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THE UNIVERSITY OF CALGARY

**THE HUMANITARIAN DISTRIBUTION OF THE BIOSAND
CONCRETE FILTER**

**By
Camille Dow Baker**

**A Master's Degree Project
Submitted to The Faculty of Environmental Design
In Partial Fulfilment of The Requirements for
The Degree of Master of Environmental Design**

**Calgary, Alberta
September, 2000**



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TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	9
INTRODUCTION	15
1.0 WATER SUPPLY IN DEVELOPING COUNTRIES	19
1.1.0 The Need	
1.1.1 Vital for life	20
1.1.2 Health	20
1.1.3 Capacity Development	22
1.2.0 The Supply Challenges	23
1.2.1 Scarcity	23
1.2.2 Competing Uses	24
1.2.3 The Development Dilemma	24
1.3.0 The Industry	25
1.4.0 Service History	
1978-88 Appropriate Technology	26
1988-94 Hardware to Software	26
1994-2000 Demand Responsive	27
1.5.0 The Future Challenges	29
1.5.1 Product Development	29
1.5.2 Understandable Technology	29
1.5.3 Demand Responsiveness	30
1.5.4 Capacity Building	31
1.5.5 Financial Sustainability	32
1.5.6 Structured Development and Standardization	33
1.5.7 Women and Water	33
1.5.8 Summary	34
2.0 THE PRODUCT	35
2.1.0 Technology Effectiveness	36
2.2.0 Development History	38
2.3.0 Filter Description	40
2.4.0 Filtration Processes	41
2.5.0 Filter Operation and Maintenance	43

2.6.0	Technology Comparison	44
2.6.1	Water Supply, Sanitation or Hygiene	45
2.6.2	Water Sources vs Water Treatment	46
2.6.2.1	Impact on Health	46
2.6.2.2	Adequacy, Affordability, Reliability and Convenience	49
2.6.2.3	Conclusions	52
2.6.3	Community Based Treatment vs Household Treatment	53
2.6.3.1	Criteria	53
2.6.3.2	Effectiveness	54
2.6.3.3	Equity	54
2.6.3.4	Efficiency	54
2.6.3.5	Sustainability	55
2.6.3.6	Replicability	56
2.6.3.7	Conclusion	57
2.6.4	Household Treatment Alternatives	58
2.6.4.1	Treatment Processes	58
2.6.4.2	Evaluation Criteria	59
2.6.4.3	Effectiveness	59
2.6.4.4	Ease of Use	63
2.6.4.5	Capital Costs	67
2.6.4.6	Operating Costs	69
2.6.4.7	Conclusions	70
2.6.5	Section Summary	71
3.0	THE STRATEGY	72
3.1.0	The Alternatives	74
3.1.1	Underlying Premises	74
3.1.2	Field Implementation	74
3.1.3	Channels of Technology Transfer	77
3.1.4	Micro Enterprises	79
3.1.5	Southern NGO Limitations	82
3.2.0	Appropriate Institutions and Linkages	83
3.2.1	Trans-National Non Governmental Organizations	83
3.2.1.1	The Benefits	84
3.2.1.2	The Concerns	85
3.2.2	National Governments	87
3.2.2.1	The Benefits	87
3.2.2.2	The Concerns	88
3.2.3	Local Business Partnerships	91
3.2.3.1	The Benefits	91
3.2.3.2	The Concerns	91
3.2.4	Summary	92
3.3.0	Social Sustainability	94
3.3.1	Demand	
3.3.1.1	Responding to Demand	94
3.3.1.2	Generating Demand	94
3.3.2	Encouraging Acceptance	95
3.3.3	Minimising Impact on Social Structure	98

3.3.4	Conclusions	99
3.4.0	Financial Sustainability	100
3.4.1	Adequate, Assured and Consistent Financing	100
3.4.2	Micro-Enterprises	104
3.4.3	Efficiencies and Economies of Scale	105
3.4.4	Standards of Performance	106
3.4.5	Risk Mitigation	107
3.4.6	Conclusions	108
3.5.0	Technical Sustainability	109
3.5.1	Viable Treatment Solutions	109
3.5.2	Quality Control	109
3.5.3	Local Innovation and Experimentation	110
3.5.4	Information Base	111
3.5.5	Training	111
3.5.6	Conclusions	112
3.6.0	Impact on Commercial Operations	113
3.6.1	Client Base	113
3.6.2	Knowledge Base	114
3.6.3	Competition	115
3.6.4	Risk Mitigation	115
3.6.5	Investor Relations	115
3.6.6	Conclusions	116
3.7.0	Conclusions	117
4.0	THE MARKETS	119
4.1.0	The Criteria	120
4.2.0	The Need	120
4.2.1	Access to Clean Water	121
4.2.2	Rural Population Density	134
4.2.3	Surface Water Availability	137
4.3.0	The Capacity	
4.3.1	NGO Availability	141
4.3.2	Governmental Support	142
4.4.0	The Business Climate	146
4.5.0	Conclusions	151
5.0	THE ACTION PLAN	152
5.1.0	Primary Strategy	153
5.1.1	Engender Stakeholder Commitment	153
5.1.2	Develop Appropriate Corporate Culture	154

5.1.3	Choose the Right Joint Venture Partner	157
5.1.4	Performance and Processes	161
5.1.5	Conclusions	162
5.2.0	Secondary Strategies	162
5.3.0	Conclusions	163
REFERENCES		164

LIST OF FIGURES

		Page
Figure 1.1.1	Major Causes of Death and Disease Worldwide	21
Figure 2.3.1	Filter Components	40
Figure 2.4.1	Filter Regions	42
Figure 2.5.1	Percentage Removal Efficiency with Time	43
Figure 2.6.1	Transmission of Disease from Faeces	47
Figure 2.6.2	Water Consumption vs Travel Time	52
Figure 2.6.3	UNICEF Upward Flow Sand Filter	63
Figure 2.6.4	Slow Sand Filter with Flow Control	64
Figure 3.1.1	Types of NGOs Involved in Bank Financed Projects ; Fiscal Years 92-97	76
Figure 3.1.2	Technology Transfer Alternatives	79
Figure 3.4.1	Household Willingness to Pay for Improved Water Supply: Dehradun, 1996	102
Figure 3.4.2	The Effect of Spreading Connection Costs on Connection Rate	102
Figure 4.2.1	Distribution of People Lacking Access to Clean Water by Region	121
Figure 4.2.2	S.E. Asia- People Needing Clean Water	122
Figure 4.2.3	East Asia (Except China and India) Country Distribution of People Lacking Access to Clean Water, 1995	123
Figure 4.2.4	East Asia (Except China and India) Percentage of Population Lacking Access to Clean Water	123
Figure 4.2.5	Africa, Percentage of Population Needing Clean Water	124
Figure 4.2.6	Sub Saharan Africa Country Distribution of People Lacking Access to Clean Water, 1995	125
Figure 4.2.7	Sub Saharan Africa Percentage of Population Lacking Access to Clean Water	125
Figure 4.2.8	Latin America & Caribbean; Numbers of People Needing Clean Water	126
Figure 4.2.9	Latin America and Caribbean Country Distribution of People Lacking Access to Clean Water, 1995	127

Figure 4.2.10	Latin America and Caribbean Percentage of Population Lacking Access to Clean Water	127
Figure 4.2.11	Arab States and Eastern Europe Country Distribution of People Lacking Access to Clean Water, 1995	129
Figure 4.2.12	Arab States and Eastern Europe Percentage of Population Lacking Access to Clean Water	129
Figure 4.2.13	Global Distribution People Lacking Access to Clean Water	132
Figure 4.2.14	Global Distribution Percentage of Population Needing Access to Clean Water	134
Figure 4.2.15	Global Distribution of Renewable Water Resources	139
Figure 4.3.1	Country Democracy Rating	145
Figure 4.3.2	Country Freedom Rating	146
Figure 4.4.1	Developing Countries: Business Climate	150

LIST OF TABLES

		Page
Table 2.1.1	Contaminant Removal Efficiency; BioSand Water Filter	37
Table 2.2.1	BioSand Concrete Filter Projects	38
Table 2.6.1	Worldwide extent of Water-Related Disease	48
Table 2.6.2	Diarrhoeal Morbidity Reduction from WS&S Projects	49
Table 2.6.3	Advantages and Disadvantages of Alternative Water Supplies	50
Table 2.6.4.	Generalized Effectiveness of Different Household Treatment Systems	61
Table 2.6.5	Operation and Maintenance Requirements Conventional Slow Sand Filter	65
Table 2.6.6	Estimated Capital Costs for Selected Household Filtration and Disinfection Systems	68
Table 2.6.7	Comparison of Operating Costs Water Treatment Systems	70
Table 3.1.1	Small Scale Providers of Water Supply and Sanitation Services	80
Table 3.1.2	Typology of Private Operators, Port-au-Prince, Haiti	80
Table 3.4.1	Prices for Piped and Vendor Supplies in Selected Countries	101
Table 4.2.1	Global Distribution of People Lacking Access to Clean Water	131
Table 4.2.2	Distribution of Countries by Percentage of Population Requiring Clean Water	133
Table 4.2.3	Global Distribution of Estimated Rural Populations Lacking Access to Clean Water	136
Table 4.2.4	Country Categorisation Internal renewable Water Resources per Capita: 1998	138
Table 4.3.1	Country NGO Density Numbers of NGOs per million population	140
Table 4.3.2	Public Expenditure on Health (as % of GDP)1996-98	142
Table 4.4.1	Overall Business Climate Indicator	149
Table 5.1.1	Choosing a Partner:Critical Questions	160

EXECUTIVE SUMMARY



BioSand Filter Factory
Bangladesh

- **This BioSand technology is a revolutionary technology.** It makes economically possible, water treatment on a much smaller scale than commonly practiced and allows the decentralisation of water treatment to the point where complex distribution systems are no longer required. It could represent to the water industry what cellular telephones signify to the telecommunications industry or what small scale fuel cells and microturbines potentially symbolize to the electric industry.
- **The concrete filter product has been proven effective and acceptable.** By year end 2000, it is estimated that over 15,000 filters will be in use by the poor in over thirty countries of the world. And there is ever increasing interest by organizations who wish to include the product in their international development work.
- **There is a desire and willingness to provide the technology to the poor** and an organization that is capable of doing so.
- **Now what is needed is a plan** and effective implementation of that plan, to be able to achieve the vision of providing clean water to the poor.

This Masters Degree Project is the first step in the creation of that plan.

The international water industry faces the challenges imposed by the increasing scarcity of fresh water supplies, the competing demands for this supply and the need for incremental investments in the range of 9 to 24 billion US dollars. Despite current expenditures of over 10 billion US dollars annually by governments of developing nations and by global institutions such as the World Bank and the United Nations Development Program, over 1.2 billion people still have no access to clean water.

Over the last twenty years, the emphasis in water supply projects has changed from appropriate technology development to the generation of increased



Bangladesh 2000

community participation and involvement, and now to the building of local capacity. Yet the successful implementation of strategies to provide clean water to the poor has proven elusive. The industry is torn between its social responsibilities - to provide basic access to services, to increase social and financial equity, to work collaboratively with and build capacity in the local population- and the need for more efficient market systems which would allow for development of products which have wide consumer appeal, can generate increased cost recovery and are easily replicated, adapted and improved.

The Davnor BioSand concrete water filter is a slow sand filter, specifically designed for household construction and use. Its performance, tested both in the laboratory and in numerous field applications in countries as diverse as Nicaragua, VietNam, Haiti and Rwanda, have proved that its effectiveness is similar to that of a conventional slow sand filter, with coliform bacterial removal efficiencies consistently greater than 99.5%.

Affordable, distributed treatment systems like the BioSand technology makes possible the use of a much wider variety of water sources, including consideration of surface water sources which may be more affordable and convenient for the consumer than alternative ground water sources. It also provides greater reliability of the water quality in the household, since water contamination during the transport to or storage in the house is a frequent occurrence. Household treatment systems also increase equity by allowing more specific targeting of service to those most in need. Moreover, enhanced efficiencies are realised because of the reduction in the water losses in the distribution systems and the ability to treat only the water required for drinking and cooking to potable water standards.

Slow sand filters are the most effective, reliable and affordable of all the household water treatment systems. The BioSand filter offers the additional advantages in that it is far easier to operate and maintain than conventional slow sand filters. Furthermore, specific manufacturing processes and

procedures provide an element of quality control, not present in other field manufactured treatment systems.



Rwanda, 2000

Indigenous non governmental organizations (NGOs) were identified as being the optimum type of organization to conduct the field implementation of the concrete filter technology, because of their skills, experience, commitment, location, relationships and planning methodologies. The three alternative channels available to Davnor to reach these local NGOs- International NGOs (INGOs), local governments or local joint venture business partnerships- all present challenges. INGOs have the societal mandate, organizational structures and funding to act as an effective channel, but they also represent a threat to local NGO autonomy and independence and are often unwilling to commit to long term development support. Davnor's ability to make connections with appropriate governments, the risk to its corporate reputation of making the wrong connections and the well recognised limitations of governments in developing countries provide restrictions to using local governments as an avenue of transfer. The inherent limitations of combining social and commercial objectives present a challenge to the third alternative.

The business-NGO alliance is the alternative that offers the most opportunity for social sustainability because it is best able to match services with what customers want and create an extended relationship between the client and service provider. Furthermore, appeal for the humanitarian product is enhanced by association of the humanitarian product with the commercial filters used by those of higher status. In addition, this alternative is best able to provide adequate and reliable sources of funding, the required efficiencies and economies of scale and the most reliable and relevant indicators of performance; the components necessary for financial sustainability. Moreover, this type of alliance would provide a technical home in which the technology can reside locally. This national centre of technical expertise would be able to provide more complete water treatment solutions, ensure adequate product quality control and encourage appropriate innovation and experimentation.

The development of the humanitarian business could also prove beneficial for the commercial business in terms of developing a potential client base and building positive relations with NGOs and funding agencies, which are also important clients of the commercial business. It also allows for the creation of an extensive knowledge base of the local water requirements and healthy internal competition. The potential to engender a unique, investor appeal is also enhanced.



China and India represent the primary target markets because they far supersede any other countries in terms of need and have stable environments in which to develop local business joint ventures. In Brazil, Turkey, Mexico, Kenya, Philippines and Argentina the need is high and the business and political climates good; while, although over 40 million people in each of Indonesia, Ethiopia, Nigeria, VietNam and Pakistan need clean water, the risk of forming a successful joint venture is high. The Democratic Republic of Congo, Tanzania, Myanmar and Sudan have smaller populations requiring assistance than the previous group of countries with similar or worse political and business risks. Other countries with populations less than ten million people who require clean water, but where the appropriate climate may be present include Madagascar, Morocco, Egypt, Peru, Iran and Thailand.

The next steps to be taken to implement the recommended strategy of distributing the humanitarian technology through a local business- NGO alliance, involve actively seeking the commitment of the major stakeholders of the corporation and developing and explicitly stating the corporate values which would lead to the desired balance between the humanitarian and commercial objectives, and between localization and globalization objectives. The ideal local partner is one, which, in addition to providing Davnor with local market access, is similar to Davnor in terms of corporate values, commitment to the humanitarian effort and technical expertise.

Davnor should also supplement its long term strategy with shorter term strategies such as the continuation of its training programs and assistance to International NGOs operating in developing countries. The results of



the work of Samaritan's Purse have been impressive and should be continued with many agencies. In addition, the promotion of the concrete filter technology, in discussions with bilateral and multi lateral funding agencies such as the World Bank and CIDA should be emphasized.

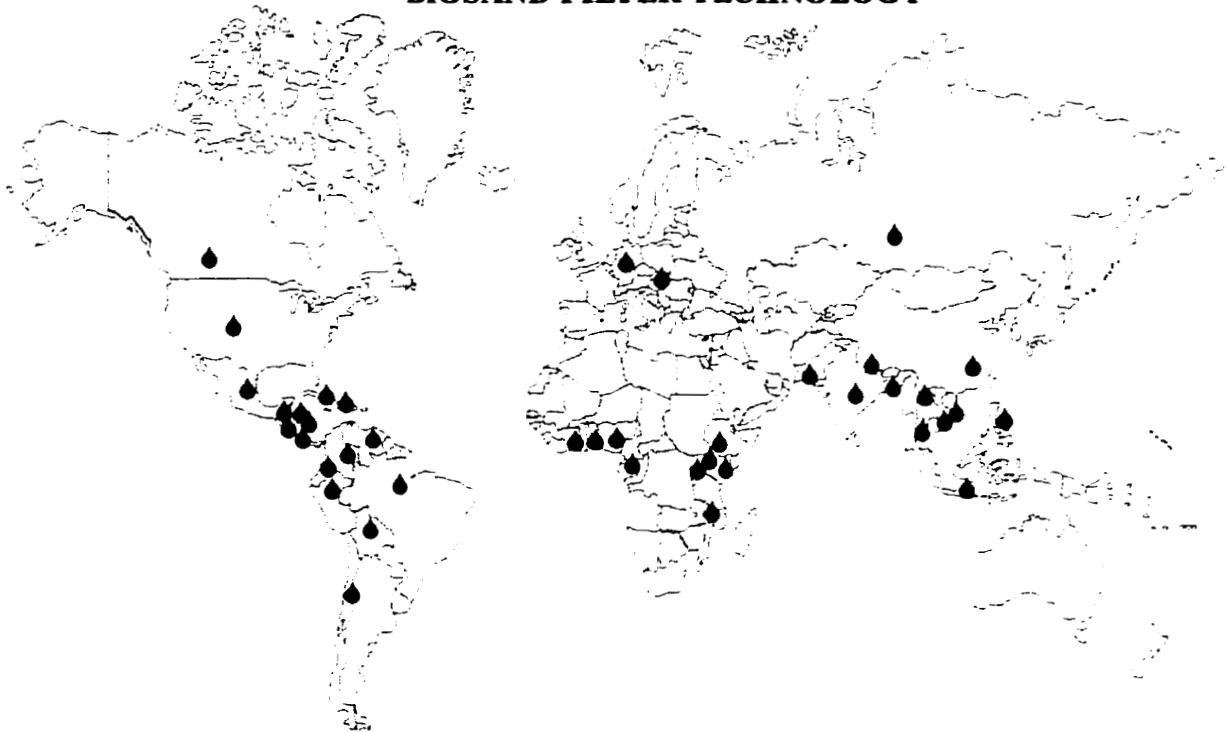
CARE Indonesia (1998)

INTRODUCTION



Davnor Water Treatment Technologies Ltd. has designed a water filter, specifically for use by very poor people in developing countries, who lack access to clean water supplies. There are now over **5000** of these concrete filters in use throughout the developing world and they have had unquestioned success in providing clean water to poor people in over **30** countries.

GLOBAL DISTRIBUTION BIOSAND FILTER TECHNOLOGY



Over the last five years, Davnor has distributed this technology free of charge to non- governmental and church organizations who wished to incorporate the manufacture of the filters in their international development work. The organization which has spearheaded the field implementation of the filter and is primarily responsible for the majority of the 5000 installations is Samaritan's Purse, a Christian organization headquartered in the United States. To date, Davnor has done little active marketing of this product, and has given training in the manufacture and use of the filter primarily at the request of the potential implementing organizations.

Given the tremendous potential of this technology to positively affect the lives of more than 1.2 billion poor people, and the proven successful field implementation of the technology, Davnor now wishes to develop a more pro-active plan for the humanitarian distribution of the concrete BioSand filter.

Although Davnor is a commercial business with the ultimate objective of generating a profit to its shareholders, Davnor recognises its responsibilities to the world's poor. Accordingly, Davnor's management has developed certain humanitarian objectives as follows (D. Manz Personal Correspondence):

1. To distribute the technology, royalty free, to those in need and who cannot afford to pay.
2. To ensure that these technology interventions can continue to operate and generate the intended benefits over their planned lives.
3. To facilitate and promote the spread of the technology.
4. To undertake the actions listed above in a manner that is financially sustainable.

The objectives of this study are, therefore, to analyse the major issues and develop a plan of action, which will meet the Davnor objectives, listed above.

Perhaps more than any other sector, water supply and sanitation hits on all the main themes of development: poverty alleviation, environmental sustainability, private-sector led growth, participatory development and good governance.

World Bank, Water Supply and Sanitation Blue Pages

The study is presented in five major sections:

1. **The International Water Industry for The Poor**
To provide the reader a context for the detailed analyses presented later in the report, this overview provides a general understanding of the worldwide potable water supply industry for the poor; - the international demand, supply, the historical responses to the need for water, the major players and the size of the present industry. A summary of the challenges facing practitioners in the industry provides a framework for the discussion of the issues Davnor needs to consider in development of its humanitarian technology distribution plan.
2. **The Product**
To establish the credibility, effectiveness and potential of the filter, this section contains a comprehensive technical analysis of the filter. Firstly a detailed description of the product development history, components, process, design, operation, maintenance and cost is provided. Secondly, this technology is compared with other available technologies commonly used to prevent the spread of faecal-oral diseases in developing countries.

3. The Strategy

Alternative means of introducing the technology are analysed and compared. The more traditional approaches involve technology introduction and promotion by means of community water supply and sanitation projects. These projects are usually implemented through NGOs or government agencies.

Alternative methods of technology transfer include product promotion and distribution through businesses, which are locally owned and operated. These options are discussed in the context of creating a system, which is socially, financially and technically sustainable. The potential impacts of the continued humanitarian distribution of the technology on the commercial business objectives are also evaluated.

4. The Market

Having established the product viability and recommended strategy for technology distribution, the potential markets for the products are analysed relative to the factors required for successful implementation of the overall strategy. Developing countries are compared worldwide in order to determine market priorities.

5. Plan of Action

The principal actions required by Davnor to successfully achieve its humanitarian objectives and implement the proposed long and short term strategies are presented and discussed.

In summary, the study examines WHY the product is needed, WHAT are the product strengths, weaknesses and potential, WHERE are the best markets, HOW should it be promoted and distributed and with WHOM should relationships be instigated. Lastly it attempts to define a plan of action to achieve the vision formulated as a result of the analyses.

1.0 WATER SUPPLY IN DEVELOPING COUNTRIES

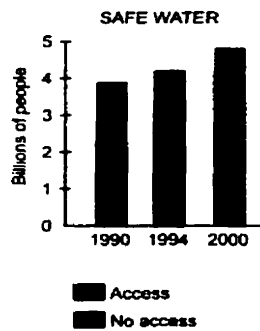
To provide the framework for discussion of the plan for the Davnor humanitarian distribution of BioSand filtration technology, this section begins by reviewing the issues which affect the worldwide demand and the constraints which affect supply. A basic understanding of the major players and the size of the industry is then provided. The historical developments, which lead to the challenges that the industry faces today are reviewed. And finally, the issues which presently confront practitioners in the industry, like Davnor, are analysed.

The major sections are summarized below:

1.1.0 The Need		
1.1.1 Vital for life		20
1.1.2 Health		20
1.1.3 Capacity Development		22
1.2.0 The Supply Challenges		23
1.2.1 Scarcity		23
1.2.2 Competing Uses		24
1.2.3 The Development Dilemma		24
1.3.0 The Industry		25
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1978-88	Appropriate Technology	26
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1.5.3 Demand Responsiveness		30
1.5.4 Capacity Building		31
1.5.5 Financial Sustainability		32
1.5.6 Structured Development and Standardization		33
1.5.7 Women and Water		33
1.5.8 Summary		34

1.1.0 THE NEED

Article 24 of the Convention of the Rights of the Child (1989) provides that a child has the right to enjoy the highest attainable standard of health. Among measures States are to take to secure this right are measures to: 'combat disease and malnutrition... through inter alia... the provision of adequate nutritious foods and clean drinking water.



Source: DFID 98

At any one time, half of all people in developing countries are suffering from one or more of the six main diseases associated with inadequate water supply: Diarrhea-caused by microbial pathogens, Ascaris, Draculiasis, Hookworm & Schistosomiasis-all caused by worm infestation and Trachoma-caused by a bacterium and leading to blindness.

Gadgil 98

Clean water affects a person's survival, health and their ability to grow beyond the intergenerational cycles of poverty.

1.1.1 Vital to Life

There is no substitute for water, clean or dirty. It is a precious resource and essential to life, and without it, a person dies in just a few days. Access to a safe and affordable supply of drinking water is universally recognized as a basic human need for the present generation and a pre-condition for the development and care of the next.

Water is so important that, at the recent World Water Forum, which took place in March 2000, there was debate as to whether basic water services should be considered a fundamental human right, and supported by major human rights treaties, statements, covenants and official practice worldwide. There was agreement that it not be classified as a human right but that it be considered a basic human need and an essential social good. (Globe & Mail, March 2000).

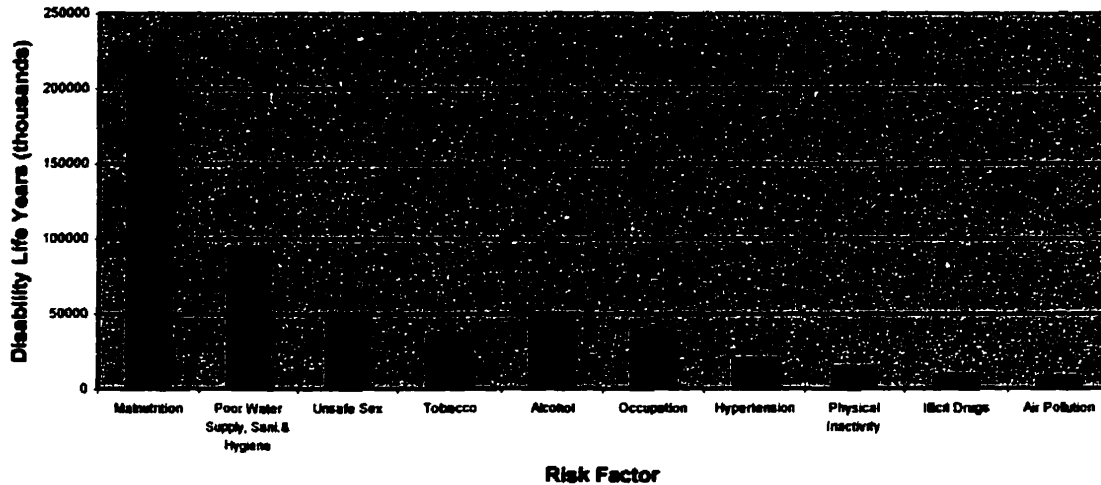
Yet over 1.2 billion people, approximately 20% of the world's population, located primarily in Asia and Africa, have no access to clean drinking water. (WHO/UNICEF '94).

1.1.2 Health

Water shortage, poor quality water or unreliable water supply have profound effects on people's well being. Although the quality of the data on mortality and morbidity from unsafe drinking water is mixed, (this author found estimates of annual child deaths that vary from 3 million to 15 million annually), the magnitude of the effects of waterborne diseases make them the second leading contributor to death and disease worldwide (Figure 1.1.1), responsible for approximately 10% of the total.(Harvard and WHO Joint Study). Over ten thousand people die from water related illnesses every day (WHO 98).

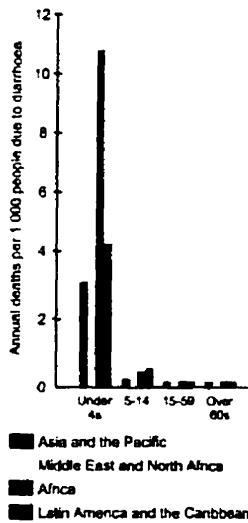
Figure 1.1.1

MAJOR CAUSES OF DEATH & DISEASE WORLDWIDE



Children are the most vulnerable to water related preventable diseases and over 5 million children die every year from diarrhoeal disease and dehydration (WHO 98), and over half experience more than fifteen attacks of serious diarrhoea before the age of five. (Bern 1992). Repeated bouts of diarrhoea inhibit the ability of the body to absorb nutrition for a much longer period than the duration of the actual diarrhoeal episode. Thus children become at risk of stunting from malnutrition (Gadgil 98). A lack of water also means that children cannot wash often enough and so suffer from eye infections and skin diseases such as scabies.

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Bern et al. 1992 ■

1.1.3 An Entry Point to Human Development and Poverty Elimination

How Water, Sanitation and Hygiene Contribute to Human Development.

