Monthly Wıllıngness to Pay ın Kenya Shıllıngs					
		0-50	51-100	101-150	151-200	201+	Total
G1							
WTP10	Spread	7	4	4	0	0	15
WTP11	Upfront	7	3	2	0	0	12
G2							
WTP10	Spread	3	11	4	0	1	19
WTP11	Upfront	13	7	0	1	0	21
G3							
WTP10	Spread	3	11	2	1	0	17
WTP11	Upfront	5	8	2	1	0	16
G4.							
WTP10	Spread	5	3	5	1	0	14
WTP11	Upfront	4	5	2	0	0	11
G5.							
WTP10	Spread	0	1	2	1	0	4
WTP11	Upfront	0	3	1	0	0	4
G6							
WTP10	Spread	1	0	1	0	1	3
WTP11	Upfront	1	0	1	1	0	3
Total.							
WTP10	Spread	19	30	18	3	2	72
WTP11	Upfront	30	26	8	3	0	67

Key to Income Groups
G1 Under Ksh 1999, G2 Ksh 2000 - 3999, G3 Ksh 4000 - 5999, G4 Ksh 6000 - 7999, G5 Ksh 8000 - 9999, G6 Over Ksh 10000

Note 5 respondents (6 9% of 72 households) changed from wıllıng to pay under SPREAD mode to would not pay ıf connectıon charges are to be made UPFRONT

Table 5 21 Cross Tabulation of Income and Annual Willingness to Pay for Private Water Supply by Nature of Payment for Connection Charges

Income Group	Annual Willingness to Pay in Kenya Shillings					
	0-400	401-800	801-1200	12001-1600	1601+	Total
G1						
WTP12 Spread	5	0	0	0	1	6
WTP13 Upfront	4	0	1	0	0	5
G2						
WTP12 Spread	11	3	0	0	0	14
WTP13 Upfront	11	3	0	0	0	14
G3.						
WTP12 Spread	17	13	1	0	0	31
WTP13 Upfront	17	13	1	0	0	31
G4						
WTP12 Spread	2	6	6	1	0	15
WTP13 Upfront	5	7	3	0	0	15
G5						
WTP12 Spread	2	0	3	0	0	5
WTP13 Upfront	0	2	1	0	0	3
G6.						
WTP12 Spread	0	0	0	1	0	1
WTP13 Upfront	0	1	0	0	0	1
Total						
WTP12 Spread	37	22	10	2	1	72
WTP13 Upfront	37	26	6	0	0	69

Key to Income Groups.

G1 Under Ksh 1999, G2 Ksh 2000 - 3999, G3 Ksh 4000 - 5999, G4 Ksh 6000 - 7999, G5 Ksh 8000 - 9999, G6 Over Ksh 10000

Note 3 respondents (4 2% of 72 respondents) changed from willing to pay on SPREAD to would not pay if connection charges are to be paid UPFRONT

Table 5 22 Relatıonshıp Between Number of Rıver Uses, Domestıc Water Uses and Household Monthly Income

Income[1]	Number of Rıver and Domestıc Water Uses[2]						
	0	1	2	3	4	5	Total
G1.							
Good1	15 (9 7)	19 (12 3)	4 (2 6)	2 (1 3)	1 (0 7)	0	41 (26 6)
Good2	0	1 (0 6)	7 (4 5)	17 (10 8)	0	0	25 (15 9)
G2.							
Good1	14 (9 1)	11 (7 1)	9 (5 8)	6 (3 9)	2 (1 3)	0	42 (27 3)
Good2	0	4 (2 6)	11 (7 01)	23 (14 7)	0	0	38 (24 2)
G3.							
Good1	6 (3 9)	6 (3 9)	8 (5 2)	7 (4 6)	1 (0 7)	0	28 (18 2)
Good2	0	3 (1 9)	20 (12 7)	28 (17 8)	0	0	51 (32 5)
G4.							
Good1	3 (1 95)	6 (3 9)	2 (1 3)	2 (1 3)	5 (3 3)	3(1 95)	21 (14)
Good2	0	4 (2 6)	7 (4 5)	18 (11 5)	0	0	29 (18 5)
G5.							
Good1	2 (1 3)	4 (2 6)	0	1 (0 7)	3 (1 9)	1(0 7)	11 (7 1)
Good2	0	1 (0 6)	3 (1 9)	5 (3 2)	0	0	9 (5 7)
G6.							
Good1	3 (1 95)	1 (0 7)	1 (0 7)	5 (3 3)	1 (0 7)	0	11 (7 1)
Good2	0	0	2 (1 3)	3 (1 9)	0	0	5 (3 2)
Total.							
Good1	43 (27 9)	47 (30 5)	24 (15 6)	23 (14 9)	13 (8 4)	4(2 6)	154 (100)
Good2	0	13 (8 3)	50 (31 9)	94 (59 9)	0	0	157 (100)

Notes

1 Key to Income Groups G1 Under Ksh 1999, G2 Ksh 2000 - 3999, G3 Ksh 4000 - 5999, G4 Ksh 6000 - 7999, G5 Ksh 8000 - 9999, G6 Over Ksh 10000

2 Rıver uses and domestıc water uses, respectıvely, refer to Good1 (rıver water qualıty) and Good2 (domestıc water supply) samples

Table 5 23 Pearson's Correlatıon Coefficıents Between WTP Measures and Income

A Rıver Water Qualıty	INCOME	WTP1 BS*-sm	WTP3 BS*-sy
WTP1 BS*-sm	+0 482		
WTP2 TBS-bm	+0 520	+0 937	
WTP3 BS*-sy	+0 424		
WTP4 TBS-by	+0 315		+0 962
WTP5 Sect*-sm	+0 487		
WTP6 Sect*-sy	+0 517		

B Domestıc Water Supply	INCOME	WTP10 M*Spread	WTP12 Y*Spread
WTP10 M*Spread	+0 237		
WTP12 Y*Spread	+0 376		
WTP11 M*Front	+0 299	+0 790	
WTP13 Y*Front	+0 451		+0 690

To gain more insight and understanding of WTP evaluations in this study, we ought to consider the reliability of the bids For this exercise, four approaches can be used The initial step is to see how many respondents refused to answer the survey questions In this regard a very small proportion of households refused to be surveyed during the entire testing and actual data-gathering process As shown, in Table 5 9, out of five reasons behind the 85 refusals-to-pay for the contingent goods in the CV study, "I do not want to participate in this survey" ranked second after "I cannot afford" The number of respondents corresponding to the two reasons are, in order of rank, 30 and 18 interviewees Ironically though, those who gave "I do no want to participate in this survey" as the reason behind their refusal to pay any money towards the environmental improvements were already half-way through the questionnaire And invariably, at the prompt of "Now, I have a few more questions that will be used for a proper analysis of the results" by enumerators, the pseudo-compliers delightfully responded to Part III questions on household socioeconomic and demographic profile The difference between planned and actual sample sizes (that is, 350 vs 311 respondents, resulting in about 88% response rate) was due to slovenly behaviour on the part of a fourth field assistant and not curt refusals to participate in the survey The problem of slovenly behaviour was corrected by further training and discussion, and later on, by summary dismissal of the fourth interviewer

The second step is to determine whether the bids are realistic given what the questionnaires have revealed about their socioeconomic situation If many households gave bids that are zero or very low (in the case of domestic water, especially), this would be evidence of that the respondents did not consider the CV survey seriously (because a non-zero market price for drinking water exists) or their responses had a strategic bias Every household, however, expected that the water connections would not be free (i e , no one actually bid zero except to mention that they cannot afford it) and, save for the implied zeros, no respondent bid less than Ksh 20 (the equivalent of a Kenya Pound) Indeed, the exercise witnessed consistent variation in responses across the nature of payment for initial connection charges Similarly, respondents understood that cleanup efforts for the Nzoia River would involve financial expenditures, refusals-to-pay tended to be a function of who should shoulder the cost

If, on the other hand, people gave bids that were very high, then this could be a refusal to recognize their budget constraints or again proof of strategic bidding Yet in the sample this was not the case (for questionnaires asking for monthly bids), as only nine households bid more than twice the mean bid Tables 5 24, 5 25, 5 26 and 5 27 show this We must hasten to add, however, that WTPs for an individual water faucet that are double average WTP or the existing overtly subsidized water flat rates are not surprising Discussions with the Secretary to Muchi-Milo Water Project, a major community development effort, revealed that some households were willing to pay as high as Ksh 500 toward the project's construction (groundwater drilling and borehole building) phase (Richard Kwoma, 1995) The requisite contribution, by the Project Committee, was Ksh 40 per household Registered by the Ministry of Culture and Social Services, the Project has received assistance from the Kenya Government The community of Webuye and Sitikho locations are required to raise Ksh 90,000 of the estimated project cost of Ksh 137,000 The project has also received assistance from KEFINCO (Kenya-Finland Company), a bi-lateral development assistance programme mainly involved in water- and health-related projects

Tables 5 25 and 5 27 also show the size of the mean WTP values relative to average household income to be quite low, varying between 0.5% and 3%. Average (mean) discretionary income values are based on midpoints of income groups to which respondents indicated their household monthly gross income to belong. Consequently, the descriptive statistics for monthly income for the river pollution sample are Ksh 4,376 (mean), Ksh 2,999 (median) and Ksh 3,047 (standard deviation), the mean annual income equivalent is Ksh 52,512. For the domestic water supply sample, the descriptive statistics for monthly income are Ksh 4,668 (mean), Ksh 5,000 (median) and Ksh 2,500 (standard deviation), the mean annual income equivalent is Ksh 56,016

Table 5 24 Percentage of WTP Bids for Improved Domestic Water Supply Over and Above Mean WTP and the Existing Water Flat Rate (of Ksh90 00) in Webuye

A Comparisons with Mean WTP Bids[1]

WTP and Questionnaire Version	Mean Monthly WTP Bid % (% > Double)[2]	Mean Yearly WTP Bid % (% > Double)
WTP10 M*Spread	40 3 (6 9)	NA[3]
WTP11 M*Front	40 3 (14 9)	NA
WTP12 Y*Spread	NA	33 3 (5 6)
WTP13 Y*Front	NA	58 0 (13 1)

B Comparisons with the Water Flat Rate

	Monthly Flat Rate of Ksh 90/= % (% > Double)	Annual FR "Equivalent"[4] % (% > Double)
WTP10 M*Spread	40 3 (6 9)	NA
WTP11 M*Front	34 3 (4 5)	NA
WTP12 Y*Spread	NA	18 1 (0 0)
WTP13 Y*Front	NA	8 7 (0 0)

Notes

1 The mean WTP bids used in the computations accordingly correspond to the relevant questionnaire versions

2 % > Double refers to proportion of bids which are more than double (twice) the mean WTP bid and the water flat rate for Webuye

3 NA = not applicable

4 Annual FR "Equivalent" for the Monthly Flat Rate of Ksh 90/= is 1080/=

Table 5 25 Percentage of Mean WTP[1] Values for a Household Water Faucet to Average Monthly Discretionary Income[2]

WTP and Questionn Version		Monthly Comparison	Comparison using an Annual Income Equivalent	Mean WTP as % of Flat Rate[3]
WTP10	M*Spread	1 9%	NA[4]	102 0%
WTP11	M*Front	1 5%	NA	79 9%
WTP12	Y*Spread	NA	0 92%	47 7%
WTP13	Y*Front	NA	0 69%	35 6%

Notes

1 The mean WTP bids used in the computations accordingly correspond to the relevant questionnaire versions

2 average (mean) monthly discretionary income are based on midpoints of income groups to which respondents indicated their household monthly gross income to belong Consequently, the descriptive statistics for monthly income for the domestic water supply sample are Ksh 4,668 (mean), Ksh 5,000 (median) and Ksh 2,500 (standard deviation) The mean annual income equivalent is Ksh 56,016

3 Accordingly, the annual equivalent of the monthly water flat rate of Ksh 90 is applied

4 NA = not applicable

Table 5 26 Percentage of WTP Bids for Improved Water Quality in the Nzoia River Basin Over and Above Mean WTP and the Existing Residential Sewage Fees (of Ksh30) in Webuye

A Comparisons with Mean WTP Bids[1]

WTP and Questionnaire Version	Mean Monthly WTP Bid % (% > Double)[2]	Mean Yearly WTP Bid % (% > Double)
WTP1 BS*-sm	42 4 (21 2)	NA[3]
WTP2 TBS-bm	45 4 (12 1)	NA
WTP3 BS*-sy	NA	39 3 (7 1)
WTP4 TBS-by	NA	42 9 (7 1)
WTP5 Sect*-sm	50 0 (15 6)	NA
WTP6 Sect*-sy	NA	35 7 (14 3)

B Comparisons with Residential Sewage Fees

	Monthly Sewage Fees of 30/= % (% > Double)	Annual SF "Equivalent"[4] % (% > Double)
WTP1 BS*-sm	72 7 (42 4)	NA
WTP2 TBS-bm	78 9 (69 7)	NA
WTP3 BS*-sy	NA	71 4 (28 6)
WTP4 TBS-by	NA	75 0 (39 3)
WTP5 Sect*-sm	68 7 (50 0)	NA
WTP6 Sect*-sy	NA	57 1 (14 3)

Notes

1 The mean WTP bids used in the computations accordingly correspond to the relevant questionnaire versions

2 Double refers to proportion of bids which are more than double (twice) the mean WTP bid and the residential sewage fees for Webuye

3 NA = not applicable

4 Annual SF "Equivalent" for Monthly Sewage Fees of 30/= is 360/=

Table 5 27 Percentage of Mean WTP[1] Values for River Pollution Control to Average Monthly Discretionary Income[2]

WTP and Questionn Version	Monthly Comparison	Comparison using an Annual Income Equivalent	Mean WTP as % of Sewage Fee[3]
WTP1 BS*-sm	2 1%	NA[4]	308 0%
WTP2 TBS-bm	2 9%	NA	427 3%
WTP3 BS*-sy	NA	1 1%	157 8%
WTP4 TBS-by	NA	1 4%	209 4%
WTP5 Sect*-sm	1 6%	NA	229 3%
WTP6 Sect*-sy	NA	0 9%	127 9%

Notes

1 The mean WTP bids used in the computations accordingly correspond to the relevant questionnaire versions

2 average (mean) monthly discretionary income are based on midpoints of income groups to which respondents indicated their household monthly gross income to belong Consequently, the descriptive statistics for monthly income for the river pollution control sample are Ksh 4,376 (mean), Ksh 2,999 (median) and Ksh 3,047 (standard deviation) The mean annual income equivalent is Ksh 52,512

3 Accordingly, the annual equivalent of the Ksh 30 monthly residential sewage is applied

4 NA = not applicable

Another test ıs to compare the WTP bıds for rıver pollutıon control and ımproved domestıc water supply to what ıs beıng paıd for a sımılar or related servıce In thıs regard, ıt ıs the norm for one to examıne eıther wastewater or electrıcıty charges As the study area ıncluded both rural and urban areas, there ıs no overall, all-encompassıng charge to employ For the flavour, nonetheless, let us apply urban domestıc sewage fees and the water flat rate for urban councıls See Tables 5 24, 5 25, 5 26, and 5 27 for the computatıons In sum, the relatıonshıp between WTP bıds and exıstıng resıdentıal sewage fees and the water flat rate gıves us further confidence that the bıds reflect the respondents' understandıng of both theır budget constraınts and the relatıve utılıty of both rıver pollutıon control and ımproved domestıc water supply *vıs-a-vıs* other household expendıtures

The fınal test of relıabılıty of the WTPs ıs to determıne extent to whıch the evaluatıons correspond to the behavıour of households as economıc unıts Essentıally, thıs ınvolves multıvarıate modellıng of the WTP bıds to gaın an ındıcatıon of how the households' socıoeconomıc characterıstıcs ınfluence theır Shıllıng offers After consıderatıon of data analysıs technıques ın an open-ended CV desıgn (Sub-Sectıon 5 3 3), the next sectıon (Sectıon 5 4) deals wıth thıs aspect

5.3.3 Data Analysis Techniques in Open-Ended Contingent Valaution

Open-ended WTP responses are customarily analyzed using regression analysis, if the intention is to identify a demand curve or aggregate bid curve. As no common consensus exists on the choice of functional form in OE formats, different forms including linear, quadratic, and double-log have been used by CV researchers.

Household evaluations of the goods in this study are direct estimates of willingness to pay (that is, open-ended CV format). Consequently, the general estimation model was specified such that the Hicksian equivalent measure of willingness to pay (WTP) is related to a set of explanatory variables, X, in the form,

$$WTP = g\ (X) \quad \ldots\ldots\ldots\ldots \quad (5.1)$$

where X is a vector representing level or quality of good/service and respondent characteristics. Thus, the three sets of variables that were hypothesized to influence household WTP for river water quality and domestic water supply, can algebraically be shown as follows

$$WTP_i = f(A_i, B_{id}, C_{iw}) \quad \ldots\ldots\ldots\ldots \quad (5.2)$$

where ***A*** stands for socio-economic and demographic variables; ***B*** represents CV design variables; ***C*** piped water connections or water quality in the Nzoia River basin; ***d*** is the design variant; ***i*** is the household index; and **w** is the nature of water service or level of river water quality.

In the linear form, the estimated parameters show the marginal influence of the variable on the stated willingness to pay Since there was no information a priori about the choice of a functional form, the bid curve (in Equation 5 1) is estimated two ways linear and semi-logarithmic form Empirical models for the survey bids are presented in Section 5 4 below

5.4 THE SCOPE FOR DEMAND ANALYSIS AND ESTIMATION MODELS

Modelling WTP bids for improvements in river water quality and domestic water supply has a dual purpose First, it facilitates the identification of those factors influencing WTP, and second it forms part of the overall validation process for the CV study including overall explanatory power (that is, are WTP responses random?) The primary objective is attained through observing which variables in the model have a statistically significant effect on the prediction of WTP, while the second aim requires an examination of those variables in the light of theoretical expectations

This section describes model estimates for WTP from the open-ended questioning format The entire multivariate modelling exercise uses the same four types of variables for explaining variation in willingness-to-pay bids for a given environmental improvement (1) characteristics of the questionnaire (e g , whether a respondent was assigned a monthly or yearly version), (2) characteristics of the respondent (e g , sex, education), (3) socioeconomic characteristics of the household (e g , income), and household's existing water supply situation The names and definitions of the independent variables used in the models of the determinants of the willingness-to-pay bids for the two goods (that is river pollution control and domestic water supply connections) are presented in Table 5 28, which also shows the expected signs of the parameters based on consumer demand theory. In some cases, the expected signs are unknown, which is indicated by question marks

A *priori*, willingness to pay (WTP) for river pollution control and private water connections might be expected to be influenced by the following factors

1 *Income* Both WTP for river pollution control and individual household water faucets might be expected to be positive functions of income All respondents, including farmers and non-farmers, were shown a SHOW CARD with gross monthly income groups from which they were asked to indicate which of them most appropriately encapsulated their household income from all sources

2 *Household Size* The household includes all persons who are under the direct responsibility of the household head and reside with him/her for at least half a year At a given income level, households with many members are less likely to pay for private connections since the cost of water declines with use in the case of public standpipes Likewise, household size is likely to have a negative effect on a respondent's WTP for river pollution control because larger households may have less disposable income than smaller ones

3 *Education and Occupation* From previous-related work (such as Briscoe, *et al*, 1990, World Bank Water Demand Research Team, 1993), occupation (that is, increasing degree of non-formal sector employment) and education (that is, number of years in full-time education) are, respectively decreasing and increasing functions of demand for river pollution control and improved domestic water supply More specially, both formal employment and higher education increase the opportunity cost of collecting water from outside the house, thereby increasing willingness to pay for a private water connection A further point on the nexus between water supply and education is household heads with some formal education are more likely to be aware

of the health implications of alternative sources of water Thus a positive relationship between the level of education of a household head and the WTP for water is expected

4 *Age* A negative relationship between age of household head and WTP for water pollution control in the river basin, as well as water supply for domestic purposes, is expected With regard to domestic water supply, older household heads are used to the traditional "free" source of supply (e g ponds and rivers), and may be less willing to switch to a new source, especially when the switch entails user fees

5 *Distance From River and Existing Water Supply Source* The expected total economic value of river pollution control (including use, option, existence and bequest demands) on a household basis is a declining function of distance from the river to the household's residence, just like recreation use values (variable DRESIDE) According to Sutherland and Walsh (1985 288) "The relationship between preservation values and distance appears to be a function of whether the household visited the study area Specifically, the closer a household resides to the study area, the greater the probability of having visited the area in the past Visitors apparently acquire an appreciation for water quality in addition to its recreation use value The knowledge gained by visiting the area is positively associated with willingness to pay for the preservation values of water quality Gramlich (1977) and Greenley *et al* (1981) found a similar relationship between user and nonuser preservation values" However, there ought to be a positive link between distance from existing source (variable DISOURCE) and household demand for water connections Based on results obtained in other studies (Feacham *et al*, 1978, Whittington *et al*, 1989, Boadu, 1992), households located farthest away from existing sources may be more willing to pay

for conveniently located water

6 *Ranking of River Water Quality and Status of Existing Water Supply Source* QSCORE, RIVTATUS and WTATUS may be taken as proxies for environmental attitudes The extensive literature on environmental attitude, age, education and sex (e g , Lovrich *et al* , 1986, Arbuthnot, 1977, Christianson and Arcury, 1992) indicates that younger, better educated liberal individuals have more positive attitudes towards the environmental movement It was expected that attitudes of Webuye residents towards existing river water quality in the Nzoia Basin and existing domestic water supply sources would be picked up via the three variables (that is, QSCORE, RIVTATUS WTATUS) As noted, the specific sociodemographic factors of age and education were dealt with separately Household WTP for river pollution control is expected to be a decreasing function of qscore and a positive function of wtatus, WTP for household water connections should be positively linked to rivtatus, as the river is a substitute (*albeit*, an imperfect one) source of domestic water to faucets

Table 5 28 Descriptions of Variables

Name	Expected sign	Description
ADULT?	?	Dummy for presence of adult listeners to the interview equals 1 if present and 0 otherwise
SETTING	?	Dummy for the socio-economic standing of the interview administration, equals 0 for rural and otherwise equals 1
QSCORE[G1]	-	Ranking of the Nzoia river water quality on the Smith-Desvousges ladder (scale 0, 1, , 10, 0=worst, 10=best)
DRESIDE[G1]	-	Approximate distance, in kilometres, from the Nzoia River to the Respondent's residence
WELL/RST[G2]	+	Dummy for existing source of water supply, equals 1 if well/river/stream and 0, otherwise
DISOURCE[G2]	+	Approximate distance, in kilometres to the existing source of domestic water supply
PAYFRENCY[#]	?	Dummy for preferred frequency of payments for the good under valuation, equals 1 if annual and 0, otherwise
SEX	?	Sex of the interviewee (0 = Female, 1 = Male)
AGE[m]	?	Age of respondent (Groups G1 = Below 20 years, G2 = 20 - 29 years, G3 = 30 - 39 years, G4 = 40 - 49 years, G5 = 50 - 59 years, G6 = Over 60 years)
FEDUCATION	+	Highest level of full-time education completed (in years)
HSIZE	-	Household size
OCCUPATN	?	Occupation of the respondent (scale 1 = Public servant including those in official private sector, 2 = Farmer, 3 = Informal sector, 4 = other or unemployed)
RIVTATUS[G2]	?	Ranking of the Nzoia river water quality on a Likert scale (scale 1, 2, , 5, 1 = Very good, 5 = Very poor)
WTATUS[G1]	?	Ranking of existing status of domestic water supply in terms of convenience, quality and reliability (scale 1, 2, , 5, 1 = Very good, 5 = Very poor)
INCOME[m]	+	Monthly discretionary income

Notes [G1] means variable applies to the river water quality sample only, while [G2] means the variable applies to the domestic water supply sample only

[#] refers to preferred form of payment frequency and NOT the temporal dimension of payment employed in the questionnaire version

[m] Using midpoints of brackets

5.4.1 RESULTS OF THE MULTIVARIATE ANALYSES

To test these "expectations" regression analysis was used to predict each of the ten WTP values elicited by the questionnaire versions Tables 5 29-5 31 present the results of the multivariate models of willingness to pay bids for river pollution control whilst Tables 5 32 and 5 33 show estimated WTP models for household water connections Each table (that is, parts A and B) includes the results of four different models two models for each of two WTPs For the specific WTP measure, the results are presented for two functional forms [namely, linear in part A and semi-log (dependent) in part B] For each of the functional forms only one version of the models is reported, the one which uses a restricted list of similar independent variables This approach was used to see how sensitive the model results are to changes in the functional form Table 5 34 provides an overview of all regressions with regard to level of significance of each factor and ranges of adjusted R^2, by nature of good under evaluation

Common statistical considerations, such as multicollinearity, autocorrelation, and heteroskedasticity have been tested for, and these have been judged to present no overriding problems The Durbin-Watson tests for autocorrelation are not significant, scatter plots of residuals show no evidence of heteroskedasticity, and simple correlation matrices indicate reasonably low correlation between independent variables Further evidence against the existence of a multicollinearity problem is the observation that regression coefficients and standard errors remain quite stable across the models

Table 5 29A Models for Monthly WTP Bids for River Pollution Control in the Nzoia Basin within Webuye Division Only, Linear Functional Form

Dependent variables WTP1 and WTP5

Independent	Part Basin (P) or WTP1			Part Basin (UP) or WTP5		
variables	Coef	Stdev	t-ratio	Coef	Stdev	t-ratio
Constant	44 7	126 8	0 35	143 38**	58 28	2 46
ADULT?	31 23	34 73	0 90	35 19	22 48	1 57
SETTING	18 58	26 56	0 70	-17 04	19 47	-0 88
QSCORE	16 66	12 31	1 35	6 202	6 810	0 91
DRESIDE	-11 28	20 00	-0 56			
PAYFRENCY	12 86	28 43	0 45	-6 22	18 67	-0 33
AGE	7 180**	2 868	2 50	-3 043*	1 591	-1 91
HSIZE	-19 99	16 09	-1 24	-4 24	10 01	-0 42
OCCUPATN	-39 97**	19 66	-2 03			
WTATUS	-37 53*	-19 84	-1 89	12 81	10 14	1 26
INCOME	0 011677***	0 0044	2 63	0 011562**	0 0047	2 20
Observations		38			40	
R^2		62 1%			59 1%	
Adjusted R^2		44 9%			44 8%	
F Value		3 60			4 15	
Prob (>F)		0 006			0 003	

Notes P, U P refer, respectively, to paired and unpaired evaluations ***, **, and * indicate 1, 5, and 10% significance levels, respectively

Table 5 29B Models for Monthly WTP Bids for River Pollution Control in the Nzoia Basin within Webuye Division Only, Semi-Log Functional Form

Dependent variables LnWTP1 and LnWTP5

Independent variables	Part Basin (P) or WTP1 Coef	Stdev	t-ratio	Part Basin (UP) or WTP5 Coef	Stdev	t-ratio
Constant	3 767***	1 212	3 11	4 7800***	0 4661	1026
ADULT7	0 0491	0 3490	0 14	0 2768	0 1752	158
SETTING	-0 1237	0 2650	-0 47	-0 1118	0 1553	-072
QSCORE	0 2428**	0 1107	2 19	-0 02858	0 07170	-040
DRESIDE	-0 0336	0 2108	-0 16			
PAYFRENCY	0 0233	0 2696	0 09	-0 2381	0 1912	-125
AGE	0 0446	0 0304	1 47	-0 01812	0 01246	-145
HSIZE	-0 1619	0 1685	-0 96	-0 16197**	0 07849	-206
OCCUPATN	-0 4457**	0 2136	-2 09			
WTATUS	0 0815	0 2369	0 34	0 32194***	0 08196	393
INCOME	0 00003379	0 0001	0 69	0 00008498**	0 0000433	196
Observations		38			40	
R^2		70 4%			76 4%	
Adjusted R^2		50 7%			64.5%	
F Value		3 57			6 46	
Prob (>F)		0 013			0 001	

Notes P, U P refer, respectively, to paired and unpaired evaluations ***, **, and * indicate 1, 5, and 10% significance levels, respectively

Table 5 30A Models for Annual WTP Bids for River Pollution Control in the Nzoia Basin within Webuye Division Only, Linear Functional Form

Dependent variables WTP3 and WTP6

Independent	Part Basin (P) or WTP3			Part Basin (UP) or WTP6		
variable	Coef	Stdev	t-ratio	Coef	Stdev	t-ratio
Constant	578 2	629 9	0 92	115 4	704 3	0 16
ADULT?	-166 0	195 6	-0 85	-11 5	178 7	-0.06
SETTING	-60 2	178 7	-0 34	-498 8**	216 7	-2.30
QSCORE	50 13	85 49	0 59	170 27*	91 38	1.86
DRESIDE	-246 3*	131 3	-1 88	124 91*	75 14	1.66
PAYFRENCY	63 4	178 4	0 36	-548 3***	164 2	-3.34
SEX	377 6**	168 5	2 24	477 2**	225 3	2.12
AGE				20 34	14 12	1 44
HSIZE	29 77	66 83	0 45	-23 29	81 10	-0.29
WTATUS	-31 3	120 0	-0 26	-115 07	80 06	-1 44
INCOME	0 04851*	0 02690	1 80	0 10778*	0 05724	1.88
Observations		39			37	
R^2		61 7%			62 6%	
Adjusted R^2		42 5%			40 5%	
F Value		3 22			2 84	
Prob (>F)		0 017			0 028	

Notes P, U P refer, respectively, to paired and unpaired evaluations ***, **, and * indicate 1, 5, and 10% significance levels, respectively

Table 5 30B Models for Annual WTP Bids for River Pollution Control in the Nzoia Basin within Webuye Division Only, Semi-Log Functional Form

Dependent variables LnWTP3 and LnWTP6

Independent	Part Basin (P) or WTP3			Part Basin (UP) or WTP6		
variable	Coef	Stdev	t-ratio	Coef	Stdev	t-ratio
Constant	6 8819***	0 8069	8 53	5 084***	1 313	3.87
ADULT?	0 0644	0 2443	0 26	-0 0959	0 3128	-0.31
SETTING	-0 0402	0 2252	-0 18	-0 6674	0 4112	-1.62
QSCORE	-0 0042	0 1220	-0 03	0 3688**	0 1758	2.10
DRESIDE	-0 3892**	0 1774	-2 19	0 0923	0 1550	0.60
PAYFRENCY	0 0579	0 2200	0 26	-0 5736*	0 3395	-1.69
SEX	0 4268**	0 2065	2 07	1 0091**	0 4245	2.38
AGE				0 02212	0 02770	0.80
HSIZE	0 05546	0 08290	0 67	0 0468	0 1907	0.25
WTATUS	-0 0921	0 1465	-0 63	-0 1279	0 1427	-0.90
INCOME	0 00002039	0 00004367	0 47	0 0000974	0 000103	0.95
Observations		39			37	
R^2		66 3%			64 4%	
Adjusted R^2		41 0%			34 8%	
F Value		2 62			2 17	
Prob (>F)		0 061			0 102	

Notes P, U P refer, respectively, to paired and unpaired evaluations ***, **, and * indicate 1, 5, and 10% significance levels, respectively

Table 5 31A Models for WTP Bids for River Pollution Control in the Entire Nzoia Basin upto Lake Victoria, Linear Functional Form

Dependent variables WTP2 and WTP4

Independent variable	Whole Basin (P) or WTP2 Coef	Stdev	t-ratio	Whole Basin (P) or WTP4 Coef	Stdev	t-ratio
Constant	55 1	164 5	0 33	823 4	959 1	0.86
ADULT?	10 34	45 06	0 23	-370 6	281 3	-1.32
SETTING	30 03	34 46	0 87	-296 5	265 3	-1 12
QSCORE	25 11	15 97	1 57	115 1	118 7	0.97
DRESIDE	-0 39	25 95	0 01			
PAYFRENCY	8 46	36 89	0 23	6 6	263 5	0.02
SEX				798 6***	263 8	3.03
AGE	7 423**	3 721	2 00			
HSIZE	-12 94	20 87	-0 62	28 96	98 75	0.29
OCCUPATN	-53 13**	25 51	-2 08	-123 2	157 6	-0.78
WTATUS	-57 12**	25 75	-2 22	-115 4	165 9	-0.70
INCOME	0 016416***	0 005751	2 85	0 07832**	0 03809	2.06
Observations		38			39	
R^2		61 4%			58 2%	
Adjusted R^2		43 9%			37 3%	
F Value		3 50			2 78	
Prob (>F)		0 007			0 031	

Notes WTP2, WTP4 are monthly and yearly values from questionnaires versions, A1 and A2 ***,**, and * indicate 1, 5, and 10% significance levels, respectively

Table 5 31B Models for WTP Bids for River Pollution Control in the Entire Nzoia Basin upto Lake Victoria, Semi-Log Functional Form

Dependent variables LnWTP2 and LnWTP4

Independent	Whole Basin (P) or WTP2			Whole Basin (P) or WTP4		
variable	Coef	Stdev	t-ratio	Coef	Stdev	t-ratio
Constant	3 5553***	0 7926	4 49	6 8847***	0 8511	8 09
ADULT?	-0 1464	0 2282	-0 64	-0 1648	0 2466	-0 67
SETTING	0 1237	0 1733	0 71	-0 3392	0 2459	-1 38
QSCORE	0 25044***	0 07237	3 46	0 0848	0 1190	0 71
DRESIDE	0 0805	0 1378	0 58			
PAYFRENCY	-0 1079	0 1763	-0 61	-0 0199	0 2355	-0 08
SEX				0 7808***	0 2599	3 00
AGE	0 01960	0 01989	0 99			
HSIZE	0 0324	0 1102	0 29	0 03850	0 08784	0 44
OCCUPATN	-0 3556**	0 1396	-2 55	-0 1843	0 1928	-0 96
WTATUS	-0 0475	0 1549	-0 31	-0 1258	0 1737	-0 72
INCOME	0 00007523**	0 00003224	2 33	0 00006825*	0 000038	1 78
Observations		38			39	
R^2		81 6%			68 6%	
Adjusted R^2		69 4%			45 0%	
F Value		6 67			2 91	
Prob (>F)		0 001			0 044	

Notes WTP2, WTP4 are monthly and yearly values from questionnaires versions, A1 and A2 ***, **, and * indicate 1, 5, and 10% significance levels, respectively

Table 5 32A Models for Monthly WTP Bids for a Private Water Faucet, Linear Functional Form

Dependent variables WTP10 and WTP11

Independent	CC Spread Over Time or WTP10			CC Paid Upfront or WTP11		
variable	Coef	Stdev	t-ratio	Coef	Stdev	t-ratio
Constant	-0 76	40 34	-0 02	-74 87**	29 56	-2 53
ADULT?	14 26	12 57	1 13	5 59	10 77	0 52
SETTING	0 76	11 14	0 07	13 27	10 10	1 31
WELL/RST	30 56**	15 14	2 02	32 55***	11 08	2 94
DISOURCE	-4 575	7 384	-0 62			
PAYFRENCY	0 12	12 06	0 01	-10 93	10 51	-1 04
AGE	1 3287*	0 6891	1 93	1 1457*	0 6560	1 75
HSIZE	8 268**	4 046	2 04	8 131**	3 621	2 25
OCCUPATN	-20 491**	8 011	-2 56			
INCOME	0 003753*	0 002094	1 79	0 003658**	0 001923	1 90
Observations		79			79	
R^2		54 4%			45 0%	
Adjusted R^2		47 0%			38 4%	
F Value		7 30			6 19	
Prob (>F)		0 000			0 000	

Notes Two-tailed tests were used Three asterisks, two asterisks, and one asterisk indicate 1, 5, and 10% significance levels, respectively

Table 5 32B Models for Monthly WTP Bids for a Private Water Faucet, Semi-Log Functional Form

Dependent variables LnWTP10 and LnWTP11

Independent	CC Spread Over Time or WTP10			CC Paid Upfront or WTP11		
variable	Coef	Stdev	t-ratio	Coef	Stdev	t-ratio
Constant	3 5859***	0 3606	9 94	2 7784***	0 3312	8 39
ADULT?	0 1183	0 1088	1 09	0 1992*	0 1210	1 65
SETTING	-0 0171	0 1007	-0 17	0 0850	0 1124	0 76
WELL/RST	0 0585	0 1431	0 41	-0 0254	0 1449	-0 18
DISOURCE	-0 04558	0 06443	-0 71			
PAYFRENCY	0 0101	0 1063	0 09	-0 0033	0 1162	-0 03
AGE	0 020991***	0 006313	3 33	0 014305**	0 007294	1 96
HSIZE	0 06523*	0 03574	1 83	0 10831***	0 04071	2 66
OCCUPATN	-0 15540**	0 07107	-2 19			
INCOME	0 00001643	0 00001914	0 86	0 00003442*	0 000021	1 66
Observations		79			79	
R^2		56 8%			46 2%	
Adjusted R^2		48 7%			38 6%	
F Value		7 02			6 13	
Prob (>F)		0 000			0 000	

Notes Two-tailed tests were used Three asterisks, two asterisks, and one asterisk indicate 1, 5, and 10% significance levels, respectively

Table 5 33A Models for Yearly WTP Bıds for a Prıvate Water Faucet, Lınear Functıonal Form

Dependent varıables WTP12 and WTP13

Independent varıable	CC Spread Over Tıme or WTP12 Coef	Stdev	t-ratıo	CC Paıd Upfront or WTP13 Coef	Stdev	t-ratio
Constant	-250 3	249 6	-1 00	-317 6	261 6	-1 21
ADULT?	-107 20	77 81	-1 38	17 21	71 05	0 24
SETTING	14 18	66 33	0 21	6 14	60 91	0 10
WELL/RST	-151 13*	92 40	-1 64	5 02	77 25	0 06
DISOURCE	145 73**	58 13	2 51			
PAYFRENCY	-33 68	68 12	-0 47	-72 45	59 46	-1 22
SEX	228 01***	77 04	2 96	116 92*	68 65	1 70
AGE				-9 951	6 583	-0 30
HSIZE	-0 43	22 21	-0 02	-12 86	42 91	-0 30
OCCUPATN				-103 12**	44 22	-2 33
RIVTATUS	84 71*	49 16	1 72	181 51***	45 55	3 98
INCOME	0 04471**	0 01981	2 26	0 04865***	0 01761	2 76
Observatıons		78			78	
R^2		48 8%			48 7%	
Adjusted R^2		40 7%			39 9%	
F Value		6 03			5 51	
Prob (>F)		0 000			0 000	

Notes Two-taıled tests were used Three asterısks, two asterısks, and one asterısk ındıcate 1, 5, and 10% sıgnıficance levels, respectıvely

Table 5 33B Models for Yearly WTP Bids for a Private Water Faucet, Semi-Log Functional Form

Dependent variables LnWTP12 and LnWTP13

Independent variable	CC Spread Over Time or WTP12 Coef	Stdev	t-ratio	CC Paid Upfront or WTP13 Coef	Stdev	t-ratio
Constant	4 2618***	0 4521	9 43	4 7696***	0 6655	7 17
ADULT7	-0 1118	0 1397	-0 80	0 0840	0 1733	0 48
SETTING	-0 0572	0 1157	-0 49	-0 0109	0 1464	-0 07
WELL/RST	0 0216	0 1723	0 13	-0 0348	0 1831	-0 19
DISOURCE	0 1378	0 1038	1 33			
PAYFRENCY	0 0188	0 1208	0 16	-0 1967	0 1541	-1 28
SEX	0 3319**	0 1358	2 44	0 1834	0 1629	1 13
HSIZE	-0 00192	0 04136	-0 05	-0 0507	0 1012	-0 50
OCCUPATN				-0 1910	0 1215	-1 57
RIVTATUS	0 22722***	0 08818	2 58	0 2877**	0 1296	2 22
INCOME	0 0001292***	0 00003858	3 35	0 00004458	0 000044	1 02
Observations		78			78	
R^2		52 9%			29 3%	
Adjusted R^2		44 6%			11 7%	
F Value		6 38			1 66	
Prob (>F)		0 000			0 125	

Notes Two-tailed tests were used Three asterisks, two asterisks, and one asterisk indicate 1, 5, and 10% significance levels, respectively

Table 5 34 Summary of Regression Results on Willingness to Pay for River Pollution Control and Household Water Connections

Good Under Valuation and factor	Functional Form and Significance of Variables: Linear Form	Semi-Log (Dependent)
A River pollution control		
ADULT?	(n s)	(n s)
SETTING	(1)**	(n s)
PAYFRENCY	(1)***	(1)*
QSCORE	(1)*	(3)***
DRESIDE	(2)*	(1)**
WTATUS	(2)**	(1)***
SEX	(3)***	(3)***
AGE	(3)**	(n s)
HSIZE	(n s)	(1)**
OCCUPATN	(1)**	(2)**
INCOME	(6)***	(3)**
range of adjusted R^2 (%)	37 3-44 8	34 8-69 4
Key variables are income, sex, age, dreside, qscore		
B Domestic water supply.		
ADULT?	(n s)	(1)*
SETTING	(n s)	(n s)
PAYFRENCY	(n s)	(n s)
WELL/RST	(3)***	(n s)
DISOURCE	(1)**	(n s)
RIVTATUS	(2)***	(2)***
SEX	(2)***	(1)**
AGE	(1)*	(2)***
HSIZE	(2)**	(2)***
OCCUPATN	(2)**	(1)**
INCOME	(4)***	(2)***
range of adjusted R^2 (%)	38 4-47 0	11 7-48 7