Improved water, sanitation and hygiene contribute to human development by:

- *Reducing the health burden of water borne and water washed diseases.*
- *Reducing the time taken off work (or school) by ill people and their carers.*
- *Improving nutrition due to reduced loss of nutrients through diarrhoea.*
- *Reducing the time and effort spent, normally by women and children, to carry water from distant sources.*
- *Hence making time for other activities such as children's school attendance and adults' income generation.*
- *Improving people's self worth and social status.*
- *Improving privacy and dignity, especially for women.*

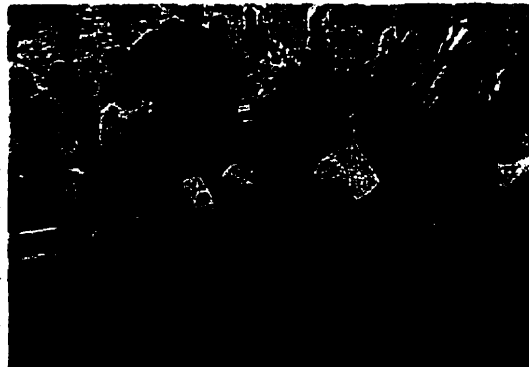
IIED in Vision 21

The benefits of a safe water supply go well beyond improvements to health and well being. It affects a person's quality of life. Access to convenient and affordable water can save people's time and energy and enhance their livelihood opportunities. The time spent collecting water is a double burden, as it means less time is available for the productive activities on which subsistence economies depend.

UNICEF estimates that the effort spent annually in developing countries fetching water is 10 million person years. (UNICEF 95).



WaterAid/Caroline Henn



WaterAid/Jim Holmes

1.2.0 THE SUPPLY CHALLENGES

In the 1977 Comprehensive Assessment of the Freshwater Resources of the World, the UN Secretary General summarized the position as follows:

'Water use has been growing at twice the rate of population increase during this century, and already a number of regions are chronically water short. About one third of the world's population lives in countries that are experiencing moderate to high water stress, partly resulting from increasing demands from a growing population and human activities. By 2025, as much as two thirds of the world population will be under stress conditions.'

Among the major factors which affect the domestic supply of potable water are water availability, the ability of the industry to compete for scarce supplies and the ability of governments to obtain the resources necessary for service provision.

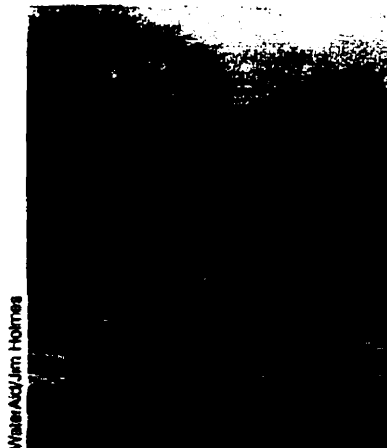
1.2.1 Water Scarcity

Only one third of the water that runs annually to the sea is accessible to humans. Of this, more than half is presently being appropriated for use, and demand is expected to double in thirty years. Furthermore, much of what is available is being degraded by eroded silt, sewage, industrial pollution, chemicals, excess nutrients and algae (deVilliers 99).

Per capita availability of good potable water is decreasing in every developed and developing country because of increasing populations, water degradation and climate changes. Moreover, most of the easy sources of water have been exploited and much of the water is in places where it isn't needed.

Swedish hydrologist, Malin Falkenmark, suggests that any nation with less than 1000m³/person/year is water scarce and water stress occurs in any country with less than 1700m³/person/year.

Around 230 million people live in 26 countries classified as water deficient, mostly in the Middle East and Sub Saharan Africa. (Black 98.)





1.2.2 Competing Uses

Domestic water consumption uses just a small fraction of the total water consumed. Water supplies are also required for agriculture, industry, power generation, ecosystem protection, navigation etc.

Irrigation uses 70 % of the world's fresh water supplies (CIDA Web page), and in developing countries it accounts for as much as 90% of the total consumptive use. Worldwide irrigated lands are only about one sixth of the total area farmed, but account for more than one third of the global harvest. Without irrigation, yields in the world's major breadbaskets- on which the feeding of the planet depends- would drop by almost half (de Villiers 99).

Although some competing uses for water, such as irrigation, are very important and although water for domestic use accounts for only 8% of water consumption (CIDA Web page), this proportion must be safeguarded in both quality and quantity as a basic human need. WS&S programs need to be part of integrated water resources management strategies in developing countries. Issues such as water allocation, pricing policies; regulatory and legislative issues in water conservation and pollution control all affect the availability and pricing of water for domestic consumption.

1.2.3 The Development Dilemma

The World Development Report 1999-2000 emphasizes that 'although macroeconomic stability is an essential pre-requisite to sustained growth, growth does not trickle down: development must directly address the pressing goals of human beings.' Consequently, it is essential that specific investments into provision of basic needs such as water be maintained.

There is a definite correlation between the state of a country's economy and the availability of basic services; between poverty and lack of safe water supply and sanitation. Establishing basic services throughout the developing world has proven to be very difficult because the service users cannot afford to pay for them. However, people need these basic services, in order to be able to develop to their potential.

Therefore there is a critical dilemma facing the water and sanitation sector; on the one hand, the provision of services depends on the eradication of poverty and the building of viable growing economies; whilst on the other hand the availability of basic services is a necessary component of poverty eradication.

1.3.0 THE INDUSTRY

The World Bank estimates that current spending on worldwide water supply infrastructure is approximately \$23 billion US per year (Panayotou 98). The total annual investment in developing countries during the 1990s was estimated at \$10 billion US.

On average 65% of this funding was raised from in country resources, the rest from bi-lateral and multi lateral external funding (Gadgil 98). But there is a strong regional variation in in-country funding, from 90% in the Middle-East to 25% in Africa.

The four main external funders of WS&S projects over the last twenty years have been:

- The World Bank
- United Nations Development Programme
- The World Health Organization (WHO)
- UNICEF.

with the World Bank and UNDP accounting for approximately 80% of the total, primarily through the joint UNDP- World Bank W&S program (Black 98).



<i>Technology</i>	<i>Cost/ Person</i>
High Cost <i>(Piped water to individual households)</i>	\$200
Intermediate Cost <i>(Piped water to public standposts)</i>	\$100
Low Cost <i>(Hand dug wells, rainwater harvesting & public standposts)</i>	\$30

UNICEF 1990

The World Bank's database on Private Participation in Infrastructure shows that the total private investment in water and sanitation in developing countries is only \$25 billion, of which zero is in South Asia and less than \$0.25 billion is in Africa (the areas with the largest unserved populations.) Therefore, in terms of basic water and sanitation services, the private sector is insignificant.

The World Water Council projects that, in addition to the \$10 billion currently being spent, incremental funds in the range of \$9 to \$24 billion a year would be required for everybody in the world to achieve the basic water and hygiene requirement (Vision 21). The costs are lower if money is allocated, from high cost, high technology projects, to affordable, more appropriate technologies. Thus, a strong focus on low cost technologies is critical for any significant acceleration of service provision.

1.4.0 HISTORY

Water supply and sanitation rose up the development agenda more than 20 years ago when the 1977 UN Water Conference recommended that the 1980s become the 'International Drinking Water Supply and Sanitation Decade' (IDWSSD). During the course of the 23 years since the IDWSSD was declared, there has been a major transformation in the worldwide water and sanitation picture.

1978-1988: The Appropriate Technology Phase

At the start of the Decade, the major inhibition to the provision of water supplies was that public health engineering authorities in developing countries were structured to provide and administer centralized piped water systems. These were impractical and unaffordable for most poor communities (Black 98).

The initial focus was therefore to identify low cost 'hardware' solutions to the need for safe water supplies. One of the key challenges was persuading the engineering establishment to endorse technologies, which appeared to belong to an earlier era, which did not provide any commercial boost to the industry or confer status on professionals associated with it. Development and acceptance of low cost, appropriate technology wisdom needed time to prevail.

In addition to the development of appropriate technology, the IDWSSD brought together the four main international players in the water and sanitation sector, the World Bank, the UNDP, WHO and UNICEF.

1988-1994: From Hardware to Software

Participatory Approaches

In acknowledgement that lack of involvement of local people explained the failure of many projects, the concept of 'participatory development' was accorded new respect. Throughout the development community, participatory approaches at the community level were promoted, to elicit information, to build confidence and leadership, undertake service tasks, select project beneficiaries or sites, and monitor results. NGOs and community based organizations were key vehicles for the promotion of participatory development (Black 98).



WaterAid/John Hornum



'It is as though everyone agreed on what ought to be done , but no one does it.'

Curt Carnemark, Chief of Supervisory Division, World Bank

Cost Recovery

There was increased recognition that governments and external agencies would be able to provide only a fraction of the financial commitment required to provide full service coverage.

Sustainability, in short, required that people-even poor people – would have to make some financial contribution. Cost recovery became one of the new watchwords (Black 98).

Women

From the early 1980s an increasing amount of attention was given to the role of women in water supplies. In most parts of the world, women are the traditional providers of the household water supply. Also with their responsibilities for family health, women are often the strongest advocates for change and improved facilities in the community. Thus as participation by the community became increasingly emphasized, the role of women grew in significance.

Government

There was growing consensus that, in the future, government should do less to provide services, and instead enable other institutions- public and private- to deliver them.

1994 to 2000

By the mid 1990s, a paradox faced the water and sanitation community. On the one hand, there was remarkable unanimity around the issues to be addressed and the appropriate policy responses. On the other hand the performance of the sector in developing countries was very poor. (Black 98).

Capacity Building

The evolution in thinking during this period involved increased emphasis on capacity building. The poor results of many projects were explained by the fact that the organization which assumed administrative responsibility for service delivery following construction turned out not to have sufficient human resources, skills or technical expertise to run them. The organization may also have been inappropriately structured or confined in a legislative framework which hampered efficiency. Focus was therefore placed on creation of an enabling environment via policy, legal and regulatory frameworks; institutional development including community participation and human resources development including training and education (World Bank).

Demand Responsive Service Provision

By the 1990s, it had become clear that the success or failure of low cost water and sanitation programs was principally determined by consumer demand. Emphasis was placed on demand driven decision making based on using community preferences and on the expression of a community's 'willingness to pay' for a given service level. It was believed that only if people attached a quantifiable value to the service, which could be factored into costs, would there be any kind of guarantee that the service would be sustained or sustainable (Sara 98).

1.5.0 THE FUTURE CHALLENGES

The previous discussion has demonstrated that there has been a slow evolution over the last twenty years to a more free market approach to water supply services for the poor, with increasing emphasis on consumer demand and willingness to pay. But this new approach, has resulted in several new challenges for the industry. It is important, for determination of its future strategies, that Davnor understand the challenges which it will face, and which are presented below.



1.5.1 Product Development

Developing a consumer market means that service providers now have to provide a menu of services and products. Moreover, these products need to match the potential market in price, appeal and technology. **But who is responsible for developing these products?**

Government departments and international donor organizations are not used to, or designed for, the developing and marketing of products. Private companies see very little profit margin in research and development of products for the poor, and engineering organizations, because of their technical focus, do not concentrate on development of, what they perceive as, low technology products. Consequently, there is very little effort being spent on product development for this market.

The ability to offer appropriate products to the poor would require that organizations make product development one of the specific objectives of the organization.

1.5.2 Understandable Technology

Experience has shown that health benefits are maximized when interventions target the three inter related areas of water supply, sanitation and hygiene (Esrey 91).



However, at the community level, water supply is primarily a communal service; whereas sanitation for the poor generally involves a simple household latrine, for which the individual family retains responsibility. Water supply also stands apart in one important respect. It has a relatively high technological content which requires technical support from the design and planning stage, through construction and into operation and

maintenance. For these reasons, support in water supply programs is dominated by technicians whereas sanitation and hygiene interventions need mainly health and social workers. (DFID '98).

Hygiene promotion provides the link between the technology and its users, and this promotion must begin before implementation because it gives users the knowledge with which to make informed decisions. But although hygiene promotion is a necessary component of both water supply and sanitation interventions, the skills required for its use are more likely to be found in organizations linked with sanitation than those found in water (DFID '98).

Therefore, one of the challenges facing Davor and the water supply industry in developing countries, is how to make the technology understandable so that the average consumer is capable of making appropriate choices; and so that water supply programs can be better integrated with sanitation and hygiene programs.

1.5.3 Demand Responsiveness

A joint World Bank- UNDP study of 125 water projects, conducted in '96-'97 found that employing a demand responsive approach at the community level significantly increased the likelihood of system sustainability (Sara & Katz 98). But it also indicated that very few projects worldwide were yet managing to implement this approach. **Why?**

For services to be consumer driven, demand must reach a point where there is significant public appreciation of the value of the services. How to create demand in a population who do not have an understanding of the value of the services- their contribution to convenience, health and quality of life- is one of the overwhelming challenges facing the water and sanitation field.

Also, unlike bureaucracies, markets cannot be made to function according to a predetermined administrative plan. Consequently, catering to or developing a consumer market around water and sanitation facilities requires enough flexibility to allow for a process of learning and growth.

Furthermore, demands for community water supply are localized demands. Therefore a demand- responsive approach requires that managerial decisions about levels of service, location of facilities



and recovery of operation and maintenance costs should be made locally. This means that communities need to be sufficiently well informed in order to make choices about matters such as technology and to articulate demands.

What's more, demand will, in general, come from those with the necessary assets and skills to make their demands heard, as well as those willing to take responsibility for maintenance and management. This will work largely against the poorer strata of societies. Ways to mitigate this effect need to be carefully considered (Smout & Parry- Jones 98).

In conclusion, the difficulties associated with balancing equity and market considerations, involved in a demand responsive approach in very poor communities, should not be underestimated.

1.5.4 Capacity Building /Community Based Management



Participation by the community in the design, construction and operation of water systems is presently being touted as one of the principal contributors to system sustainability (Narayan 93). But participatory approaches can be time consuming and require considerable investment of resources. Much longer lead times are also required (Minatullah et al 98). **Are participatory approaches always necessary?**

If a professional encounters an urgent situation, does he obtain input from those who do not and cannot have the same knowledge base as he does, or does he simply assess the situation and prescribe the most appropriate solution based on his professional judgment. There is a balance which needs to be achieved between the participation necessary to achieve support and championing of the system by the community, and the efficiency and efficacy of prescribed solutions by professionals in their field. Furthermore, there are times when the scale of projects and the technology used may make participatory approaches impractical.

Participation can also be a source of tension, and sometimes a destabilizing force in the community, if it inappropriately unbalances existing socio-political relationships. Participatory approaches need to be built on a thorough understanding of the leadership and organization of the community, including both

formal and informal groups and structures. There is a need to comprehend how changes in resources can affect livelihoods at the household level and the stratification within the community. One cannot classify an entire community as poor. Every community tends to subdivide itself and marginalize sub groups within it.

Community based management may provide communities with a sense of ownership, but community based structures and systems need to be carefully laid out. There is a need to define:

- What does the community own?
- In what kind of institution is this ownership vested?
- What systems are necessary to ensure that people are treated equitably? Village water committees can be weak and easily controlled by a few.

Establishment of appropriate and effective linkages among all the required participants in a water project continues to be a challenge.

1.5.5 Financial Sustainability

Without adequate cost recovery, water supply and sanitation services will not be sustainable. The concept of water as an economic good is gaining currency; but it has to be read with the condition that was attached to it at the Dublin conference:

“within this principle, it is vital to recognize the first basic right of all human beings to have access to clean water and sanitation at an affordable price.”

The affordable price, in question, needs to consider the recurrent costs of the water supply, the capital costs, the users willingness to pay and the users poverty (DFID 98). Safeguarding the poor from hardship, economic approaches, while pursuing the objective of full cost recovery is a major challenge for all countries.

Social scientists argue that economic positions are being used to reinforce inequity and that present approaches result in economic tariffs being demanded from the unserved, poor people rather than from richer people who enjoy subsidised rates. There are concerns about the effects on poor consumers of privatizing water supply utilities in countries without a strong regulatory framework. There are also apprehensions that the labour



contributions of a community are not being fully valued, so that a community's contribution and commitment to the water project are underestimated (Smout & Parry- Jones 98).

The narrow road between social sustainability and financial sustainability needs to be manoeuvred carefully.

1.5.6 Structured Learning and Standardization

As more emphasis is placed on demand responsiveness and decision making at the lowest levels, there is a larger number of variables, which affect the success or failure of a project. It is becoming harder to identify common indicators from which to learn lessons, and more difficult to synthesize experiences and institute a structured learning process.

In this more unstructured environment, it is difficult to achieve consistency in the approach to projects. These inconsistencies are heightened when large numbers of intermediaries, including NGOs, are involved in the implementation. NGOs suffer from lack of continuity in staffing and funding and so are often not in a favourable position to replicate projects (Minatullah 98).

Donor based projects can do no more than illustrate the way ahead. Permanent solutions need to be replicable by the indigenous populations using their available material and human resources.

Furthermore, standardization of equipment and parts is often not very common between projects, especially, if they are funded by different donors (DFID 98). The multiplicity of designs and equipment installed by different agencies has left many countries with such a wide variety of facilities that none are supportable. Standardization is a crucial part of any strategy to achieve sustainability and replicability (DFID 98).

The challenge is therefore to provide a system with enough flexibility to allow for changing conditions at the community level within a framework which, promotes consistency, standardization where appropriate, and structured learning.

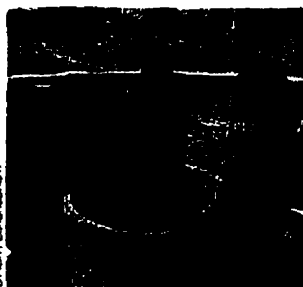
1.5.7 Women and Water

All significant donor agencies in the water supply and sanitation

Lessons on Gender

- *Gender is a central concern in water and sanitation.*
- *Ensuring both women's and men's participation improves project performance.*
 - *Specific, simple mechanisms must be created to ensure women's involvement.*
 - *Attention to gender needs to start as soon as possible.*
 - *Gender analysis is integral to project identification and data collection.*
 - *A learning approach is more gender responsive than a blueprint approach.*
 - *Projects are more effective when both women's and men's preferences about 'hardware' are addressed.*
 - *Women and men promote project goals through both their traditional and non traditional roles.*
 - *Non- governmental organisations and especially women's groups can facilitate a gender- balanced approach.*
 - *Gender related indicators should be included when assessing project performance.*

Source: the World Bank's toolkit on Gender in Water and Sanitation



industry presently place a very strong emphasis on considering and promoting the role of women in water projects. CIDA, the Canadian International Development Agency, lists the involvement of women in a project, as one of the criteria used for project funding.(CIDA 99).

However, this strong gender approach raises sensitive issues to do with confronting social and cultural norms and challenging power structures- something that communities, governments and donor agencies must do with care and respect. For women and children, additional care must be taken to ensure that participation is neither tokenistic nor an added burden.

While female empowerment may be a desirable end in itself, for purposes of this industry, it should be viewed as one of the principal means of providing communities with the required water services.

1.5.8. Summary

The water industry in developing countries appears to be in a state of flux, somewhat torn between its social responsibilities to:

- ensure that everyone, including the very poor, has basic access to services,
- develop capacity within communities to manage their own systems,
- democratically involve as many people as possible in the decision making processes,
- promote equity between men and women

and its need for more efficient market systems which involve:

- Development of products and technologies which are understandable and have wide consumer appeal
- Creating consumer demand
- Cultivation of processes and systems that are efficient, effective and permit continuous learning
- Recovery of costs sufficient to allow for financially sustainable service provision.

The strategies and plan of action, developed for the humanitarian distribution of the Davnor concrete water filter within this document, focus on the optimum ways of balancing these two sets of requirements.

2.0 THE PRODUCT

The reader gains an understanding of how the product was developed, how it works and its effectiveness at achieving the desired results. This is followed by a comprehensive analysis of comparative technologies, in order to demonstrate its potential impact on poor people in developing countries.

The major sections include:

2.1.0	Technology Effectiveness	36
2.2.0	Development History	38
2.3.0	Filter Description	40
2.4.0	Filtration Processes	41
2.5.0	Filter Operation and Maintenance	43
2.6.0	Technology Comparison	44
2.6.1	Water Supply, Sanitation or Hygiene	45
2.6.2	Water Sources vs Water Treatment	46
2.6.2.1	Impact on Health	46
2.6.2.2	Adequacy, Affordability, Reliability and Convenience	49
2.6.2.3	Conclusions	52
2.6.3	Community Based Treatment vs Household Treatment	53
2.6.3.1	Criteria	53
2.6.3.2	Effectiveness	54
2.6.3.3	Equity	54
2.6.3.4	Efficiency	54
2.6.3.5	Sustainability	55
2.6.3.6	Replicability	56
2.6.3.7	Conclusion	57
2.6.4	Household Treatment Alternatives	58
2.6.4.1	Treatment Processes	58
2.6.4.2	Evaluation Criteria	59
2.6.4.3	Effectiveness	59
2.6.4.4	Ease of Use	63
2.6.4.5	Capital Costs	67
2.6.4.6	Operating Costs	69
2.6.4.7	Conclusions	70
2.6.5	Section Summary	71

2.1.0 Technology Effectiveness



Testing Water from BioSand Filter
Londiani, Kenya 1998

The Davnor BioSand filter is a slow sand water filter, which has been specifically designed to be built on a very small scale, suitable for households, and to be used intermittently. Prior to these design improvements, slow sand filters generally involved large scale community size filters, which required a continuous flow of water for effective treatment to occur. These innovations to a technology, which has been used effectively in water treatment for over 150 years, has resulted in the technology being made available to a much broader spectrum of consumers at a very low cost.

Slow sand filters have been proven to remove, almost completely, all disease causing organisms, contained in water. These organisms known as pathogens include bacteria, viruses, protozoa or cysts and helminths or worms. The treatment effectiveness reported in the literature is as follows:

The average (BioSand) filter effectiveness was high (96%). Considering the fact that some of the source water was more than 10000 coliform units per 100 ml of source water and that the average was over 2500 cfu/100ml, the efficiency of the filter was remarkable

Kaiser and Chang (98)
Viet Nam

	Removal Rates
Total and Faecal Bacteria	99 to 100% (Bellamy et al, '85)
Viruses	99.9 to 100% (Hendricks & Bellamy '91)
Cysts	>99.99% (Bellamy '85; Schuler, Ghosh '91)
Worms	100% (Bernarde & Johnson '70)

The BioSand adaptation of slow sand filtration has proven to be just as effective as traditional slow sand filters in both laboratory and field tests. The technology has been introduced into over 30 countries by different organizations and people, in a variety of ways.

In conjunction with the introduction of the technology, the filter has been tested by several government, research and health institutions as well as NGO agencies. A summary of the test results is given below in Table 2.1.1.

**Table 2.1.1
Contaminant Removal Efficiency
BioSand Water Filter**

Country	Organization	Date	Contaminant	Reported Removal Efficiency %
Nicaragua	Instituto Nicaraguense de Acueductos y Alcantarillados	Jul 1993	Coliform Bacteria	99.1 to 99.6
Canada	University of Calgary	Nov 1995	Faecal Coliform	99.1 to 99.7
			Turbidity	94.1 to 96.1
Canada	National Water Research Institute	Nov 1996	Heterotrophic Bacteria	65 to 90+ ⁽¹⁾
			Giardia Cysts	100
			Cryptosporidium Oocysts	99.99
			Organic and Inorganic Toxicants	50 to 99.9
			Total Suspended Solids	100
			Total Organic Carbon	14 to 18
			Chemical Oxygen Demand	100
VietNam	Samaritan's Purse	Nov 1998	E. Coli Bacteria	95.8 ⁽²⁾
Brazil	Samaritan's Purse	Nov 1998	Fecal Coliform	99.7 ⁽³⁾
Bangladesh	Proshika Manobik Unnayan Kendra	Aug 1999	Total Coliforms (River water)	99.8 ⁽⁴⁾
			Fecal Coliforms (River water)	99.9 ⁽⁴⁾
			Total Coliforms (Three Households)	60.0 to 100 ⁽⁴⁾
			Fecal Coliforms (Three Households)	74.3 to 100 ⁽⁴⁾
Canada	Montana Native Reserve		Iron (F)	91.5
			Iron (T)	90.5
			Turbidity	85.7

(1) Damage of 10 to 15 % of schmutzdecke discovered at end of test period

(2) Average of 32 households

(3) Average of 21 households

(4) Raw and treated water not tested on the same days.

All samples show zero levels of fecal coliform and minimal levels of total coliform on day of final test.

2.2.0 Development History

The water filter was invented by Dr David Manz, P.Eng., Ph.D., an expert in the field of water supply and sanitation, while at the University of Calgary in the early 1990s. In 1999, Dr Manz resigned as a professor in the Department of Civil Engineering at the University of Calgary, to devote his full attention to the further development and marketing of the filter technology. The technology is patented by the University of Calgary and licensed to Davnor Water Treatment Technologies Ltd., which is primarily owned by Dr Manz. The rights to the humanitarian distribution of the technology are held by Dr Manz.

A brief summary of the international, humanitarian projects, implemented or contemplated, is given in Table 2.2.1

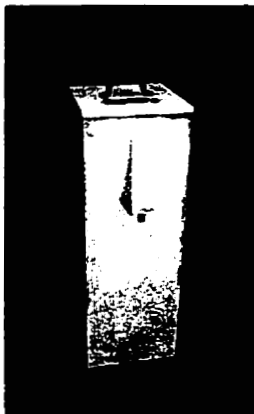


**Dr Manz Teaching the BioSand Filter Technology
Indonesia, 1998**

Table 2.2.1**BioSand Concrete Filter / Humanitarian Projects**

Country	Organization	Activity
Bangladesh	Proshika	Proshika has entered into a commercial joint venture with Davnor related company. Proshika helps poor purchase plastic filters.
Belize	Samaritan's Purse	Started in 2000
Benin	Samaritan's Purse	Started in 2000
Bolivia	Mennonite C. Com	Field worker trained. Status of project unknown.
Brazil	Samaritan's Purse	Hundreds of filters installed: Filter well accepted and demand is larger than the ability to supply.
Cambodia	Samaritan's Purse	Offering training and assistance to other organizations
Chile	IDRC	Successful field test of concrete filter in Maputo, Chile
Costa Rica	Davnor/ IDRC	Training provided to local organizations
DomRepublic	Davnor/ Rotary	Working to develop training program for local organizations.
Ecuador	Samaritan's Purse	Projects initiated in 2000
Egypt	Agra/ Rotary Club	Interest expressed in developing training program
El Salvador	Samaritan's Purse	Started in 2000
Ethiopia	Samaritan's Purse	Two year Project-co-funded by CIDA
Guatemala	Samaritan's Purse	
Haiti	Davnor / Rotary Club	Hospital Albert Schweitzer Community Health Program; Three steel moulds; Several hundred filters constructed
Honduras	Samaritan's Purse	500 filters installed as a component of Hurricane Mitch housing project.
Honduras	Shoulder to Should	Filters installed in two local communities
India	Rick Good	Individual initiative for local community. Filter mould purchased.
Indonesia	Davnor/ CARE	Training CARE field staff in filter construction.
Kenya	Samaritan's Purse	Training Centre established 1998
Laos	Samaritan's Purse	Started 1999
Malawi/ Mozambique	Davnor/ Local consultant	Discussions initiated with governments agencies in central African nations to introduce technical training as part of micro-enterprise development programs
Mexico	Samaritan's Purse	Training and steel moulds introduced with two or three church ministries in Tuxtla, Southern Mexico
Nepal	Samaritan's Purse	Two steel moulds constructed and used for local initiatives
Nicaragua	University of Calgary	Nicaragua Successful Field Test Only cholera free area in Nicaragua was the community where the filters were installed.
Nicaragua	Samaritan's Purse	Three year project co-funded by CIDA. Distribution of over 300 emergency water filters. In addition, almost 600 concrete filters installed . Four local organizations trained.
North America	Samaritan's Purse	In partnership with CIDA, internship program in three different countries initiated. Goals include transferring the ability to build and use the filters to local organizations, develop pilot projects in villages and analyse social and cultural acceptability of the filter.
Pakistan	Samaritan's Purse	No information.
Rwanda	Southside Pentecostal	Small community scale plastic filters introduced as part of Presbyterian church international development work.
Thailand	Samaritan's Purse	Initiated 2000
Uganda	Samaritan's Purse	Technology introduced to 20 organizations in Kampala
Viet Nam	Samaritan's Purse	400 filters installed: Plans for a training centre in development

2.7 Filter Description

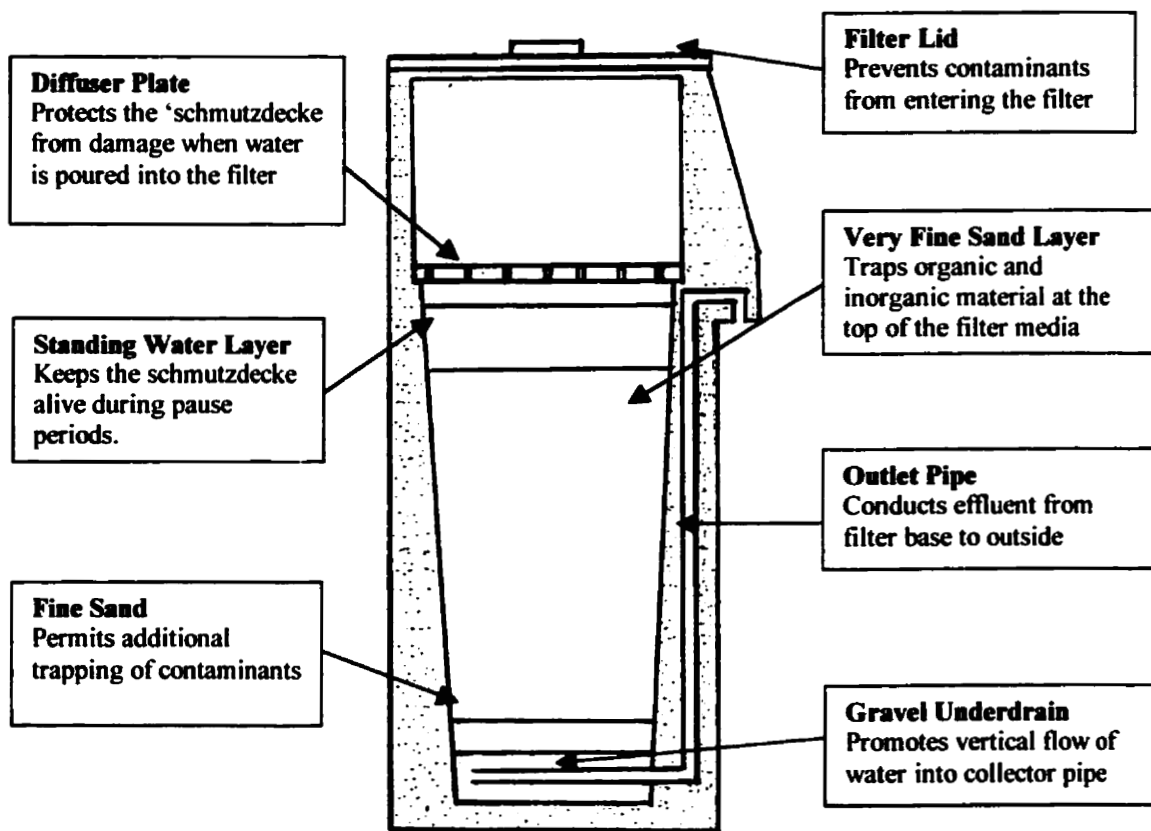


The filter is quite simply a container built of concrete, which contains layers of sand and gravel. The water is poured into the top of the filter when needed, and the initial force of the water is dissipated by a diffuser plate placed above the sand bed. Subsequently, it moves slowly through the sand bed to a gravel underdrain at the base of the filter. The water is then collected in the pipe at the filter base and conducted through plastic piping encased in the concrete exterior to the outside of the filter. (Figure 2.3.1).

There are two important design features incorporated into the BioSand filter design which allows the filter to be constructed on a small scale and used intermittently.

1. The level of the outlet pipe is such that a 5 to 10 cm layer of water is maintained above the sand at all times.
2. A diffuser plate placed above the level of the water protects the sand below from damage when water is poured into the filter.

Figure 2.3.1
Filter Components



2.4.0 Filtration Processes

Pathogen Removal

In this filter, as with all slow sand filters, removal of pathogens is due primarily to biologic processes. Organic material gets trapped at the surface, or very close to the surface of the sand, developing a biologic layer or *schmutzdecke*. Over a period of approximately three weeks, micro organisms colonize the filter in this region, because of the abundance of organic food and oxygen derived from the water. These micro organisms consume bacteria and other pathogens in the water, thus providing a very effective water treatment process (Droste 97).

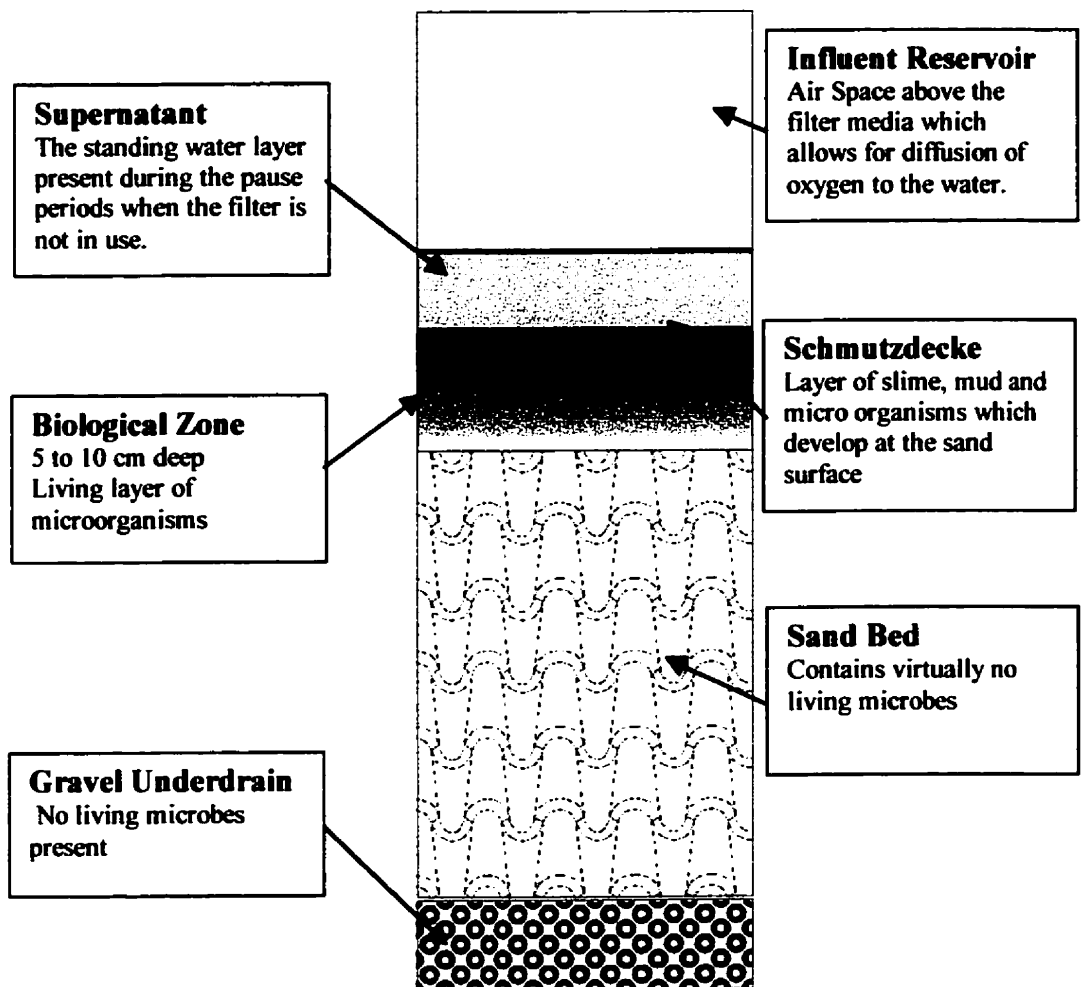
In addition to this process known as predation, pathogens also simply die over time, because, in the filter, food is scarce and the temperature is lower than the optimal temperature required by the pathogen.

Viruses are adsorbed or become attached to the sand grains. Once attached, they are metabolised by the cells or inactivated by antiviral chemicals produced by the organisms in the filter. (Ellis '85 in Buzunis '95). Cysts and worms are removed physically from the water by the trapping of these organisms in the spaces between the sand grains.

Maintaining the Integrity of the Biologic Layer

There are five distinct regions in the filter; the influent reservoir, the supernatant, the *schmutzdecke*, the biologically active zone and the sand support and underdrain.

**Figure 2.4.1
Filter Regions**



The small layer of water, maintained above the sand, ensures that the schmutzdecke is always kept moist, thereby keeping the micro organisms alive between periods of use. These organisms also require oxygen for survival. When the water is flowing through the filter, oxygen is supplied to the biologic layer by the dissolved oxygen in the water. During pause periods when nobody is using the filter, and the water is not flowing, the oxygen is obtained primarily by diffusion from the air, through the water layer. The design level of the supernatant allows enough oxygen to pass through to the micro organisms, to keep them alive and thus effective.

2.5.0 Operation and Maintenance

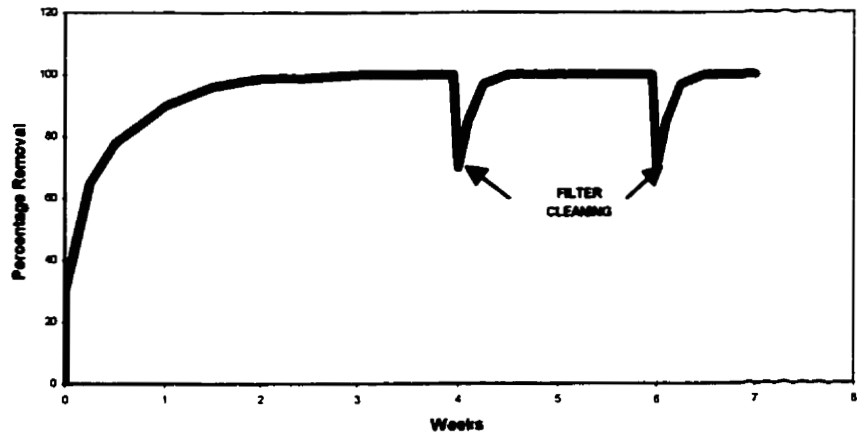


The filter operation is very simple, as previously described; simply remove the lid, pour a bucket of water into the filter and collect the treated water in a pail immediately.

It normally takes three weeks for the biologic layer to develop to maturity in a new filter. During that time, the removal efficiency and thus effectiveness of the filter grows. With continued use, the rate of flow of water through the filter decreases because the pore openings between the sand grains become clogged with particles and debris.

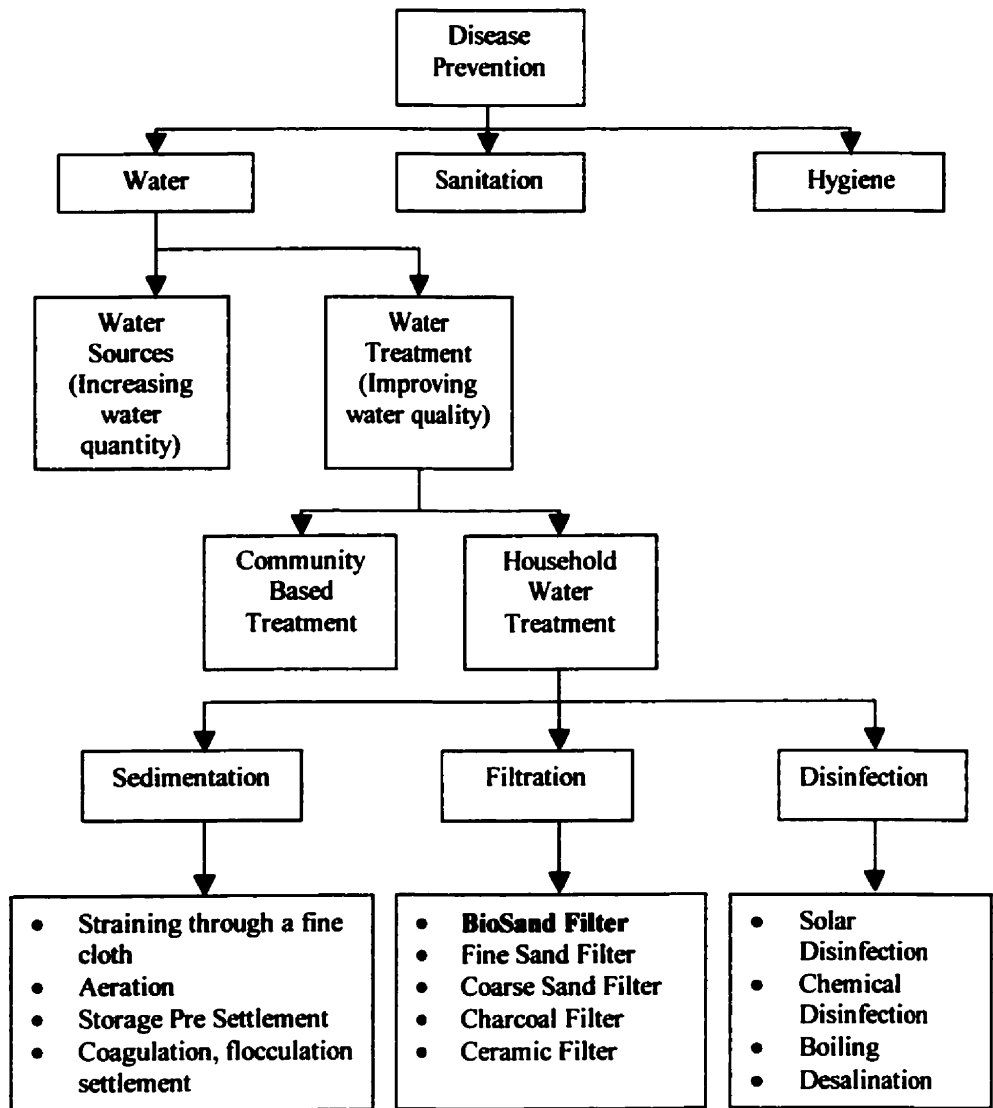
The filters are cleaned by removing a very thin layer of sand at the surface. This sand can be washed and returned to the filter. After cleaning, the removal efficiency declines somewhat, but increases very quickly to its previous level as the biologic layer becomes re established. (Figure 2.5.1)

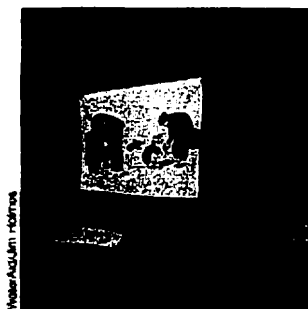
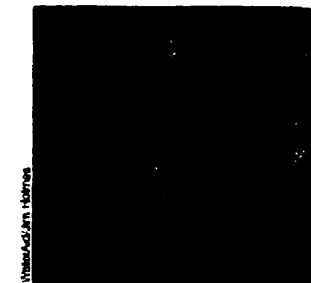
Figure 2.5.1
Percentage Removal Efficiency with Time



2.6.0 Technology Comparison

The chart below outlines where the BioSand technology fits within the context of disease prevention in developing countries. This section compares the different means of achieving this result in order to gain an understanding of the significance of the technology.





2.6.1 Water Supply, Sanitation or Hygiene



Since improving the quantity and quality of water, better sanitation practices and improved hygiene all lead to better health, one of the first questions a person must ask is how does an investment in water supply or water treatment compare with one in sanitation or hygiene in achieving the overall objective.

Both Vision 21, produced by the World Water Council in the Hague and the Department for International Development in the UK (DFID), lists sanitation projects as a higher future priority to water projects for two reasons:

1. 'Experience has shown that clean water alone leads to only minor health improvements. The essential factor is personal hygiene as a core issue in its own right, with adequate sanitation and clean water as supporting components.' (DFID 98).
2. There are 2.9 billion people who lack sanitation as compared to 1.2 billion who lack access to clean water.

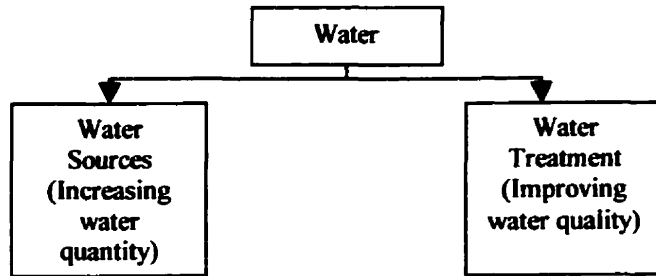
However, after consideration of the following facts:

- (a) There is no substitute for clean water. Health is not the only issue. Water is vital for life, and even dirty water is preferable to no water at all.
- (b) Given a choice, people indicate a much stronger desire for clean water than for sanitation (DFID 98).
- (c) It has been proven that water and sanitation improvements spur changes to hygiene behaviour (DFID'98).
- (d) As outlined previously, access to convenient and affordable water supplies can save people's time and energy and enhance their livelihood opportunities.

It is evident that, although sanitation and hygiene are very important, and although more people lack access to sanitation facilities than water, investing in water must still be a priority. Health benefits are maximized when improvements cover all three inter related areas in a cohesive strategy.



2.6.2 Water Sources vs Water Treatment



The next question facing the WS&S industry is one of whether money should be invested in providing additional sources of water, or should it be invested in water treatment to improve the water quality. This issue is addressed by firstly reviewing the impact of the alternatives on the health of the consumer and secondly by discussing how each of the two alternatives affect the affordability, adequacy, reliability and convenience of water supply to the consumer.

2.6.2.1 Impact on Health

Water can affect faecal-oral disease transmission in two principal ways, firstly through waterborne transmission and secondly through waterwashed transmission.

Waterborne infectious diseases are transmitted primarily through contamination of water sources with excreta of humans and animals. Use of such water for drinking, contact with it during washing or bathing, or even inhalation of its fine droplets as aerosols, may result in infection (Gadgil 98).

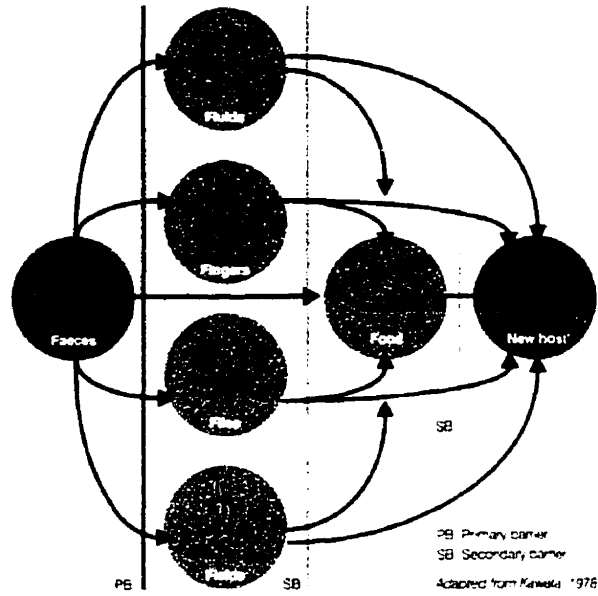


Figure 2.6.1
Transmission of Disease from Faeces (Source: DFID 98).

The minimum infectious dose necessary to cause disease varies widely for various micro-organisms.

It also varies by the age, health, nutritional and immunological status of the exposed individual. 'Those at greatest risk of waterborne disease are infants and young children, people who are debilitated or living under unsanitary conditions, the sick and the elderly. For these people, the infectious doses are significantly lower than for the general, adult population.'

WHO 98

Water washed transmission is transmission encouraged by poor hygiene due to insufficient quantities of water for washing (Cairncross and Feachem 93). Where water is scarce, it is difficult to maintain clean hands, clean food and the clean household environment essential to control the many routes of disease transmission.

Water borne transmission of disease caused by contaminated drinking water can lead to dramatic epidemics, in which large numbers of people are simultaneously exposed to infection. On the other hand, the conditions for water washed transmission are common and this contributes more to the endemic (continuous) toll of diarrhoea than does the water borne transmission.

Table 2.6.1 summarizes the relative impacts of water related diseases and the effect of increasing water quantity or improving water quality on these diseases.

Table 2.6.1
Worldwide extent of Water-Related Disease
(Classified after Cairncross & Feachem '93)
Source: DFID '98 (modified)

Disease Type	Morbidity	Mortality	Water Related Control Measures
1. Faecal Oral			
Diarrhoeal disease	1,000 million episodes per year	3.3 million	<ul style="list-style-type: none"> ▪ Improve water quality. ▪ Increase water quantity used
Cholera	>300,000	>3000	
Enteric fevers	>500,000	>25,000	
Roundworm (Ascariasis)	20-40% rate of infection in developing countries		
2. Strictly water-washed			
Trachoma	6-9 million blind		<ul style="list-style-type: none"> ▪ Increase water quantity used
Skin Infections	Very common, millions		
3. Water-based intermediate host (parasitic)			
Shistosomiasis	200 million	>200,000	<ul style="list-style-type: none"> ▪ Restrict contact, provide alternative sources
Guinea-worm	1989: 350,000 1996:35,000 (and dropping)		
4. Water related insect vector			
Malaria	300-500 million cases	1.5-1.7 million	<ul style="list-style-type: none"> ▪ Focus on insect breeding sites (not much scope in domestic water supply)
Filariasis	128 million		
Dengue	30-60 million infected/year		

There have been remarkable advances in the provision of groundwater supplies in India with the installation of 100,000 deep borehole wells annually, and with each well serving approximately 200 people. This has enabled the rural population to shift from their overwhelming reliance on polluted surface water.

A similar aggressive effort in the Indian state of West Bengal and in Bangladesh, however, has led to the largest ever case of mass arsenic poisoning.

Gadgil 98

Furthermore, Esrey and colleagues ('85, '91) have attempted to compare the effects of different types of interventions on diarrhoeal morbidity. In spite of a wide range of results, a summary of those studies, which were felt to be free of methodological error (Table 2.6.2.) indicate that, in general water

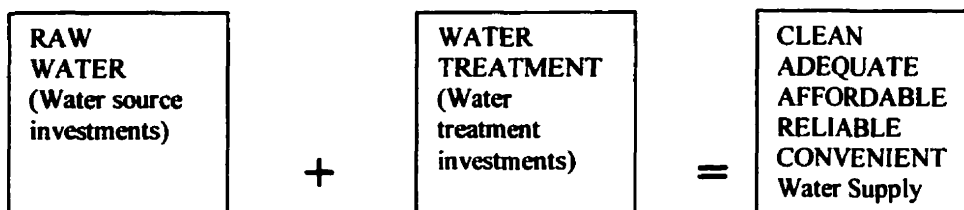
quantity is more important than water quality, but that an integrated approach with sanitation and hygiene achieve maximized results.

Table 2.6.2
Diarrhoeal Morbidity Reduction from WS&S Projects
 Source: Esrey et al 1991 in DFID '98

Rigorous Studies		
Type of Intervention	No.of Studies	Median % Reduction
Water and Sanitation	2	30
Sanitation	5	36
Water quality and quantity	2	17
Water quality	4	15
Water quantity	5	20
Hygiene	6	33

2.6.2.3 Adequacy, Affordability, Reliability and Convenience of Water Supply

It is somewhat simplistic to present the alternatives as simply a choice between investing in additional water sources or water treatment. The ultimate objective is to provide the consumer with an adequate, affordable, reliable and convenient supply of clean water. **The choice between water quality and water quantity or, investing in water treatment vs water sources, is interdependent.** The level and cost of water treatment, or the need for treatment at all, depends on the quality of the raw water. One needs to evaluate the different sources of water available to a community, together with all the alternatives for treating these different sources to determine which combination of source and treatment provides the consumer with the desired end product.



Raw Water Sources

Of the three principal sources of freshwater, captured rainwater, ground water and surface water; in general, captured rainwater and groundwater require much less treatment than surface water

(Chanlett 95). Groundwater, however, often contains chemicals, such as arsenic, which are very harmful and difficult to treat. Furthermore, contamination of shallow aquifers through seepage of dirty water, contaminated by animals or humans, in the immediate vicinity of the wellbore or further upstream, is a frequent occurrence.

Also, the different sources need to be compared, not only with respect to their water quality, but also as to their affordability, adequacy, reliability and convenience. These are summarized in Table 2.6.3.

Table 2.6.3
Advantages and Disadvantages of Alternative Water Supplies
Source: Brock '86

Source	Advantages	Disadvantages
Captured Rain	<ul style="list-style-type: none"> ▪ Uncontaminated ▪ Soft water 	<ul style="list-style-type: none"> ▪ Unreliable supply ▪ Storage expensive ▪ Potential mosquito breeding ground
Cistern (under or above ground)	<ul style="list-style-type: none"> ▪ Uncontaminated ▪ Soft water 	<ul style="list-style-type: none"> ▪ Easily polluted by runoff or catchment surface ▪ Storage limited and expensive
Groundwater	<ul style="list-style-type: none"> ▪ High biological quality ▪ Reliable supply ▪ Constant temperature 	<ul style="list-style-type: none"> ▪ Limited quantity ▪ Water often hard
Dug well- shallow	<ul style="list-style-type: none"> ▪ Inexpensive 	<ul style="list-style-type: none"> ▪ Easily contaminated ▪ Undependable
Drilled well- deep	<ul style="list-style-type: none"> ▪ Less contaminated ▪ More dependable 	<ul style="list-style-type: none"> ▪ Expensive
Spring	<ul style="list-style-type: none"> ▪ Inexpensive 	<ul style="list-style-type: none"> ▪ Often contaminated ▪ Water often hard ▪ Very limited supply
Surface Water	<ul style="list-style-type: none"> ▪ Inexpensive ▪ Easy access for bank communities ▪ Quantity can be observed and predicted 	<ul style="list-style-type: none"> ▪ Often contaminated ▪ Unreliable supply ▪ Temperature varies
Rivers	<ul style="list-style-type: none"> ▪ Readily available 	<ul style="list-style-type: none"> ▪ Often turbid
Lakes	<ul style="list-style-type: none"> ▪ Less turbid 	<ul style="list-style-type: none"> ▪ Few good lakes
Reservoirs	<ul style="list-style-type: none"> ▪ Reliable supply 	<ul style="list-style-type: none"> ▪ Expensive ▪ Excess algae growth





Affordability

The least expensive water comes from surface sources such as rivers or streams (Snell 98). Although ground water is relatively free of biological contaminants, it is often difficult to locate. Not only are deep wells expensive to drill, they also often contain chemical contaminants, such as arsenic and fluoride, which are difficult and costly to remove. The storage facilities required for collection of rainwater are also costly in comparison.

Adequacy

The amount of water which can be abstracted from underground sources is often difficult to assess because of the limited knowledge of water flow beneath the ground whereas locals are normally very aware of the variations which can be expected in surface supplies (Ferrouki & Chokkakula 97).

Reliability

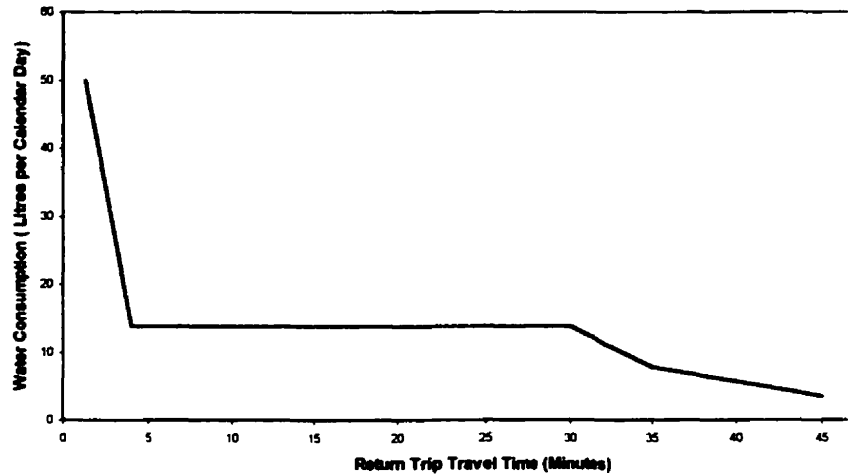
No water source is uniform or static. Ground, surface and rain water vary in quantity and quality over the annual cycle and from place to place. Quantity also varies from year to year and over longer time periods. Moreover, climatic change is predicted to increase this variability and uncertainty. In the short term however, ground water sources are generally more reliable than surface water sources.

Convenience

Convenience of both water supply and sanitation facilities is given a high priority, particularly by women and children. Facilities need to be accessible and easy to use

As a result of studies in water use patterns carried out in the 70s and 80s Cairncross (Cairncross and Feachem '93) developed the diagram below. It illustrates that when water is brought within easy reach of the household, water use increases dramatically. When water is further away or involves a return trip of more than half an hour, water consumption drops off (Figure 2.6.2). Between these two extremes, however, water consumption is constant and does not vary substantially when the return travel time is in the approximate range of three to thirty minutes.

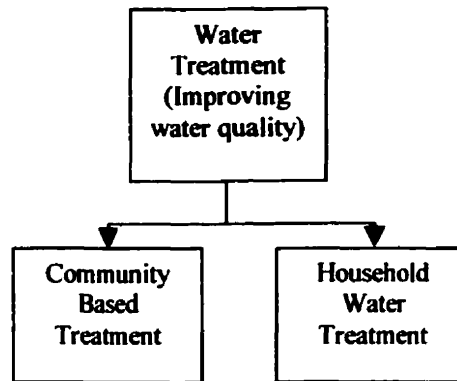
Figure 2.6.2
Water Consumption vs Travel Time
(Source: Cairncross & Feachem in DFID 98)



2.6.2.4 Conclusions

The discussion has illustrated the extent of the interdependence between the choice of water sources and the level of treatment. Over the last few years, much money has been invested into the drilling of groundwater wells because groundwater is relatively pure and requires only minimal treatment (DFID '98). However, development of affordable treatment processes, like the BioSand technology makes possible the use of a much wider variety of sources including consideration of surface water sources, which may be more affordable and convenient to the consumer. It also provides greater reliability of the water quality within the household since water contamination in the aquifer, around the wellbore or in the household is a frequent occurrence. It is therefore possible to increase the volume of supply of clean water by investing in low cost water treatment rather than additional water sources.