Notes Figure in brackets refers to the total number of times (out of 6 and 4 for Good 1 and Good 2 respectively) the variable is significant in the regression models whilst the asterisk (*) indicates highest level of significance of the factor in the models For instance, (n s) = not significant in any of the models Three asterisks, two asterisks, and one asterisk indicate 1, 5 and 10% significance levels, respectively

As may be seen from the estimated bid curves, all WTPs are well-explained on Mitchell and Carson's (1989) criterion of a minimum adjusted R^2 of 15%, the values in this case varying between 11.7% and 69 4% In the case of the "water connection" good, these coefficients of determination for WTP models are within the range of those obtained in other important Third World surveys, e g Boadu's (1992) study in Ghana, Whittington *et al* 's (1991, 1993) studies in Ghana and Nigeria, and Kwak and Russell's (1994) study in Korea Adjusted R^2 for WTP models for river quality, however, are greater than those obtained in many CV studies, and higher than R^2 values derived by Gramlich (1977) and Desvousges, Smith and McGivney (1983) in estimating WTP for changes in water quality from boatable to fishable to swimmable, we know no comparable Third World applications of contingent valuation High R^2 values are not necessarily evidence of theoretical validity there may be much stochastic variation in the data which overshadows the systematic influence of variables Nevertheless, high R^2 values do provide evidence of reliability

Overall, the multivariate results from both functional forms are remarkably robust and consistently show the same independent variables as being statistically significant The results presented in Tables 5 29-5 33 show conclusively that the willingness-to-pay information obtained from the contingent valuation survey for all ten evaluations/levels of improved water-resource service is systematically related to the socioeconomic characteristics of the household and the respondent in ways suggested by consumer demand theory and the relationships posited earlier This is true regardless of the functional form

The influence of the selected factors on households' willingness to pay for river pollution control in the Nzoia Basin are shown in Tables 5 29-5 31 and summarized in Table 5 34 The range of adjusted R^2 were good, from 37 3% to 44 8% for linear models, and from 34 8% to 69 4% for models based on the semi-log (dependent) functional form The OLS regression results show that household income is a statistically significant factor (upto 99% level in one case) influencing the willingness to pay for river pollution control This result is confirmed in all linear models, in only one model is this rejected in semi-log estimates

The next two important determinants of household willingness to pay for improved river water quality are respondent's WTATUS (that is, ranking of the status of domestic water supply with regard to convenience, quality and reliability) and sex these factors were, respectively, significant in three and two of the six linear models In all cases, male respondents bid higher amounts than females But there is no discernible consistency in the effect of ranking of water supply status on willingness to pay for river pollution control

As may be seen, bid curve coefficients for DRESIDE and OCCUPATION are both correctly signed, the only one DRESIDE coefficient in semi-log functional form that is incorrectly signed is not significant Distance from household residence to the river and occupation (that is, increasing degree of non-formal sector employment) significantly decrease WTP for river pollution control in three of the 12 bid curve estimates Even though the age of the household head is statistically significant in explaining the willingness to pay for river pollution control in three of the six linear models, the direction of its influence is confused Except in the WTP5 measure, age appears to increase willingness to pay

The regression results do not suggest that household size and ranking of the water quality in the Nzoia River has an effect on the wish to control water pollution in the Basin The expected negative relationship between household size and willingness to pay was not significant in any of the linear models, the effect of WTATUS was significant at 10% level in one of the linear models, however The effect of these two factors is projected more in semi-log models than in the linear ones For instance, in one of the models household size is significant at 5% level whilst in three cases household ranking of the river water quality is significant (in one case, upto 1% level!) In sum, no consistency in the effect of both household size and household ranking of the river water quality is discernibly significant on willingness to pay for river pollution control

As noted, the effect of selected socio-economic factors on households' willingness-to-pay bids for private water connections to their homes are depicted in Tables 5 32 and 5 33, and summarized in Table 5 34 The overall fits (R^2) were satisfactory, ranging from 38 4% to 47 0% (for linear forms) and from 11 7% to 48 7% (for semi-log functional forms) The expected positive effect of income on households' WTP the homestead faucets is statistically significant at the 90%, 95% or 99% levels in all linear models and half of the models in semi-log (dependent) form The dummy variable for well, river and stream as an existing source of domestic water, WELL/RST, had a significant positive effect in three of the four linear WTP models, the non-significant coefficient had a wrong expected sign Households' ranking of water quality in the Nzoia River had, in the main, a positive effect on their willingness to pay for private water connections On statistical grounds, however, the variable RIVTATUS, was entered in the modelling of only two of the four WTPs

The expected negative relationship between household size and willingness to pay for individual family water connections was statistically significant in half of the linear WTP models estimated, in contrast to the lack of statistically significant relationships for river pollution control

Both sex (female) and occupation (non-formal sector employment) yielded significant negative OLS coefficients in two linear models, the highest levels of significance were 1% and 5% for sex and occupation respectively The estimated coefficient of the effect of distance between a household and existing water sources was generally poor, in one of the two WTP models in which it is included, distance to existing water source is inconsistent with the a priori hypothesis One reason for the inconsistent result may be that the effect in models is dominated by the dummy WELL/RST Indeed, on statistical criteria, DISOURCE is omitted from two of the four models for WTP for private household faucets

5.4.2 EFFECT OF HOUSEHOLD'S SOCIO-ECONOMIC SETTING

To test whether respondents' WTP bids were affected by the socio-economic set-up of the region (i e , rural versus urban), enumerators indicated RURAL or URBAN on the questionnaires after every interview Due to logistical and financial considerations we did not have separate samples Our hypothesis was that respondents in the rural areas would bid lower than those in the urban areas owing to the fact that urban-dwellers' high incomes, more environmental knowledge and hence evaluation of recreation, as well as the positive linkage between personal hygiene and their occupations in the formal sector employment[46] This dataset, however, shows no evidence of differences in WTP bids between rural and urban residents, Table 5 35 shows that in only three cases out of 13 WTP measures are mean evaluations for rural folk less than those of urban households

[46]Holding other factors constant (specially body proportionality and height), this author contends that beauty is associated with clean clothes and amount of water used in body cleanliness Though tangential to this work, Hamermesh and Biddle (1993) develop a theory of sorting across occupations based on looks and derive its implications for testing for the source of earnings differentials related to looks In part, the paper's abstract reads " Holding constant demographic and labour-market characteristics, plain people earn less than people of average looks, who earn less than the good-looking [However] the impact of individuals' looks on their earnings is mostly independent of occupation"

Table 5 35 Proportion of Respondents and Associated Mean WTP Measures by Household Socio-Economic Setting

WTP	Households in Rural Setting		Households in Urban Setting	
Measure	Count (%)	Mean (Stdev)	Count (%)	Mean (Stdev)
A River pollution control.				
WTP1	19 (57 6)	103 20 (85 6)	14 (42 4)	77 90 (79 1)
WTP2	19 (57 6)	137 40 (103 3)	14 (42 4)	115 70 (112 6)
WTP3	13 (46 4)	569 20 (411 1)	15 (53 6)	566 70 (547 3)
WTP4	13 (46 4)	784 60 (592 8)	15 (53 6)	726 70 (765 8)
WTP5	17 (53 1)	71 18 (56 1)	15 (46 9)	70 70 (77 8)
WTP6	14 (50 0)	428 60 (270 8)	14 (50 0)	492 90 (499 6)
B Domestic Water Supply				
WTP10	40 (55 6)	94 25 (58 8)	32 (44 4)	88 75 (62 3)
WTP11	40 (55 6)	70 95 (44 9)	32 (44 4)	72 90 (57 9)
WTP12	36 (50 0)	494 40 (337 4)	36 (50 0)	536 10 (433 9)
WTP13	36 (50 0)	406 10 (290 7)	36 (50 0)	363 90 (332 9)
Total	139 (44 7)	NA	126 (40 5)	NA

Notes % = percentage of respondents in the sub-sample Figures in brackets are standard deviations NA = not applicable All values in Kenya shillings

Furthermore, the results of the SETTING test from the multivariate analyses shows that whether or not a household location was in an urban or rural area had no significant impact on respondents willingness to pay, the only exception was in the models for WTP6 in Table 5 30 Clearly then, there was no significant influence of a household's location on the resultant willingness-to-pay

5.4.3 Effect of the Presence of People Listening to the Interview

Ideally, each respondent would have been interviewed without other people listening However, due to the crowded housing conditions in urban Webuye and extended family systems in rural areas, many times this was not possible In approximately one-fifth of the interviews, other adults listened as the interview was conducted (see Table 5 36) This fact was noted by the enumerator It is possible that the presence of listeners may have biased a respondent's WTP bids, but the direction of the potential bias is unclear Respondents may have been reluctant to indicate their ability to pay a large amount and may thus have bid low Alternatively, they may have wanted to demonstrate their ability to pay to their neighbours and thus have bid high in an attempt to gain status

Table 5 36 Relationship Between Presence of Listeners to Interview and Associated Means and Standard Deviations of WTP Measures

WTP	Presence of Listeners		Non-Presence of Listeners	
Measure	Count (%)	Mean (Stdev)	Count (%)	Mean (Stdev)
A. River Pollution Control.				
WTP1	5 (15 2)	124 00 (100 7)	28 (84 8)	86 80 (79 8)
WTP2	5 (15 2)	140 00 (96 2)	28 (84 8)	126 10 (109 4)
WTP3	7 (25 0)	457 10 (364 5)	21 (75 0)	604 80 (515 2)
WTP4	7 (25 0)	628 60 (543 8)	21 (75 0)	795 20 (725 6)
WTP5	9 (28 1)	62 20 (48 4)	23 (71 9)	74 35 (72 4)
WTP6	4 (14 3)	400 00 (294 4)	24 (85 7)	470 80 (414 4)
B Domestic Water Supply				
WTP10	24 (33 3)	105 80 (55 60)	48 (66 7)	84 80 (61 5)
WTP11	24 (33 3)	75 80 (48 10)	48 (66 7)	69 65 (52 9)
WTP12	17 (23 6)	427 80 (286 6)	55 (76 4)	544 40 (412 6)
WTP13	17 (23 6)	403 10 (278 4)	55 (76 4)	378 30 (323 5)
Total	66 (21 2)	NA	199 (63 9)	NA

Notes % = percentage of respondents in the sub-sample Figures in brackets are standard deviations NA = not applicable All values in Kenya shillings

A variable, ADULT?, designed to test the effect of the presence of listeners was included in the multivariate analysis, in all models except in the bid curve for monthly WTP bids for domestic water supply connections when connection charges are to be paid upfront [in the semi-log (dependent) functional form, Table 5 32B] the results clearly show that effect of presence of people listening to the interview was not significant We interpret this finding to mean that the presence of listeners had little, if any, effect on the WTP bids This suggests that the WTP bids are robust with respect to another variation in the interview context, and again increases our confidence that WTP bids are not easily manipulated or influenced by contextual issues

5.4.4 Effects of Frequency of Payments in Contingent Valuation

As noted, to study the influence of temporal dimensions of payments on contingent values, a field experiment was conducted with the two commonly used frequencies, *one (yearly payments) and twelve (monthly payments)* Equal sharing of six questionnaire versions between the two frequencies meant that two variants and one version of river water quality and domestic water supply questionnaires, respectively, asked for yearly WTP

Ideally, each respondent would have been happy to go by the payment frequency specified in the CV questionnaire version But the availability of choice of payment frequency in the CV saw some respondents preferring a different temporal dimension of payment than the one on offer About 47% and 52 9% of respondents in the river water quality and domestic water supply samples, respectively, did express preference for a different payment frequency format than the one that was on offer

To avoid respondents registering protest against the temporal dimension of payment in the survey instrument, all versions were structured in a manner that asked for interviewees' preference first before being told what was on offer Table 5 37 shows that yearly payment formats generally resulted in higher WTPs than the monthly temporal dimension of payment, the yearly WTPs, however, were less than 12 times monthly WTPs

Table 5 37 Bivariate Table Showing the Relationship Between Respondents' Preferred Frequency and the Temporal Dimension of Payments in the Valuation Through Associated Means and Standard Deviations for WTP Measures

Preferred Frequency of Payments and WTP Measure		Temporal Dimension of Payments in Valuation			
		Monthly Payments		Yearly Payments	
		Mean	Stdev	Mean	Stdev
Monthly Payments					
A Good 1,	WTP1	98 95	89 90	NA	NA
	WTP2	136 30	111 80	NA	NA
	WTP3	NA	NA	466 70	526 00
	WTP4	NA	NA	633 30	767 80
	WTP5	67 30	53 70	NA	NA
	WTP6	NA	NA	545 00	511 20
B Good 2,	WTP10	91 40	67 60	NA	NA
	WTP11	79 10	56 20	NA	NA
	WTP12	NA	NA	506 60	392 50
	WTP13	NA	NA	406 80	305 80
Yearly Payments					
A Good 1,	WTP1	83 60	73 90	NA	NA
	WTP2	117 10	101 00	NA	NA
	WTP3	NA	NA	684 60	410 00
	WTP4	NA	NA	892 30	557 50
	WTP5	74 10	76 80	NA	NA
	WTP6	NA	NA	413 90	322 10
B Good 2,	WTP10	92 50	46 90	NA	NA
	WTP11	62 40	42 20	NA	NA
	WTP12	NA	NA	525 00	385 20
	WTP13	NA	NA	357 80	321 60

Note Good 1 and Good 2 relate to river pollution control and domestic water supply connections respectively NA stands for not applicable All values in Kenya shillings

The models ındicate that yearly ones performed comparatıvely better ın terms of explanatory power than monthly models Thıs was expected gıven the non-salarıed nature of most Webuye households Indeed our hıgh adjusted R^2 values could be attrıbuted to the fact that budgetary ımplıcatıons of the contıngent schemes were made more explıcıt wıth the requırement for the households to choose a payment frequency For lınear models, adjusted R^2 ranges from 38 4% to 47 0% (for monthly WTP bıds) and 37 3% to 42 5% (for yearly WTP bıds), for semı-log (dependent) models, the coeffıcıent of determınatıon ranges from 37 7% to 69 4% (for monthly WTP bıds) and 11 7% to 45 0% (for yearly WTP bıds) The ıdea that WTPs were not asked for ın the respondents' preferred pf ıs a moot poınt as the ıntervıewees would have used the ınformatıon to bıd approprıately, anyway In addıtıon we see that the dummy varıable for pf, PAYFRENCY, ıs sıgnıficant ın the multıvarıate analysıs of only one WTP measure, WTP6 (that ıs, unpaıred annual WTP for rıver pollutıon control ın Part Basın, see Table 5 30) The dırectıon of the effect PAYFRENCY varıable ıs consıstently negatıve, except ın one model of monthly WTP bıds for rıver water qualıty The dummy ındıcates that preference for annual payments result ın a lower WTP (sınce PAYFRENCY = 1 for yearly payments)

Another possıble, plausıble ınterpretatıon of the result on PAYFRENCY effect to mean that preferred pf had ınfluence on respondents' wıllıngness to pay bıds But the effect ın the models ıs domınated by the ıncome, occupatıon and "settıng" effects By "settıng" we mean the urban-rural dıchotomy It ıs ımportant, though, to reıterate the poınt that PAYFRENCY ıs a dummy for preferred payment frequency and *not* for the temporal dımensıon of payment ın the value elıcıtatıon exercıses

5.4.5 Concluding WTP Estimation Models

As this is an open-ended CV study, both the ordinary least squares (OLS) and the maximum likelihood (ML) procedures are arguably reasonable in terms of yielding unbiased efficient parameter estimates Consequently, the choice of the OLS procedure in this analysis was random, though influenced by the statistical capabilities of MINITAB®[47] software Cameron and Huppert (1989) assess the potential distortion introduced into contingent valuation estimates due to the inappropriate application of OLS regression methods to payment card interval midpoints The authors conclude that "[d]epending upon the design of the payment card, OLS can yield biased parameter estimates, misleading inferences regarding the effects of different variables on resource values, and biased estimates of the overall resource value" (p 230) By and large, in non-open-ended CV studies, the resulting total value of a non-market resource can be manipulated by intentional decisions regarding estimation procedures The argument that our regression models are too simple and that more information could be discerned from use of other estimation techniques is a legitimate concern Yet this author conjectures that modelling WTP values with non-OLS techniques will not change any of the conclusions obtained

What emerges from the results of this multivariate analyses of bids is that the significant factor influencing households' willingness to pay for river pollution control and domestic water supply connections is family income The effects of other factors are more specific to the contingent good In particular, the order of strength of determinants of willingness to pay for river pollution control are sex, age, household ranking of status of domestic water source, distance from river to household residence,

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[47]®MINITAB is a registered trademark of Minitab Inc

the other factors affecting WTP for household domestic water connections are existing source of water supply, household size, ranking of river water quality, and age of household head

Perhaps the most surprising finding of these multivariate analyses is how little effect any of the social or cultural variables had on individuals' willingness to pay for river pollution control or household water supply connections More educated respondents generally bid more than less educated respondents, but this effect is statistically significant in only a few of the models and its magnitude is always small The sex and occupation of the respondent are almost never significant, and the direction of these effects if mixed Even though we hypothesized that older respondents would bid less for the improvements than younger individuals, the overall effect of age on WTP is confused We must hasten to add, however, that most of the social and cultural factors were strongly correlated to income levels This explains why in models where the income effect was small, such factors turned up to be significant The next section rigorously tests, amongst other hypotheses, the impacts of temporal dimensions (or frequencies) of payments on average (that is, mean and median) WTPs

5.5 DEFINITION AND TESTS OF DIFFERENCES

The natural way to define differences between two evaluation question designs is the difference in the mean, although difference in median seems as plausible Note that even though we might find that two distributions generate about the same mean, it is certainly not true that two distributions are the same An individual may interpret two contingent valuation designs very differently even if we obtain the same estimated means (e g , Hanley *et al* , 1994, Hanley *et al*, 1995)

Descriptive statistics for the ten measures of WTP have already been given in Tables 5 14, 5 15, 5 16, and 5 17 In order to tests any hypotheses over these measures, appropriate statistical examinations must be chosen and conducted One possible approach, mainly used in discrete response valuation studies, is to calculate the empirical distribution functions and use a Kolmogorov-Smirnov type of statistic (Kristrom, 1993) Our open-ended responses and the complications entailed in determining the relevant degrees of freedom for a Kolmogorov-Smirnov goodness-of-fit test, nevertheless, make such an approach inadmissible on a cost-benefit evaluation of resources Therefore, we use a simpler approach, but we are aware that distance-type test may be applied in comparisons undertaken here

Specific distributional assumptions are made for WTP data in rough comparisons of means But then we go further and appropriately perform both the Mann-Whitney U test and the paired-rank Wilcoxon test as well Paired *t*-tests are generally ruled out on the grounds that untransformed WTP data is not normally distributed[48], whilst the presence of zeros means that log transformations can not be

[48]This was shown by calculating normal scores for all WTP variables, and correlating these scores with the untransformed data in each case The correlation coefficients can be used as test statistics for normality, following a version of the Shapiro-Wilk test

done The Mann-Whitney test is frequently used in non-normal samples (e g , Kahneman and Knetsch, 1992), but it assumes independent data sets (Mann and Whitney, 1947, Kazmier and Pohl, 1987 496) Further, when data sets have skewed distributions and dependent on each other, a paired-rank Wilcoxon test is used (Wilcoxon, 1945, Mendenhall *et al*, 1986 806, Hanley *et al*, 1994 10)

The key research questions, and hence hypotheses, that this study set up to investigate are fourfold (1) Does the Nature of the Good Matter? (2) Do Average WTP Measures Vary with Temporal Dimension (or Frequency) of Payments in CV Design? (3) Embedding in WTP Values for Water Pollution Abatement in the Nzoia River Basin (4) Does Nature of Connection Charges Influence WTP for Domestic Water Supply? We presently deal with each of these hypotheses, in turn