2.6.3 Community Based Treatment vs Household Treatment



2.6.3.1 Criteria

The selection of a technology appropriate to the needs of a community should be based on whether that technology is capable of providing the chosen level of service in a way which is **effective, equitable, efficient, sustainable and replicable** (DFID 98).

- Effectiveness is the degree to which the technology meets its objectives.
- Equity is the capability of the technology to reach the poor and other disadvantaged groups.
- Efficiency represents the output per unit of resources (water, staff, funds); e.g. the number of people served for every thousand dollars invested.
- Sustainability is the ability of the services to be of long term use to the community and country. i.e. they must operate reliably for a considerable period.
- Replicability is the degree to which solutions to similar problems can be repeated in a consistent manner.

2.6.3.2 Effectiveness

Is it possible to provide household systems which are as effective as community systems? In general, scale has little impact on the effectiveness of water treatment processes. Furthermore, in Section 2.1.0 it was demonstrated that the effectiveness of the household size BioSand water filter is comparable to traditional community scale slow sand filtration, with pathogen removal

rates greater than 99%.

Also household systems or point-of use systems have the advantage in that there is a low probability that the water is recontaminated between treatment and use. It is common knowledge that the water which comes from the taps in major cities like Mexico City, Delhi or Djarkarta is not fit for drinking, even though this water was previously treated. This is due to the significant recontamination of water in the distribution systems. Under certain circumstances, therefore, household systems can be more effective than community systems.

2.6.3.3 Equity

Centralized provision of WS&S services often fail to reach the poor and other disadvantaged groups since community water supplies function through a hierarchy of primary and secondary distribution systems which feed the neighbourhood level tertiary distribution systems. Consequently, the ability to deliver a particular level of service to the consumer is dependent on the larger network. Thus, in order to target improvements to the urban poor, it is often necessary to augment the city supply system, which will also benefit those outside the target group

It is much easier to target those most in need, when providing individual household treatment systems.

<i>Stolen or Unaccounted for Water</i>	
<i>Manila</i>	58%
<i>Most Latin American Cities</i>	
	40%

2.6.3.4 Efficiency

Past WS&S community projects have been inefficient in a variety of ways (DFID 98).

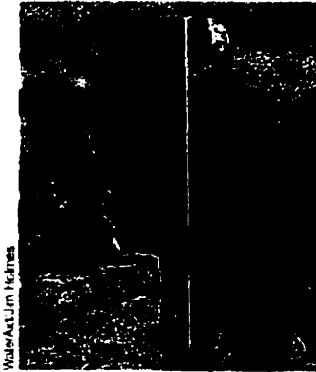
- Focus on high cost projects serving urban elites has severely limited the number of people served per unit invested.
- Poor operation and maintenance has led to high water losses and low cost recovery.
- Neglect of sanitation and hygiene education has reduced benefits from water schemes.

<i># Employees per 1000 connections</i>	
<i>Developed Countries</i>	3 to 4
<i>Most Latin American Utilities</i>	10 to 20
<i>Mimba, India</i>	33
<i>Gadgil 98</i>	

Community systems are also inefficient in one other significant way. All the water used by the consumer, including water for drinking, bathing, cleaning, laundry and flushing of toilets is treated to potable water specifications. Household systems allow the user to treat only the water required for drinking and cooking, thereby making the whole system more efficient.

2.6.3.5 Sustainability

Although operation and maintenance and consumer acceptability are arguably the primary considerations in evaluating a technology's sustainability, the issues of water conservation and water disposal should also be analysed.



WaterAid/Um Khatun

Operation and Maintenance Acceptability

The guiding factor in deciding between single, centralized community services or household collection and treatment is sustainability, not technical feasibility. One needs to consider whether the community has the institutional capacity and capability to operate and maintain the system and whether the system is socially and culturally acceptable to the users and operators, i.e. can you create a demand which will sustain a supply?

The choice of technology is central to achieving a sustainable system.

- The technology must be understandable and physically within the capability of the people responsible for operation and maintenance.
- Spare parts need to be easily obtainable, preferably in country.
- The technology must be affordable to operate and maintain for the people bearing these costs.
- The technology or level of service provided must be attractive and culturally acceptable to users.

(DFID 98).

Household systems are more likely to satisfy these criteria than large community systems because they are generally simpler, more understandable and in the control of the individual or family. Moreover, they do not require formation of user groups or other community support systems, which are normally difficult to develop. Developing countries often lack the governance and regulatory processes necessary for sustainable multi family systems.

Water Conservation

In several parts of the world, another key element of sustainability is the question of conservation. Does the technology encourage conservation of scarce water supplies

Groundwater abstractions which are greater than the natural

The arsenic in the shallow tube wells of Bangladesh is hypothesized to have leached from local, underground geologic strata because of the lowering of the water table.

Gadgil 98

recharge inevitably cause a continuing fall in ground water levels; which in some instances can result in saline intrusion from the sea or a saline lake, thereby contaminating the aquifer. Surface water abstractions which are greater than the natural recharge inevitably cause dry river beds downstream, and disturbance to the natural eco-systems.

The choice of water source, whether surface or ground water, and the method of supplying this water to the community, whether household or community system, therefore needs to consider the necessity for water conservation to protect the long term viability of the water supplies vs the immediate needs of the residents.

Household treatment systems encourage greater conservation than do community systems. Individual users are more cognizant of how much water they use and there is much less wastage in distribution systems.

Water Disposal

Whenever water is delivered to a community, some provision must be made for its removal after use. Waste water removal is important for health and environmental reasons.

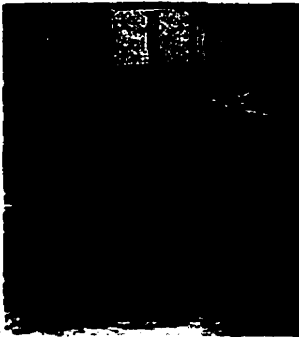
In rural areas, the problem is most significant at the supply point. In urban areas, the problem can be much greater. Not only is there a larger quantity of water entering the area, there is less space for its disposal (DFID 98).

Community systems normally require much larger investments in water disposal provisions than household systems.

2.6.3.6 Replicability

Population growth, increased urbanization and aspiration for better services will necessitate continued expansion of WS&S services for the foreseeable future. It is therefore essential that services and interventions be replicable to meet these expansion requirements.

Simple systems can be standardized and repeated. Community based systems require much more specific engineering and design. Furthermore, community supply engineering design standards and construction practices are often based on national



DFID Edward J. Davets



WaterAid Jim. Lufman

codes of practice and standards. It can be very difficult to change or modify these standards to suit the local context even though they may be inappropriate for the particular circumstance.

2.6.3.7 Conclusion

Having a piped water supply to one's home is a convenience that every householder aspires to. However, it is not financially possible to provide this level of service to the 1.2 billion people who currently do not have access to clean water within the foreseeable future. Household technologies have been proven to meet more of the key service criteria; effectiveness, equity, efficiency, sustainability and replicability than do the larger scale community technologies and may provide more appropriate solutions for initial service coverage to poor people in developing countries.

2.6.4 Household Treatment Alternatives

How does the BioSand water filter compare to other household treatment alternatives?

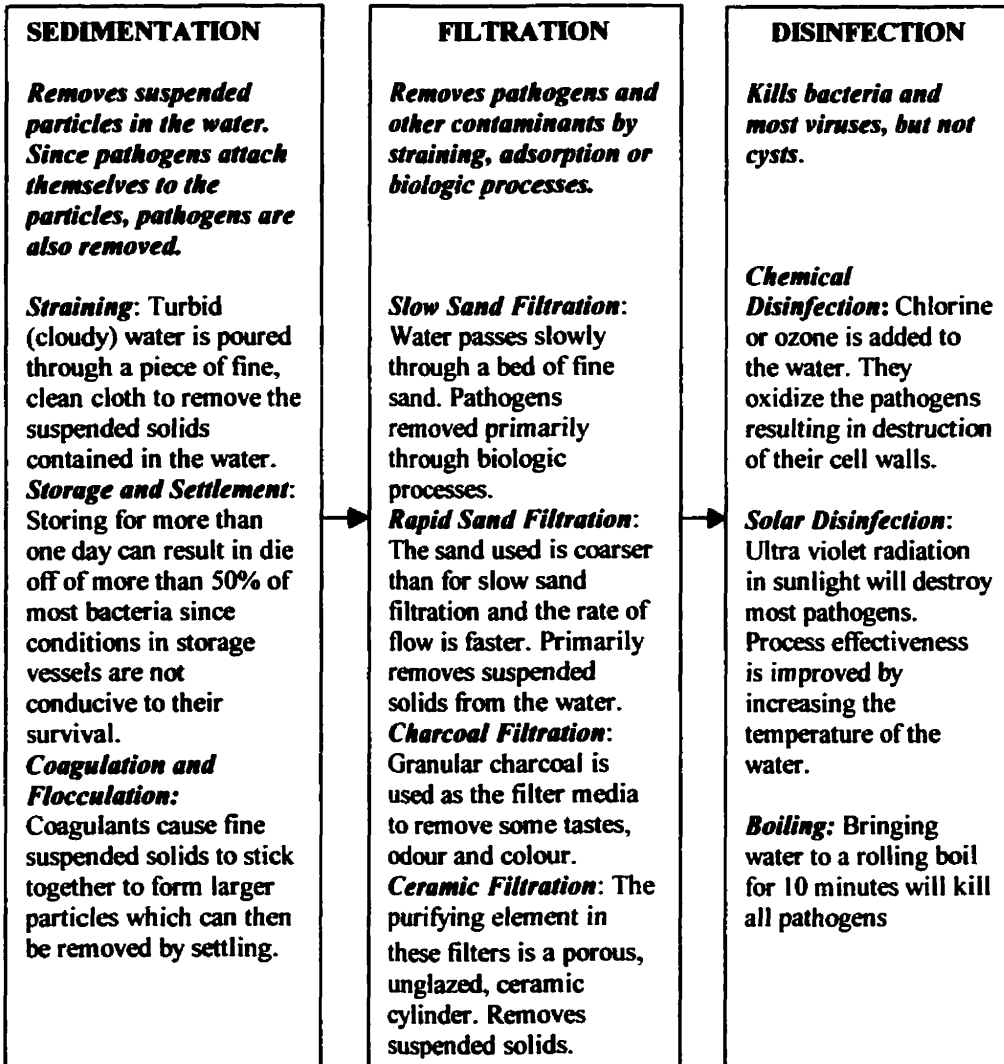
2.6.4.1. Treatment Processes

Of all the contaminants contained in water, the microbial contaminants generally present the most risk to the health of the consumer. The first priority of any treatment system is, therefore, the removal of pathogens from the water.

The main treatment processes used to produce potable water are, sedimentation, filtration and disinfection.



Straining through cloth



2.6.4.2 Evaluation Criteria

The criteria which will be used to compare the BioSand filter to these other treatment processes are:

- **Effectiveness:** To what degree does the process remove or kill disease-causing organisms in the water?
- **Ease of Use:** Can the consumer understand and use the technology properly?
- **Cost:** Can the very poor afford to acquire, operate and maintain the system?

2.6.4.3. Effectiveness

Sedimentation-Filtration-Disinfection

In a very real sense, filtration is the bulwark of water treatment (Droste '97). The sedimentation and coagulation processes are normally used as pre-treatments for filtration since these processes alone cannot be guaranteed to produce water of potable drinking standards. Filtration, however, removes most of the harmful substances in the water.

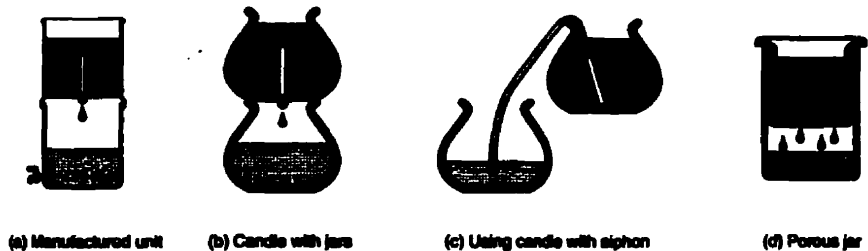
Furthermore, for chemical and solar disinfection to be effective, the water should be free of organic matter and suspended solids. Hence disinfection is best used as a polishing process to kill any contaminants not previously removed during filtration. Water obtained from surface sources almost always require filtration. (Droste 97).

If water is disinfected before use, then care should be taken that this be done consistently, because people who drink disinfected water lose immunity to some diseases.

Filtration Types

Ceramic Filters

The purifying element in these filters is a porous, unglazed, ceramic cylinder (often called a candle). Ceramic filters are appropriate only for fairly clear water because they block quickly if the water contains suspended particles.



The effectiveness of ceramic filters depends on the size of the pores of the clay. Filters with very small pore sizes can remove all pathogens (Shaw 99). However, the International Water and Sanitation Centre do not recommend the use of ceramic filters because their effectiveness is significantly adversely affected by any cracks which occur in the filter bowl (Brikke et al 97).

Charcoal Filters

Granular charcoal can be quite effective at removing some tastes, odours and colour, but it has negligible effect on pathogens. Furthermore, there is evidence that charcoal, particularly if not regularly replaced, can become the breeding ground for some quite harmful bacteria (Shaw '99).

Rapid Sand Filters

Rapid sand filters reduce larger micro organisms and suspended solids. They do not by themselves produce water of potable water quality (they will not remove fecal pathogens) but can prepare water for disinfection by UV, chlorine or ozone (Gadgil 98).

In a downflow filter the water flows down through a layer of sand, ideally between 1 and 2 metres deep, below a depth of water between 1.5 and 2.5 metres. These depths are rarely practical for household filters which have shallower depths and are therefore less effective (Shaw 99).

Slow Sand Filters

As shown in the Table 2.6.4 and, as generally accepted in the water industry, slow sand filtration is the most effective filtration process for the removal of pathogens, natural chemicals and turbidity in water. Slow sand filters use a very effective combination of biologic and mechanical processes to clean the water whereas rapid sand filters rely primarily on mechanical processes.

Table 2.6.4.
Generalized Effectiveness of Different Household Treatment Systems
 (Source: Technical Brief No. 58, Shaw '99)

Problem with raw water	Effectiveness of treatment method											
	0 = minimal effect if any - = unknown effect						1-4 = increasing effectiveness + = helpful to another process					
	Straining through fine cloth	Aeration	Storage/ Pre-settlement	Coagulation, flocculation and settlement or filtration	Fine Sand filtration (slow)	Coarse sand filtration (rapid)	Charcoal Filter	Ceramic Filter	Solar disinfection	Chemical Disinfection	Boiling	Desalination/Evaporation
PATHOGENS												
Bacteria, amoeba, viruses and ova	0	+	1-2	0-1	4	2	-	3-4	4	4	4	4
Guinea worm larvae	4	0	0	-	4	2-3	-	4	2-4b	-	4	4
Schistomiasis cercaria	-	0	4	-	4	2-3	-	4	2-4b	4	4	4
NATURAL CHEMICALS												
Iron and manganese	0	+	1	1	3	3	-	-	-	-	-	4
Fluoride	0	-	0	4			-	-	-	-	-	4
Arsenic	0	+	-	4	4	4	-	-	+	-	-	4
Salts	0	0	0	-	0	0	0	0	0	0	0	4
OTHER PROBLEMS												
Odour and taste	0	2	1	1	2	2	3 - 4	2	0	1	-	3- 4
Organic Substances	1	1	2	1	3	3	-	3	-	4	-	4
Turbidity/cloudiness caused by suspended solids	1	0	2	3	4	3	-	4	0	0	0	4

b. Removal depends on sufficient temperature rise, cercaria die at 38^o

Some of the problems and limitations to the process reported in the literature (Brikke 97) include:

- A drop in water quality if the flow rate is too high.
- Potential death of the beneficial micro organisms in the filter if the flow is interrupted for more than a few hours or when the filter runs dry.
- Rapid clogging of the filter if there is excessive turbidity in the raw water (>30NTU)
- Formation of harmful and badly tasting products like NH_3 and H_2NO_3 in the lower levels of the filter when water quality is very poor.
- Short circuiting in the water flow if there are smooth vertical surfaces
- Reduction in removal effectiveness of the filter immediately after cleaning or resanding the filter.

One boy calls the water from the filter, 'agua de saude' meaning water of health and water from the river, the 'water of death'. News of the filters in San Jose has spread rapidly to surrounding communities and villages of more than five hours away. Many people on their way through will stop at San Jose and collect water to take to their homes downriver. Some bring large containers enough for a week while others will take a thermos for the day. It is also interesting to see that the filters have been painted in an array of different colours. One even has the Brazilian colours of yellow and green to show support for the national soccer team.

Liang 98
Brazil
Samaritan's Purse

BioSand Filter

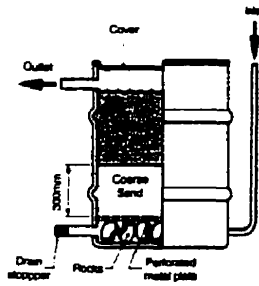
The BioSand filter is a slow sand filter, and, as demonstrated in Section 2.1.0, has proven to be as effective as conventional slow sand filters. In addition, it has been designed to address almost all the shortcomings of a conventional slow sand filter.

- Construction of the filter in accordance with the specified instructions results in design flow rates that allow for effective treatment.
- The integrity of the biologic layer is assured by maintaining the water level at a specific design depth.
- Short circuiting of bad water is minimized by dissipating the force of the water in the diffuser basin and by having all piping external to the sand bed.
- The ease with which the filter can be cleaned means that water of higher turbidity can be put through the BioSand filter as compared to a conventional slow sand filter. The filter just needs to be cleaned more regularly with the higher turbidity water.
- If the water is very turbid, placing two BioSand filters in series; one of which is cleaned daily and the other which is cleaned only periodically, would address any concerns with respect to the filter effectiveness due to frequent cleaning.

Moreover, the effectiveness of the BioSand filters produced in the field, in accordance with instructions specified, is consistent from filter to filter. This is because the specific manufacturing processes and procedures provide an element of quality control, which is not available for most other slow sand filters constructed in the field.

2.6.4.4. Ease of Use

Since sedimentation alone is insufficient to consistently remove enough pathogens to ensure that the water meets potable standards, further comparisons of the different household treatment technologies will be limited to the most effective filtration and disinfection systems, which include rapid sand and slow sand filters as well as chemical and solar disinfection.



Simple Upward Flow Rapid Sand Filter

Rapid Sand Filters

When rapid sand filters become clogged, the flow is reversed to mobilize the sand particles and wash out the trapped solids. This flow reversal or backwashing, may be carried out every day to prevent the build-up of deposits in the sand. These cleaning requirements make the operation of rapid sand filters, normally too complex for household use. It also results in considerable water wastage, a very important consideration in communities where water is scarce and may be carried considerable distances.

The UNICEF filter (Figure 2.6.3) is a modification of an upward flow filter; designed to reduce the backwashing requirements through incorporation of elements which encourage microbial action to reduce the number of pathogens. It is capable of treating up to 40 litres per day. However, the complexity of design, as indicated below, makes its construction and operation and maintenance difficult. It is also not effective at removing all pathogens. (Singh and Chaudhuri 93)

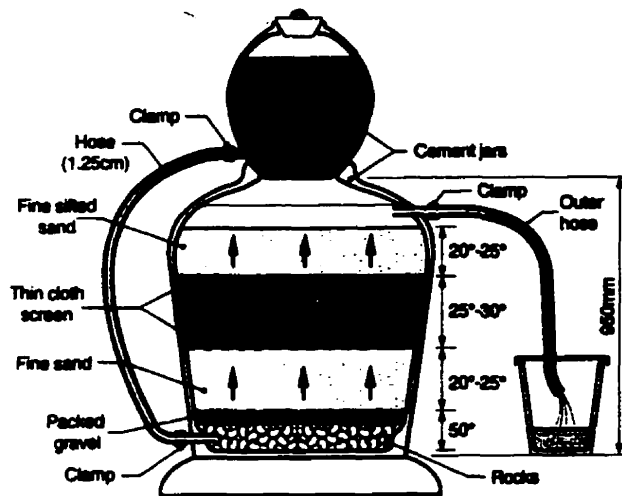


Figure 2.6.3
UNICEF Upward Flow Sand Filter

Conventional Slow Sand Filters

A typical household slow sand filter is shown in Figure 2.6.4. The filters are designed to operate at a constant flow rate. In the design shown, flow regulation is done by adjusting the floating weir. The operation and maintenance of such a system requires careful attention by the householder.

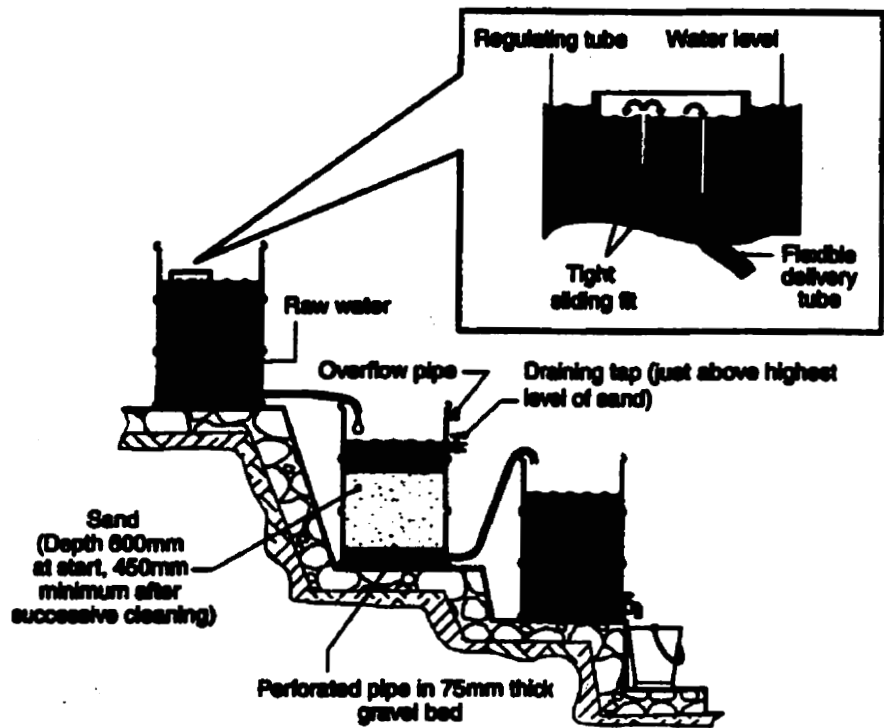


Figure 2.6.4
Slow Sand Filter with Flow Control (IRC 1988)

The operation and maintenance requirements for this filter is summarized in the table below.

Table 2.6.5
Operation and Maintenance Requirements
Conventional Slow Sand Filter
Source: IRC International Water and Sanitation Centre
(Brikke et al)

Activity	Frequency	Human Resources	Materials & Spare Parts	Tools & Equipment
Fill raw water reservoir	daily	family	Raw water	bucket
Check flow rate	daily	family	watch	
Scrape off sand, wash, dry and store	About every six weeks	family	water	Scraper, bucket
Restore sand	Yearly or less	family	Water, clean recycled and new sand	Bucket, sieve
Replace hoses	Every two years	family	hose	Knife
Repair tap	occasionally	Family or local	Washer, spare tap	Screwdriver, spanners
Disinfect clean water tank	occasionally	family	chlorine	Bowl, spoon

The filters were easily integrated into the community lifestyle. One of the most interesting observations noted is the way people were already allowing their water to settle for ten minutes before using it. The men involved in the construction and installation of the filters were both careful to teach the proper care for users. They were both anxious to help build filters for other village households. Children have also understood the importance of drinking filtered water.

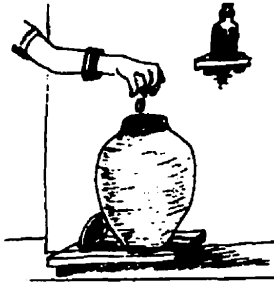
Liang 98
 Samaritan's Purse
 Brazil

The BioSand Filter

The following design features of the BioSand filter all contribute to its ease of use.

- The water needs to be filtered only when required. This is very important, since the safe storage of water in the household has been identified as one of the three key risk areas in disease prevention. (WHO 1993b).
- The concrete or manually operated, plastic BioSand filter is a singular container with no moving parts. Its successful operation is well within the ability of any householder, including women and children.

- Maintenance is less onerous than any of the filters previously described. It involves simply removing the supernatant with a cup or other similar device, removing the top centimetre of sand where all the debris has collected, washing it and returning it to the filter.
- The concrete container is small, but extremely stable. It can be placed in the area of the house, most convenient to the user.
- The plastic piping is encased in concrete, and is not easily damaged.



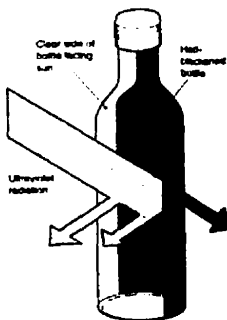
Chemical Disinfection

Chlorination is the most widely used method for disinfecting drinking water. There are several different sources of chlorine for home use including liquids (such as bleach), powders such as bleaching powder and purpose made tablets. Iodine, another excellent chemical disinfectant is used occasionally.

Among the issues to be considered with the use of chemical disinfection at the household level are:

- These chemicals are not readily available in rural communities in developing countries.
- If water quality differs over time, the necessary doses have to be re established. since the dosage required depends on the substances in the water, which may vary from season to season.
- The strength of chlorine compounds vary with time. Bleaching powder loses about half its strength in a year.
- If not stored properly, the chemicals lose their strength even more quickly. Air tightness, low temperature and absence of light are particularly important during storage.
- The chemicals must have sufficient contact time with the pathogens(30 minutes in the case of chlorine) to destroy them.
- Users do not always accept the taste, which results from the addition of the chemicals.

In summary, the necessity of maintaining an appropriate supply chain of chemicals to individual households is the primary disadvantage to chemical disinfection at the household level.



The SODIS system

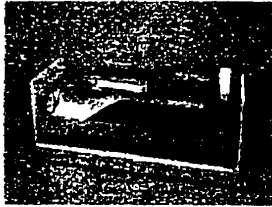
Solar Disinfection

Solar disinfection may be a more appropriate means of disinfecting water in poor communities in developing countries. One easy method is to expose bottles of water to the sun. The SODIS system uses half blackened bottles to increase the heat gain since the process effectiveness is increased by increasing the temperature.

However:

- The water needs to be clear for the process to work.
- Only small amounts of water can be disinfected at any time.
- The water needs to be cooled subsequently, because people are unlikely to drink warm water.

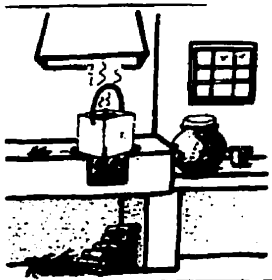
Another method of solar disinfection called solar pasteurization uses solar radiation to heat water to 70⁰ C for 15 minutes to kill all pathogens. It is considered , however, too complicated for use by low income households. (Shaw 99).



Household Ultraviolet Unit

It is estimated that 1% of Djarkarta's GDP is spent by its residents in boiling water.

Gadgil 98



Ultra Violet Disinfection Units

A low cost UV disinfection unit is currently being marketed by UV Waterworks (Environmental Engineering Technologies, Berkeley). This unit is designed to circumvent the problems normally associated with UV units, such as chemical and bio-fouling of the solid surface between the UV source and the water, and the need for a pressurized water source.

The use of this unit, however, requires a supply of electricity to the home, which limits its applications in developing countries.

Boiling Water

Boiling water is an onerous activity which requires the collection of firewood or other fuel in addition to the collection of water. Water has a high specific heat and consequently much fuel is required for the disinfection process. This practice also contributes to the indoor air pollution as well as the deforestation and desertification in many developing countries. In short, boiling water is environmentally and economically unsustainable and should never be considered a permanent solution to potable water supply (Gadgil 98).

2.6.4.5 Capital Costs

Table 2.6.6 compares the capital costs associated with some of the different filtration and disinfection alternatives discussed previously.