5.5.1 Does the Nature of the Good Matter?

To meaningfully compare the performance of the CV method when applied to the two goods (that is, river pollution control and domestic water connections), it is necessary to hold constant all other aspects of the application of the method As already mentioned, for both goods the CV was applied to the population of Webuye residents This allows us to isolate commodity-specific characteristics as the source of any discrepancy in our measures of reliability and validity The proportion of protest and zero bids, coefficient of variation of WTP measures, and results from the multivariate analyses are the criteria used to compare the reliability and validity of the contingent values across the two goods being evaluated On the basis of the first criterion, the following observation can be made There were more refusals to pay and protests in Good 1 (rwq) than in Good 2 (dws) The proportion of zero bids, however, were more ın the latter contıngent good than ın the former (51 9% versus 43 1%)

Although the mean monthly WTP for rwq ın Webuye area was quıte close to the mean monthly WTP for dws on both types of connectıon-charges (ı e , Ksh 70 00 for WTP and Ksh 65 00 for WTP5 vs Ksh 91 80 for WTP10 and Ksh 71 90 for WTP11), the former had a hıgher standard devıatıon than the latter The fact that valuatıons of water ın nature were more dıspersed than those of water ın socıal uses may possıbly be explaıned by the famılıarıty of the respondents wıth domestıc water supply as compared wıth rıver water qualıty Indeed, when the respondents were asked for WTP for rıver cleanup ın the entıre basın, the standard devıatıon ıncreased from Ksh 82 60 and Ksh 66 00 to Ksh 106 20, the mean and medıan for addıtıonal WTP values was Ksh 35 80 and Ksh 20 00 respectıvely

Secondly, Webuye resıdents appear to recognıse non-use values of the Nzoıa rıver, specıally ın theır annual WTP bıds for water pollutıon control ın the basın Even though thıs study dıd not set out to ısolate the dıfferent types of use value from non-use values, ıt can be ınferred that the hıgher WTP values for rwq ımprovement could be symptomatıc of the resıdents recognıtıon of these other values of nature The mean annual WTP for rwq wıthın Webuye area ıs Ksh 567 90 and Ksh 460 70 (from questıonnaıre versıons A2 and A4) whılst the mean yearly WTP for prıvate water faucets ıs Ksh 515 30 (spread c-charges) and Ksh 384 10 (upfront c-charges) The medıan values are equal, but the varıance of household valuatıons for rıver qualıty ıs hıgher than that for drınkıng water Notwıthstandıng, the strong assumptıon of no costs of water supply development ın thıs argument on there beıng non-use values ın the resıdents' evaluatıons of rıver water qualıty ımprovements, water supply ıs, understandably, just one of many benefits from rıver conservatıon and management

As a relative measure of dispersion, the coefficient of variation (c v) is an appropriate statistic of comparing two dissimilar groups (Mason, 1970 123) In the influential paper by Kealy and co-workers (1990), one measure of reliability used is estimated 'proportionate' variance (or c v) of WTP values as measured within a given commodity type The standard deviation of the mean as a percentage of the mean gives a standardized measure of the degree of precision of the estimate Therefore, in the present context in which a similar CV method is applied to very similar populations, this is a useful statistic for making comparisons of relative precision of WTP values across the two goods

Alongside other descriptive statistics, the and coefficients of variation of WTP for the two commodities are reported in Tables 5 14, 5 15, and 5 17 The c v s for wtp values for in-house water connection vary between 65% and 81% while those for river water quality are more unreliable, varying between the range of 82% and 137% The divergence of these values is consistent with the Cummings *et al*, (1986) hypothesis that welfare measures for public goods will have a higher variance (as a proportion of the mean) and therefore be less reliable than those for a private good However, the nature of goods in this experiment do not epitomise polar extremes of the public-private good continuum found in Kealy *et al*'s (1990) study Indeed, the coefficients of variation in this study are quite big in both circumstances The Kealy and co-workers (1990) survey found the "proportionate variance of WTP is 44 7% for the public good and 40 4% for the private good using the full sample When we recalculate the value for the private good using the random subsample, the proportionate variance rises to 44 6%" (p 256) Secondly, Kealy *et al* employed the referendum, or closed-ended method of questioning whilst this one took an open-ended format, this divergence may explain, to a large extent, our high coefficients of variation

As regards the OLS modelling of WTP evaluations for river pollution control and household water connections, it is worth re-iterating a number of points The range of adjusted R^2 for estimated models of WTP for both contingent goods were satisfactory. For river water quality the values ranged from 37 3% to 44 8% for linear models, and from 34 8% to 69 4% for models based on the semi-log (dependent) functional form For private household water connections, the overall fits (R^2) for WTP models ranges from 38 4% to 47 0% (for linear forms) and from 11 7% to 48 7% (for semi-log functional forms)

The main factor influencing households' willingness to pay for both river pollution control or household water supply connections is family income No significant effect of households' socio-economic setting, presence of adults, nor social or cultural variables (such as age, education and sex) was discernible in the multivariate analysis of bids from evaluation of both goods The regression analyses also included WTATUS and RIVTATUS, factors that were meant to measure the extent to which household valuation of river pollution control and individual water connections are dependent on the status of existing water source and water quality in the Nzoia River basin respectively In the 16 models in which these variables were included, they were significant in four of them

Further still, annual payments as a temporal dimension of payments in the CV design generally resulted in higher WTPs than the monthly temporal dimension of payment, the yearly WTPs, however, were less than 12 times monthly WTPs This result equally applied to both goods In sum, therefore, the nature of good being valued in this CV study compromised neither the reliability nor the validity of resultant WTP measures

5.5.2 Do Average WTP Measures Vary with Temporal Dimension (or Frequency) of Payments in Contingent Valuation Design?

As noted earlier (in Chapter 4 and in Section 5 4 4), to study the influence of temporal dimensions of payments on contingent values, a field experiment was conducted with the two commonly used frequencies, *one (yearly payments)* and *twelve (monthly payments)* Equal sharing of six questionnaire versions between the two frequencies meant that two variants and one version of river water quality and domestic water supply questionnaires, respectively, asked for yearly WTP

Ideally, each respondent would have been happy to accept the payment frequency specified in the CV questionnaire version But the availability of choice of payment frequency in the CV saw some respondents preferring a different temporal dimension of payment than the one on offer Table 5 38 gives the results About 47% of respondents in the river water quality sample expressed a preference for a different payment frequency format than the one that was on offer, contrary to the temporal dimension of payment in the questionnaire versions to which they responded to, 48 7% and 46 1% of the interviewees chose annual and monthly payments respectively

In the domestic water sample, the proportion of respondents who preferred a different payment frequency from that offered in their assigned questionnaire versions was also about 47% But 39 2% of respondents in the monthly questionnaire version would prefer yearly payments and 55% of those in the version seeking annual WTP bids would have wanted 12 payments instead To avoid respondents registering protests against the temporal dimension of payment in the survey instrument, all versions were structured in a manner that asked for interviewees' preference first before being told what was on offer, people then bid on the basis of the interviewers/researchers' preferred structure Owing to this, the above descriptive statistics can only be interpreted to mean that the respondents' preferences were tilted in favour of annual payments

Table 5 38 Relationship between Preferred Frequency of Payments and Temporal Dimension of Payment in Valuation by Nature of Contingent Commodity

Temporal Dimension of Payment in Valuation	Preferred Frequency of Payment		
	Monthly (%)	Yearly (%)	Total (%)
A River Water Quality			
Monthly Versions	40 (25 97)	38 (24 68)	78 (50 65)
Yearly Versions	35 (22 73)	41 (26 62)	76 (49 35)
Total sample size	75 (48 70)	79 (51 30)	154 (100 0)
B. Domestic Water Supply			
Monthly Version	48 (30 57)	31 (19 75)	79 (50 32)
Yearly Version	43 (27 39)	35 (22 29)	78 (49 68)
Total sample size	91 (57 96)	66 (42 04)	157 (100 0)

Tables 5 39 and 5 40 show cross tabulatıons between payment frequency and occupatıon, and payment frequency and ıncome respectıvely As can be seen, respondents ın the non-salarıed employment sectors of agrıculture and ınformal apprentıceshıps/actıvıtıes preferred yearly payments to monthly ones Ostensıbly, thıs was due to the nature of theır ıncome flows, out of 16 respondents ın the hıghest ıncome category just 6 expressed preference for annual payments as compared to 50% of those ın the lowest ıncome bracket (Table 5 40)

Tables 5 41 and 5 42 present a comparıson of sample characterıstıcs for monthly payment questıonnaıre versıons and yearly payment questıonnaıre versıons as well as the socıo-economıc and demographıc data accordıng to respondents' expressed preference of payment frequency In general the samples are quıte sımılar Because of the sımılar sample characterıstıcs, we conclude that any dıfferences ın the responses are due to the temporal dımensıon of payment

Table 5 39 Relationship Between Occupation and Preferred Frequency of Payment

Preferred Frequency	Occupation I	II	III	Total
A River Water Quality				
Monthly Payments	34	26	29	89
Yearly Payments	10	26	29	65
Total	44	52	58	154
B Domestic Water Supply				
Monthly Payments	38	11	38	87
Yearly Payments	12	52	6	70
Total	50	63	44	157

Note Occupation categories are defined in terms of increasing degree of non-formal sector employment I (Public servant including those in the official private sector), II (Farmer), III (Informal sector)

Table 5 40 Relationship Between Income and Preferred Frequency of Payment

	Income Group						
	I	II	III	IV	V	VI	Total
A. River Water Quality							
Monthly payment	17	24	20	16	6	6	89
Yearly payment	24	18	8	5	5	5	65
Total	41	42	28	21	11	11	154
B Domestic Water Supply							
Monthly payment	16	20	24	18	5	4	87
Yearly payment	9	18	27	11	4	1	70
Total	25	38	51	29	9	5	157

Notes The Income Groups are I (Under Ksh 1999), II (Ksh 2000 - 3999), III (Ksh 4000 - 5999), IV (Ksh 6000 - 7999), V (Ksh 8000 - 9999), VI (Over Ksh 10000)

Table 5 41 Percentage Comparısons of Sample Household Characterıstıcs Between Monthly and Yearly Questıonnaıre Versıons and Preferred Payment Frequency, Rıver Pollutıon Control Sample

Varıable	Questıonnaıre Versıon		Payment Preference	
	Monthly	Yearly	Monthly	Yearly
Sex:				
Female	31 82	26 62	32 47	25 97
Male	18 83	22 73	25 32	16 23
Age:				
Under 20 years	2 60	2 60	2 60	2 60
20 - 29 years	1 95	1 95	2 60	1 30
30 - 39 years	16 88	17 53	19 48	14 94
40 - 49 years	19 48	17 53	23 38	13 64
50 - 59 years	8 44	8 44	7 79	9 09
Over 60 years	1 30	1 30	1 95	0 65
Full-time education:				
No educatıon	9 09	7 14	8 44	7 79
Prımary school	22 73	22 08	23 38	21 43
Lower secondary	10 39	14 94	18 18	7 14
Upper secondary	4 55	2 60	3 90	3 25
College/Unıversıty	3 90	2 60	3 90	2 60
Home ownership:				
Renter	29 22	22 73	29 22	22 73
Owner	21 43	26 62	28 57	19 74
Occupation:				
Publıc servant[1]	13 64	14 94	22 08	6 49
Farmer	16 23	17 53	16 88	16 88
Informal sector	20 78	16 88	18 83	18 83
Monthly income group:				
Under Ksh 1, 999	13 64	12 99	11 04	15 58
Ksh 2,000 - 3,999	14 94	12 34	15 58	11 69
Ksh 4,000 -5,999	7 79	10 39	12 99	5 19
Ksh 6,000 - 7,999	5 84	7 79	10 39	3 25
Ksh 8,000 - 9,999	5 19	1 95	3 90	3 25
Over Ksh 10,000	3 25	3 90	3 90	3 25
Total	50 65	49 35	57 79	42 21

Note [1] ıncludes respondents employed ın the prıvate sector

Table 5 42 Percentage Comparisons of Sample Household Characteristics Between Monthly and Yearly Questionnaire Versions and Preferred Payment Frequency, Domestic Water Supply Sample

Variable	Questionnaire Version		Payment Preference	
	Monthly	Yearly	Monthly	Yearly
Sex:				
Female	26 75	31 21	30 57	27 39
Male	23 57	18 47	24 84	17 20
Age:				
Under 20 years	3 18	5 73	3 82	5 10
20 - 29 years	7 01	4 46	6 37	5 10
30 - 39 years	21 02	17 20	17 83	20 38
40 - 49 years	12 10	15 92	17 20	10 83
50 - 59 years	5 73	6 37	8 92	3 18
Over 60 years	1 27	0	1 27	0
Full-time education:				
No education	10 83	4 46	9 55	5 73
Primary school	21 66	21 66	25 48	17 83
Lower secondary	14 65	19 75	17 20	17 20
Upper secondary	1 91	3 18	2 55	2 55
College/University	1 27	1 91	0 64	1 27
Home ownership:				
Renter	21 66	26 75	26 11	22 29
Owner	28 66	22 93	29 30	22 29
Occupation:				
Public servant[1]	15 29	16 56	24 20	7 64
Farmer	17 83	22 29	7 01	33 12
Informal sector	17 20	10 83	24 20	3 82
Monthly income group:				
Under Ksh 1, 999	10 83	5 10	10 19	5 73
Ksh 2,000 - 3,999	13 38	10 83	12 74	11 46
Ksh 4,000 -5,999	12 10	20 38	15 29	17 20
Ksh 6,000 - 7,999	8 92	9 55	11 46	7 01
Ksh 8,000 - 9,999	2 55	3 18	3 18	2 55
Over Ksh 10,000	2 55	0 64	2 55	0 64
Total	50 32	49 68	55 41	44 59

Note [1] includes respondents employed in the private sector

Two points are worth repeating here In tandem with expectation, annual WTP values were greater than monthly WTPs (see Tables 5 14, 5 15, 5 16, and 5 17) However, the former are less than twelve times the latter The arithmetic converse holds too Secondly, the size of the mean WTP values relative to average household income appears to be quite low, varying between 0 5% and 3% (see Tables 5 25 and 5 27)

It is important to determine the statistical importance of the difference between average WTPs across frequency of payments in the value elicitation question To do this we employed three tests (Student t-test, Mann-Whitney test and a paired-rank Wilcoxon test) to assess the following hypotheses on temporal dimension of payments

Test 1	H_0 wtp7 = wtp1	versus	H_1 wtp7 ≠ wtp1
Test 2	H_0 wtp7 = wtp5	versus	H_1 wtp7 ≠ wtp5
Test 3	H_0 · wtp8 = wtp2	versus	H_1 wtp8 ≠ wtp2
Test 4	H_0 wtp9 = wtp1	versus	H_1 wtp9 ≠ wtp1
Test 5	H_0 wtp9 = wtp5	versus	H_1 . wtp9 ≠ wtp5
Test 6	H_0 wtp14 = wtp10	versus	H_1 wtp14 ≠ wtp10
Test 7	H_0 · wtp15 = wtp11	versus	H_1 wtp15 ≠ wtp11

Table 5 43 shows the results of these tests As may be seen, the null hypothesis is rejected in each case at the 95% level, except in one instance The only test that fails falsification involves standardized annual WTP from a paired questionnaire (A2) in which respondents were asked to bid for improved river water quality in both a section of and the entire Nzoia Basin, on one hand, and monthly WTP from a non-paired questionnaire version (A3) in which households were asked for bids for the Nzoia River section in Webuye Division alone, on the other So, therefore, there exits a possibility that the results from test two are influenced by the paired-unpaired effect We address this influence in Section 5 5 3 But by a majority of six to one, the tests show that the two payment frequencies produced statistically different estimates of WTP for improved river water and a private water connection

Table 5 43 Results of Tests of the Hypothesis on Temporal Dimension of Payments, Student *t*, Mann-Whitney and Wilcoxon tests

HYPOTHESIS #2 FREQUENCY IMPACTS

Test No	Null Hypothesis (H_0)	*t*-statistic Decision (*t*)	Mann-Whitney test Decision (sign	Wilcoxon test Decision (p-value)
A River Water Quality				
Test 1	WTP7 = WTP1	R (-2 78)	R (0 0484)	R (0 005)
Test 2	WTP7 = WTP5	N R (-1 56)	N R (0 2586)	R (0 054)
Test 3	WTP8 = WTP2	R (-3 06)	R (0 0115)	R (0 002)
Test 4	WTP9 = WTP1	R (-3 45)	R (0 0092)	R (0 001)
Test 5	WTP9 = WTP5	R (-2 32)	R (0 0503)	R (0 003)
B. Domestic Water Quality				
Test 6	WTP14 = WTP10	R (-6 09)	R (0 0000)	R (0 000)
Test 7	WTP15 = WTP11	R (-5 72)	R (0 0000)	R (0 000)

Notes

1 All tests are two-sided and all decisions on H are at 95%, N R , R = cannot reject, reject hypothesis of equal means in t-test and of equal medians in the cases of Mann-Whitney and Wilcoxon tests

2 Both the non-parametric tests (Mann-Whitney test and paired-rank Wilcoxon test) use medians as measures of average WTP.

Hypotheses tests thus show that significant reductions in WTP were forthcoming for all formats involving yearly payments regardless of the good under investigation It is important to understand whether the reduction was a reflection of respondents' budget constraints or an undervaluation caused by the CV specification If the second reason is correct then this result may provide more ammunition for the criticism offered by Sagoff (1988) of valuation becoming endogenous to the valuation process

So, what is the explanation for the divergence in WTPs? The literature overview in this paper opened up two lines of analytical focus One from the behavioural decision research (marketing-related consumer investigations) and the other from development literature (timing-of-income, consumption and income smoothing)

The former view is that payment frequency (hereinafter, pf) simplifies information encodement So in its role as a proxy for information, we would expect its statement and availability to yield better, reliable estimates than when the choice is not available to respondents The latter view on the other hand would predict pf preferences to track/follow the periodicity in a household's income In other words, we would expect a relationship between a preferred pf with the nature of income flow of an individual/household's income (determined in part by occupation) More zero bids given for the reason that the respondent could not afford to pay would be expected from non-monthly earning households if the payments are to be made on a monthly basis Chapter 6 continues the discussion on this

5.5.3 Embedding in WTP Values for Water Pollution Abatement in the Nzoia River Basin

In our experiment on embedding effects six hypotheses were tested The first four hypotheses relate to statistical equivalence of average WTP for pollution control over geographic extents of the Nzoia River Basin (a form of part-whole bias) In terms of this experiment, embedding will occur if the average WTP value for pollution control in the entire Nzoia River Basin upto Lake Victoria is the same as the WTP value for pollution control in the section of the Nzoia River Basin within Webuye Division only Hence the following hypotheses were tested between samples A1, and A2, and samples A3 and A4

Test 1	WTP1 = WTP2	versus	WTP1 ≠ WTP2
Test 2	WTP3 = WTP4	versus	WTP3 ≠ WTP4
Test 3	WTP2 = WTP5	versus	WTP2 ≠ WTP5
Test 4	WTP4 = WTP9	versus	WTP4 ≠ WTP9

The last two hypotheses relate to whether asking for "sectional" evaluation over paired and unpaired response modes The CV estimates will be invalid if the two WTPs are not statistically equivalent as, in both paired samples (that is, A1 and A2), we deliberately asked for "sectional" values for river pollution control before those for water pollution control in the "entire" Nzoia River Basin In other words, the irrelevant change in the benefit measurement procedure should yield insensitive WTP measures Specific tests of statistical equivalence of PAIRED versus UNPAIRED valuations of benefits of the water quality improvement in the Nzoia River section in Webuye dıvısıon are

Test 5	WTP1 = WTP5	versus	WTP1 ≠ WTP5
Test 6	WTP3 = WTP9	versus	WTP3 ≠ WTP9

Tables 5 44 and 5 45, respectively, show the results from the two sets of hypotheses on embeddıng and paıred-unpaıred comparısons The dıfferences between "sectıonal values" and "basınwıde" evaluatıons wıthın paıred questıonnaıres (represented ın Test 1 and Test 2) are not sıgnıficant at the 5 percent level WTP values for basınwıde cleanup are ın the order of the valuatıons for rıver pollutıon control wıthın Webuye sectıon alone (ı e , Ksh 128 20 versus Ksh 92 40 for the monthly versıon, A1, and Ksh 754 00 versus Ksh 567 90 for the annual payment format, A2)

Response mode effect (see Table 5 45) The next step ıs to see the effect of paırıng the two goods (that ıs, rıver pollutıon control wıthın Webuye Dıvısıon alone and entıre Nzoıa Rıver basın cleanup) ın the same questıonnaıre (Test 5 and Test 6) Respondents asked for wtp for sectıon cleanup and then entıre basın cleanup gave "sectıonal value" figures whıch were dıfferent but ınsıgnıficant from WTPs obtaıned vıa questıonnaıre versıons (A3 and A4) whıch asked for "part basın" evaluatıons rıver pollutıon control only. The monthly and annual WTPs dıffered by 30 3% (Ksh 92 40 versus Ksh 70 90) and 23 3% (Ksh 567 90 versus Ksh 460 70) respectıvely So, as expected, the contıngent values for rıver pollutıon control ın Webuye's Nzoıa Basın were ınsensıtıve to the ırrelevant (ı e , sımılar) changes posıted ın the desıgns Overwhelmıngly, the statıstıcal tests ındıcate that we cannot reject the hypothesıs of equal average WTPs for water pollutıon management ın the Nzoıa rıver sectıon ın

Webuye division at both 1 and 5 percent levels

In the light of these tests (that is, Tests 1, 2, 5 and 6), the crucial, relevant tests for embedding effect in this study are Test 3 and Test 4 (see Table 5 44) The tests involve comparisons between WTPs from the nested/paired values for entire basin cleanup and those from nonnested/unpaired values for section cleanup Put differently, these tests relate to comparisons between WTP for water pollution control in the entire Nzoia River Basin upto Lake Victoria (samples A1 and A2) and WTPs for the river pollution control within Webuye (Division) section only in questionnaires asking for direct estimates (samples A3 and A4) Taken together, therefore, our hypotheses tests suggest no embedding effect in the contingent values for river pollution control in the Nzoia Basin, Kenya

Table 5 44 Results of Tests of the Hypothesis on Embedding Effect in the Valuation of Improved Water Quality in the Nzoia River Basin, Student *t*, Mann-Whitney and Wilcoxon tests

HYPOTHESIS # 3a. EMBEDDING

Test No	Null Hypothesis (H_0)	*t*-statistic (Decision (*t*)	Mann-Whitney test Decision (sign level)	Wilcoxon test Decision (p-value)
A. Within Same Sample				
1	WTP1 = WTP2	N R (-1 53)	NA	N.R. (0 636)
2	WTP3 = WTP4	N R (-1 18)	NA	N.R. (0 112)
B In Independent Samples				
3	WTP2 = WTP5	R (2 73)	R (0 0175)	R (0 003)
4	WTP4 = WTP9	R (1 97)	R (0 0671)	R (0 012)

Notes

1 All tests are two-sided and all decisions on H_0 are at 95% level, N R , R = cannot reject, reject hypothesis of equal means in *t*-test and of equal medians in the cases of Mann-Whitney and Wilcoxon tests, NA = test not applicable

2 Both the non-parametric tests (Mann-Whitney test and paired-rank Wilcoxon test) use medians as measures of average WTP

Table 5 45 Results of Tests of the Hypothesis on Paired versus Unpaired Evaluations of Improved Water Quality in the Nzoia River Basin in Webuye Division, Student *t*, Mann-Whitney and Wilcoxon tests

HYPOTHESIS # 3b PAIRED-UNPAIRED

Test No	Null Hypothesis (H_0)	*t*-statistic Decision (*t*)	Mann-Whitney test Decision (sign level)	Wilcoxon test Decision (p-value)
A Monthly Payments				
5	WTP1 = WTP5	N R (1 28)	N R (0 3549)	N R. (0 140)
B Annual Payments				
6	WTP3 = WTP9	N R (0 91)	N R (0 2980)	N R. (0 119)

Notes

[1] All tests are two-sided and all decisions on H_0 are at 95% level, N R , R = cannot reject, reject hypothesis of equal means in *t*-test and of equal medians in the cases of Mann-Whitney and Wilcoxon tests

[2] Both the non-parametric tests (Mann-Whitney test and paired-rank Wilcoxon test) use medians as measures of average WTP

5.5.4 DOES THE NATURE OF CONNECTION CHARGES INFLUENCE WTP FOR DOMESTIC WATER SUPPLY?

The fourth hypothesis of this study was that average wtp measures for domestic water supply improvement would vary across profiles of initial connection charges Specially, two sub-hypotheses are tested, one on monthly bids and the other on yearly WTPs

Test 1	WTP10 = WTP11	versus	WTP10 ≠ WTP11
Test 2	WTP12 = WTP13	versus	WTP12 ≠ WTP13

Like in the other study hypotheses, this is tested using differences of means and medians tests (i e , Student's *t*-test and Wilcoxon test) Mann-Whitney U test is inappropriate here due to the survey design, the two WTPs in both temporal dimensions of payments (monthly and annual bids) are dependent on each other by virtue of being elicited in B1 and B2 questionnaire versions (see Table 5 23) On the surface (Tables 5 16 and 5 17), the bid distributions across nature of connection charges appear dissimilar, in particular the mean bid or offer amounts of completed interviews differed (by more than 20 percent) For example the difference within the annual payments questionnaire version is Ksh 131 20 (i e , Ksh 384 10 and Ksh 515 30)

The results of the tests of statistical equivalence of WTP over SPREAD and UPFRONT initial water connection charge profiles are shown in Table 5 46 The null hypothesis H_0 $WTP[SPREAD]_{(m,y)} = WTP[UPFRONT]_{(m,y)}$ is rejected at the 5 percent significance level for both the monthly and annual bids for the improvement programme The apparent inability to reject the hypotheses of equal medians in the Wilcoxon test can be traced to the significance of temporal dimensions (or frequencies) of payments in the survey (see Sub-Section 5 5 2), consequently, we exclude the test So, as is shown in Table 5 46, support is given for the alternative hypothesis that $WTP[SPREAD]_{(m,y)} > WTP[UPFRONT]_{(m,y)}$ (i e , greater wtp values from the SPREAD initial connection charges)

Table 5 46 Results of Tests of the Hypothesis on Influence of Water Connection Charges on Household Willingness to Pay for a Faucet, Student *t*, Mann-Whitney and Wilcoxon tests

HYPOTHESIS # 4 SPREAD-UPFRONT

Test No	Null Hypothesis (H_0)	*t*-statistic Decision (*t*)	Mann-Whitney test Decision (sign level)	Wilcoxon test Decision (p-value)
A Monthly Payments				
1	WTP10 = WTP11	R (2 12)	NA	R (0 000)
B Annual Payments				
2	WTP12 = WTP13	R (2 22)	NA	N R (0 075)

Notes

1 All tests are two-sided and all decisions on H_0 are at 95% level, N R , R = cannot reject, reject hypothesis of equal means in *t*-test and of equal medians in the cases of Mann-Whitney and Wilcoxon tests, NA = test not applicable

2 Both the non-parametric tests (Mann-Whitney test and paired-rank Wilcoxon test) use medians as measures of average WTP

Besides assessing the potential utility or otherwise of applying the CV methodology in Kenya, it is useful to calculate aggregate benefit estimates Indeed, the overall objective of CV as a tool of Cost-Benefit Analysis is to provide estimates of *aggregate* benefits which can then be compared with total costs of environmental programmes or projects (Hanley and Spash, 1993, Willis and Garrod, 1995) In the light of this CV survey's WTP values, the next section deals with aggregate benefits of river pollution control and private water connections in Kenya

Expanding CV sample evaluations to aggregate benefit estimates often focuses on accuracy of mean WTP values As a matter of fact, the different methodologies for aggregating benefits (e g , no adjustment, conservative zero bid, weighted average, Ordinary Least Squares and Weighted Least Squares) are typed with respect to the nature of adjustments made on mean WTPs (Loomis, 1987 399) Because this CV survey employed an open-ended face-to-face questioning format, the difficulty of dealing with low response rates and self-selection bias was greatly minimized However, lack of up-to-date, reliable statistics on Kenya's national socio-economic characteristics militates against use of OLS or WLS willingness-to-pay equations Instead, we determine aggregate benefits of river pollution control and private water connections in Kenya by using frequency distributions of the Webuye WTP values, a form of weighted average approach

5.6 AGGREGATE BENEFITS AT DIVISIONAL, DISTRICT, AND NATIONAL LEVELS

To recapitulate, the purpose of this Webuye-Kenya survey was to obtain total economic valuations from households for the impacts of improved river water quality and domestic water supply The respondents were asked to perceive existing water quality in the Nzoia Basin and consider the possibility of a monthly/yearly (the temporal dimensions applied to different sub-samples of the river quality sample) charge to improve the water quality standard to the highest level on the Smith-Desvousges (1986) ladder On the other hand, respondents in the water supply sample were asked to consider the possibility of getting a private water connection when initial connection charge is spread over time or paid upfront (in each sub-sample) and having to pay for it on either monthly or yearly basis (separate sub-samples) The payment vehicles for river pollution control and improved water supply would be by means of additions to council charges/sewerage fees and a water bill respectively As a result of the open-ended questioning format, household WTP for the changes was established for each respondent.

Faced with ten wtp distributions as we are in this survey, it is necessary to make assumptions on which to peg aggregate benefits of the environmental resource and service flow improvements (Table 5 47) There are six distributions for wtp for improvements in river water quality In each of the goods, we can identify two plausible, conservative assumptions A payment-frequency assumption where yearly wtp values are used instead of monthly ones applies to both goods But specific to river water improvement, when aggregation is done at the national level, is the idea that basinwide valuations are apt to be more conservative than area-specific wtp figures Together with the payment-frequency axiom, this assumption may be called the scale-payment-frequency supposition, because it involves picking on basinwide evaluations on yearly basis Similarly, in the case of domestic water supply we can plausibly employ an upfront-payment-frequency assumption For Third World households in need of water, "markets" with upfront connection charges may represent something of a "second best" vis-a-vis a private water connection where the initial charges are spread over time within water bills, the consumer surplus in the former can a *priori* be seen as lower than that in the latter's case

Even though Tables 5 48 and 5 49 include calculations of total WTP for the Kenya using the aforementioned suppositions, regional (Webuye Division and Bungoma District) consumer surpluses/market benefits of the goods are based on more elaborate, realistic assumptions Benefits of River water and domestic water improvements to a regional economy have, of necessity, to take cognizance of the local demographic and socio-economic profile More specifically, it is useful for regional wtp evaluations to reflect the complexities of embedding effect and nature of the payment system for initial connection charges for domestic water supply It is for these reasons we have computed regional WTP (a) for river water improvement using part evaluations and not whole values, distance to the river has been shown to be an important determinant of household wtp due to use-value implications, (b) for a private water connection on the basis of both upfront and spread connection charges, it is often argued that high connection charges are a major factor in Third World household decisions not to hook onto a water supply system

Table 5 47 Assumptions and Secondary Data Used in Benefit Aggregation

A. Assumptions[1] on WTP Distributions.

Good Under Evaluation	Frequency of Payments: Monthly	Yearly
River Water Quality Improvements		
in the entire River Basin	TBS-bm	TBS-by
within the Webuye Division alone	Sect*-sm	Sect*-sy
Domestic Water Supply Improvements	Upfront[2]	Upfront

B Secondary Data.

Aggregation level	Population size[3]	Household size[4]	Number of households	Households without access to portable water[5]
Webuye Division	135,561	5 89	23,015	80 3%
Bungoma District	945,677	5 89	160,555	80 3%
Western Province	2,500,000	5 5	454,546	80 3%
Kenya (National)	28,870,000	4 8	6,014,583	5 0 %[6]

Notes and sources

1 refers to conservative assumptions, assumptions that yield the lowest possible wtp for the improvements in the goods described in the contingent markets

2 refers to upfront connection charges for a private water connection as opposed to a case where the initial charges are spread over time within water bills

3 Gould (1995) p 206, Table 1, Republic of Kenya (1994)

4 NCPD-CBS-MI (1994) p 12

5 for lack of relevant statistics, we use that of western Province (NCPD-CBS-MI, 1994 p 14) for both Webuye Division and Bungoma District, 80 3% refers to proportion of households without access to drinking water piped into residence nor a public tap

6 a 1992 statistic quoted in UNDP (1994) report, p 133

Accepting the survey of the Webuye sub-locations as representative of the population of Webuye Division, the household responses can then be aggregated and applied to an eligible population of approximately 135,561 people This is equivalent to 23,015 households It is as well to note, however, the definitions of eligible populations at aggregate levels and over the contingent commodities Total WTP values are calculated over three levels divisionwide, districtwide, and nationwide All households over the relevant aggregation levels are assumed to be beneficiaries from improved river water quality

Arguably, an appropriate aggregation mode would be the population within the Lake Victoria Development Authority comprising provinces through which the Nzoia River flows Lack of demographic and socio-economic data, nonetheless, militates against computations at such a level More importantly, Water Development Authorities have no legal remit over revenue collection in Kenya (Smoke, 1993) Local Government authorities, like many forms of administrative boundaries, are invariably not in the norm of tracing ecological zones let alone river drainage basins (King, 1984, Smoke, 1993)

As for a private water connection, the eligible population consists of only the proportion of households --at the three levels-- without access to clean, safe water Besides varying across administrative regions, the population of households without access to a safe water supply is also dependent on an area's social economy For instance, Kenya's population with access to safe water increased, respectively, from 17% to 50% over the 1975-80 and 1988-91 periods (UNDP, 1994 136) But owing to rural-urban disparity in the country, the improvement was not evenly realized Over the 1988-91 period, 74% of urban population had access to safe water compared to

43% of rural folks (*Ibid* p 149)

The calculations for total WTP for the Division/region are presented in Table 5 48 (river water quality) and Tables 5 50 and 5 52 (private water supply) Table 5 47, and Tables 5 51 and 5 53, on the other hand, contain computations of total WTP for river pollution control and improved domestic water supply for the entire country

Table 5 48 Regional Aggregate WTP Calculations for River Pollution Control[1]

WTP value	Percentage of of population[2]	WEBUYE DIVISION Number	WEBUYE DIVISION Pop WTP	BUNGOMA DISTRICT Number	BUNGOMA DISTRICT Pop WTP
A	Monthly Payment Frequency				
300	3 1	713	213,900	4,977	1,493,100
250	0 0	0	0	0	0
200	3 1	713	142,600	4,977	995,400
150	9 4	2,163	324,450	15,092	2,263,800
100	12 5	2,877	287,700	20,069	2,006,900
90	3 1	713	64,170	4,977	447,930
80	6 3	1,450	116,000	10,115	809,200
70	12 5	2,877	201,390	20,069	1,404,830
60	6 3	1,450	87,000	10,115	606,900
50	6 3	1,450	72,500	10,115	505,750
40	6 3	1,450	58,000	10,115	404,600
30	9 4	2,163	64,890	15,092	452,760
20	0 0	0	0	0	0
0	21 9	5,040	0	35,162	0
Total	100	23,015	**1,632,600**	160,555	**11,391,170**
			K£ 81,630		**K£ 569,558.50**
B.	Annual Payment Frequency				
2000	0 0	0	0	0	0
1500	7 1	1,634	2,451,000	11,399	17,098,500
1000	7 1	1,634	1,634,000	11,399	11,399,000
800	0 0	0	0	0	0
700	7 1	1,634	1,143,800	11,399	7,979,300
600	3 6	829	497,400	5,780	3,468,000
500	10 7	2,463	1,231,500	17,179	8,589,500
450	7 1	1,634	735,300	11,399	5,129,550
400	14 3	3,291	1,316,400	22,959	9,183,600
350	3 6	829	290,150	5,780	2,023,000
300	10 7	2,463	738,900	17,179	5,153,700
250	3 6	829	207,250	5,780	1,445,000
200	7 1	1,634	326,800	11,399	2,279,800
0	17 9	4,120	0	28,739	0
Total	100	23,015	**10,572,500**	160,555	**73,748,950**
			K£ 528,625		**K£ 3,687,447.50**

Notes [1] Parts A and B are, respectively, based on monthly and annual wtp for pollution control within the Nzoia River Basin within Webuye section alone under Sect*-sm and Sect*-sy questionnaire versions

[2] Last rows may not add up to 100% due to rounding off

Table 5 49 Nationwide Aggregate WTP Calculations for River Pollution Control[1]

WTP value	Percentage of Population[2]	Number of Households	Population WTP
A	Monthly Payment Frequency		
350	6 1	336,890	117,911,500
300	6 1	336,890	101,067,000
250	9 1	547,327	136,831,750
200	6 1	336,890	67,378,000
150	18 2	1,094,654	164,198,100
100	15 2	914,217	91,421,700
90	3 0	180,438	16,239,420
70	6 1	366,890	25,682,300
50	9 1	547,327	27,366,350
0	21 1	1,269,077	0
Total	100	6,014,583	**648,096,120**
			K£ 3,240,480.60
B	Annual Payment Frequency		
3000	3 5	210,510	631,530,000
2000	3 6	216,525	433,050,000
1500	7 1	427,035	640,552,500
1200	3 6	216,525	259,830,000
1000	17 9	1,076,610	1,076,610,000
900	3 6	216,525	194,872,500
800	3 6	216,525	173,220,000
700	10 7	643,560	450,492,000
600	7 1	427,035	256,221,000
500	3 6	216,525	108,262,500
400	10 7	643,560	257,424,000
200	3 6	216,525	43,305,000
0	21 4	1,287,121	0
Total	100	6,014,583	**4,525,369,500**
			K£ 226,268,480

Notes

1 Parts A and B are, respectively, based on total monthly and annual wtp for pollution control in the entire Nzoia River Basin upto Lake Victoria according to TBS-bm and questionnaire versions

2 Last row may not add up to 100% due to rounding off

Table 5 50 Regional Aggregate Monthly WTP for a Private Water Connection by Nature of Initial Connection Charge[1,2]

WTP value	Percentage of population[3]	WEBUYE DIVISION Number	WEBUYE DIVISION Pop WTP	BUNGOMA DISTRICT Number	BUNGOMA DISTRICT Pop WTP
A	With Spread Connection Charges				
250	2 8	517	129,250	3,609	902,250
200	4 2	776	155,200	5,415	1,083,000
150	25 0	4,620	693,000	32,232	4,834,800
100	8 3	1,534	153,400	10,700	1,070,000
90	5 6	1,035	93,150	7,219	649,710
80	11 1	2,052	164,160	14,311	1,144,880
70	11 1	2,052	143,640	14,311	1,001,770
60	5 6	1,035	62,100	7,219	433,140
40	11 1	2,052	82,080	14,311	572,440
30	4 2	776	23,280	5,415	162,450
0	11 1	2,052	0	14,311	0
Total	100	18,482	**1,699,260**	128,926	**11,854,440**
			K£ 84,963		**K£ 592,722**
B.	With Upfront Connection Charges				
200	4 5	832	166,400	5,802	1,160,400
150	10 5	1,941	291,150	13,537	2,030,550
120	1 5	277	33,240	1,934	232,080
100	17 9	3,308	330,800	23,078	2,307,800
90	1 5	277	24,930	1,934	174,060
80	2 9	536	42,880	3,739	299,120
75	1 5	277	20,775	1,934	145,050
70	4 5	832	58,240	5,802	406,140
60	10 5	1,941	116,460	13,537	812,220
50	11 9	2,199	109,950	15,342	767,100
40	16 4	3,031	121,240	21,144	845,760
30	1 5	277	8,310	1,934	58,020
20	1 5	277	5,540	1,934	38,680
0	13 4	2,477	0	17,276	0
Total	100	18,482	**1,329,915**	128,926	**9,276,980**
			K£ 66,495.75		**K£463,849**

Notes

1 Parts A and B are, respectively, based on spread and upfront connection charges

2 Total number of households for Webuye Division and Bungoma District is a function of proportion of population without access to safe drinking water See last column in Table 5 47

3 Last row may not add up to 100% due to rounding off

Table 5 51 Nationwide Aggregate Monthly WTP for a Private Water Connection by Nature of Initial Connection Charge[1,2]

WTP value	Percentage of Population[3]	Number of Households	Population WTP
A.	With Spread Connection Charges		
250	2 8	84,204	21,051,000
200	4 2	126,306	25,261,200
150	25 0	751,823	112,773,450
100	8 3	249,605	24,960,500
90	5 6	177,430	15,968,700
80	11 1	333,809	26,704,720
70	11 1	333,809	23,366,630
60	5 6	177,430	10,645,800
40	11 1	333,809	13,352,360
30	4 2	126,306	3,789,180
0	11 1	333,809	0
Total	100	3,007,292	**277,873,540**
			K£ 13,893,677
B.	With Upfront Connection Charges		
200	4 5	135,328	27,065,600
150	10 5	315,766	47,364,900
120	1 5	45,109	5,413,080
100	17 9	538,305	53,830,500
90	1 5	45,109	4,059,810
80	2 9	87,212	6,976,960
75	1 5	45,109	3,383,175
70	4 5	135,328	9,472,960
60	10 5	315,766	18,945,960
50	11 9	357,868	17,893,400
40	16 4	493,196	19,727,840
30	1 5	45,109	1,353,270
20	1 5	45,109	902,180
0	13 4	402,977	0
Total	100	3,007,292	**216,389,640**
			K£10,819,482