Table 2.6.6
Estimated Capital Costs for
Selected Household Filtration and Disinfection Systems

Alternative	Estimated Capital Cost
Ceramic Filter	\$40US (Source: Liang 98)
Concrete BioSand Filter	\$20-30US (Source: Samaritan's Purse)
Plastic BioSand Filter	\$70-80 (Source: Davnor North America price)
Household UV Disinfection Unit	\$300 (Source: http://eetd.lbl.gov/CBS/NEWSLETTER/NL9/waterworks.html)
Rainwater Catchment System for Individual household	\$320 US (Source: IRC)

Most everyone has bought a clay filter simply because it is the only affordable option presented to them. The BioSand filter is not only more effective in removing fecal coliform, it is also more cost effective as it will last a lifetime. It does not require costly cartridges every three months and the maintenance requirements are minimal. Trying to sell the BSF would also not be a barrier to sustainability because the people are willing to pay. From discussions and interviews, it can be concluded that the filter is of great value to the majority of families surveyed. It was becoming one of their most prized possessions. Many reported that the filter could be sold for over \$50US even to those living in villages. Approximately fifty percent of families living in the village would pay for the filter. However, most families would have to pay in instalments.

Liang 98
 Brazil,
 Samaritan's Purse

Sand Filters

Although there are no estimated costs available in the literature for other sand filters, the relative cost of the BioSand filter as compared to other sand filters can be obtained by an analysis of the factors which affect the cost: design complexity, size and construction material.

Design Complexity

As evident from the filter designs discussed previously, the BioSand filter design is the simplest of the proven effective filter designs. This simplicity contributes to the low unit costs.

Sizing

The BioSand filter has been carefully designed to achieve the minimum depths and cross sectional areas required for effective treatment of the design throughput. This results in optimal sizing of the filter container and media, as compared to using home made field designs.

Materials

The sand filters, whether rapid sand, slow sand or BioSand, use similar components; containers and filter media. The filter media for all the filters is sand and gravel, so the remaining variable is the material used for the container.



Building The Concrete Filter
Kenya, 1998
Samaritan's Purse

Using concrete as the container material is more cost effective than the use of plastic for several reasons:

- Local labour or volunteer labour can be used in the manufacturing process.
- Cement is readily available in most developing countries and people are familiar with the construction techniques used.
- The container is heavy and durable and does not need to be replaced as often as a plastic container.
- All the plastic piping is internal to the filter and consequently is not liable to become damaged as quickly as a plastic filter, where the piping is external to the body of the filter.

Containers such as steel drums or large plastic garbage cans etc. may be initially cheaper than a manufactured product. But;

1. Experience has shown that obtaining containers of the right specifications is difficult.
2. They cannot be obtained in large enough quantities to meet a consistent demand.
3. They are not as durable as the manufactured products. Steel drums rust and plastic garbage cans etc. are not made of food grade, good quality plastic.

So, after consideration of the design complexity, size and construction material the concrete BioSand filter is estimated to be the most cost effective of the sand filter alternatives.

2.6.4.6 Operating Costs

Table 2.6.7 shows that recurrent costs associated with the BioSand filter are the lowest of the effective household treatment alternatives. Furthermore, the community level slow sand filtration systems are also among the most cost effective of the community systems.

Table 2.6.7
Comparison of Operating Costs
Water Treatment Systems
 (Source: Burch & Thomas in Gadgil 98)

Alternative	Operating Cost US cents per m ³
Household Systems	
Batch-scale chlorine for home	9
Boiling at home with purchased fuel	2083
<i>Household BioSand</i>	Negligible
Community Systems	
Roughing filter and chlorine dosing plant	7
<i>Roughing filter & Slow Sand Filter</i>	3
Roughing Filter & Grid Powered MOGGOD	58
Roughing Filter & Grid Powered UV	3
Roughing Filter and PV Powered UV	15

2.6.4.7 Conclusions

Slow sand filtration can be used independently of either sedimentation or disinfection processes to produce water of potable quality, whereas chemical or solar disinfection generally requires prior filtration. In addition, chemical disinfection, requires a supply chain that severely limits its usage for poor people in developing countries

It has been clearly demonstrated that, the BioSand filter is just as effective as a conventional slow sand filter, which is itself the most effective of all the treatment alternatives. It is also undoubtedly the most cost effective and easy to use. Moreover, the manufacturing processes and procedures result in a consistent product and provide an element of quality control which is not possible with other household sand filters produced in the field.



Preparing Media
Kenya, 1998

2.6.5 SECTION SUMMARY

PACCOM (the People's Aid Coordinating Committee) is eager for us to expand this program. A successful program with PACCOM will also open doors with government agencies. CIDA has expressed interest in funding some village projects. We have also had inquiries from two NGOs.

River pastors were so anxious for a project like this, that some of them had promised their communities a project before a decision was made. The two most popular television stations in Santarem came three times to document the workshops and the work being done on the projects. Besides word of mouth by the filter recipients, and the village leaders, a radio spot on the local radio station also publicized the filter's success. The director of the local federal university was interested in receiving training. As a scientist, he was interested in comparing the bioSand filter with the current projects being funded by the university.

The BioSand filter could potentially be the most practical solution to the Amazon Basin's clean water need.

Liang (98)
Brazil
Samaritan's Purse

- Investing in water supply to poor communities must be a top priority. Water is a resource, which is vital to life, health and the human capacity development of the poor. Integration of water projects with sanitation and hygiene provides optimal results.
- Provision of low cost water treatment alternatives would enable communities to consider using a wider variety of water sources and provide more reliable water quality to the individual household. The combination of water source and water treatment alternatives can then be compared to determine which combination is most affordable, convenient, reliable and adequate.
- Household treatment systems can be just as effective as community scale systems. Moreover, when considering the particular needs of the poor, they better allow the targeting of low income residents and are more likely to be socially and financially sustainable, more efficient and more replicable than community systems.
- Of all the household treatment systems evaluated, the BioSand filter is the most effective, low cost and easy to use.

3.0 THE STRATEGY

The alternatives available to Davnor for the humanitarian distribution of the technology are analysed using criteria established during the discussions in Section 1.0. These criteria include wide technology distribution, social sustainability, financial sustainability, technical sustainability and the impact on the Davnor commercial operation. The section concludes with a recommendation on the most appropriate strategy.

3.1.0	The Alternatives	74
3.1.1	Underlying Premises	74
3.1.2	Field Implementation	74
3.1.3	Channels of Technology Transfer	77
3.1.4	Micro Enterprises	79
3.1.5	Southern NGO Limitations	82
3.2.0	Appropriate Institutions and Linkages	83
3.2.1	Trans-National Non Governmental Organizations	83
	3.2.1.1. The Benefits	84
	3.2.1.3 The Concerns	85
3.2.2	National Governments	87
	3.2.2.2 The Benefits	87
	3.2.2.3 The Concerns	88
3.2.3	Local Business Partnerships	91
	3.2.3.2 The Benefits	91
	3.2.3.3 The Concerns	91
3.2.4	Summary	92
3.3.0	Social Sustainability	94
3.3.1	Demand	
	3.3.1.1. Responding to Demand	94
	3.3.1.2 Generating Demand	94
3.3.2	Encouraging Acceptance	95
3.3.3	Minimising Impact on Social Structure	98
3.3.4	Conclusions	99
3.4.0	Financial Sustainability	100
3.4.1	Adequate, Assured and Consistent Financing	100
3.4.2	Micro-Enterprises	104
3.4.3	Efficiencies and Economies of Scale	105
3.4.4	Standards of Performance	106
3.4.5	Risk Mitigation	107
3.4.6	Conclusions	108
3.5.0	Technical Sustainability	109
3.5.1	Viable Treatment Solutions	109
3.5.2	Quality Control	109
3.5.3	Local Innovation and Experimentation	110
3.5.4	Information Base	111
3.5.5	Training	111

3.5.6	Conclusions	112
3.6.0	Impact on Commercial Operations	113
3.6.1	Client Base	113
3.6.2	Knowledge Base	114
3.6.3	Competition	115
3.6.4	Risk Mitigation	115
3.6.5	Investor Relations	115
3.6.6	Conclusions	116
3.7.0	Conclusions	117

3.1.0 THE ALTERNATIVES

Given the potential impact of the filter, how best can Davnor accomplish its goals of distributing the BioSand concrete filter technology to those most in need?

Organizational leaders with visions of reaching masses of people are more likely to have impact than those who aim to do an excellent job in a few communities.

Tendler 89

3.1.1 Underlying Premises

The alternatives identified for the distribution of the technology to the world's poorest have been based on three premises derived from Davnor's focus and core competencies. Davnor's competency is water treatment technology and Davnor's focus is on technology transfer. Although Davnor's corporate philosophy is to make the technology accessible to the poor, Davnor is a business not a social service agency. Consequently,

1. Davnor Canada is not well equipped to work directly with users of the technology in developing countries on an ongoing basis. It is best prepared to train other organizations who have an ongoing community presence and can better identify the community needs, in the construction and use of the concrete filter.
2. Davnor Canada will not seek out external funding, either from private donors or bilateral or multi lateral funding agencies, to support its humanitarian activities. The financing arrangements must be initiated from either the donor agencies or from the field implementing agencies.
3. To promote the humanitarian effort, no royalties would be charged on any of the concrete filters. However, Davnor needs to be compensated at rates which are fair and equitable for the time expended on these efforts and for all out-of-pocket expenses.

<i>Country</i>	<i>#NGOs (1992)</i>
<i>China</i>	<i>181,000</i>
<i>Dom. Rep</i>	<i>110</i>
<i>Egypt</i>	<i>13,000</i>
<i>L. America</i>	<i>4,327 & 5,827 non-profit groups</i>
<i>Lebanon</i>	<i>1,300</i>
<i>Pakistan</i>	<i>5,000</i>
<i>Thailand</i>	<i>12,000</i>
<i>Zimbabwe</i>	<i>642</i>

Source: Smillie 95

3.1.2 Field Implementation

If Davnor Canada is not prepared or equipped to be the field providers of the humanitarian technology, the first question is therefore which type of organization is most suitable to be responsible for implementation of the concrete filter at the field level.

The recent experiences of agencies and governments who have been responsible for implementing programs such as this at the field level, suggest that the agencies most suited to accept field responsibility for this humanitarian technology are **local community based NGOs**. Snell (98) describes these NGOs as indispensable in the provision of

water and sanitation services to the urban poor. The increasing recognition, use and appreciation of the services of these NGOs worldwide over the last decade are attributed to several reasons as articulated by (Fisher(98), Smillie(95), Tandler(89) and the World Bank (99).

Indigenous NGOs:

1. Lead the initiative in improving the living conditions of the poor in their own countries.
2. Work directly with the poor and are well placed to reach the poor in terms of commitment, location, relationships and planning methodologies.
3. Base their interventions on participation and respect for local traditions and have a great understanding of the cultural and social environment.
4. Have greatest empirical evidence of success.
5. Gain the trust and cooperation of the community by having an ongoing community presence.
6. Are more familiar with low cost techniques and local innovations.
7. Are flexible, willing to take risks and less subject to political control.

But most of all, their success is due to the person to person contact, they have been able to maintain within the poor communities. Their main achievements have been when working with ethnic, religious or socially homogeneous groups (Tandler 89, Yunus 89).

Over the last ten years, there has been an extraordinary growth in the political and technical capability of 3rd world NGOs and their relationships with their governments and with multilateral and bilateral funding agencies (see Figure 3.1.1). Furthermore, there is an immense field based body of evidence that these NGOs are the backbone of effective and sustainable development. (Fisher 98).

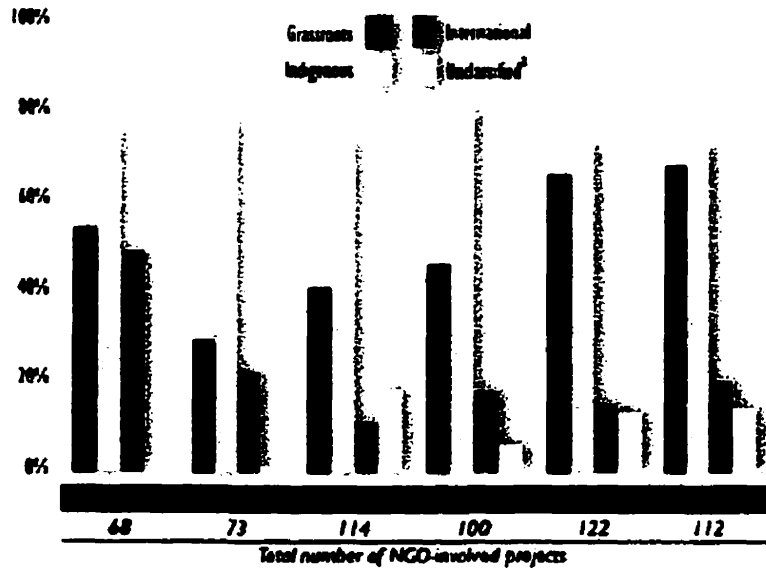
The high level of NGO participation in (World) Bank-supported development activities was maintained, with 47% of operations approved in fiscal 1997 involving NGO participation in some capacity.

NGO liaison staff have been appointed to 72 resident missions: more than half of these are full time NGO specialists. They are strengthening communication and information flows and ensuring more systematic in-country consultation and dialogue between the Bank and indigenous NGOs.

World Bank Annual Report 1997

Figure 3.1.1
Types of NGOs Involved in Bank Financed Projects
Fiscal Years 92-97

(Source: World Bank Annual Report 1997)



WELK Sarah Pany Jones

The proliferation of Southern NGOs (The NGOs of developing countries are frequently termed Southern NGOs) began in the late 1960s and by 1993 there were at least 50,000 NGOs reaching over 100 MM people and that number was expected to triple by 1996. (Fisher 98). This increase in the number of NGOs have been attributed to three factors:

1. The conscious response to worsening poverty
2. High unemployment among the educated
3. Increased availability of foreign assistance for voluntary associations.

In third world countries, there is a historically, unprecedented partnership between intellectual elites and the common people. In addition, an emerging international civil society resulting from international media, access to the internet and increased publicity about human rights violations have led to increased support for local institutional development (Fisher 98).

Consequently if Davnor Canada can develop the appropriate linkages with a significant number of indigenous NGOs in the appropriate countries, it can make the technology available on an extremely large scale to those who require its use.

Corporations recognise that NGOs represent one source among many for providing complementary skill sets and expertise, facilitating communication and understanding with local stakeholders, and strengthening process credibility.

Grenall and Rovere 99

3.1.3 Technology Transfer Channels

But how does Davnor connect with these NGOs given the sheer number and diversity of the organizations? And what exactly do we mean when we talk about technology transfer?

Technology is defined as the means for transforming inputs into outputs. Islam (92) defines the components of technology as:

Technoware: Object embodied: This includes physical facilities, instruments, equipment, machinery, devices, structures etc

Humanware: Person embodied forms of technology: It includes expertise, proficiency, dexterity, creativity, perseverance, diligence and ingenuity.

Inforeware: Document embodied forms of technology: facts and figures, designs, accounts, specifications, observations, relations, equations, charts and theories.

Orgaware: Institution embodied forms of technology. This includes frameworks such as groupings, allocations, systematization, organizations, management and marketing.

Successful technology transfer requires that all the components, which form part of the concrete filter technology be transmitted to the local NGOs. This, in turn, requires that the local NGOs have good access to the organizations providing the technology. But, **access is directly related to proximity** (Meyer 89). So, in order to provide indigenous NGOs access to the technology, Davnor needs to channel the concrete filter technology through an organization that is present in the country.

Major bilateral and multilateral funders, such as the Canadian International Development Agency (CIDA) or the World Bank often use Trans National NGOs or national governments for precisely this purpose in water and sanitation projects. Davnor can utilise these two traditional channels of technology transfer in its own work.



Gabiro, Rwanda
2000

In fact, the current principal means of promoting the concrete filter is through Trans National NGOs, primarily church groups such as Samaritan's Purse and the Mennonite Central Committee who work through their local church groups and associations to introduce the filter in their development work in third world countries. The impact of this work to date has been significant. Current plans project that over 15,000 filters will be installed in over 25 countries of the world by year end 2000.

Another option would be for Davnor to develop relationships with the government institutions in the countries of interest, since these

government institutions have been the traditional provider of basic services, including potable water, worldwide.

But, there is a third alternative, a more non-traditional route, and this involves channelling the humanitarian technology as well as the commercial products through a joint venture corporation that is jointly owned by Davnor Canada and a local partner. These joint venture partnerships form the cornerstone of Davnor's international business development strategy and should be considered for the humanitarian as well as commercial purposes.

These three alternatives are represented graphically in Figure 3.1.2.

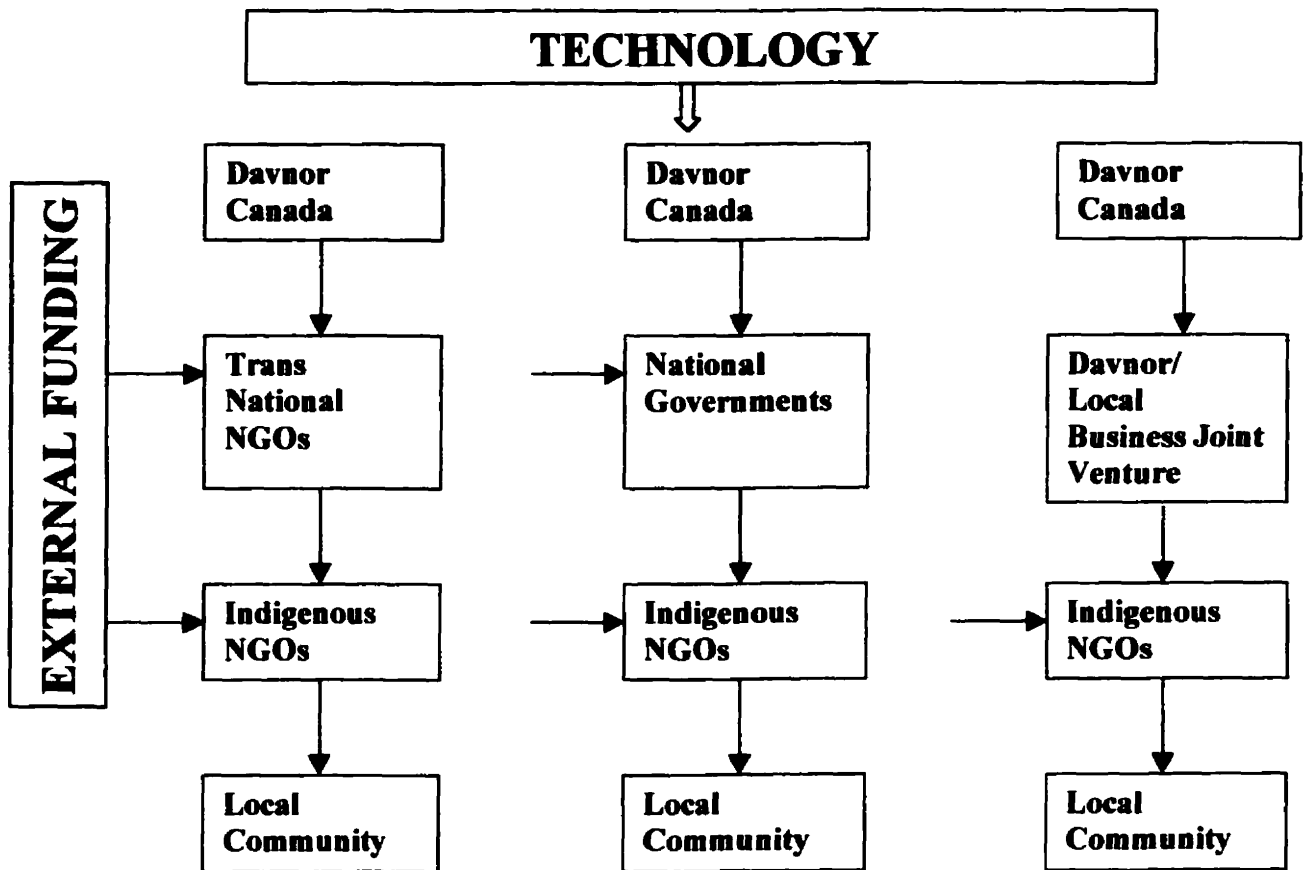


Figure 3.1.2
Technology Transfer Alternatives

3.1.4 Micro-Enterprises

Is it correct to assume that the concrete filter technology needs to be implemented at the field level by an NGO? Or is it possible that people would be willing to purchase the product, such that it is able to form the basis of a micro-enterprise?

There are several examples, as indicated in Table 3.1.1 of small scale, private suppliers of water. These include water vendors and water truckers who provide much needed services to the poor.

The majority of peri-urban residents buy water and sanitation services from small, private providers who deliver what public providers are unwilling or unable to provide.

Snell 98



Table 3.1.1 Small Scale Providers of Water Supply and Sanitation Services	
Sources: Collignon(99), Snell (98), Troyano (99)	
Provider Type	Profile Examples
Resale Subscribers Permanent partners with water utilities whose water they distribute at kiosks or standpipes	Kenya Mali Haiti Senegal
Developers * Creators of Small Scale water supply systems based on underground sources	Paraguay Argentina Guatemala Philippines
Water Carriers Trucks, Carts, Wagons and Barrows	Senegal Haiti Peru
Public Facility Providers Of public toilet and bathing facilities	India Benin Peru Philippines

* Approx. 33% of the water connections made in the past 20 years in Asuncion and Ciudad del Este in Paraguay have been provided by 'aguateros.' There are approximately 350-600 independent 'aguaterias' currently operating. They serve about 0.5 million persons and represent an investment of some \$30MM.

Furthermore, most of these water suppliers earn a living wage from their activities (Table 3.1.2).

Table 3.1.2 Typology of Private Operators, Port-au-Prince, Haiti		
Source: Collignon (99)		
Name	Principal Occupation	Weekly Earnings \$US
Street Peddler	Retail water sales (bottle, glass)	2-5
Water Carrier	Home sales	6-15
Fountain manager	Water sales by the bottle or gerrycan	10-70

The methods employed in the concrete filter production lend themselves beautifully to the creation of micro- businesses which can be owned and operated by an individual or family within the community. The major capital investment required is the purchase of a steel mould, which can be built in developing countries at a cost of less than \$500US. The working capital required for each unit is in

of less than \$500US. The working capital required for each unit is in the range of \$30US. These levels of capital investment are well within the reach of several small entrepreneurs.

The most successful initiatives in the field of international development over the last few years have been in the areas of micro-business development and micro-finance. Incorporating the use of micro-enterprises as a means of providing clean water for individual communities would result in several other beneficial effects. It would:

- facilitate a continuous supply to households as required
- create employment
- utilise capital very efficiently
- rely on locally available resources
- expand the regional dispersal of the technology.

The informal sector is a group of people who have entrepreneurial abilities, but who are also dispossessed and poor.

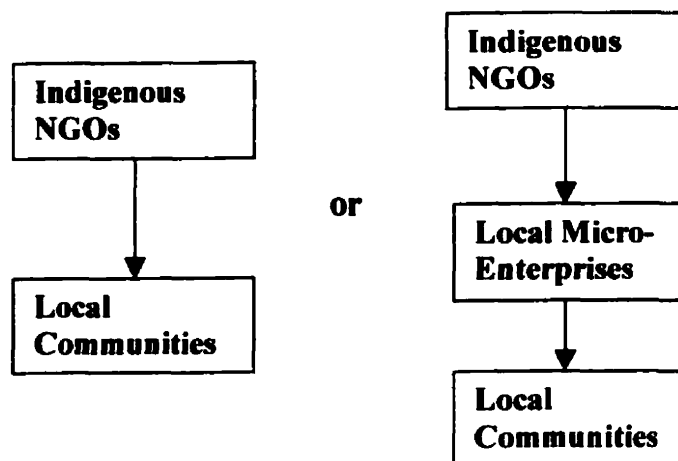
The informal sector is not a marginal sector. It is the majority of the people in many developing countries. In Peru, it constitutes:

- 47% of the population on a permanent basis
- 61% of the man hours worked
- 47% of buildings were built outside existing regulations
- 95% of the public transportation system
- 60% of all sales are through street vendors.

de Soto 89

However, the challenge is again being able to transfer the technology successfully to the micro-entrepreneurs. This is a new technology, which is not known to the locals, the benefits of which have not been proven to them and the market for which has not yet been developed.

Indigenous NGOs have much experience and expertise in microenterprise development. These organizations are therefore again the obvious choice for introducing the filter at the field level, whether directly to poor individuals or households through the provision of filters, or through micro-enterprise programs which will provide the training and marketing assistance required by entrepreneurs who wish to sell the filters into the local market.



3.1.4 Southern NGO Limitations

Before analysing each of the alternatives with respect to the social, financial and technical sustainability of the technology transfer, one needs to understand some of the limitations and inherent constraints with respect to the capability of Southern NGOs. Smillie(95) and Tendler (89) have summarised some of these concerns as follows:

1. *Local NGO strength and effectiveness are often derived from their smallness and homogeneity, which gets lost when NGOs try to expand and become less parochial.*
2. *There is often no clear idea of the organizational structure required to support their social objectives.*
3. *Their financial base is often very precarious.*
4. *They are heavily project based- Thus providing no long term security for employees and little continuity, memory or stability from project to project.*
5. *Foreign funding accounts for a large share of NGO funding in some countries which places the NGO sector somewhat at odds with the State, thereby blocking the path to replication of NGO experiments by the public sector.*
6. *NGOs often see each other and the public sector as competitors for scarce donor funding, rather than as co-operators in a quest to alleviate poverty; which makes it inherently difficult for them to cooperate with each other or imitate each other's success.*
7. *The sector suffers from a lack of comparative knowledge about what has worked and what has not, in the public as well as the non governmental domain.*
8. *Though NGOs often have small budgets in comparison to the public sector, their cost per beneficiary is often high, which means that even their successful projects are not necessarily feasible as models of serving larger populations*
9. *NGOs themselves often do not strive to serve large numbers of clients, nor are they under pressure to do so, which means that they are often content to accomplish programs that work well in a handful of communities.*

The appropriate channel of transfer must therefore mitigate these shortcomings as much as possible.

3.2.0 APPROPRIATE INSTITUTIONS AND LINKAGES

This section compares the characteristics of Trans National NGOs, governments and local businesses and their relationships with local NGOs to determine the effect of these characteristics and linkages on the ability of each of the alternatives to provide a successful conduit for distributing the concrete filter technology to as many people as possible.

3.2.1. Trans National Non Governmental Organizations

These organizations which are commonly referred to as international non- governmental organizations or INGOs are typically headquartered in industrial countries and carry out operations in more than one developing country. Many INGOs serve an intermediary function, channelling development resources to community-based organizations, providing them with services or technical assistance, or helping them to strengthen their capacity.

INGOs have become a significant international force over the last century and have increased in number from 176 in 1909 to 12,457 in 1993 (Merle 95). Rice and Ritchie (95) attribute the new importance of INGOs to three changes:

1. The enormous expansion of NGOs at local levels, particularly in the Third World, but also in the transition states of the former Soviet bloc.
2. The need for global action on global problems such as preserving the integrity of the natural environment.
3. The impressive breakthroughs in communication technologies.

The spending and job creation of today's non profit sector in both developed and developing countries is enormous.

In Canada, an estimated \$62billion US passed through registered charities in 1993: nearly 13% of the country's entire gross domestic product. Almost half of this was paid out in the form of salaries and benefits to 1.3 million people. At 9% of the labour force, this represented more jobs than the entire construction industry.

Smillie 95

Although many international secular organizations can trace their ancestry to missionary organizations as far back as the 1600s, the shape of the modern trans national NGO scene began to form in the years between and immediately after the First and Second World Wars, as people were not only ministering to the poor and suffering, but attempting to deal with some of the causes (Smillie 95).

Some of the major development INGOs include:

- CARE International
- Doctors Without Borders
- OXFAM
- Plan International

- The Red Cross
- Save The Children
- World University Service
- World Vision

This list excludes organizations such as the Peace Corps and CUSO which primarily supply volunteer labour (volunteer NGOs) or any environmental INGOs.

The use of INGOs as a channel of transfer offers many advantages, but the experiences of others indicate that some caution may be required. Sections 3.2.1.1 and 3.2.2.2 summarise the major positive and negative elements of this alternative.

3.2.1.1 The Benefits



Gabiro, Rwanda
2000



1. Social Objectives

Most INGOs, like their indigenous counterparts in developing countries, are committed to assisting the poor. They are dedicated to identifying their needs and generating programs to meet those needs. Consequently, they seek out or develop those technologies that they believe would be most suitable for use by the poor.

2. Important Source of Funds

Large trans national NGOs are a major source of funding for local NGOs. In 1989, they contributed US \$6.4 billion to developing countries (including \$2.2 billion of official funds), representing some 12% of total development assistance (Bebbington and Farrington in World Bank 99b). Being large and professional make them attractive to individual donors and essential to bilateral and multilateral donor agencies.