Notes

1 Parts A and B are, respectively, based on spread and upfront connection charges

2 Total number of households (last row, column three) is a function of proportion of population without access to safe drinking water See last column in Table 5 47

3 Last row may not add up to 100% due to rounding off

Table 5 52 Regional Aggregate Annual WTP for a Private Water Connection by Nature of Initial Connection Charge[1, 2]

WTP value	Percentage of population[3]	WEBUYE DIVISION Number	WEBUYE DIVISION Pop WTP	BUNGOMA DISTRICT Number	BUNGOMA DISTRICT Pop WTP
A.	With Spread Connection Charges				
2000	1 4	259	518,000	1,805	3,610,000
1500	2 8	517	775,500	14,311	21,466,500
1200	1 4	259	310,800	1,805	2,166,000
1000	12 5	2,310	2,310,000	16,116	16,116,000
800	1 4	259	207,200	1,805	1,444,000
750	2 8	517	387,750	14,311	10,733,250
700	6 9	1,275	892,500	8,896	6,227,200
600	4 2	776	465,600	5,415	3,249,000
500	12 5	2,310	1,155,000	16,116	8,058,000
450	2 8	517	232,650	14,311	6,439,950
400	12 5	2,310	924,000	16,116	6,446,400
350	2 8	517	180,950	3,610	1,263,500
300	11 1	2,052	615,600	14,311	4,293,300
250	1 4	259	64,750	1,805	451,250
200	11 1	2,052	410,400	14,311	2,862,200
150	1 4	259	38,850	1,805	270,750
100	2 8	517	51,700	3,610	361,000
0	8 3	1,534	0	10,701	0
Total	100	18,482	**19,703,602**	128,926	**954,558,300**
			K£ 985,180.1		**K£ 4,772,915**
B.	With Upfront Connection Charges				
1200	1 5	277	332,400	1,934	2,320,800
1000	5 8	1,072	1,072,000	7,478	7,478,000
900	1 5	277	249,300	1,934	1,740,600
800	4 4	813	650,400	5,673	4,538,400
700	2 9	536	375,200	3,739	2,617,300
600	7 3	1,349	809,400	9,412	5,647,200
500	21 7	4,011	2,005,500	27,977	13,988,500
450	1 5	277	124,650	1,934	870,300
400	11 6	2,144	857,600	14,955	5,982,000
350	1 5	277	96,950	1,934	676,900
300	2 9	536	160,800	3,739	1,121,700
250	2 9	536	134,000	3,739	934,750
200	5 8	1,072	214,400	7,478	1,495,600
100	2 9	536	53,600	3,739	373,900
0	26 1	4,824	0	33,649	0
Total	100	18,482	**7,136,200**	128,926	**49,785,950**
			K£ 356,810		**K£ 2,489,297.50**

Notes [1] Parts A and B are, respectively, based on spread and upfront connection charges

[2] Total number of households for Webuye Division and Bungoma District is a function of proportion of population without access to safe drinking water See last column in Table 5 47 [3] Last row may not add up to 100% due to rounding off

Table 5 53 Nationwide Aggregate Annual WTP for a Private Water Connection by Nature of Initial Connection Charge[1, 2]

WTP value	Percentage of Population[3]	Number of Households[3]	Population WTP
A.	With Spread Connection Charges		
2000	1 4	42,102	84,204,000
1500	2 8	84,204	126,306,000
1200	1 4	42,102	50,522,400
1000	12 5	375,912	375,912,000
800	1 4	42,102	33,681,600
750	2 8	84,204	63,153,000
700	6 9	207,503	145,252,100
600	4 2	126,306	75,783,600
500	12 5	375,912	187,956,000
450	2 8	84,204	37,891,800
400	12 5	375,912	150,364,800
350	2 8	84,204	29,471,400
300	11 1	333,809	100,142,700
250	1 4	42,102	10,525,500
200	11 1	333,809	66,761,800
150	1 4	42,102	6,315,300
100	2 8	84,204	8,420,400
0	8 3	249,605	0
Total	100	3,007,292	**1,552,664,400**
			K£ 77,633,220
B.	With Upfront Connection Charges		
1200	1 5	45,109	54,130,800
1000	5 8	174,423	174,423,000
900	1 5	45,109	40,598,100
800	4 4	132,320	105,856,000
700	2 9	87,212	61,048,400
600	7 3	219,532	131,719,200
500	21 7	652,582	326,291,000
450	1 5	45,109	20,299,050
400	11 6	348,846	139,538,400
350	1 5	45,109	15,788,150
300	2 9	87,212	26,163,600
250	2 9	87,212	21,803,000
200	5 8	174,423	34,884,600
100	2 9	87,212	8,721,200
0	26 1	784,903	0
Total	100	3,007,292	1,161,264,500
			K£ 58,063,225

Notes
1 Parts A and B are, respectively, based on spread and upfront connection charges
2 Total number of households (in last row of third column) is a function of proportion of population without access to safe drinking water. See last column in Table 5 47
3 Last row may not add up to 100% due to rounding off

The calculations in the above tables show that the population of Webuye Division would be prepared to pay approximately Ksh 10 6 million and Ksh 7 14 million per year for the defined improvements in river water quality and domestic water supply For the entire Bungoma District, the household valuation of the benefits of the improvements are Ksh 73 7 million (or K£3 69 million) for improved river water quality and Ksh 49 79 million (K£2 49 million) for a private connection to water supply Note that K£1 is equivalent to Ksh 20 These figures represent an average of approximately Ksh 459 40 (K£22 97) per household and Ksh 386 10 (K£19 31) per household, valuations which are limited to the "intangible" aspects of improved river water (health, recreation, aesthetics and conservation values) and a private household connection to water supply (health, convenience, time savings, reliability and quality) These aggregate evaluations of river pollution control and domestic water supply, in turn, represent K£1 91 and K£1 61 per household per month

Moving on to the republic level, if an arbitrary allocation of a possible average valuation by the national population for both conserving a resource and providing a service of national significance is made, an indication of total national WTP could be calculated The household population of Kenya (minus Bungoma District homesteads) is approximately 5,854,028 and 2,878,366 for purposes of aggregating benefits of river water "salubrity" and a domestic water supply "connection" respectively If K£1 per year per household is arbitrarily assigned as an average WTP for conserving the water resources of the Nzoia Basin and a similar amount for providing water supply, then the total conservation and connection/hook worth to the country of the improvements would be K£5 85 million and K£2 88 million per annum

Accepting this somewhat arbitrary accounting, a total worth to the nation of the ımprovements ın nver water qualıty and domestıc water supply ıs approxımately K£9 54 mıllıon (Ksh 190 8 mıllıon) and K£5 37 mıllıon (Ksh 107 4 mıllıon) per year respectıvely Thıs ındıcatıon of possıble total magnıtude ıs not presented as a defınıtıve calculatıon, ıt ıs provıded merely to stımulate perceptıons of the possıble relatıve magnıtude of benefıt Indeed, two poınts need notıng The countrywıde values are lower - to the order of a tenth - than calculatıons of natıonal WTP ın Tables 5 49, 5 51 and 5 53 Thıs ıs expected Secondly the above value for nver pollutıon control excludes "market" benefıts as well as vısıtor benefıt due to water-based recreatıon Dıscussıons wıth the proprıetor of Nabuyole Falls Lodge, sıtuated at the maın waterfall on the Nzoıa Rıver, revealed that many Kenyan and non-Kenyan tounsts vısıt the sıght, no records were kept at the lodge, however

CHAPTER VI

DISCUSSION OF THE SURVEY RESULTS

6.1 INTRODUCTION

The Nzoia River Basin and domestic water supply are integral parts of the natural and human environment of residents of Webuye Division, Kenya Indeed, residents of the study area are well informed on the twin problems of river pollution and inadequate water supply for domestic purposes This fact explains the relatively good acceptance of this contingent valuation (CV) exercise for Webuye Division dwellers

This Chapter discusses results from the CV survey, presented in Chapter 5, with special focus upon three aspects First, we discuss the demand for river pollution control and individual household water faucets (Section 6 2) Secondly, the section focuses on each of the main research hypotheses Effect of Nature of Good on Contingent Values (Section 6 3), Impacts of Frequency of Payments (Section 6 4), Embedding Effect (Section 6 5), and Effect of Connection Charge Profiles on Evaluation of Household Water Connections (Section 6 6) Ultimately, Section 6 6 presents limitations of the study

6.2 Demand for River Pollution Control and Individual Household Water Connections

This research project has gone some way towards determining the economic value of river pollution control and improved domestic water supply as well as evaluating the applicability of the Contingent Valuation Method in a developing country, Kenya The results of the study suggest that it is possible to do a contingent valuation survey in setting where respondents have limited education and monetary resources and obtain reasonable, consistent answers The multivariate analyses of the willingness-to-pay responses compare very favourably with similar analyses carried out in industrialized countries and other developing countries

The analysis of WTP bids has showed that almost 70% of the families surveyed would be willing to pay Ksh 30 (£0 35)[49] per month for pollution control in the Nzoia River Basin, and over 40% stated that they would pay at least Ksh 60 (£0 69) For an individual household water connection, over 30% would be willing to pay Ksh 90 (£1 04) or more per month, and about 5% stated they would pay at least double the existing water flat rate for Webuye Town Council Therefore, it is clear that the surveyed households in Webuye Division of Bungoma District, Kenya have an unmet desire for the control of river pollution, and for individual water connections The households are willing to contribute significant amounts of money, compared to existing Webuye residential sewage rates, towards river pollution control in the Nzoia Basin Further still, Webuye residents without water connections are willing to pay at least as much as other similar customers who possess them

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[49]From this section onwards, Pound (£) refers to the UK Sterling Pound and not the Kenya Pound equivalent of Ksh 20 00

Results of ordinary least squares (OLS) regression models show that the principal factor influencing households' willingness to pay for river pollution control and individual water faucets is family income The effects of other factors were more specific to the contingent good In order of strength, the other determinants of WTP for river "salubrity" are sex, age, household ranking of status of domestic water source, distance from river to household residence, the other factors affecting WTP for water "connections" are existing source of water supply (in terms of convenience, quality and reliability), household size, ranking of river water quality, and age of household head In addition, a strong correlation between education, income and occupation was noted

In so far as households were willing to place a higher average monetary value on river pollution control than improved domestic water supply connotes a possible appreciation of the non-use component of water resources management This is an inspiring finding when seen in the light of the fact that little environmental valuation research in Third World economies has directly addressed components of total economic value Almost exclusively, existing work in this area involves conservation of biodiversity (e g , Perrings *et al* , 1992), tropical deforestation (e g , Adger *et al* , 1993 in Mexico), and wildlife (Brown and Henry, 1989 on Kenya elephants, Thomas *et al* , 1991 in Tunisia)

As a matter of fact, we know no Third World CV survey that breaks down water-related values into the four possible components of Actual User Value, Option of Use Value, Existence Value and Bequest Value Brookshire *et al* (1986) warn the water analyst about conceptual problems that arise in valuing existence values of water resources, "existence value may have two components (1) an economic component that is consistent with utility maximizing behaviour and (2) an ethical component that is inconsistent with normative benefit-cost assumptions" (p 1509) In most state-of-the-art CV surveys in developing countries, environmental media such as air and water quality have remained marginalized thereby reinforcing the notion that real environmental issues are the preserve of the rich, industrialized nations[50] Yet this study suggests otherwise

6.3 NATURE OF THE GOOD AND THE VALIDITY OF CONTINGENT VALUES

The first question explored in this study was whether the nature of the good being valued influences the validity of evaluations made using the CV approach in a Third World setting In particular we hypothesized that contingent values for river water control (RWQ) would be less reliable and less accurate than those for a household connection to piped water (DWS) because the DWS was more well-defined and concrete, and because of respondents' greater familiarity with it

There appears to be *prima facie* evidence that Webuye residents understood the two goods differently owing to their familiarity This is because willingness to pay responses were higher in improved domestic water supply than for river water quality improvement In particular, the number of households who would not pay for pollution control in the Nzoia River Basin was more than double that of those not wtp for a private water connection (58 versus 27) A closer scrutiny reveals that more of the

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[50]Most economists often argue intuitively that environmental improvement is a luxury good or a pursuit of the more privileged (Pearce, 1980, McFadden and Leonard, 1992) For instance, McFadden and Leonard (1992 p 22) write "Environmental protection should be a 'luxury' good that in poor families is displayed by basic needs for food and shelter, and in wealth families more affordable" However, recent results by Kristrom and Riera (1996) (albeit based on European data-sets) do not support the economic folklore suggesting that environmental quality is a luxury good

refusal-to-pay (rtp) responses ın the latter group (51 9%) are true zeros whılst 56 9 per cent of the former group are protests Second, sınce a hıgher proportıon of those not wtp for dws gave "I cannot afford" reason, there were more protest bıds ın rwq valuatıon than ın the evaluatıon of ımproved water supply

Yet, coeffıcıents of varıatıon (c v s) of mean WTP measures, as well as OLS models for WTPs dıd not support the hypothesıs Instead these results ındıcate that both contıngent good scenarıos yıelded valıd and relıable value estımates The c v s for wtp values for ın-house water connectıon vary between 65% and 81% whıle those for rıver water qualıty are more unrelıable, varyıng between the range of 82% and 137% The dıvergence of these values ıs consıstent wıth the Cummıngs *et al* (1986) hypothesıs that welfare measures for publıc goods wıll have a hıgher varıance (as a proportıon of the mean) and therefore be less relıable than those for a prıvate good However, the nature of goods ın thıs experıment do not epıtomıse polar extremes of the publıc-prıvate good contınuum found ın Kealy *et al* 's (1990) study Indeed, the coeffıcıents of varıatıon ın thıs study are quıte bıg ın both cırcumstances The survey by Kealy and co-workers found the "proportıonate varıance of WTP ıs 44 7% for the publıc good and 40 4% for the prıvate good usıng the full sample When we recalculate the value for the prıvate good usıng the random subsample, the proportıonate varıance rıses to 44 6%" (p 256) Secondly, Kealy *et al* employed the referendum, or closed-ended method of questıonıng whılst thıs one took an open-ended format, thıs dıvergence may explaın, to a large extent, our hıgh coeffıcıents of varıatıon

The experımental desıgn ıncorporated numerous tests to check the ınternal consıstency and relıabılıty of the households' wıllıngness-to-pay responses, ıncludıng a test for effect of bias due to the socio-economic setting, and the effect of effect of observers listening to the interview (as in Whittington *et al*, 1993 study on demand for improved sanitation in Ghana) These tests revealed little reason for serious concern about the reliability or validity of the willingness-to-pay responses, across the two commodities

This finding is important for those seeking to apply CV surveys to the evaluation of environmental and public goods in developing and transition economies Nonetheless, one experiment can only be suggestive and not conclusive The often amorphous nature of public goods and the public's frequent lack of familiarity with them may not be the major impediments to obtaining reliable WTP estimates through the CV methodology Indeed, recent research in environmental psychology (e g , Hull and Buhyoff, 1983, Williams, 1985) shows that familiarity does predict preference, but only in a non-linear inverted U fashion The crucial factor in CV application, therefore, is careful design and judicious presentation of "sufficient" information in the hypothetical scenario

6.4 THE IMPACTS OF FREQUENCY OF PAYMENTS IN CONTINGENT VALUATION

This CV application has studied, amongst other aspects, the effect on WTP values of two temporal dimensions of payment, monthly and yearly contributions The contingent valuation markets were those of improved river water quality in the Nzoia Basin and a private water connection in Kenya

It is well known in psychology and marketing research that alternative methods of conveying information can have profoundly different impacts in terms of a consumer's interpretation and perceptions of the content The results of this CV survey show that different payment frequencies produce statistically different estimates of WTP for improved river water quality and a private water connection

Which of these temporal dimensions of payment yields values closer to the "truth" is of course difficult to determine in contingent valuation This is because as we have already argued, different payment schedules may cause respondents to re-evaluate their true WTP for the good, through both the perceived-frequency route and the income-smoothing route These two factors could exert opposing influences on the difference between the stated value of river water improvements, or drinking water connections (in this case)

Clearly, one reason for respondents bidding higher for monthly payments than for annual ones is that it spreads the payment period and thus potentially can earn interest on savings However, the necessary implied discount rate if this were to entirely explain the difference is very high (over 9 49%) Such levels of effective interest rate are highly unlikely in most developing countries indeed, due to both lack or insufficient collateral that is acceptable by commercial banks as well as low, erratic incomes most households often *pay* informal savings collectors (such as rotating savings and credit associations, moneylenders, moneykeepers) to save and hence protect their savings from the incessant appeals of food and other basic needs (Steel and Aryeetey, 1994, Ardener and Burman, 1995) Secondly, the relevance of this argument depends on the size of WTP amounts relative to average income In this study, mean WTP bids are less than 3 percent of average household income

A further complication, which has not been considered in this thesis, is whether changes in the frequency of payment affect the extent of "warm glow" effects in CV The propensity to respond to CV questionnaires in the context of donations to charity (which gives rise to warm glow effects) depends on the proportion of the total economic value of the good in question accounted for by non-use values, which in turn depends on the position of the good along the pure public-pure private good continuum (Kealy *et al* , 1990) In this case, river water quality lies closer to the public good end of the continuum, and drinking water closer to the private good end Thus, any effect of frequency of payment on warm glow responses should be less important for the latter than the former

In conclusion, the frequency of payments embodied in a CV survey do seem to matter for the revealed benefits of goods This is perhaps particularly the case in developing countries where income flows are erratic than in the developed world Whether this sensitivity to timing could be avoided by seeking WTP amounts in alternative forms than money, such as crops (e g , Shyamsundar and Kramer, 1993, Shyamsundar and Kramer, 1996) or labour (e g Swallow and Woudyalew, 1994) needs to be established empirically, but it is not obvious why this should be so

6.5 Embedding in WTP Values for Water Pollution Abatement in the Nzoia River Basin

Amongst other questions, this study has dealt with one specific aspect of the CV method's validity claim, namely, to what extent does the method produce different values in situations for which economic theory claims different values A valid measurement method should be sensitive to relevant changes in applications and insensitive to irrelevant ones Embedding is a critical test for contingent valuation (CV) because it involves an objective definition of relevance, namely, magnitude variation People who value a small amount of a good should assign a greater value to a much larger amount (although marginal utility is expected to decline)

It is recalled that embedding occurs when the WTP value for a specific good - in this experiment, pollution control in Webuye part of the Nzoia River Basin - is similar to the WTP value for a more inclusive good here pollution control in the entire Nzoia River Basin upto Lake Victoria

On the basis of nine studies that examined similar effects (Kahneman and Knetsch, 1992a, Magnussen, 1992, Desvousges *et al*, 1993, Diamond *et al*, 1993, Fischhoff *et al*, 1993, Kemp and Maxwell, 1993, McFadden and Leonard, 1993, Owen and Hanley, 1994, Hoevenagel, 1996), six hypotheses were formulated and tested these studies refer to work done since Kahneman's 'Comments' in Cummings *et al*, (1986) Embedding did not manifest itself in this experiment Respondents considered pollution control in the entire Nzoia River Basin more significantly valuable than pollution control in Webuye part of the Basin only One possible explanation for this result is that the inclusive good was largely different from the specific good (McFadden and Leonard, 1993), specially in terms of number of kilometres, the study did not numerically (i e , in kilometres or miles as in Majunder *et al* , 1990 or Fischhoff *et al* , 1993) specify the length of the river from Webuye to Lake Victoria Instead, a map of the geographical spread of the Basin was shown to respondents A second, more reasonable and plausible explanation for non-occurrence of embedding in this experiment because the environmental goods involved were well-defined This is in line with Magnussen (1992) and the misperception hypothesis of Mitchell and Carson (1989) Consequently, it is argued that CV surveys, when properly designed, can discriminate between different environmental goods in a way that corresponds to the economic axiom of "more will always be better"

6.6 Initial Charges and WTP for Private Household Water Faucets

The comparatively low WTP estimates for improved domestic water supply (*vis-a-vis* existing water flat rate) from this survey appear to underscore the familiar problem of equity concerns in the provision of improved water services The finding that less than 50% of the households surveyed were willing to pay Ksh 90 and more, in particular, suggests that conventional water connections with initial connections costs paid up-front are simply not affordable to the majority of households in Webuye Division without massive government subsidies

An alternative interpretation is that some of the households had already made significant investment in other options (e g , in water storage facilities, construction of wells, and contributions to the Much-Milo Community water project) and, hence, focused on the unreliability of the government-provided water service Subsequently, some households did not perceive any advantage to the government-provided service, despite interviewers' assurances that the new scheme would work better than the existing one This is particularly so as the residents were well-informed, by local water supply personnel, of the inadequacy of the Webuye Water Supply facility in covering the 1973-planned area given the post-1973 population increase that has occurred The Webuye Water Supply, while giving water of good quality, was unreliable and was frequently stated to be out of service or suffering from an elevated demand that reduced pressure to levels that made it *de facto* unusable

These interpretations highlight the need for increased household choices in respect of water services Offering a greater range of services is a vital element of a demand-driven strategy to improved domestic water supply as it is a necessary condition for moving from a "low-level equilibrium trap" (in which a low level of services is provided, willingness to pay and thus, revenues are low, and the operation consequently deteriorates) to a "high-level equilibrium" (in which users get a high level of service, pay for it, and maintain the desired system) (Briscoe, 1992, World Bank Water Demand Research Team, 1993)

Results of this survey and the statistical tests on average WTP measures for domestic water supply improvement across profiles of initial connection charges indicate that an inability to afford the cash portion of the connection charge is the main reason people do not hook up to the piped water system in Webuye, Kenya This finding on the role of connection charges in household decisions to hook on to a water distribution system is supportive of Altaf *et al*'s (1992, 1993) and McPhail's (1994) results, respectively, from rural areas of Punjab, Pakistan and urban areas of Tunisia

So, therefore, a combination of subsidized public standposts and individual faucets with "spread" connection charges, but at full cost monthly tariffs, would appear to be the relevant options Whereas the former offers a partial solution to the equity concern, the latter addresses the financial viability of the piped water system To avoid the relatively better-off households from interpreting this as a disincentive to connect to the system (and thus compromise the financial viability of the system), this arrangement would work if the water utility puts the public taps nearer to areas of poorer households It is the relatively better-off families in this study area who are choosing to install private faucets and who are, therefore, the principal beneficiaries of the subsidies implicit in this service Individual water connections and public taps, as a matter of fact (Briscoe, 1990, 1992, World Bank Water Demand Research Team, 1993), are not perceived by Third World households as close substitutes Besides price variation between the two systems, families with more income and assets perceive public taps and any other water source (apart from individual taps and bottled water) as inferior goods It would appear possible, then, to improve equity in developing country water supply systems through effective cross-subsidization by charging high tariffs for the individual taps used mainly by the better-off and providing free or subsidized public taps that are used mainly by the poor The overall goal of public tap policy ought to be to provide a basic level of water supply for the poor, not to generate revenues

Importantly, the piped water system ought to be made more reliable for households to decide in favour of either using the standpipes or private connections Parallel to studies elsewhere in the developing world (McPhail, 1993, 1994, Briscoe, 1990), Webuye residents found reliable dug wells close to homes more attractive than the alternative of unreliable tap water relatively far from most houses Indeed, this reason was cited most frequently by interviewees and water officials alike for the failure of public taps or water kiosks in Webuye Division (e g , Kubebea, 1995, Kwoma, 1995) As McPhail (1992) writes "while . up-front charges discourage connections to the piped water service, the level and quality of the water company's service seems to be the important determinant to the role that the monthly tariff plays in the connection decision Thus, the more the water company can guarantee good quality and reliable service, then the less the monthly tariff will be a deterrent to making a connection to the piped water system" (p 195)

Because of the intimate link between financial viability, on one hand, and reliability and quality of service on the other, however, the often high up-front connection charges appear to be a key policy area for intervention with regard to household decisions to hook It might be advisable, therefore, for the Government or future Webuye water utility to seriously consider either to lower upfront costs (that is, utility required down payment and connection charges) or eliminate them altogether and institute a slightly higher monthly water tariff Evidence from this survey and similar ones (e g , Whittington *et al* , 1990, Altaf *et al* , 1993, McPhail, 1993, McPhail, 1994) indicate that water bills constitute a small portion of the overall household budget (typically under 5 per cent), and there would appear to be room for the slight increase in tariffs necessary to finance the household connection

6.7 Limitations of the Study

The use of contingent valuation to value river water quality and domestic water supply improvements in Webuye Division was a test application designed to identify the potential for general use in non-market valuations in Kenya, as well as an attempt to inform the procedure on the role of temporal dimensions of payments in WTP values Problems with the technique have been well documented in other publications, e g Thaler (1981), Hanley and Spash (1993), Scanlan (1994), and Hanley *et al* (1994, 1995) This section discusses some limitations associated with the Webuye-Kenya application

This study is constrained both by generic limitations of cost-benefit analysis (CBA) and specific shortcomings of clean water data Regarding the first set of issues, CBA considers economic efficiency criteria that have inherent limitations as a guide to policy decisions For example, policies that maximize net benefits may yield losers that are not directly compensated In addition, if people initially have a right to clean water (clean water in Nzoia river and tap water, in this case), this could suggest that placing additional emphasis on WTA in place of WTP as a valuation measure[51] WTA data for river water quality improvements and improved domestic water supply in Kenya are unavailable for comparison, however

Also, the apparent popularity of river pollution control in the Nzoia basin and household connections to piped water supply could be viewed as a revealed preference

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[51]As noted in Chapters 3 and 4, WTP is a standard approach for cost-benefit analysis It assumes that the respondent does not own the property rights for the environmental good WTA shifts the initial ownership to the respondent Research indicates that WTA can be significantly more than WTP where goods in question do not have good substitutes and where demand is sensitive to income (Hanemann, 1991) *Cummings et al* (1986, p 35) found that WTA was roughly 3-5 times WTP in the environmental valuation studies they surveyed

by voters that they perceive the benefits as being greater that the costs However, voting behaviour also may reflect the distribution of benefits and costs, as well as a lack of good information, so that popular policies do not necessarily have positive aggregate net benefits

In addition to these conceptual constraints, this economic analysis has specific limitations related to water quality analysis. As noted in the next chapter, these limitations suggest a number of directions for further research, including development of better data linking anticipated policy changes, costs, and river quality improvements, comprehensive evaluation of the incremental costs and effectiveness of point and nonpoint source pollution reduction practices, and further analyses (using CV and other methods) of the economic benefits of water quality improvements and policy programmes on other water resources issues Such additional information, on both national and regional levels, could help guide policy makers toward more efficient policies

Even more specific limitations to the CV survey relate to its design In this regard three aspects are discernible order effect, decomposition of Total Economic Value and potential salience bias

1 Order effects in the evaluation of improved water supply across upfront and spread payment profiles for initial charges might be the main limitation This may be particularly so because work by Tversky (1977, Tversky and Gati, 1978), as well as some recent studies (Fischhoff *et al*, 1993, Wanke *et al*, 1995) on judgment of similarity indicate that comparing A to B may result in different similarity judgments than comparing B to A The researchers' results demonstrate that the direction of comparison elicited by a given question wording can have an impact on obtained

results

2 In valuing public goods and impacts there is need to give more consideration to the national benefits of option, existence and bequest values It is possible that the costs and benefits reflected in these values may be of significant magnitude in relation to other market and non-market impacts Obviously, to obtain such information would require a much broader sampling base, increasing survey costs considerably

3 A limitation of any valuation is that it is only valid for a particular point in time and will change with changing attitudes Environmental consciousness has increased markedly over the past 25 years and the trend is expected to continue Individual valuations of environmental resources and service flows will be dependent on the overall level of consciousness at that time Five years hence, the perceived worth of many environmental and public goods may have changed considerably

CHAPTER VII

SUMMARY, CONCLUSIONS AND IMPLICATIONS

7.1. REVIEW OF THE STUDY OBJECTIVES

This study set out to apply and assess the contingent valuation (CV) method in river pollution control and domestic water supply improvements in a developing country, Kenya The CV method is one approach to measuring benefits of environmental improvements that has gained currency in the economics literature as well as the interdisciplinary valuation of environmental and public goods in the Third World The specific objectives of this research were (a) to estimate the value of improved river water quality and a private water supply connection, (b) to evaluate the feasibility of using the contingent valuation method to value an environmental amenity and its quasi-public service in rural setting where respondents have limited education and monetary resources, (c) to empirically investigate the embedding effect in contingent valuation of river water quality improvement in a less developed economy, and (d) to examine the role of the temporal dimension of bid payments (i e , frequency of payments) in contingent values for environmental improvements

Unlike other water catchment areas and river basins in Kenya, the Nzoia River ecosystem has received disproportionately less focus of scientific investigation The inattention is surprising because, during the last 25 years or so, anthropogenic alterations or stress, especially those related to non-point pollution from sugarcane agriculture, municipal water use, and to pollution by toxic substances from industries, have been applied to the Nzoia river with ever-increasing frequency Non-point pollution from agricultural farms (especially soil erosion from farms and heavy use of herbicides), raw sewage from the municipalities (such as Webuye) as well as effluents from paper and sugar processing industries and the East African Heavy Chemicals Industries at Webuye are the principal sources of pollution for Webuye water resources and the Nzoia river basin in Webuye administrative division and its surrounding areas Sediment transported from land through erosion is a major pollutant of water resources in Webuye Recent increased use of chemical fertilizers and pesticides in sugarcane agriculture results in residual inputs transported by water to endanger stream and groundwater supplies It also encourages and allows intensified row-crop farming of maize, which is accompanied by silt exports and the degradation of water supplies Generally the pollutants have led to deterioration of river water quality thereby occasioning eutrophication, as evidenced by the extensive blooms of blue-green algae, frequent fish kills, and a steady decline in fish landings during recent years

7.2 CONCLUSIONS

This research project has gone some way towards determining the economic value of river pollution control and improved domestic water supply as well as evaluating the applicability of the Contingent Valuation Method in a developing country, Kenya The results of the study suggest that it is possible to do a contingent valuation survey in setting where respondents have limited education and monetary resources and obtain reasonable, consistent answers The multivariate analyses of the willingness-to-pay responses compare very favourably with similar analyses carried out in industrialized countries and other developing countries The multivariate analyses indicated that the principal factor influencing households' willingness to pay for river pollution control and individual water faucets is family income The effects of other factors were more specific to the contingent good In order of strength, the other determinants of WTP for river "quality" are sex, age, household ranking of status of domestic water source, distance from river to household residence, the other factors affecting WTP for water "connections" are existing source of water supply (in terms of convenience, quality and reliability), household size, ranking of river water quality, and age of household head In addition, a strong correlation between education, income and occupation was noted

The limitations of the technique must be acknowledged and minimized in the design and implementation stages Inasmuch as undertaking a contingent valuation is relatively costly, its use should be restricted to major impacts, i e to investigations involving "non-market" impacts that may be significant in major, large-scale evaluations The extent of publicness of "non-market" effects need to be the key element in tilting the balance in favour of the CV approach *vis-a-vis* other methodologies

Benefit transfer is yet another issue related to the expensiveness of CV surveys It would be advantageous if CV results from one study could be gencralised to other cases For example, a CV estimate of WTP for a given water quality improvement in a particular river (river A) might be capable of being 'transferred' to the measurement of the benefits of a similar improvement of water quality in a different river (river B), other things being equal Such a straightforward transfer of benefits is not likely to be possible, however, since other aspects are typically not equal (Walsh *et al*, 1989, Desvousges *et al*, 1992, O'Doherty, 1995, Willis, 1995) Usually, value estimates have to be adjusted if transfers are to be made This implies an empirical knowledge of the determinants of WTP

Added advantages of using the survey approach are that additional information on attitudes, socio-economic parameters, etc , can be obtained at no extra cost, and the public are made aware that their attitudes and valuations are being acknowledged by decision-makers These merits, however, are neither restricted to developing country scenarios nor to Kenya Next we consider the implications of these results for contingent valuation, policy, and further research

7.3 IMPLICATIONS FOR CONTINGENT VALUATION, POLICY, AND FURTHER RESEARCH

The emerging lessons from this study can be typed into three broad categories methodological implications, policy implications, and directions for further research

(a) Methodological Implications

The experimental design incorporated numerous tests to check the internal consistency and reliability of the households' willingness-to-pay responses, including a test for effect of bias due to the socio-economic setting, and the effect of effect of observers listening to the interview These tests, as well as those on embedding effect and the impact of connection charge profiles on evaluation of piped water connections, revealed little reason for serious concern about the reliability or validity of the willingness-to-pay responses From a methodological perspective, however, there was an interesting aspect about the evidence on the impacts of temporal dimensions of payments on contingent values

The frequency of payments embodied in a CV survey do seem to matter for the revealed benefits of goods This is perhaps particularly the case in developing countries where income flows are more erratic than in the developed world Whether this sensitivity to timing could be avoided by seeking WTP amounts in alternative forms than money, such as crops or labour needs to be established empirically, but it is not obvious why this should be so

(b) Policy Implications

From a policy perspective, it is possible to draw several conclusions from the results of the household surveys performed in Webuye, Kenya and the subsequent analysis outlined in this report First, an analysis of the WTP bids shows that almost 70% of the families surveyed would be willing to pay Ksh 30 (£0 35) per month for pollution control in the Nzoia River Basin, and over 40% stated that they would pay at least Ksh 60 (£0 69) For an individual household water connection, over 30% would be willing to pay Ksh 90 (£1 04) or more per month, and about 5% stated they would pay at least double the existing water flat rate for Webuye Town Council Therefore, it is clear that the surveyed households in Webuye Division of Bungoma District, Kenya have an unmet desire to control river pollution, and for individual water connections The households are willing to contribute significant amounts of money, compared to existing Webuye residential sewage rates, towards river pollution control in the Nzoia Basin Further still, Webuye residents without water connections are willing to pay at least as much as other similar customers who possess them Thus, from a standard welfare economic perspective, social welfare could possibly be improved by controlling water pollution in the Nzoia River Basin and extending the existing piped water system to unconnected households

A second policy conclusion relates to the comparatively low WTP estimates for improved domestic water supply The finding that less than 50% of the households surveyed were willing to pay Ksh 90 and more suggests that conventional water connections with initial connections costs paid up-front are simply not affordable to the majority of households in Webuye Division without massive government subsidies In retrospect this is perhaps not so surprising What was less apparent before this research, however was the residents' understanding of the diverse budgetary implications of a piped water connection under the hypothetical "Spread" and exiting "Upfront" connection charges Moreover, it was not clear at the outset whether or not the households' WTP for river pollution control would be higher than that for a individual water connection The results of the CV study showed that most households were willing to about as much for pollution control in the Nzoia River Basin within Webuye Division as for a household water faucet The study also indicated that households' willingness to pay for pollution control in the Nzoia Basin within Webuye Division and for river water quality improvement in the entire Nzoia Basin upto Lake Victoria appear to be of approximately the same order of magnitude and largely separable

(c) Further Research Directions

Limitations to this CV study have already been raised But on effects of temporal dimensions (or frequencies) of payments in contingent valuation our experiment is only a pointer to what mechanisms/factors could erode the validity of resultant WTP estimates All the factors need a follow up, even via comparative research over developed and developing/transition economies, as well as regional economies with different expenditure-income temporal patterns Secondly, there is need for follow-up studies across a variety of CV questioning formats to discern the direction of the impacts One possible format is a bidding game for a given contingent commodity, determine WTP by offering respondents a choice of X per month or 12X per annum and relevant discount rates X is the relevant monetary unit

Another area for future work is to do with decomposition of total economic value of environmental improvements This study has shown that little compromise on the validity of contingent values due to the nature of the good under valuation Given this, it would be useful to study components of total economic value in developing country natural resources service flows Past work in this area has involved, in the main, tropical deforestation and wildlife conservation Environmental media such as air quality and water quality have remained on the margin, thereby reinforcing the notion that real environmental issues are the preserve of the rich

Two further research directions relate to environmental impacts of river water pollutants and the role of connection charges in domestic water supply The need for an environmental impact assessment of water pollutants of the Nzoia River as further area for investigation may appear to be tangential to this report Yet for better, realistic resolution of the river pollution problem, we need to determine the cost side For cost-benefit analysis (CBA), CV results are meant to be an input in the decision making process and not an end in themselves For this reason, there is need for (i) Evaluations of Critical BOD Loadings from Manufacturing Industries especially sugar mills and the Panafrican Paper Mills, and the East African Chemical Industries, and (ii) Evaluation of Impact of Standards on Manufacturing Industries in the River Basin Ideally COD standards for domestic /municipal and industrial wastewater must be different Standards specific to industries may have to be devised, but this will depend on Kenya's inspectorate Pollution regulations generally have the effect of raising production costs and, hence, product prices Traditionally, many developing countries like Kenya have feared that regulations and emission standards will result in a loss of international competitiveness This loss can have a consequent negative effect on export industries and on the country's trade balance. In view of Kenya's proposed *National Environmental Enhancement and Management Act*, however, an evaluation of the impact of imposing progressively more stringent effluent regulations on the sugar and paper industries operating in the Nzoia Basin and its trade consequences has to be carried out to determine the effect of such environmental protection on competitiveness

The reliability and quality of the water service provided by a water supply utility is important in household reaction to monthly tariffs as signals to decisions to hook onto a piped system Owing to the intimate link between financial viability, on one hand, and reliability and quality of service on the other, however, the often high up-front connection charges appear to be a key policy area for intervention with regard to household decisions to hook It might be advisable, therefore, for the Government or future Webuye water utility to seriously consider either to lower upfront costs (that is, utility required down payment and connection charges) or eliminate them altogether and institute a slightly higher monthly water tariff The full implications of this system for the financial viability of a water system, such as Webuye Water Supply, as well as mechanisms of collecting payments for water use from public taps need investigation

APPENDICES

APPENDIX 3A: REFERENCES FOR DEVELOPING COUNTRY CONTINGENT VALUATION STUDIES

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APPENDIX 4A: QUESTIONNAIRE FOR GOOD 1: ESTIMATING BENEFITS OF IMPROVED WATER QUALITY IN THE NZOIA RIVER BASIN, KENYA (Note Six different versions of this questionnaire were used Each version varies only)

THE CV QUESTIONNAIRE

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IDENTIFICATION INFORMATION

A Site/Village ID No

B Interviewer ID No

C Interview number

D Date / . / 1995

E Interview Start Time . am/pm

F Questionnaire Version **A**

G Presence of Adult Listeners to the Interview Yes [ ] No [ ]

H Interview Setting Rural [ ] Urban [ ]

I SURVEY BACKGROUND AND INTRODUCTION

Good morning/afternoon My name is Wilson Wasike I am doing research into peoples's attitude to water quality in the Nzoia River It would be of great help to me if you participated in this survey All answers will be treated in strictest confidence and are for research purposes only

1 To what extent do you think river water quality is a problem

(a) in Kenya [ ]

1	2	3	4	5
Serious problem				No problem

(b) in Webuye Division [ ]

1	2	3	4	5
Serious problem				No problem

Please put a value of 5 indicating no problem and a value of 1 for a serious problem, you may also indicate any value between the two numbers

2 (a) What activities does your household engage in that involve use of the Nzoia River?

Water for drinking/cooking/domestic washing	Yes/No,
Watering flowers	Yes/No,
Irrigating vegetables (e g sukuma wiki, tomatoes etc)	Yes/No,
Watering livestock	Yes/No,
Fishing	Yes/No,
Other (specify)	______________________
Total number of uses	[ ]

(b) Are you planning to use it at any other time within the next one year?

Yes [ ] No [ ]

3 (a) Are you aware of any changes in water quality in the Nzoia River in Webuye Division?

Yes [ ] No [ ]

(b) If YES, where on the following water quality ladder/ranking would you place the Nzoia River?

Best water quality	[ ]	10	A	drinkable, swimmable, fishable, boatable
	[ ]	9		
	[ ]	8		
	[ ]	7	B	swimmable, fishable, boatable
	[ ]	6		
	[ ]	5	C	fishable, boatable
	[ ]	4		
	[ ]	3	D	boatable
	[ ]	2		
	[ ]	1	E	no activity recommended
Worst water quality	[ ]	0		

(c) What is the distance (in km) from the Nzoia River to your residence? ____ km

4 (a) Would you (and your family) benefit from an improvement in water quality in the River Nzoia from the current level?