3. Global in Scope

Many INGOs focus on issues that are naturally cross-boundary and lend themselves to multi national constituencies, such as potable water supply. Thus extending successful programs from the local level to the global level is a natural progression (Koenig 96).

Moreover, the existing world wide organizational structures of large TN NGOS provide them with the infrastructure and capability to reach large numbers of people.

4. Institutional Capacity Development

Given their expertise and experience, INGOs are capable of transferring, not only specific technologies to the indigenous NGOs, but can provide guidance in the development of institutional capacity to assist the local NGO in the delivery of services.

3.2.1.2 The Concerns

This is not a partnership, but the same old paternalism.

Smillie 95



Most top management positions at Save The Childrens Fund are held by expatriates, mainly British. This has been justified as 'a matter of responsibility and accountability to donors.' Trust and control, however, appear to be the central issues, often disguised as 'protection of name' or 'aversion to dependency.'

There is a direct equation between having the money and having the right to spend it oneself

Where policy management and control are concerned- international really means 'North'

Smillie 95

The association between INGOs and local NGOs, however, cannot always be described as smooth. Several sources of tension exist. These include:

1. Local NGO autonomy and independence.

Most INGOs are driven by their own organizational, vision, mission and philosophies. Local NGOs often cannot openly express ideological differences for fear of loss of funding. And, as with any foreign influence, there is an ongoing fear that development assistance, when designed and managed by outsiders

- Often comes uninvited
- May not go home
- Cannot be described as an expression of local concern.

Even those organizations that support local NGOs cannot avoid imposing their views of development, their priorities and their bureaucratic requirements on the recipient.

In fact, most INGOs continue to devise, manage and evaluate their own projects directly (Smillie 95). The criticism of their own management in this regard is that, while most have moved to full devolution of responsibilities and accountabilities to the local area offices in the North, in the South there has been mostly simply delegation of tasks – primarily to expatriate managers.

2. Determination of Priorities

The priorities of a Transnational NGO are quite often not determined by objective need but by what an organization can sell to its donors or bilateral agencies.

Smillie (95) emphasizes that larger Northern NGOs have returned to relief as an increasingly important part of their work, in a large part because it is easier to raise money by emphasizing disaster appeals. Fundraising has been accused of thriving on the 'pornography of poverty' where pictures of starving babies create an image of horror and helplessness that far outweighs the reality.

Furthermore, Northern NGOs have become increasingly answerable to their governments for priorities, management practices and approaches to advocacy. They have stumbled into a contracting era. Whenever a new funding window opens in a bilateral agency, INGOs have or make programs to suit the criteria.

About half of the aid to the poorest countries remains tied in some way. To donors, it is a way of supporting their own firms or farmers as well as the poor. America's government can buy their farmers' grain surpluses and send them to feed Africans. Europeans can buy water pumps at home and send them to thirsty India. Japan can hire its nationals to advise poor countries' governments, rather than paying others to do so.

But such help risks being driven by the givers' interests, not those of the needy. Donors often pay for inappropriate schemes, which require their export and expertise (such as the Pergau dam in Malaysia, promoted by Britain), where smaller, locally run projects would serve better. When donors favour their own contractors over those from other countries, rivals who might do the job more effectively are excluded. (The European Commission is investigating whether such preference breaks the laws of the EU internal market.)

Poor countries are littered with electrical equipment for villages without electricity, machines for which no spare parts can be found, recycled clothes that destroy local markets. As long ago as the 1960s, it was apparent that America's PL480 grain program had virtually destroyed Egypt's wheat farmers. All in all, says one British charity, tied aid is 25% less effective than the untied sort.

The Economist Magazine
P21, June 17-23, 2000

And Northern NGOs that receive support from their own governments run the risk of becoming agents of political or strategic rather than humanitarian objectives. British Official Development Aid (ODA) specifies that 70% of support must be spent in 45 preferred countries. Furthermore, some Southern NGOs complain that Northern NGOs act largely as brokers for their government's money less 10 to 15 % for administration.

There are probably hundreds of Southern NGOs formed simply because there was a strong donor interest in a particular type of activity and many more whose objectives are skewed in the direction of donor priorities.

3. Northern NGO Commitment

The commitment of the Northern NGOs often revolve around a singular project. Most Northern NGOs do not pay for administrative costs or recurrent expenditures. This, combined with not knowing how much money is available for a particular project, frequent delays in decision making and sending money result in Southern NGOs having to live with a level of financial insecurity that would quickly bankrupt the average private sector firm.

'Life does not work on a donor- project cycle' (Smillie 95).

4. Onerous Co-ordination and Reporting Requirements

Northern NGOs are able to shape the lives of the organizations they support because of the processes, discipline and bureaucratic requirements they oblige organizations to institute. Southern NGOs are often pressured to conform to external, foreign images of professionalism (Smillie 95). Time-consuming assessment methodologies lend concern that evaluations:

- Are being designed by the donor agencies as control and justification mechanisms.
- In absence of baseline data, are highly subjective and rely heavily on intuition.
- Can result in the entire NGO, not just the project being funded, becoming subject to the evaluation.

5. Focus on Quick Results

The expectations created by fundraising are often counterproductive in terms of creating understanding and awareness for longer term development assistance. Development is rarely speedy and simple. There is a need to balance fundraising messages for a public most easily moved by short term disaster appeals, with recognition that long term development depends on the willingness of the public to support costly and difficult change (Smillie 95).

Trans National NGOs have developed effective delivery and programming for responding to emergency and refugee situations, developing expertise in specific areas;

- *CARE in logistics,*
- *OXFAM in water supply*
- *Doctors without Borders in health.*

Almost 40% of all US food aid in 1991 was channelled through CARE and the bulk of the money in emergencies flows through 6 or 8 trans national organizations.

Smillie 95

Emergency assistance now accounts for 50% of all United Nations aid. Emergency aid allocations in the U.S. budget rose from \$786 million in 1989 to \$2.2 billion in 1993, representing 23% of all aid resources and necessitating cuts in child survival activities and sustainable development projects. European donors follow the same trend – in 1991, the European Union's funding of NGO emergency and refugee programs exceeded development grants by 290%.

Hoy 98

The net result is that, with the exception of Plan International, most major INGOs now devote a significant part of their fundraising effort and program expenditures to emergencies- because money for development is shrinking, because administrative procedures are less demanding, because government support is generally provided on a cost plus basis, because of increased fundraising competition, and because emergency assistance is finite in scope and time.

In development, they have considerably less and declining impact. The most innovative and influential work on poverty alleviation, job creation and on the environment is being done by Southern NGOs. Of the major NGOs, only OXFAM and some Save The Children affiliates work with Southern NGOs. Most continue to devise, manage and evaluate their own projects directly (Smillie 95).

3.2.2 National Governments

National governments have been the traditional provider of basic services, including water supply, in both developing and developed countries. But do they possess the appropriate characteristics to deliver the technology effectively and can appropriate linkages be set up between Davnor and national governments and between these governments and NGOs? Sections 3.2.2.1 and 3.2.2.2 outline the advantages and disadvantages associated with this alternative.

3.2.2.1 The Benefits

1. A Traditional Role

Governments have and always will have a role in providing basic services to the poor. While NGOs can be part of the service delivery system, they cannot replace government and be a permanent substitute for public sector capacity (World Bank 1998).

In recent years government emphasis has been changing from one of direct service delivery to one which focuses on building partnerships of service providers and service users and ensuring equity. But nonetheless, governments cannot surrender their responsibility for taking care of the poor and for social service provision in their own country.

2. Replicability and Expansion

One of the key reasons for using national governments as channels of technology transfer is that if this link up with the public sector is successful, it facilitates expansion and replicability of the technology



UP:ID/Enc Don Arthur

application. If experiments carried out in the public sector work well, then the institutional infrastructure to expand them is already in place, as well as the political pressure to do so.

3.2.2.2 The Concerns

1. Making the Right Connections.

One of the overriding concerns with this avenue of technology transfer is Davnor's ability to create connections to the appropriate governments, for this purpose. These relations to foreign governments would have to be made through a third party; either the local NGO, the Canadian government (through CIDA), or perhaps multilateral funding agencies like the World Bank and the United Nations agencies. It therefore introduces another level of complexity into the technology transfer process.

2. The Corporate Reputation

Furthermore, the co-operation of a foreign company with the government of a repressive regime can have very adverse consequences on the reputation of that corporation. The experiences of Talisman Energy in Sudan and Shell International in Nigeria are clear demonstrations of the negative public reaction to corporate associations with repressive regimes. Even if such an association is meant to be for the benefit of the poor, collaboration with a foreign government can be construed as an expression of support for the policies of such a government.

3. Reaching the Right People

Experience the world over indicates that government programs are influenced, just as much or more, by political concerns as they are by human priority concerns. One of the reasons provided for the decline in bilateral Official Development Aid (ODA) is the high rate of public scepticism about whether aid actually reaches those in need and the belief that national governments are not the most useful or effective means of channelling development assistance to the third world.

Government focus tends to be on infrastructure and capital intensive projects, because these more readily lend themselves to public demonstration and proof that the government is taking action. The experiences of the 60s and 70s have provided ample evidence that this approach is not successful.

4. Lack of Institutional Capacity

Regarding the involvement of the State with respect to provision of public services like electricity and water supply, the World Bank and



The Sri Lanka Experiences in Promotion of Small and Cottage Industries through government programs.

- *Technology packages are determined in response to two sources of influence; politicians and members of parliament*
- *They are formulated in response to what people and IDB staff consider to be relevant technologies for small and cottage industries (SCIs)*
- *It is impossible to identify clear cut criteria for selecting target groups. Anyone interested is allowed to participate.*

Fernando 92

On Micro-enterprise Programs

- *Government supported programs fail to attract trainees from existing small enterprises, concentrating instead on young labour market entrants.*
- *Training is often given in over-equipped centres in urban locations to trainees who have no relation or motivation to set up a small scale business.*

de Wilde, Schreurs & Richman 91

others have emphasized that the parastatals and public enterprises generally have poor performance records. They have functioned ineffectively and inefficiently. Most governments in developing countries have not either had the necessary financial resources or sufficient administrative and technical capacity to handle the tasks. (Martinussen 97).

Martinussen (97) summarises the views of neo-classical economists on the major causes of government failures in developing countries as:

- Self seeking and calculating politicians and other actors who form coalitions to control the allocation of resources in accordance with their own narrow, self interests.
- Corrupt behaviour among politicians and government officials
- Lack of or absence of competent administrators with the necessary knowledge of economics and business operations.
- General lack of knowledge of the private sector and its way of functioning.

Furthermore, the administrative capabilities and capacities of governments in developing countries are severely strained by the weight of their numerous activities.

Third world governments have long been associated with corruption, inefficiency and bureaucracy. Southern NGOs actually pride themselves as being what governments are not, not bureaucratic, not rigid, not directive, not stultifying of local initiative (Smillie 95).

5. The Tensions which exist between Governments and NGOs
In the third world, the rise of NGOs is partly due to governmental failure to provide basic services and to implement developmental policies (Fisher 98). Thus, fears about NGOs crowding out government and creating parallel delivery systems are, in fact, legitimate worries about collapse of basic government administrative systems and concern for their revival rather than the creation of substitutes. These fears often lead to tenuous relationships between governments and local NGOs.

There is also a feeling that increased bilateral and multilateral financing of NGOs threatens Southern governments and erode their sovereignty. There is increasing execution of state functions by staff who are not answerable to them but to foreign governments, a diversion of skilled staff and a gradual takeover by foreign influence, culture and values.

Government policies towards NGOs vary widely worldwide

In Kenya, NGOs provide the largest single source of foreign exchange.

Civil society is more consistently autonomous in Latin America in relation to the State than it is in Africa or Asia.

Latin American NGOs have helped reshape the political systems within which they operate.

NGO policies in Asia are more likely to be schizophrenic.

African dictatorships generally repress NGOs.

Most Middle Eastern governments tend to be suspicious of NGOs and often subject them to political surveillance.

Fisher 98

depending on whether the government is authoritarian or democratic, stable or unstable, weakly or strongly institutionalized or constrained by political culture or not (Fisher 98). A democratic political context defined by freedom of expression and freedom of association makes it more likely that a country will avoid repressive policies to NGOs.

However, even in repressive regimes, there can be islands that are friends to NGOs because:

- NGOs provide needed resources and capacity to deliver services.
- NGOs have contacts with foreign donors and international support.
- When dominated by professionals, NGOs rarely provoke a perception of overt threat.
- Governments need to enhance their legitimacy.
- Governments are often unable to make major reforms without NGO support.

In response to the different policy environments, NGOs develop different strategies for working with the State. These vary from complete isolation in repressive regimes, where there are no common starting points and no wish from either side to search out areas of agreement (examples include Zaire, Kenya and Pinochet's Chile) to cooperation through parallel or collaborative field projects (examples India and Brazil) to where NGOs are in a dependent-client position vis-a vis the government; in which NGOs implement state-prepared programs (examples Tanzania and China) (Clark 93 and Fisher 98).

Whether governments cooperate on an ad hoc basis or systematic basis with NGOs, they are generally unwilling or unable to take up front research on NGO projects, to find out who is doing what where, much less to evaluate success or failure in relation to possible field collaboration. Nor do governments or NGOs track the combined environmental or developmental impacts of joint projects (Fisher 98).

3.2.3 Local Business Joint Ventures



BioSand Filter Factory
Bangladesh. 2000

The Davnor business plan includes, as the primary avenue of international business development, the formation of local corporations jointly owned by Davnor Canada and a local individual or business. These corporations can be used as the primary avenue of transfer of the humanitarian technology as well as the commercial technology. The major benefits and difficulties associated with the utilization of this alternative are discussed in Sections 3.2.3.1 and 3.2.3.2.

3.2.3.1 The Benefits

1. The Right Connections

This avenue provides probably the most appropriate connections for sustainable technology transfer. It allows Davnor Canada to relate to the local business in terms of technology and business and the local business to relate to its own customers, the local NGOs, within the national social and cultural context.

'While the resolution of problems relating to the transfer of technology from one country to another requires an economic sensitivity, the resolving of problems related to the transfer of technology once received, requires a predominantly sociological sensitivity. Transferring technologies for small and cottage industries from one country to another becomes meaningless unless the modes and mechanisms for technology transfer to the ultimate users who constitute the poorer segments of society display a high level of effectiveness.' (Fernando 92).

Attempts to speed up the community development process by circumventing existing or customary institutions and investing in new or externally designed organizations have frequently failed in their aims. This option uses existing stocks of social capital and works through existing power structures and organizations.

3.2.3.2 The Concerns

1. Clarity of Objectives

The dissemination of the concrete filter technology has largely social objectives. The consumer is the poor population who appear risky and least able to repay. The commercial business objective is to make a profit. Owners of businesses are clearly not inclined to give away the technology which forms the basis of their commercial operations.



Hybrid organizations that combine these social and business objectives need to be very clear to the public about the dual values, the different performance expectations for each part of the business, and how the two aspects integrate within the company.

2. Lack of Existing Models

The role of private enterprise in international development has been fairly limited to date. Their role has primarily included:

- Supplying parts and equipment as necessary.
- Providing professional consulting or management services
- As a source of charitable donations.

There is no existing model available in the literature, of a private enterprise doing research and development of technologies for the poor and providing the training and skills required for the dissemination of this technology.

This, therefore, would be a pioneering effort.

3. Prioritisation of Countries of Interest

The populations which most require the concrete filter may not be located in those countries most amenable to the formation of a commercial business. There may therefore be an inherent conflict between the directions for growth of the humanitarian technology distribution and that of the commercial application.

4. Delayed Timing

Using this option, the introduction of the humanitarian technology is subsequent to the formation of a local business. The timing of technology introduction is therefore somewhat delayed.

3.2.4. Summary

In conclusion, each of the avenues of technology transfer has a series of positive and negative attributes. The underlying challenge is to determine which of these can be successfully overcome by Davnor and which contributes most to the social, financial and technical sustainability of the technology.

INGOs have the societal mandate and organizational structure which provide them with the opportunity to identify the needs of the poor worldwide and to find appropriate solutions. They are a major source of funding for local NGOs. However, they do represent a threat to their autonomy and independence, do not always set objective priorities based on need, often focus on quick results, are unwilling

to commit long term support and often require burdensome reports and evaluations.

Although national governments will always have a significant responsibility to provide water services to the poor, Davnor's ability to make the right connections, the effect on its corporate reputation, the ability and willingness of government to reach the poorest, the frequent lack of institutional capacity and the tenuous relationships which often exist between governments and their NGOs all limit the ability of this avenue of technology transfer.

The local business-NGO alliance provides the most appropriate connection for sustainable technology transfer given the means to overcome the potential obstacles presented by the duality of social and commercial objectives, the lack of existing models, the potential delays in field implementation and possible conflict between the humanitarian and commercial strategies.

3.3.0 SOCIAL SUSTAINABILITY

To be socially sustainable a product or technology must

- Respond to the needs of the people
- Gain their acceptability.
- Minimise the impact on the existing social structure.

Which of the alternatives under consideration is best able to do all three of these?



3.3.1 Demand

3.3.1.1 Responding to Demand

The different avenues of transfer use different means of determining demand. INGOs and Governments represent the more traditional modes of providing assistance- through development projects, while association with a commercial enterprise affords a more market oriented approach.

In development projects, demand is determined by soliciting from the poor their preferred choice among a series of alternatives, through the use of participatory techniques which encourage local input and feedback. The alternatives and decisions are made on the basis of what program designers believe would be good for the beneficiaries and programmers spend a great deal of time deciding which beneficiary groups are most deserving of assistance (Harper and Finnegan 98).

In the market model, consumers are offered a range of products that may be capable of satisfying their needs and the individual consumer chooses the one most appropriate for their particular circumstance.

Health education has often become the scapegoat for all kinds of program failures. It is easy to blame people for program failures. Planners and administrators would like to change people's behaviour to fit program requirements, technology and procedures. Health education becomes a tool of compulsion.

Kochar 81 in Van Wijk- Sijbesma 98

3.3.1.2 Generating Demand

But the real difference in the two models is not so much in the methods used to satisfy demand, but in the **creation of demand**. As discussed in Section 1.5.3, one of the key challenges, facing the water supply industry is the creation of significant public appreciation of the value of the services- how to create demand in a population who do not have an understanding of the value of the services-their contribution to convenience, health and quality of life.

In the normal aid funded NGO approach, creating demand is not given a priority because the products are generally provided free of charge or at minimal cost to those who are deemed to require it. The

agencies providing the products understand their significance and attempt to demonstrate their importance to the local population through the use of training programs and workshops in areas such as hygiene education.

In classical market economics, the role of business is to respond to market demand, not create it. Tax deductions for advertising provide a public subsidy for hundreds of billions of dollars a year in corporate advertising aimed at enticing people to buy things that they neither want nor need and creating a society that is alien to the needs of healthy societies.

David C.Korten 95

The private sector, however, has always emphasised demand creation as one of the key attributes of success. In recent times the sector has come under increasing criticism for creating more and more demand for superficial products or products that people do not really need.(Korten 95, Rifkin 96). But private sector marketing strategists have developed and perfected the four basics Ps of demand creation. (Lazer and Kelly 73):

Product: Develop the right product
Promotion: Encourage its use
Place: Put it in the right places
Price: At the right price

Ott (1992) lists the pre- requisites for demand creation as;

- A marketing mindset
- Commitment to developing a quality product
- Money for Marketing or the time to develop slowly.

All three of these requirements are best fulfilled by a business-NGO alliance, which has links close to the grass roots level which enables relevant feedback to product developers and generation of products suitable to meet the particular needs of that market segment.



Furthermore, this alternative allows the introduction of the concrete filter as a part of a more complete set of options and alternatives for the people to consider when choosing the solution to their water problems. The creation of demand for the commercial products by the local business will also generate a demand for the humanitarian product.

Since non-profit organizations have no comparative advantage in marketing, which itself often involves economies of scale, their attempts at creating marketing outlets frequently fail, or at best benefit a limited number of clients (Tendler 89).

3.3.2 Encouraging Acceptance

1. Generating Appeal

Richard Ott (92) articulates that among the four top things that people really want to obtain when they acquire a product or service are:

1. Higher Status- the tendency to want higher social status is instinctive and normal.

2. What others want- the value that people place on things is largely influenced by the value other people place on those things.

Clear association of the humanitarian product with the commercial product would generate that higher status and the mass appeal.

This strategy is clearly demonstrated by most small entrepreneurs. They make products, which are lower cost, lower priced versions of products which are made and marketed through an aggressive marketing strategy at a relatively higher price by big producer firms e.g. soap, processed food. The informal production sector through its informal market analysis techniques, has identified the existence of a fairly large category of consumers who want to consume the same well advertised items that are used by the more affluent, but cannot afford to do so. Thus when products are targeted towards the local, non upper class market, the small producer has the necessary skills and access to information to work out his own marketing strategies. (Fernando 92).

If the organizations at whatever level and whatever nature do not deliver the service and cannot be held accountable, users have no other choice than to stop paying. Creating a system of accountability is part of a demand based approach..

Van Wijk-Sijbesma 98

The willingness to accept a product is dependent on the product but is also closely linked to the legitimacy and effectiveness of the agencies and organizations responsible for service delivery. People are more likely to believe a credible spokesman, someone they view as having expertise in a particular area. Consequently, the poor are probably more willing to accept a product endorsed by a well known and reputable local business than that promoted by a government which they may or may not trust, or by an INGO they do not know. Furthermore, the message is more persuasive if presented by a number of people, business, local NGO and government, rather than just a single source (Richards 96).

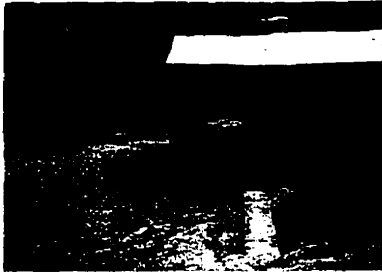
2. Building Familiarity

For NGO or government funded projects, there is great impetus to be able to define the project results in quantitative and qualitative terms with a specific beneficiary populations and timeframes. For instance, the target results are often expressed as: '*reduce the presence of e.coli from xx/ppmv to xx/ppmv in the drinking water of xx households in xx towns by xx time.*' (Tollefson July 2000, Internal Correspondence).

However, to create and sustain demand, one needs to build familiarity with the product as well as periodically change or improve some aspects of the product's performance. Marketers are well aware that a greater number of smaller sized impressions are much more effective than a singular large impression (Ott 92.).

Whenever Grameen starts functioning at any new location it creates the impression that it is no hurry to do anything. It allows the process to take time. It offers the following explanation: 'Why hurry? If poor people have survived without Grameen for all these years, they will survive without it in some more years to come.'

Yunus 89



Gabiro, Rwanda
2000

Promotions for the poor:

- *Must perform an educational function*
- *Which are people oriented are much more meaningful than promotions that are highly technical, impersonal or objective*
- *Which feature locals exclusively have higher impact.*

Wall 73

Gradual dissemination of knowledge, followed up by people experimenting on a small scale works best. People are given the opportunity to feel it in practice.

WaterAid in India.

3. Encouraging Demonstration

Wall (73) characterizes the low income consumer as one who is:

- Less physically and psychologically mobile
- More inhibited in his behaviour
- Considers stores which are always almost small
- More often buy at the same store
- Buy at local stores

The language, communication patterns and attitudes to advertising of low income consumers are unique to their lifestyle. Their language is concrete, relying primarily on observation and less on the intellectual process. Consequently, they are less verbally oriented than better educated groups and deal primarily with concrete objects and situations (Wall 73).

Experience has shown that demonstration is a key factor in building local acceptability. The stronger the demonstration and extension work, the more effective has been the organization in delivery of a new technology and putting it to actual work (Islam 92)

4. Nurturing Relationships

One of the critical characteristics of the culture of poverty is that the attitude toward the world outside their environment is often hostile and they think in terms of 'we and 'them'. Consequently, Wall (73) recommends that a marketer in a low income area:

- Must translate his image from them to we
- Must make certain that the product best fits into the lifestyle of the low income customer
- Make the product available in the right package sizes
- Make the product available continuously for a consumer who has a more frequent shopping pattern.

Merchandising policies, distribution and sales activities as well as community relations and public relations are key factors.

In order to be socially sustainable, therefore, the product should be part of a continuous service offered by the local NGO or by a local micro-enterprise, so that consumers have the option of acquiring it when they are ready to do so. A permanent relationship between the NGO and a large, commercial local business more readily provides this continuity relative to INGO or government programs, which generally have fixed timeframes. Commitment takes time, but if an individual is influenced to commit on a low level greater commitment levels may follow. Small commitments lead to larger commitments.

After a person has agreed to use the filter, there is also a need to

maintain a relationship with the user - to squelch doubt and reinforce the acquisition decision. During this time period, doubt about the product frequently occurs (Ott 92) because many people are unable to judge the benefits of the product or they might have had different expectations about the product capability. There is also competitive propaganda. Internal reinforcement comes from the actual performance of the product but external reinforcement is much stronger. Consequently there is a need to reinforce after every filter delivery.

In a Muslim society like Bangladesh it is almost an impossible situation to attract a women's group, with the opposition from the religious leaders and the frightening rumours floating around the village regarding what will happen to a woman if she takes a loan from Grameen, it is only the desperate women who finally push their way to form the first group. These groups gradually set the level of economic conditions of the future members. Better off people are kept away because they do not enjoy being classed with these destitutes.



The usual scene of a poor, rural woman is that under a long veil, she bows down and her eyes are fixed on the ground and she talks in a shy and timid manner. When one talks to a Grameen loanee woman, the difference is striking and very obvious. They will stand confidently and speak out as an equal partner in the conversation. Though they have veils and a baby on their lap, they do not bow down but reflect the spirit that they are now being valued by society.

Yunus 89

3.3.3 Minimizing the Impact on Current Social Structures.

In order to be socially sustainable, the product and method of introduction must be in keeping with existing values. Richards (96) emphasises that there are three selectivity processes human beings use in processing messages.

- Selective Exposure: Human tendency to concentrate messages consistent with prior attitudes and experience
- Selective Perception: Tendency to interpret message based on those prior attitudes
- Selective Retention: People evaluate communications based on existing attitudes but also on their perception of social norms.

Not only should the product and messages be in keeping with existing values, change is particularly difficult when the power relationships appear to be threatened. The individuals with power may not want to relinquish control and the people who are becoming empowered may not be ready or prepared.

The three channels of technology transfer all have a varying impact on the social structure of the target communities. The programs associated with INGOs and governments are often associated with specific social objectives such as "promoting women's empowerment" or promotion of the philosophies and ideologies of the associated INGO, especially if this is a missionary organization.

The local business- NGO association, however, is less likely to focus on any other objective than the dissemination of the water treatment technology. Marketing management examines the wants, attitudes and behaviour of potential customers, which could aid in the designing of the desired product. The main focus of marketing is on creating products and messages attuned to existing attitudes and values. It places emphasis on preference engineering rather than attitude conditioning. The concern is the production of desired

responses in free individuals by judicious creation and offering of values (Ott 92). It does not attempt to change these values. Any specific social change would most likely be a longer term consequence of a more healthy population having the option and ability to make rational decisions for itself. This social change is probably a longer, more gradual progression but is likely to be more sustainable because it is a course of action of education and empowerment rather than the imposition of external values.

3.3.4 Conclusions

It is evident that, of the three alternatives available, the local business- NGO alliance would provide the methods for technology introduction that are most likely to be socially sustainable by:

- Developing a more direct consumer-producer link
- Creating a range of products designed to meet the local needs
- Making demand creation a priority
- Generating appeal by association of the humanitarian product with the commercial filters used by those of higher status
- Building product familiarity
- Encouraging demonstration
- Nurturing relationships
- Minimising the impact on the current social structure.

This new model:

- Transforms the relationship with clients from one based on charity to a more commercial relationship based on mutual respect.
- Centres on creating an extended relationship between the client and the service provider.
- Attempts to match services with what customers want.
- Seeks to broaden rather than narrow the client base. Good customers strengthen the business and allow it to develop additional products to provide a broader range of services.

The business-NGO alliance changes the focus from creating good projects for the poor to creating healthy institutions or institutional alliances for the poor.

3.4.0 FINANCIAL SUSTAINABILITY

To determine which channel of technology transfer is likely to be most financially sustainable several issues are reviewed:

- Which avenue would provide the most adequate, consistent and reliable sources of funds?
- Is the formation of a network of micro-enterprises a suitable or desirable means of achieving financial sustainability?
- Which alternative will be the most cost effective and efficient?
- Which option provides clearest proof of performance?
- How can we best mitigate the risks?

3.4.1 Adequate, Consistent and Reliable Financing Levels



The cost of a concrete filter, including labour costs, is approximately \$30US. Even if only 10% of those 1.2 billion people worldwide who lack clean water can benefit from, or express a desire for a concrete filter, the material supply costs alone would be \$3.5 billion. Clearly not all this money is available from donor governments or agencies. The individual consumer would need to pay for a part or all of the costs associated with the filter if adequate levels of financing are to be achieved.

Sustainability, however, depends not just on the customer's willingness to pay but on the organization's willingness to charge (Yepes 99). Although charging consumers for at least a partial cost of the service is possible with each of the three alternatives under consideration, governments and INGOS have, in the past been reluctant to charge the full costs, either because they believe that charging poor consumers is unfair or they want to avoid the appearance of being unfair.

Subsidization of water supply services has long been a practice by both NGOs and governments in most developing countries. In these countries, **water utilities on average recover around 30 percent of their total costs** (World Bank 94). As a result, utilities are less able to serve the low income populations in the long run and too weak to provide sustained service to the higher income groups. While they have been planned with good intentions, subsidies often do not assist the poor for whom they were intended, as illustrated in Table 3.4.1. Moreover, they invite political corruption and intervention.

Few sectors have been classified as market failure more universally than the supply of water to households and residences.

Cowen and Cowen 98



WaterAid/Jim Holmes

The myth that the poor cannot afford to pay for water and sanitation has never been widely believed by small providers; whether individuals or communities, they know that people will pay for water and sanitation.

Snell 98

Table 3.4.1 Prices for Piped and Vendor Supplies in Selected Countries Source: Asian Development Bank (1993) In Cowen and Cowen 98			
City and Year	Percent without Connections	Price for Piped Water (US cents/m ³)	Price for Vendors (US cents/m ³)
Bandung (1991)	61	9.9	616
Jakarta (1991)	75	17.2	185
Manila (1992)	29	10.5	187
Karachi (1992)	17	7.5	175
Ho Chi Minh (1991)	35	7.6	151

In the absence of sufficient funds available internal to the country, both INGO and government programs for water supply and treatment rely heavily on soft sources of funds, i.e. funds that are available from private, bilateral or multi lateral donors. Since soft sources are in short supply, however, they cannot always be relied upon. One is at the mercy of the donor whose judgments are influenced by a number of factors outside one's control.

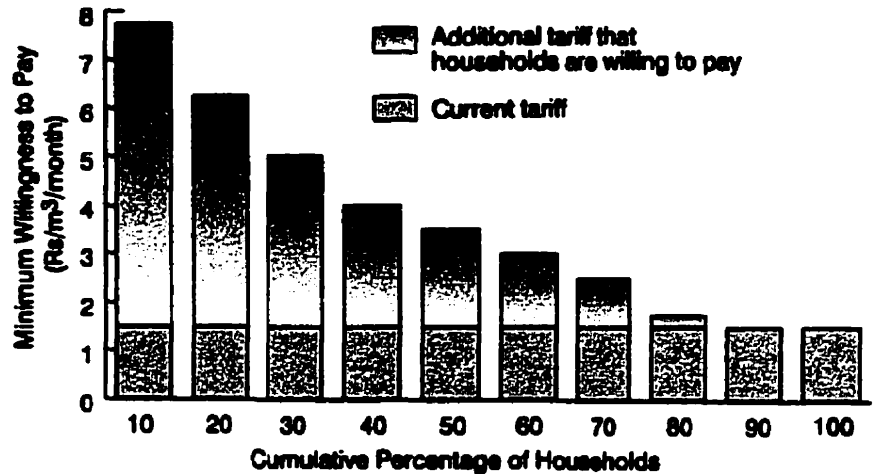
But can one expect a steady and sufficient source of funds through the sale of the filters to the poor? Are the poor willing and able to pay? There is growing evidence that many communities are willing to pay more than the prevailing rates for water and sanitation. Besides the evidence from a range of 'willingness to pay studies', as illustrated in Figure 3.4.1, the cost of water from vendors is a good indication of the poor's willingness to pay for this vital service.

'An analysis of the turnover of operators in five towns in Burkina Faso, Mali, Senegal and Haiti gave an average budget for drinking water of \$US 4-9 per person per annum, which represents 2-3% of the per capita GNP of these countries.' (Collignon 99).

Figure 3.4.1

Source: Chloe, Varley and Bijlani 96 in UNDP/World Bank 99b

**Household Willingness to Pay for Improved Water Supply
Dehradun, 1996**

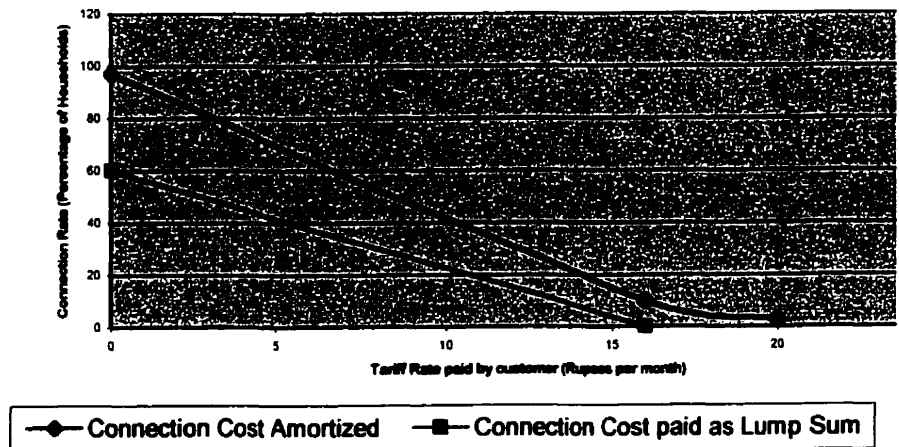


80 per cent of households are willing to pay more than the prevailing tariff
10 per cent of households are willing to pay up to Rs 6.25 more per month

The willingness to pay is tied to household budgets but is also closely linked to the legitimacy and effectiveness of the agencies and organizations responsible for service delivery. How people pay and to whom therefore influences how much they are willing to pay. Low income households can seldom pay large lump sums (van Wijk-Sijbesma 98). Allowing users to pay smaller amounts more frequently makes water more affordable for low income families.

Figure 3.4.2

The Effect of Spreading Connection Costs on Connection Rate
(Source: World Bank 1982 in van Wijk-Sijbesma 98)



Another constraint, especially for women, is the distance to where payments have to be paid (van Wijk- Sijbesma 98).

Grameen started out as a small personal project in 1976 in a village next to Chittagong University campus. It struggled through several years to grow into a bank owned by the poor (75% of the shares are owned by landless borrowers, the remaining 25% by the Government of Bangladesh) for the poor. Today it has 400,000 borrowers, 82% of whom are women. Grameen Bank lends out more than \$2.5M each month in tiny loans averaging \$67US. Its recovery rate is 98%. Now it has over 400 branches working in over 8000 villages (out of 68,000) of Bangladesh. Borrowers have accumulated over \$7.0MUS in their savings funds.

Yunus 89

By and large informal lenders concern themselves with the overall credit standing and financial position of the borrower rather than with the end purpose of the credit. Nor do they supervise the end use of the credit being generally content with surveillance of the borrower's overall activity, including his social conduct which is only possible in a close face to face society based on multiple relationships.

Chandavarkar 89

The recent experiences of micro -finance programs like the Grameen Bank and the Unit Desa system in Indonesia prove that, not only are the poor willing to pay for the services they require, they are capable of saving money, providing that the vehicles which meet their needs are provided (Robinson 94). The myth that rural households cannot save because they are too poor, prefer to use their incomes for consumption or choose to save in other forms has been seriously challenged. It was revealed that the previous poor deposit record was due to lack of trust of banks and the lack of appropriate services.

Successful micro finance organizations have specifically designed services to meet the needs of the poor, to provide them with the access and convenience they require:

- Loan terms are less than 1 year.
- Lending outlets are located near the clients.
- Application processes are simple and there is quick disbursement of funds.
- Interest rates are high as compared to Formal Financial Institutions but low compared to Informal Financial Institutions. Moreover, they have successfully imitated and modified some of the practices of informal moneylenders:
 - There is little attempt to direct credit to specific uses.
 - Group liability provides a substitute for collateral.
 - Repayments are made weekly.
 - The promise of repeat loans in increasing amounts motivate repayments.

Several of these institutions such as Bank Rakyat in Indonesia are well on their way to financial self sufficiency, moving away from donor grants or soft loans to more heavy reliance on clients' savings deposits and borrowing from commercial banks as the principal means of financing. Financial self sufficiency is seen as the only means of being able to provide continuous services to the poor. (Glosser 94, Otero 94)

Consequently, both the experiences within the water supply and sanitation sector as well as the practices of the micro-finance industry lead one to believe that it is reasonable to expect that the concrete filter technology can be financially self sufficient through payments by the users, providing that the services are provided in the appropriate fashion.

3.4.2 Micro-enterprises

The findings of the previous section lead one to believe that the formation of microenterprises to provide these concrete filters, in the long term, is a viable option.

The formation of micro-enterprises, however, introduces the concept of profits and the need to distinguish between profitability and sustainability. When speaking previously in the context of financial self sufficiency, operating surpluses are seen as essential to long term sustainability and expansion but not as an end in itself. To achieve genuine commercial viability, even for micro-businesses, there must also be a profit to the owners.

Promotion of technology distribution through the creation of micro-enterprises would direct resources, not just to provision of services but to the development of capacity in the local population to meet their own needs. Subsidies or external funding could be directed towards this objective while actual services are paid for directly by the users.

Practical demonstration of an improved technology can contribute a great deal to its quick adoption by the producer. Trial production and test marketing of new products are also helpful. The package approach normally includes

- *Information about availability, source and effectiveness of a new technology*
- *provision of credit*
- *assistance in procuring and installing the needed machinery and equipment*
- *skill training in their use*
- *Support services for smooth operations and even marketing of products.*

The question of which of the three avenues for technology transfer best lends itself to success in the development of micro enterprises is a difficult one. Previous experience with providing credit services for poor micro-entrepreneurs indicated that NGO credit programs had the character of welfare activities- they were less inclined to emphasize the business and profit making character of the micro business (Levitsky 89). NGOs found it difficult to move from social welfare to sustainability (Mutua 94). Furthermore, when welfare criteria were used to select beneficiaries, the credit programs ended up with borrowers who were not entrepreneurs. The poorest people in any community are not likely to be business operators. They are more concerned with survival.

Islam 92

Consequently, one would be inclined to think that association with a large commercial business could provide local NGOs better ability to learn about the behaviour required by the small business to achieve success in the modern economy. However, micro- businesses require services and the question of how one is going to fund these services is extremely important. Institutions which provide financial services to microenterprises often provide several non-financial services such as training in areas related to production.

There are two schools of thought as to the value that these 'extra' services provide and whether the costs of these services are social costs, which should be subsidised or whether they are a necessary

element of providing services to the poor and should be built into full cost pricing (Otero 94). This is the debate as to the value of the so-called 'minimalist' or 'integrated' approaches to micro-enterprise development.

Proponents of the integrated approach argue that it is impossible for micro-enterprise owners to pay the cost of advisory services, which is extremely high and that preparation of micro-enterprise owners should be subsidised and viewed as a positive and enduring social investment. From a socialist point of view, investments in micro-enterprise programs may be justified because of their effects on income distribution and social integration (Carvajal 89, Otero 89, Timberg 89). The experiences of several micro-finance programs indicate that credit alone without training or technical assistance is of limited value (Levitsky 89).

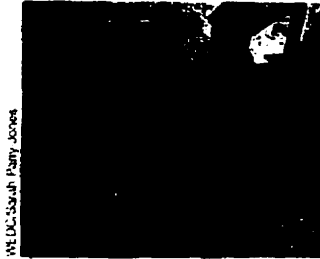
Others maintain that the minimalist approach allows for a much greater reach. Programs that reach large numbers of borrowers have diversified least into non credit activities. Most donor agencies, particularly NGOs favour the integrated model; Banks or financial institutions favour the credit only programs (Levitsky 89).

In addition, initiating new services or services in new areas requires a greater degree of investment than providing ongoing services. Programs undergoing expansion need to raise increasing amounts of funds.

In conclusion, micro-enterprises are a viable, financially sustainable means of disseminating the concrete filters, and a local business-NGO alliance is perhaps the most appropriate alternative for developing these. However, although the level of financing required for this alternative is lower than direct gifting of the filters to those in need, significant levels of funding may still be required for the training and support of the micro-entrepreneurs. There is evidence to indicate that the high cost of training has limited the effectiveness of some micro-enterprise programs historically. In the case of the business-NGO alliance, the local NGO needs to assume clear responsibility for arranging the necessary financing.

3.4.3 Efficiency and Economies of Scale

The sustainability of this technology transfer, its ability to continue operations without continuous recourse to outside funding, will be very much affected by its volume of operation. Operating costs of a program by program approach are traditionally very high. Decreased costs must come from efficiency and economies of scale.



W.L. D.C. Squah Parry Jones

There are agglomeration economies in serving dense populations. In cities, one can see more clients per staff trip away from the office, one can use public transport instead of having to invest in vehicles, one can spend less on the operation of one's own vehicle.

Tendler 89

The problem is one of insufficient networks of financial institutions with enough branches to permeate the rural areas where the majority of microenterprises are located.

Okelo 89

The success of the Grameen Bank has, in no small measure, been due to the volume of lending achievable in Bangladesh, a country of 180MM people. No program in Latin America or Africa has approached the volume of lending achieved in Asia (Levitsky 89).

Again, the experiences of those in the micro- finance industry may prove informative in this regard. One of the factors which has contributed to their success was the development of special administrative techniques which slashed the high costs associated with reaching large numbers of people.

- Loan applications are no more than 1 page
- Approval is decentralised and based on readily verifiable eligibility criteria
- Borrower groups handle much of the processing burden.

One of the significant learnings is that in order to reach significant volumes of the target population, one is required to use the poor themselves as part of the process. Micro-finance organizations, through the formation of peer groups, use their clients to screen each other and to pressure each other into compliance.

To reach large volumes of people also requires a highly decentralised structure. *'Grameen is a highly decentralised organization, as decentralised as a franchise business'* (Yunus89). The Bank is comprised of nested, federating units, each autonomous and self regulating.

Both the need for a highly decentralised structure and the ability to use the poor themselves to provide services again lends one to believe that an infrastructure containing a series of local community micro-enterprises may be one of the only means to create the economies of scale required for financial sustainability

3.4.4 Clear Standards for Performance

Financial sustainability is only possible when the expectations for performance are clear. When resources are abundant, survival becomes unlinked from performance and self evaluation is not a priority (Meyer 89).

'Market discipline is one of the most reliable and relevant indicators of performance.' If people pay the full cost of the service, then evaluators can be sure that the service is valued at least as highly as its price' (Rhyne 89).



Rhyne (89) recommends that performance evaluations should produce information that enables the organization to improve its performance by reaching new customers, offering better services, and operating more efficiently and that meeting this objective requires detailed information on clients. She advises that it does not make sense to carry out management only evaluations, confined to operations and administration, nor to allow evaluations of the impact on clients to stray very far from the interaction between client and service.

The normal organizational performance measures used in NGO-government type programs, - training, monitoring, evaluations and audits, though standard good practice, are costly and time consuming and often do not yield the desired results. Instead finding tasks and structures that produce these pressures themselves, without the expenditure of time and funds is a better investment (Tendler 89).

Consequently, of all the alternatives under consideration, micro-enterprise development or the business-NGO alliance are the most likely to provide the most unambiguous and concise measures of good performance.

3.4.5 Mitigating Risk

In addition to reducing donor related risk, micro enterprise development is an important means of ensuring program longevity. Equity investment by the micro-entrepreneurs plays a central role in ensuring that the micro-enterprise owners have a stake in the solvency of their own organizations. Even if an NGO owns funds that capitalize its programs, these funds are not owned by its investors who stand to lose their money. Thus the capital can act as emergency reserves but cannot ensure prudent control by the directors or managers of the NGO (Chavez and Gonzalez-Vega 94).

The risk taking capacity of the micro-entrepreneurs themselves, however, is low. Their willingness to bear additional risks will depend on their assessment of how the new technology would fare in a new arena, the disaster level income requirement related to the minimum subsistence needs of the family as well as the structure and value of the family assets (Mukhopadhyay 92). They cannot afford a long gestation period and need to enjoy immediate, concrete results in terms of income augmentation (Charsombut and Islam 92). Thus, small enterprise development can succeed only with the intervention of a support agency having the capacity of sharing the risk with potential beneficiaries during the period of gestation.

The technology needs to be sufficiently attractive in terms of the potential impact on productivity and income. It is less likely to be adopted where it is only a supplementary source of income

Charsombut and Islam 92.

3.4.6 Conclusions

One of the best means of achieving financial sustainability is through the formation of micro-enterprises. These businesses offer the best hope for attaining adequate and consistent levels of funds, achieving the economies of scale required, for measuring performance and ensuring that it meets expectations and for managing risks.

Micro enterprises are motivated by the need to achieve, i.e. to survive, and they display all the traditional characteristics of entrepreneurs, by grasping opportunities, working persistently and delaying gratification in order to accumulate and preserve the modest capital that they need. (Harper 89).

When it comes to micro enterprise development, the experience of Carr (89) leads her to believe that private organizations which concentrate on a single sector, which have a good understanding of the nature and location of the training needed, which invests in developing technology appropriate to local conditions make good lead agencies in micro-enterprise support programs.

These findings in conjunction with the previous discussion, indicates that the NGO-local business alliance provides the best alternative for financial sustainability.

3.5.0. TECHNICAL SUSTAINABILITY

To be technically sustainable, the technology needs to reside in a sound institutional home with an interested and dynamic leader. *'There will be no impact without a viable institution; there will be no institution without perceived value.'* (Boom and Angel 94). The institutional home must be the base for the technological competence and expertise in water treatment and supply solutions. It must be responsible for enforcing quality standards, encourage local experimentation and adaptation, be the keeper of the information base and the provider of appropriate training. NGOs are not likely to have the capacity for expansion and technical intermediation on their own. It is clear at the outset that the local business is the authorized, in-country keeper of the technology, and that the business-NGO alliance is very likely the alternative which is most capable of contributing to the technical sustainability of the technology.

There are two ways in which new technologies can be introduced into developing countries:

1. Indigenous development.

This route is often advocated on the basis that technology developed in advanced countries has been in response to their specific needs and factor endowments which are at sharp variance with those in developing countries.

2. Technology transfer from developing countries

This avenue avoids reinventing the wheel, the long gestation period and considerable investment in local R&D.

Fernando 92

The primary unifying element in the production system (of microenterprises manufacturing appropriate wheelchairs in Colombia) is the set of special tools developed by Hotchkiss. Uniform tooling combined with procedures illustrated in the production manual ensures the integrity of the design is maintained in numerous, isolated workplaces.

De Wilde and Schreurs 91

3.5.1 Viable Treatment Solutions

Water treatment is a very important business; the health and survival of the individuals in the community are related to whether or not the water is treated to the appropriate health standards. Furthermore, water treatment solutions depend on the contaminants contained in the water, which in turn, are highly dependent on the water sources used, as discussed in Section 2.6.2. **Although the concrete filter has wide applicability, it cannot provide adequate treatment for all contaminated water.** In several circumstances, the filter may need to be combined with other methods of treatment to deliver a complete solution.

The institutional home must be able to provide advice to individual communities as to the most appropriate water sources and the treatment alternatives for each of the sources. It must ensure that the proper procedures and systems are in place to guarantee that, once treated, the water is safe to drink. At the very minimum, it needs to understand the technical limitations of the concrete filter.

3.5.2 Quality Control

Moreover, the institutional home must ensure that the concrete filters produced are consistently effective and capable of delivering the results claimed.

The design of the filter casing and the methods employed during its construction have purposely incorporated techniques and standards

which ensure consistent reproduction of the filter body. The filter media, however, is prepared on location. This preparation and installation are crucial to the effectiveness of the filter. Care must therefore be taken to ensure that the filter is manufactured in accordance with the specified instructions.

Once installed correctly, with the appropriate flow rates through the filter, and providing the quality of the inflow water remains consistent, the quality of water produced should be reliable with time, except immediately after cleaning, as described in Section 2.5.0.



The business-NGO alliance is clearly the alternative, most capable of ensuring that the correct procedures with respect to filter construction and required water testing are followed. **Furthermore, the business has a vested interest in guaranteeing that the concrete products are effective, since the commercial business could be very adversely affected by non performance of the humanitarian products.**

3.5.3 Local Innovation and Experimentation

To be sustainable the technology must be consistent with the local context. The success of the introduction of treadle water- pumps in the Prey Veng Province of Cambodia (2480 pumps were sold in 3 years) was attributed to the similarity of the technology to traditional technology. *'When the villagers saw the first treadle pump, they immediately understood the mechanism of the framework and have been able to duplicate and make modifications easily.'* (Crenn 99).

Local innovation and experimentation with the basic technology results in better understanding and acceptance by the locals as well as lower costs (Islam 92). A local business can apply the necessary technical, engineering and scientific skills to modify, service, maintain or scale down the imported technology to meet the local requirements.

And, as discussed previously, it is the business rather than the NGO or government, which is most capable of instituting the research and development required for the generation of marketable products and solutions. Fernando (1992) reports that the Sri Lankan experience with small and cottage industries is such that *'neither the Government nor the NGOs apart from ATI and PRDA have invested sufficiently in market oriented product development. Neither sector has been creative enough to set about their task of small enterprise*

development through technology transfer by first studying the market and the macro economic environment, identifying the type of product that can be produced in the small and cottage industry sector and carefully defining segments in the market to which they can be targeted and then developing the technology for specific products that are marketable.'

The business is best equipped to shoulder the R&D burden for the small producers and micro-entrepreneurs, given their small margins and risk aversiveness.

Grameen managers never fail to give a mild shock to everybody by their having good university degrees and deciding to work in the village.

They cannot believe that after completing university education, anybody would ever come back to work in the village and to work with poor people, walking several miles every day- no big chair, big table, big office- no glamour.

Yunus 89

Whether the filters are constructed by the local NGO itself or through micro- entrepreneurs, the technical problems presented normally require high levels of skill and effort to resolve. Some of the typical challenges which may face these small producers include (Harper 92):

- Production Materials and Techniques Constraints, where the producer does not know how to alter his/her operation to meet the local consumer requirement
 - materials choice is limited
 - basic services such as power, transport and water are absent or in unreliable supply
- Public Policy Constraints, where the sale of the filters may be affected by national water quality standards.
- Institutional Issues

Again, the business is evidently the most capable of providing support in this area.

3.5.4 Information Base

The institutional home should also provide a base for information sharing. NGOs frequently complain that information is typically unavailable and when available, it is typically in a format, which is difficult to interpret and apply to conditions on the ground (Smout and Parry-Jones 99). When available, it may also be at a prohibitive cost. The challenge for them has been finding the best or most appropriate source. Furthermore, there is a need to provide technology publications in simple, native language (Fernando 92).

3.5.5 Training

The ability to provide effective and adequate training is a central issue in comparing the various alternatives for technology introduction. *'Many NGO efforts are ineffective primarily because of lack of funds: courses are too short, or centres have too few facilities*

to be of any significant use to the trainees. Although NGOs do understand the needs of the trainees, they lack the professional expertise to put forth a serious effort in the training area.' (de Wilde and Schreurs 91).



Effective training in the areas of

- correct operation of tools
- quality control procedures
- sourcing of materials, and
- marketing of the product

is essential. Training for NGOs in the field of micro- enterprise support is also vital, because for NGOs to provide effective support to micro-enterprises, there needs to be an understanding of the practical needs and constraints of small, often remote production operations. Both field presence and technological credibility are required. Support units need a core of expertise, but they also need a larger group of generally trained field officers who can understand and function within workshop environments and must be able to communicate on a technological basis with micro-producers. These field officers would understand enough about what is involved in the manufacture of a given product or execution of a given technique to guide more expert staff to the most critical areas for technological support (Gamser and Almond 89).



Davnor Training
Haiti, 1999

One of the main training problems is the readiness of the recipients to absorb new technology (Kathuria 92, Kiasarn 92). The business-NGO alliance would best be able to provide the necessary complementary skills to choose those candidates most suitable for training. In addition, it would be best able to provide both basic preparation, specific management and scientific training.

3.5.6 Conclusions

The business-NGO alliance is clearly the alternative which provides the ability for greatest technical sustainability in terms of:

- Being able to provide complete water treatment solutions for individual communities.
- Ensuring adequate product quality control.
- Engendering R&D for the development of specific products to meet the needs of the poor
- Encouraging appropriate innovation and experimentation at the local level
- Providing an institutional base of technical expertise, training and information that is readily accessible.
- Offering technical support for micro enterprises.

3.6.0 IMPACT ON COMMERCIAL OPERATIONS

It is clear that, although the business- NGO alliance may appear to be the most viable alternative to achieve the humanitarian aims so important to Davnor Canada, the parent corporation, it would not be acceptable to the local business if there were an adverse effect on its commercial operations. This section examines the impact of the various alternatives on the business client base, its knowledge base, the market competition, investor relations and risk management.

3.6.1 Client Base

One of the objections most often raised against rural microenterprises is the narrowness of the market. If markets were not expandable, there would be no such thing as development.

In Sierra Leone and Nigeria, a 10% increase in income leads to a 13 to 14% rise in expenditure on local goods and services (other than food), as compared to 11% for imports.

Nowak 89



Transporting Concrete Filters by Donkey, Samaritan's Purse Kenya, 1998

Will providing the technology on a cost plus basis to the very poor shrink the number of clients available to the local business? One would be inclined to believe that perhaps just the opposite effect may occur.

The market segment at which the concrete filter is directed is not the same as those for the plastic filters. There are several limitations associated with the concrete filter:

- It cannot easily be moved. Consequently,
 - Construction must take place close to installation.
 - It does not lend itself to the mass marketing and distribution systems, necessary for urban usage.
 - It is difficult to move around within the household.
- It does not possess the modern aesthetics of the plastic filter.
- Production using a singular steel mould is limited to one filter per day i.e. it does not lend itself to mass production.

The concrete filter is therefore directed primarily at the poor, rural consumer who lives in a community where individual families must collect water from surface or ground water sources, which are contaminated. From a marketing perspective, these communities are very difficult to reach by businesses located outside the community. They are better served by a small micro enterprise located within the community.

This market segregation is again confirmed by Fernando(92) when discussing the appropriateness of micro-enterprise development. Fernando (92) cautions that *'a technology can successfully get transferred from a big entrepreneur to a small entrepreneur and be sustained at the small enterprise level only under conditions in which the demand for the product which both the large and small scale sectors produce is well in excess of its supply.'* He goes on to elaborate that the lesson is clear. A technology that produces a mass

In urban areas, fewer than 10% of the population wanted public taps. However, about 75 % expressed a desire for a private connection, signalling a widespread willingness to pay for a more expensive service of better quality. This is in spite of the fact that the cost of private connections exceeded the usual cut-off threshold of 3-5% of household income.

Foster 98

Communities express aspirations for house connections. Projects should be designed as the first phase of upgradable schemes that can support house connections.

Kwadzokpo Kwame 98



Concrete and Plastic Filters
Gabirol. Rwanda
2000

My name is Carmen Plante and I am a CUSO volunteer working in Guatemala. I have met here a representative of Samaritan's Purse of Calgary who will be training communities on how to make household water filters. We have spoken briefly and while the community is very interested in the individual household filter they are also asking whether or not this filter can be adapted to a larger size to treat river water for a community? The representative told me that it would be best to contact Davnor directly with this question..

Davnor Internal Correspondence
July 13, 2000

product to a basic human need can sustain itself in the small enterprise sector only in relation to a specific, narrow product line. It can sustain itself producing a mass product only under very special socio-political circumstances or if it receives protection against its competitors through government policy. 'In an open economy, in the manufacture of mass products, the large scale sector will always out compete the small producer in terms of technology, quality and price. Under conditions of an open economy, the transfer of technology for small and cottage industries should be confined to very specific product lines in which the quality of the product of the small producer will have a decided advantage in relation to a specific and narrow market segment to which it should address itself.'

Consequently, there is very little overlap in the market segment for the concrete and plastic filter. The introduction of the concrete filter to communities as an initial solution to their water treatment problems would actually, very likely create a potential market for the more expensive water treatment systems which use the BioSand technology by

- increasing awareness
- generating understanding
- building familiarity and acceptance

Every family wants a potable water supply delivered directly to their individual household. The reason that people will buy a concrete filter is because that is all they can afford. But if one believes in development and progress, one needs to view the poor as potential consumers with whom it would be beneficial to initiate a relationship. The key to long term successful growth and profitability is the ability within a particular market segment to aggregate exponentially growing numbers of clients who pay for services rendered. i.e. build client base in a methodical, step by step fashion based on performance. (Jackelen 89)

Furthermore, the market potential associated with the ability to develop relationships with local NGOs and to work with them in providing solutions to water treatment problems should not be overlooked. Local NGOs now have significant influence in water service provision for both families and communities. They are a key customer segment now and in the foreseeable future.