Yes [ ] No [ ]

(b) If YES, how would you rank the following benefits of river quality improvement in order of importance? Put scores 1 to 5 where 1 stands for "not important at all", "not very important", "neither important nor unimportant", "somewhat important", and 5 for "very important"

[ ] Contribute towards a cost-effective water supply for personal use and increase enjoyment of its users

[ ] Protect the river water for use by the future generations

[ ] Avoid dirty, unsightly and smelly nature of river

[ ] Contribute towards the improvement of the environment in general

[ ] Conserve wildlife and plants

II. Benefit Measures

Now I would like to ask you some questions about how much your household would be willing to pay to improve water quality in the Nzoia River basin to the top most level on the water-quality ladder

5 Assume that all the households living in the neighbourhood of the Nzoia River are asked to pay so that they can benefit from a cleaner river The local authority might have to compensate farmers and industries for the extra expenditure incurred by them in cleaning their effluents, or spend extra money policing the cleaning of the Nzoia river The current Webuye Municipal Council sewerage fees and charges for domestic use per family are Ksh 30/= per month, but these service charges would have to be raised to cover the river-cleaning project

If you were asked how frequently you would like to pay for improved water quality on the Nzoia River, which of these two frequencies would you prefer?

Monthly [ ] Yearly [ ]

Version A1: Basin and Section on Monthly Payment Scheme

6 (a) Now suppose the payments are to be made monthly and the payment would mean that you need to spend less on other items, would you be willing to pay any charge to reducing pollution on the Nzoia river section within Webuye Division?

Yes [ ] No [ ]

(b) SHOW CARD If NO, which of the following reasons best describes why you are not willing to pay any money to clean the Nzoia River?

[ ] Not enough information

[ ] I do not want to place a shilling value on the water quality in the Nzoia River

[ ] Improving the Nzoia river water quality has no value to me

[ ] I do not want to participate in this survey

[ ] I cannot afford to pay

(c) If YES, what is the most you as a household would be willing to pay per month in council charges and sewage fees in order to improve the Nzoia river quality in Webuye Division (area)?

_____ Kshs/month

(d) The current water quality for the Nzoia River as a whole may vary at different points along the river In addition to the amount you have just told me [READ THE AMOUNT FROM 6c], how much more monthly council charges and sewage fees would you be willing to pay to have a cleaner Nzoia River upto Lake Victoria (i e , the entire river basin)?

_____ Kshs/month

Version A2: Basin and Section on Yearly Payment Scheme

6 (a) Now suppose the payments are to be made yearly and the payment would mean that you need to spend less on other items, would you be willing to pay any council charges and sewage fees to improve the Nzoia River water quality in Webuye Division (area)?

Yes [ ] No [ ]

(b) SHOW CARD If NO, which of the following reasons best describes why you are not willing to pay any money to clean the Nzoia River?

[ ] Not enough information

[ ] I do not want to place a shilling value on water quality in the Nzoia River

[ ] I do not want to participate in this survey

[ ] I cannot afford to pay

(c) If YES, what is the most you as a household would be willing to pay per year in council charges and sewage fees to improve the Nzoia River quality in Webuye Division (area)?

_____ Kshs/year

(d) The current water quality for the Nzoia River as a whole may vary at different points along the river In addition to the amount you have just told me [READ THE AMOUNT FROM 6c], how much more annual council charges and sewage fees would you be willing to pay for a cleaner Nzoia River upto Lake Victoria?

____ Kshs/year

Version A3: Section on Monthly Payment Scheme

6 (a) Now suppose that the payments are to be made monthly and the payment would mean that you need to spend less on other items, would you be willing to pay council charges and sewage fees to improve the Nzoia River water quality in Webuye Division (area)?

Yes [ ] No [ ]

(b) SHOW CARD If NO, which of the following reasons *best* describes why you are not willing to pay any money to clean the Nzoia River?

[ ] Not enough information

[ ] I do not want to place a shilling value on water quality in the Nzoia River

[ ] I do not want to participate in this survey

[ ] I cannot afford to pay

(c) If YES, what is the most you as a household would be willing to pay per month in council charges and sewage fees to improve the Nzoia River water quality in Webuye Division (area)?

____ Kshs/month

Version A4: Section on Yearly Payment Scheme

6 (a) Now suppose that the payments are to be made yearly and the payment would mean that you need to spend less on other items, would you be willing to pay council charges and sewage fees to improve the Nzoia River water quality in Webuye Division (area)?

Yes [ ] No [ ]

(b) SHOW CARD If NO, which of the following reasons **best** describes why you are not willing to pay any money to clean the Nzoia River?

[ ] Not enough information

[ ] I do not want to place a shilling value on water quality in the Nzoia River

[ ] I do not want to participate in this survey

[ ] I cannot afford to pay

(c) If YES, what is the most you as a household would be willing to pay per year in council charges and sewage fees to improve the Nzoia river quality in Webuye Division (area)?

____ Kshs/month

III BACKGROUND AND SOCIOECONOMIC DATA

I have a few more questions that will help in a proper analysis of the study results

7 (a) Sex Female [ ] Male [ ]

(b) To which of the following age categories do you belong?

Under 20 Years [ ]

20 - 29 Years [ ]

30 - 39 Years [ ]

40 - 49 Years [ ]

50 - 59 Years [ ]

Over 60 Years [ ]

8 At what level did you complete full-time education?

No education [ ]

Primary/Elementary school [ ]

Lower secondary (O'Level) [ ]

Upper secondary (A'Level) [ ]

College/ University [ ]

9 Do you rent or own your home/house?

Rent [ ] Own [ ]

10 How many persons, including yourself, are there in your household? _____

11 (a) Do you work in a sugar related industry (e g farmer or factory employee) or the PanAfrican Paper Mills?

Yes [ ] No [ ]

(b) To which of the following occupations do you belong?

Public servant [ ]

Farmer [ ]

Informal sector/*Jua kali* [ ]

Other (specify) ____________________

12 (a) Where do you obtain most of your domestic water requirements?

Mains supply/private tap [ ]

Water kiosk/vendor [ ]

Well, river and stream [ ]

(b) Which of the following best describes your present water supply status in terms of quantity, quality and convenience?

Very good [ ]

Good [ ]

Normal [ ]

Poor [ ]

Very Poor [ ]

13 If you don't mind, could you indicate which of the following brackets represents your household's gross (pre-tax) income per month from all sources?

Under Ksh 1,999 [ ]

Ksh 2,000 - 3,999 [ ]

Ksh 4,000 - 5,999 [ ]

Ksh 6,000 - 7,999 [ ]

Ksh 8,000 - 9,999 [ ]

Over Ksh 10,000 [ ]

14 Finally, do you think the present controls on the Nzoia River pollution are sufficient?

Yes [ ] No [ ]

If NO, what controls would you like to see introduced?

Thank you for taking part in this survey

INTERVIEW STOP TIME . AM/PM

DURATION OF INTERVIEW . MINUTES

APPENDIX 4B: QUESTIONNAIRE FOR GOOD 2: ESTIMATING BENEFITS OF IMPROVED DOMESTIC WATER SUPPLY IN WEBUYE DIVISION, KENYA (Note Four different versions of this questionnaire were used Each version varies only)

THE CV QUESTIONNAIRE

*****

IDENTIFICATION INFORMATION

A Village ID No .	B Interviewer ID No

C. Interview number . . .	D Date . / / 1995

E Interview Start Time am/pm	F Questionnaire Version **B**

G Presence of Adult Listeners to the Interview Yes [ ] No [ ]	H Interview setting Rural [ ] Urban [ ]

I SURVEY BACKGROUND AND INTRODUCTION

Good morning/afternoon My name is Wilson Wasike and I am conducting a survey on people's attitudes to water supply I wonder if you would answer a few questions for me All answers will be treated in strictest confidence and are for research purposes only

1 In your opinion, to what extent is domestic water supply a problem

(a) in Kenya [ ]

1	2	3	4	5
Serious problem				No problem

(b) in Webuye District [ ]

1	2	3	4	5
Serious problem				No problem

Please put a value of 5 to indicate no problem and a value of 1 for a serious problem, you may also indicate any value between the two numbers

2 (a) Where do you obtain your water requirements?

Mains supply/Personal tap [ ]

Water kiosk/vendor [ ]

Well/stream/river [ ]

(b) If WELL or VENDOR, what is the distance to the water source?

______ kilometres

(c) How much time do you spend collecting water per day, including travel time, queue time and fill time (minutes per day)? minutes per day

3 (a) How do you rank the reliability of the water source?

1	2	3	4	5
Very Good	Good	Normal	Poor	Very Poor

(b) How do you rank the quality of the water from the source?

1	2	3	4	5
Very Good	Good	Normal	Poor	Very Poor

(c) How do you rank the convenience of obtaining water from your current source?

1	2	3	4	5
Very Good	Good	Normal	Poor	Very Poor

4 (a) What activities does your household engage in that involve use of water?

Drinking/cooking/domestic washing Yes/No,

Watering flowers and irrigating vegetables Yes/No,

Watering livestock Yes/No,

Other (specify) ____________________

(Tick accordingly & indicate total number of uses ______)

(b) What amount of water storage capacity do you have?

litres

II Benefit Measures

Now I would like to ask you some questions about how much your household would be willing to pay for a piped water connection to your house

5 Suppose that you have the option to have a water faucet installed in your house This installation is considered a privilege Your family would have access to safe, reliable water 24 hours per day, all year round

However you would be responsible to pay the monthly or annually water bill for the consumption of water from your faucet The amount of the bill is based on the quantity of water used You do not have to pay anything additional to cover the cost of the water standposts (kiosks) in the street Your family also does not have to immediately pay for making the private connection from the main water pipe to your house because Webuye Municipal Council pays these costs now and then you would repay it via your water bill for several years The cost of installing the pipes and plumbing accessories in your house is about Ksh 2,000 (approx £ 25 00)

If you were asked how frequently you would like to pay water charges for the private water connection to your house, which of these two frequencies would you prefer?

Monthly [ ] Yearly [ ]

Version B1: Monthly Payment Scheme

6 (a) Now suppose the payments are made monthly, and that the payment would mean that you need to spend less on other items, would you be willing to pay any charge for having a private water connection in your house?

Yes [ ] No [ ]

(b) SHOW CARD If NO, which of the following reasons **best** describes why you are not willing to pay anything to have a private water connection to your house?

[ ] Not enough information

[ ] I do not want to place a shilling value on a private water connection

[ ] A private water connection has no value to me

[ ] I do not want to participate in this survey

[ ] I cannot afford to pay

(c) If YES, what is the most you as a household would be willing to pay per month in water charges for a private water connection to your house?

_____ Kshs/month

7 Upto now we have talked about piped water supply based on the assumption that the Municipal Council makes the private connection to your home and then charges you for the installation costs through the water charges over several years An alternative approach would be for the Municipal Council to insist that each household meets the cost of installing the pipes and plumbing accessories in advance Given this condition, what is the most your household would be willing to pay per month in water charges to have a private water connection ?

_____ Kshs/month

Version B2: Yearly Payment Scheme

6 (a) Now suppose the payments are made annually, and that the payment would mean that you need to spent less on other items, would you be willing to pay any charge for having a private water connection in your house?

Yes [ ] No [ ]

(b) SHOW CARD If NO, which of the following reasons **best** describes why you are not willing to pay anything to have a private water faucet in your house

[ ] Not enough information

[ ] I do not want to place a shilling value on a private water connection

[ ] A private water connection has no value to me

[ ] I don't want to participate in this survey

[ ] I can't afford it

(c) If YES, what is the most you as a household would be willing to pay per year in water charges to have a private water connection in your house?

_____ Kshs/year

7 Upto now we have talked about piped water supply based on the assumption that the Municipal Council makes the private connection to your home and then charges you for the installation costs through the water charges over several years An alternative approach would be for the Municipal Council to insist that each household meets the cost of installing the pipes and plumbing accessories in advance Given this condition, what is the most your household would be willing to pay per year in water charges to have a private water connection to your house?

_____ Kshs/year

III Background and Socioeconomic Data

I have a few more questions that will be used for a proper analysis of the results

8 (a) Sex Female [ ] Male [ ]

(b) SHOW CARD To which of the following age categories do you belong?

Under 20 Years [ ]
20 - 29 Years [ ]
30 - 39 Years [ ]
40 - 49 Years [ ]
50 - 59 Years [ ]
Over 60 Years [ ]

9 At what level did you complete full-time education?

No education [ ]
Primary/Elementary school [ ]
Lower secondary (O'Level) [ ]
Upper secondary (A'Level) [ ]
College/University [ ]

10 Do you rent or own your home?

Rent [ ] Own [ ]

11 How many persons, including yourself, are there in your household?

12 To which of the following occupations do you belong?

Public servant [ ]
Farmer [ ]
Informal sector/*Jua kali* [ ]
Other (specify) ________________

13 (a) Are you aware of any changes in water quality in the Nzoia River?

Yes [ ] No [ ]

(b) If YES, how would you describe the current water quality in the Nzoia River?

Very Good [ ]
Good [ ]
Normal [ ]
Poor [ ]
Very Poor [ ]

14 If you don't mind, could you indicate which of the following brackets represents your household's gross (pre-tax) income per month from all sources?

Under Ksh 1,999 [ ]
Ksh 2,000 - 3,999 [ ]
Ksh 4,000 - 5,999 [ ]
Ksh 6,000 - 7,999 [ ]
Ksh 8,000 - 9,999 [ ]
Over Ksh 10,000 [ ]

15 Finally, do you think the present efforts at improving household water supply are sufficient? Yes [ ] No [ ]

Thank you for taking part in this survey

INTERVIEW STOP TIME AM/PM

DURATION OF INTERVIEW MINUTES

APPENDIX 5A: FREQUENCY DISTRIBUTIONS OF MONTHLY WTP VALUES FOR IMPROVED WATER QUALITY IN THE PART OF THE NZOIA RIVER BASIN WITHIN WEBUYE DIVISION

	Questionnaire-Vers1 (BS*-sm)		Questionnaire-Vers3 (Sect*-sm)	
Value	Count (%)	Cumpct (%)	Count (%)	Cumpct (%)
0	7 (21 2)	21 2	7 (21 9)	21 9
20	1 (3 0)	24 2	-	-
30	1 (3 0)	27 3	3 (9 4)	31 3
40	1 (3 0)	30 3	2 (6 3)	37 5
50	6 (18 2)	48 5	2 (6 3)	43 8
60	-	-	2 (6 3)	50 0
70	3 (9 1)	57 6	4 (12 5)	62 5
80	-	-	2 (6 3)	68 8
90	-	-	1 (3 1)	71 9
100	3 (9 1)	66 7	4 (12 5)	84 4
150	4 (12 1)	78 8	3 (9 4)	93 8
200	4 (12 1)	90 9	1 (3 1)	96 9
250	3 (9 1)	100 0	-	-
300	-	-	1 (3 1)	100 0
N	33		32	

Appendix 5B: Frequency Distributions of Annual WTP Values for Improved Water Quality in the Part of the Nzoia River Basin within Webuye Division

	Questionnaire-Ver2 (BS*-sy)		Questionnaire-Vers4 (Sect*-sy)	
Value	Count (%)	Cumpct (%)	Count (%)	Cumpct (%)
0	6 (21 4)	21 4	5 (17 9)	17 9
200	1 (3 6)	25 0	2 (7 1)	25 0
250	-	-	1 (3 6)	28 6
300	1 (3 6)	28 6	3 (10 7)	39 3
350	-	-	1 (3 6)	42 9
400	4 (14 3)	42 9	4 (14 3)	57 1
450	-	-	2 (7 1)	64 3
500	5 (17 9)	60 7	3 (10 7)	75 0
600	1 (3 6)	64 3	1 (3 6)	78 6
700	2 (7 1)	71 4	2 (7 1)	85 7
800	1 (3 6)	75 0	-	-
1000	5 (17 6)	92 9	2 (7 1)	92 9
1500	1 (3 6)	96 4	2 (7 1)	100 0
2000	1 (3 6)	100 0	-	-
N	28		28	

APPENDIX 5C: FREQUENCY DISTRIBUTIONS OF ADDITIONAL WTP VALUES FOR IMPROVED WATER QUALITY IN THE ENTIRE NZOIA RIVER BASIN UPTO LAKE VICTORIA

A From Part to Whole Basın under monthly payment mode (dBS*-bm)

Value	Count	Percent (%)	Cumulatıve percent (%)
0	13	39 4	39 4
10	1	3 0	42 4
20	3	9 1	51 5
30	2	6 1	57 6
50	8	24 2	81 8
100	5	15 2	97 0
150	1	3 0	100 0
N	33		

B From Part to entıre Basın under yearly payment mode

Value	Count	Percent (%)	Cumulatıve percent (%)
0	14	50 0	50 0
100	3	10 7	60 7
200	2	7 1	67 9
300	2	7 1	75 0
400	1	3 6	78 6
500	5	17 9	96 4
1000	1	3 6	100 0
N	28		

APPENDIX 5D: FREQUENCY DISTRIBUTIONS OF TOTAL WTP VALUES FOR IMPROVED WATER QUALITY IN THE ENTIRE NZOIA RIVER BASIN UPTO LAKE VICTORIA

A Total Monthly WTP for Pollution Control in the River Basin

Value	Count	Percent (%)	Cumulative percent (%)
0	7	21 1	21 2
50	3	9 1	30 3
70	2	6 1	36 4
90	1	3 0	39 4
100	5	15 2	54 6
150	6	18 2	72 7
200	2	6 1	78 8
250	3	9 1	87 9
300	2	6 1	93 9
350	2	6 1	100 0
N	33		

B Total Annual WTP for Pollution Control in the River Basin

Value	Count	Percent (%)	Cumulative percent (%)
0	6	21 4	21 4
200	1	3 6	25 0
400	3	10 7	35 7
500	1	3 6	39 3
600	2	7 1	46 4
700	3	10 7	57 1
800	1	3 6	60 7
900	1	3 6	64 3
1000	5	17 9	82 1
1200	1	3 6	85 7
1500	2	7 1	92 9
2000	1	3 6	96 4
3000	1	3 6	100 0
N	28		

APPENDIX 5E: FREQUENCY DISTRIBUTION OF MONTHLY WTP VALUES FOR A PRIVATE WATER CONNECTION AMONGST WEBUYE RESIDENTS

Value	SPREAD C-CHARGES		UPFRONT C-CHARGES	
	Count (%)	Cumpct	Count (%)	Cumpct
0	8 (11 1)	11 1	9 (13 4)	13 4
20	-	-	1 (1 5)	14 9
30	3 (4 2)	15 3	1 (1 5)	16 4
40	8 (11 1)	26 4	11 (16 4)	32 8
50	-	-	8 (11 9)	44 8
60	4 (5 6)	31 9	7 (10 5)	55 2
70	8 (11 1)	43 1	3 (4 5)	59 7
75	-	-	1 (1 5)	61 2
80	8 (11 1)	54 2	2 (2 9)	64 2
90	4 (5 6)	59 7	1 (1 5)	65 7
100	6 (8 3)	68 1	12 (17 9)	83 6
120	-	-	1 (1 5)	85 1
150	18 (25 0)	93 1	7 (10 5)	95 5
200	3 (4 2)	97 2	3 (4 5)	100 0
250	2 (2 8)	100 0	-	-
N	72		67	

Note C-Charges are connections charges for private water supply, Cumpct is cumulative percent

APPENDIX 5F: FREQUENCY DISTRIBUTIONS OF ANNUAL WTP VALUES FOR A PRIVATE WATER CONNECTION AMONGST WEBUYE RESIDENTS

Value	SPREAD C-CHARGES		UPFRONT C-CHARGES	
	Count (%)	Cumpct	Count (%)	Cumpct
0	6 (8 3)	8 3	18 (26 1)	26 1
100	2 (2 8)	11 1	2 (2 9)	28 9
150	1 (1 4)	12 5	-	-
200	8 (11 1)	23 6	4 (5 8)	34 8
250	1 (1 4)	25 0	2 (2 9)	37 7
300	8 (11 1)	36 1	2 (2 9)	40 6
350	2 (2 8)	38 9	1 (1 5)	42 0
400	9 (12 5)	51 4	8 (11 6)	53 6
450	2 (2 8)	54 2	1 (1 5)	55 1
500	9 (12 5)	66 7	15 (21 7)	76 8
600	3 (4 2)	70 8	5 (7 3)	84 1
700	5 (6 9)	77 8	2 (2 9)	86 9
750	2 (2 8)	80 6	-	-
800	1 (1 4)	81 9	3 (4 4)	91 3
900	-	-	1 (1 5)	92 8
1000	9 (12 5)	94 4	4 (5 8)	98 6
1200	1 (1 4)	95 8	1 (1 5)	100 0
1500	2 (2 8)	98 6	-	-
2000	1 (1 4)	100 0	-	-
N	72		69	

Note C-Charges are connection charges for private water supply, Cumpct is cumulative percent

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