In addition, the promotion of the concrete filter engenders a very favourable relationship between the corporation and bi-lateral and multi-lateral agencies, which often provide funding for the development projects which utilise this product. The agencies are

potential markets for several of the commercial products, which include engineered community systems and emergency response systems.

Knowledge generates the basic breakthroughs in technology that create the disequilibrium conditions in which high returns and high growth rates are possible. Knowledge suddenly allows new things to be done in new ways.

Advances in basic knowledge and breakthrough technologies do not just happen. They have to be discovered and invented.

Although human talent is spread evenly throughout the world, inventiveness is not.

Being curious-wondering why things work and what is beyond the next ridge of hills; wanting to explore-having the courage to go where no man has gone before; being willing to learn- getting new knowledge from others; and wishing to build- using new knowledge to make something different; while these four characteristics are embedded in human nature, they only become evident when combined with other ingredients in the right environment.

Thurrow 99

3.6.2 Knowledge Base

Consumers are not only a source of funds, but a source of information. One of the key benefits of an NGO-business alliance is the knowledge base that it provides the business. The company would be able to compile a comprehensive understanding of the

- water quality
- potential treatment solutions
- water source potential
- what works and what doesn't

throughout the country, without investing significant amounts of its own money to gather the data.

This kind of knowledge base would provide the business with a huge competitive advantage. The value of this knowledge base should not be underestimated. It is probably the most important reason for the business to offer the concrete filter technology as an integral part of its product line.

3.6.3 Competition

The inclusion of the concrete filter, as part of its product line, would create healthy competition internal to the company. It would force the company to produce the plastic filters at very competitive pricing to minimise any product substitution. This would encourage production efficiency and ensure that the company is capable of winning the race against any external competitors or imitators of the technology.

3.6.4 Risk Mitigation

The most serious risk facing the business is non- performance of any of its filters, whether the humanitarian products or the commercial products. One of the key ways to mitigate that risk is by engendering a close alliance between the business and the NGOs responsible for field implementation of the concrete products.

3.6.5 Investor Relations

Would potential equity investors react negatively to the concept of a

business- NGO alliance for the purpose of the humanitarian distribution of the technology ?

[SA8000] provides what other initiatives have lacked: a common framework for ethical sourcing of companies of any size and any type, anywhere in the world. Financial Times, December 12, 1997

SA 8000 is both authoritative and comprehensive in its approach. What makes it so important is that SA 8000, like ISO 9000 and ISO 14,000, is designed to work across countries, across industries and in companies of all sizes. Jeff Horner, Corporate Director, SGS-ICS (World's largest certification company)

Certainly in the developed countries, the issue of corporate responsibility in the areas of social, environmental as well as financial sustainability is gaining increased support.

- **There is now a comprehensive global system of standards for companies to monitor social accountability. Now there is SA 8000.**
- **Terms such as 'triple bottom line', which encourage companies to think about three results-social, environmental as well as financial results are being introduced.**
- **Agencies which rate corporations now have separate indices to reflect a corporation's commitment on all three fronts.**
- **The growth of 'ethical funds'**

These are all indications that Davnor's unique integration of the commercial and humanitarian services would have a positive impact on investors rather than a negative one.

As with all corporate investor relations, clear communication is essential. Communication of:

- **The benefits of the concrete filter distribution**
- **The accounting and accountability practices that would be associated with the practice: i.e although there would be no profit in the strictest sense, the services would be charged for on a cost plus basis, at rates sufficient to ensure its sustainability.**
- **The relationship between the humanitarian and commercial divisions**

would enable investors to develop a clear understanding of the importance of the humanitarian technology and make their judgments accordingly.

3.6.6 Conclusions

The impact of developing business-NGO alliances for the purposes of humanitarian technology distribution are, by and large, very positive for the business, in terms of :

- **Developing a potential client base**
- **Building positive relationships with NGOs and bi-lateral and multi-lateral agencies**
- **Increasing the knowledge base**
- **Creating healthy internal competition**
- **Mitigating key risks**
- **Engendering a unique investor appeal.**

However, there needs to be absolute clarity with respect to how the two segments integrate, the expectations associated with the alliance

as well as the development and implementation of appropriate procedures and accountabilities.

3.7.0 CONCLUSIONS

Of the three alternatives considered, the NGO- business alliance is the most socially, financially and technically viable solution. This concept is certainly very different from the NGO and Government based projects that have been implemented to date. But, not only is the solution viable, the climate is right, right now. Tendler (89) articulates that there is an opportunity for experimentation today because:

- *The harsh austerity programs of the 1980s have created a more receptive environment for targeted programs, or at least for political gestures to the poor.*
- *Current economic conservatism of economists and policy advisors is sympathetic to policy reforms favouring informal sector producers or private sector input.*
- *Current balance of payment and debt problems of 3rd world countries, leading to restraints on imports, have created a more enabling environment for local businesses and some informal sector producers to flourish.*
- *Current sympathy for decentralization has created a more enabling environment for local level experimentation in the public sector.*
- *Public sector actors, humbled by the disappointing experience with state sponsored poverty initiatives of the 70s have become more receptive to modest approaches and learning from NGO experiences.*

Furthermore, the NGO- business alliance appears to be the most suitable format for promoting micro-enterprises which themselves promote financial, social and technical integrity.

This innovation in service delivery provides several of the traits of previous, successful projects (Tendler 89, Carr 89).

- **There is a narrow focus on the water supply and sanitation sector, and even more specifically, very small scale systems within this sector.**
- **Interventions are tailored to the needs of the particular sector.**
- **There is a highly grounded understanding of the sector; the treatment processes, sources of supply, product markets, industry structure.**
- **The alliance combines the technical expertise of the business with the passionate dedication and street smarts of the NGO.**
- **There is no less concern about the broader issues of poverty, but**

The answer is more than simply hoping for the best, more than vague ideas about 'strengthening over time the institutional forms and activities associated with global society and accelerate the transfer of technology.'

The problem with the recommendations is that they lack a subject. Who will accelerate, establish, promote and channel?

Smillie 95



WELCO/Safran Perry-Jones

- it does not try to be too ambitious, to do everything at once.
- The way of thinking is iterative and incremental: there is a continual process of study, identification and intervention.
 - The focus is on building indigenous, technological capability.
 - There is a good understanding of the nature and training needed.
 - Problems can be defined in a way that attracts powerful technocrats and agencies.

Moreover, the NGO-business alliance benefits, not only the poor who need water, **it is good business**. Most importantly, of all the strategies considered, this plan is within the control and ability of Davnor Canada to execute as an integral component of the overall strategic direction of the corporation, **provided there is a corporate willingness to do so**.

4.0 THE MARKETS

This section examines the characteristics of developing countries worldwide, relative to certain key criteria, to determine which countries represent the principal target markets for the concrete filter technology. Given the lack of available data, no attempt was made to analyse information on a scale smaller than the country level, even though it is recognised, that within most countries, there are marked regional variations.

4.1.0	The Criteria	120
4.2.0	The Need	120
4.2.1	Access to Clean Water	121
4.2.2	Rural Population Density	134
4.2.3	Surface Water Availability	137
4.3.0	The Capacity	
4.3.1	NGO Availability	141
4.3.2	Governmental Support	142
4.4.0	The Business Climate	146
4.5.0	Conclusions	152

4.1.0 THE CRITERIA

Given the recommended strategy of using local businesses which produce and market the commercial products, as a vehicle for distribution of the humanitarian technology to indigenous NGOs worldwide, what are the major factors to be considered in selecting the primary target markets?

The number of people who need or would benefit from the technology in a particular country or region is obviously the principal, decisive factor in the determination of where one needs to concentrate.

Secondarily, the availability of NGOs within the country and the potential support from the national government will also play a key role in the successful execution of the broad strategy.

The potential for formation of a local joint venture corporation, which would provide a national home for the technology is the third, very important factor in prioritising the countries of focus.

The following sections analyse the pertinent country data with respect to these criteria, in order to recommend the primary countries of focus.

4.2.0 THE NEED

As discussed previously, the concrete filter is a technology, which is more likely to be used to treat surface water in rural environments. Because of this, the determination of which countries would potentially benefit most from this particular Davnor product was based on three characteristics:

- 1. The total number of people who lack access to clean water.**
- 2. The estimated rural population without a clean water supply.**
- 3. The availability of surface water supplies within the country.**

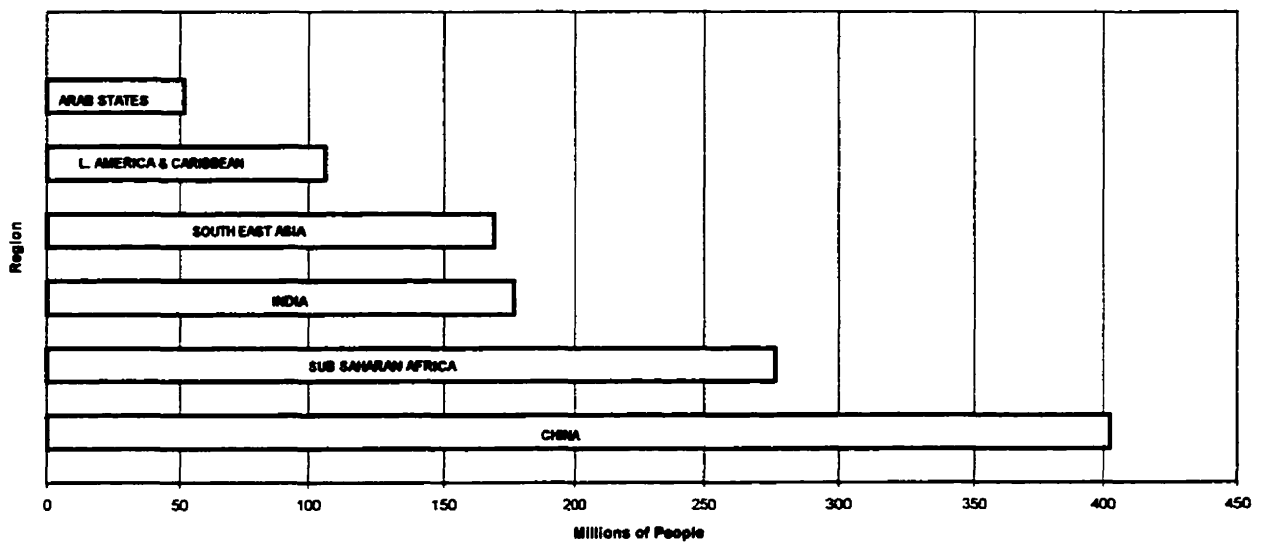
4.2.1 People Lacking Access to Clean Water

Based on statistics available from the 1998 United Nations Human Development Report, the greatest need for clean water lies in South East Asia, in particular China and India, and Sub Saharan Africa. (Figure 4.2.1). These two regions of the world represent over 70% of the world's population in need of clean water.

Figure 4.2.1

DISTRIBUTION OF PEOPLE LACKING ACCESS TO WATER BY REGION 1995

Source: United Nations Human Development Report 1998



Asia

With over 400 million people lacking access to clean water, China represents the greatest need as a singular country worldwide. This is followed closely by India, with almost 180 million people. As shown in Figures 4.2.2., 4.2.3 and 4.2.4, the numbers of people requiring assistance in the remaining East Asian countries, are also significant.

Indonesia, VietNam, Pakistan, and Myanmar represent countries, where not only high numbers of people require assistance, but where large percentages of the population have no clean water. In Japan and Thailand, however, although the numbers of people are significant, they only represent approximately 10% of the population.

Figure 4.2.2
SOUTH EAST ASIA:
PEOPLE NEEDING CLEAN WATER

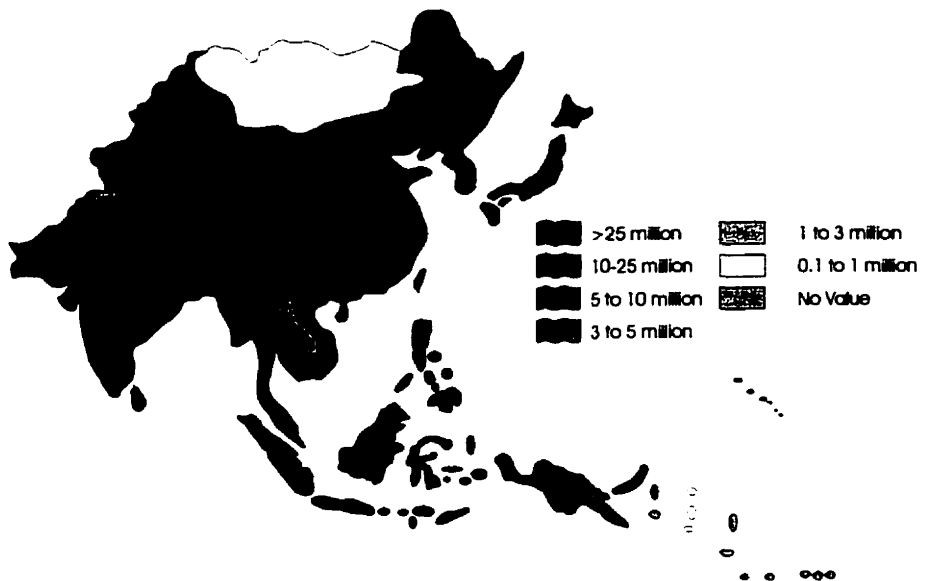


Figure 4.2.3

**EAST ASIA: EXCEPT CHINA AND INDIA
TOP TEN COUNTRIES WITH PEOPLE LACKING ACCESS TO CLEAN WATER(1995)**
Source: United Nations Human Development Report 1998

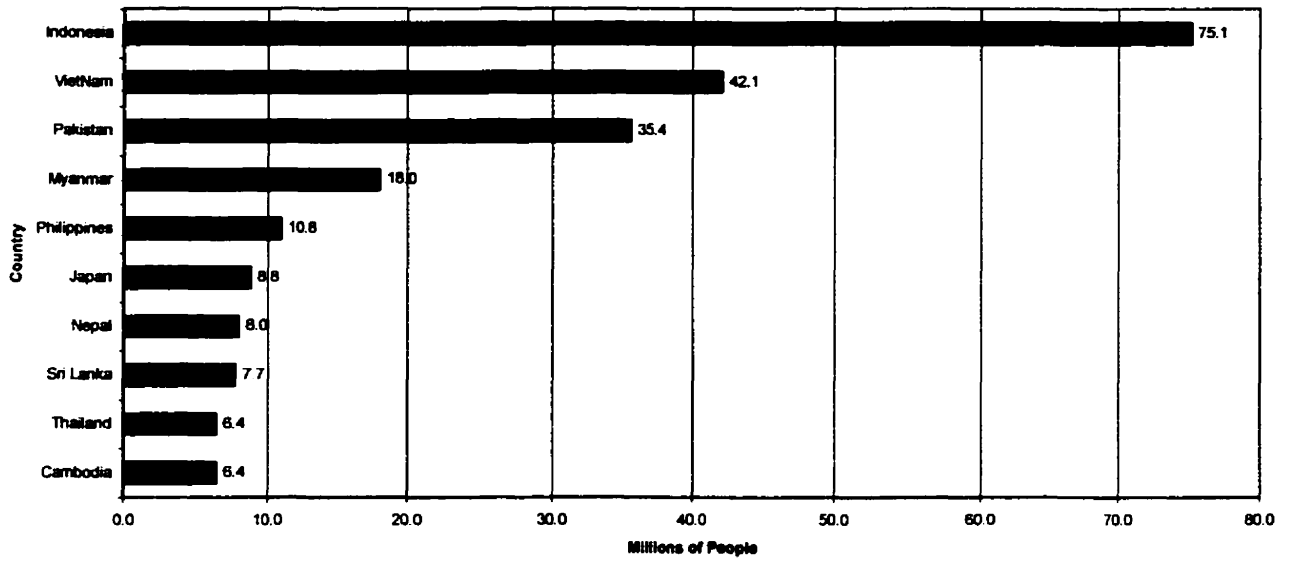
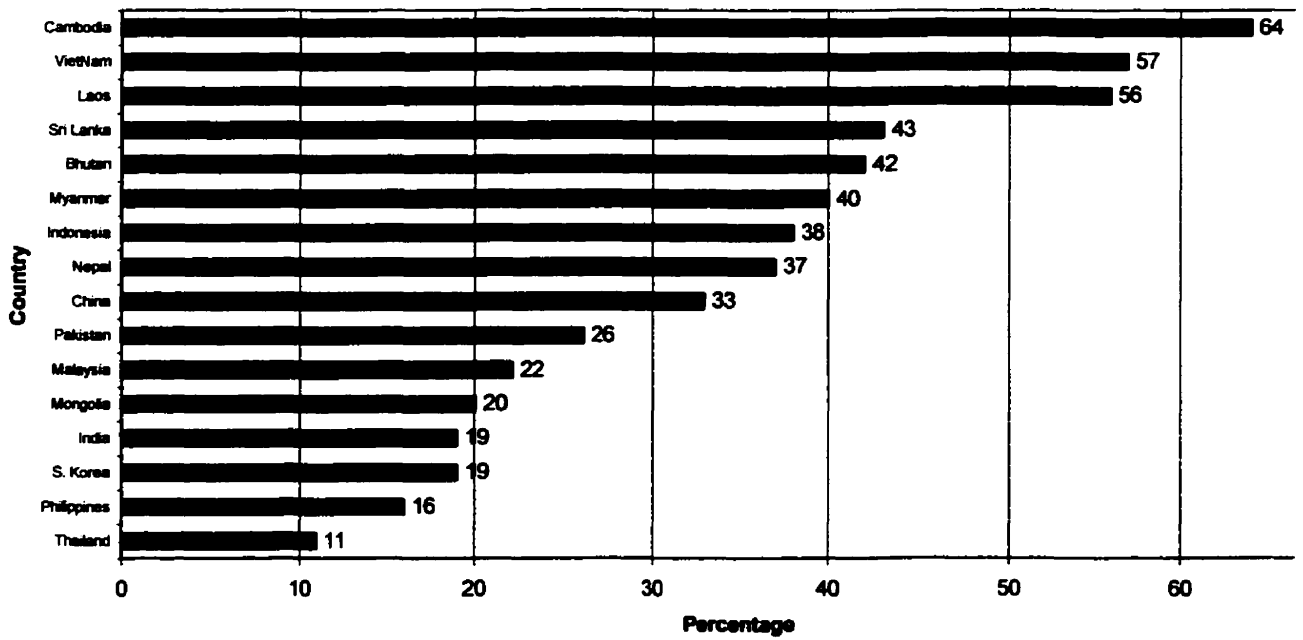


Figure 4.2.4

Percentage of Population with No Access to Clean Water:1995
Source: UNDP Human Development Report 1998



Africa

Within Sub Saharan Africa, no individual countries dominate, as is the case in Asia. Figures 4.2.5 and 4.2.6 and 4.2.7 illustrate that, although Nigeria and Ethiopia represent the countries of principal need, the demand is widespread throughout the region. With the exception of South Africa and a few of the very small countries like Mauritius, the percentage of people who need clean water is significantly over 40% of the population.

Figure 4.2.5
AFRICA
Percentage of Population
Needing Clean Water

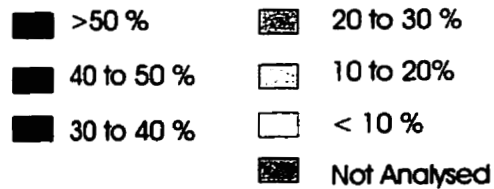
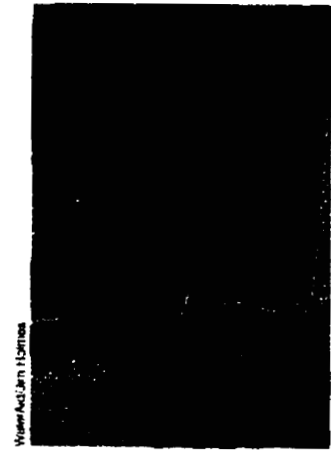


Figure 4.2.6

SUB_SAHARAN AFRICA: TOP TEN COUNTRIES WITH PEOPLE LACKING ACCESS TO CLEAN WATER (1995);

Source: United Nations Human Development Report 1996

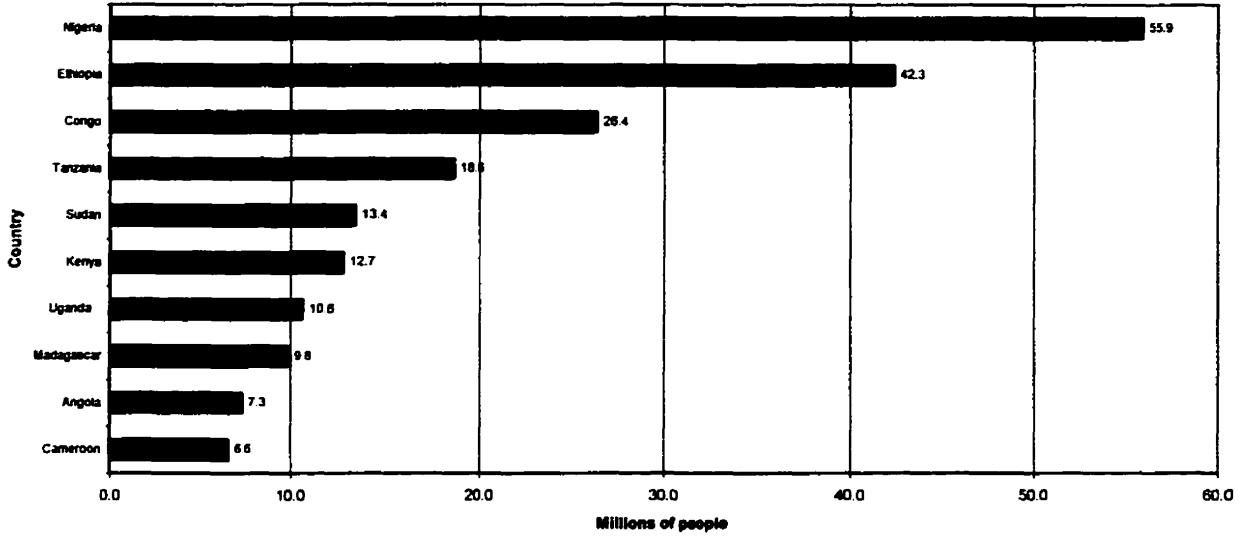
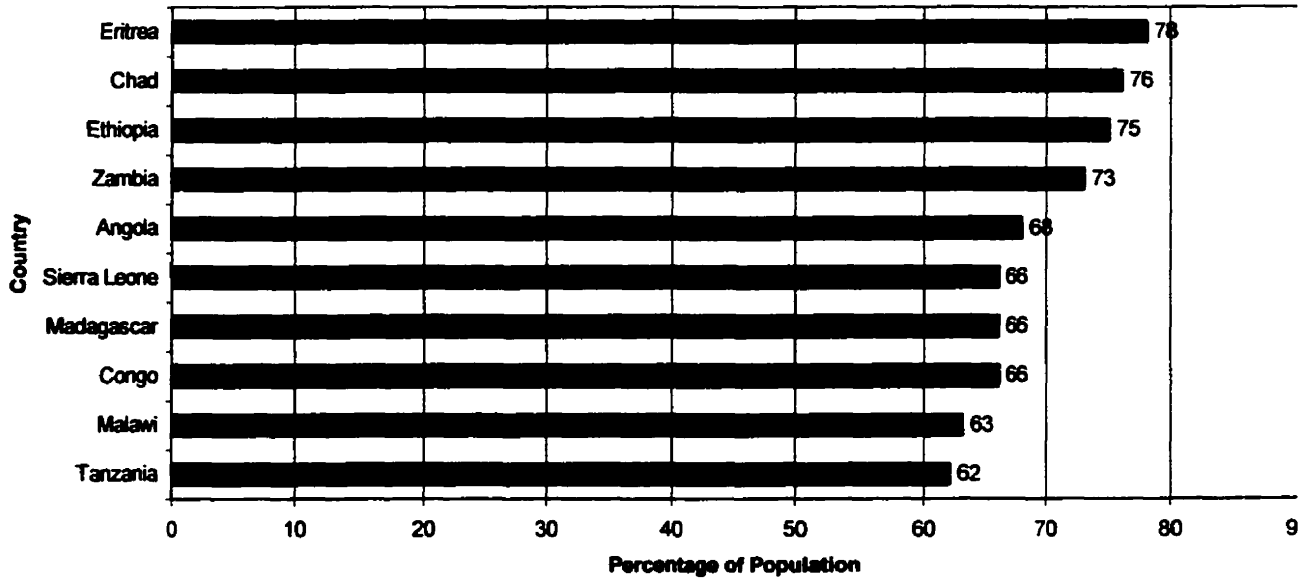


Figure 4.2.7

**Percentage of Population with no Access to Clean Water: 1995
Top Ten Countries**

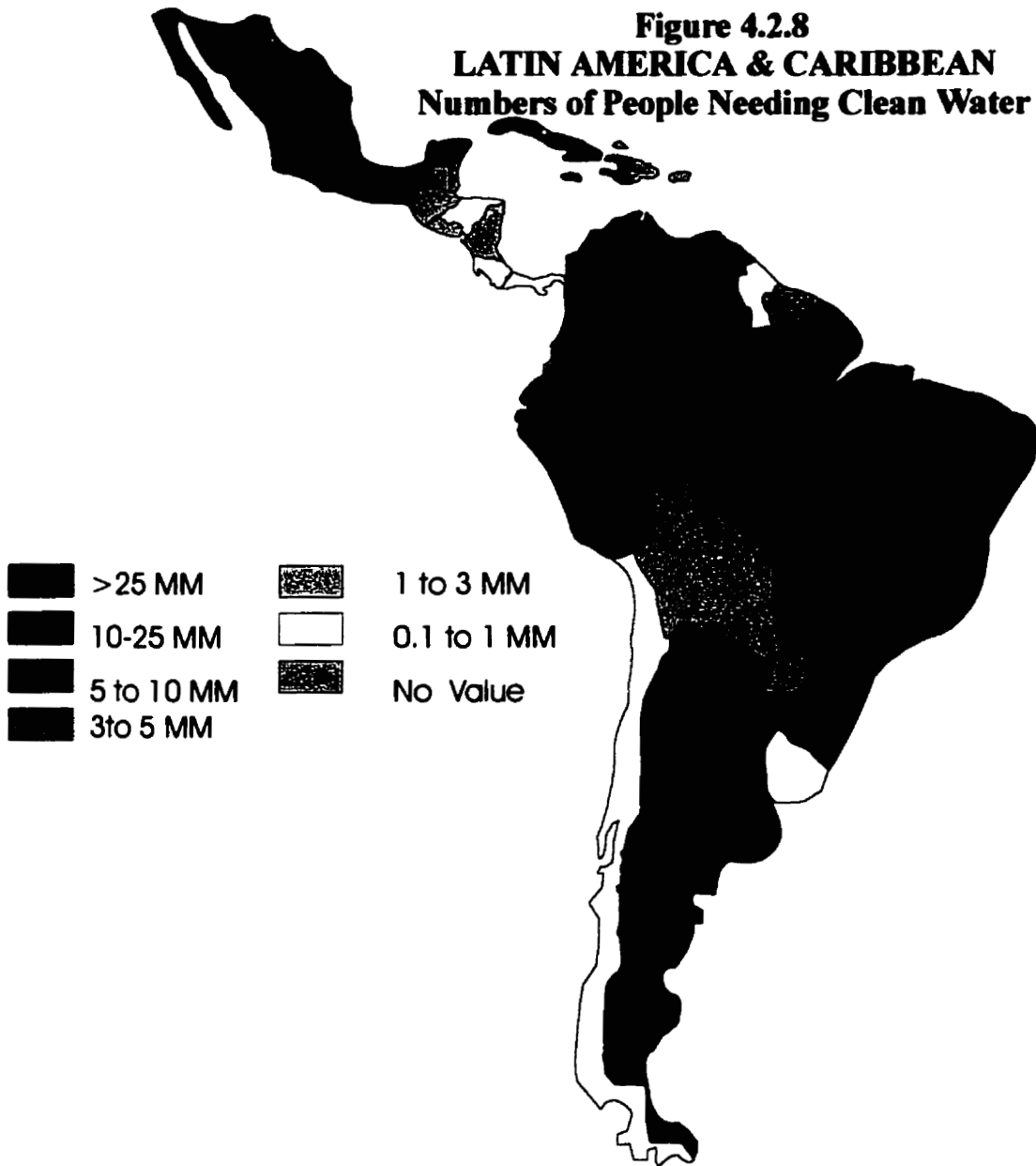
Source: UNDP Human Development Report 1996

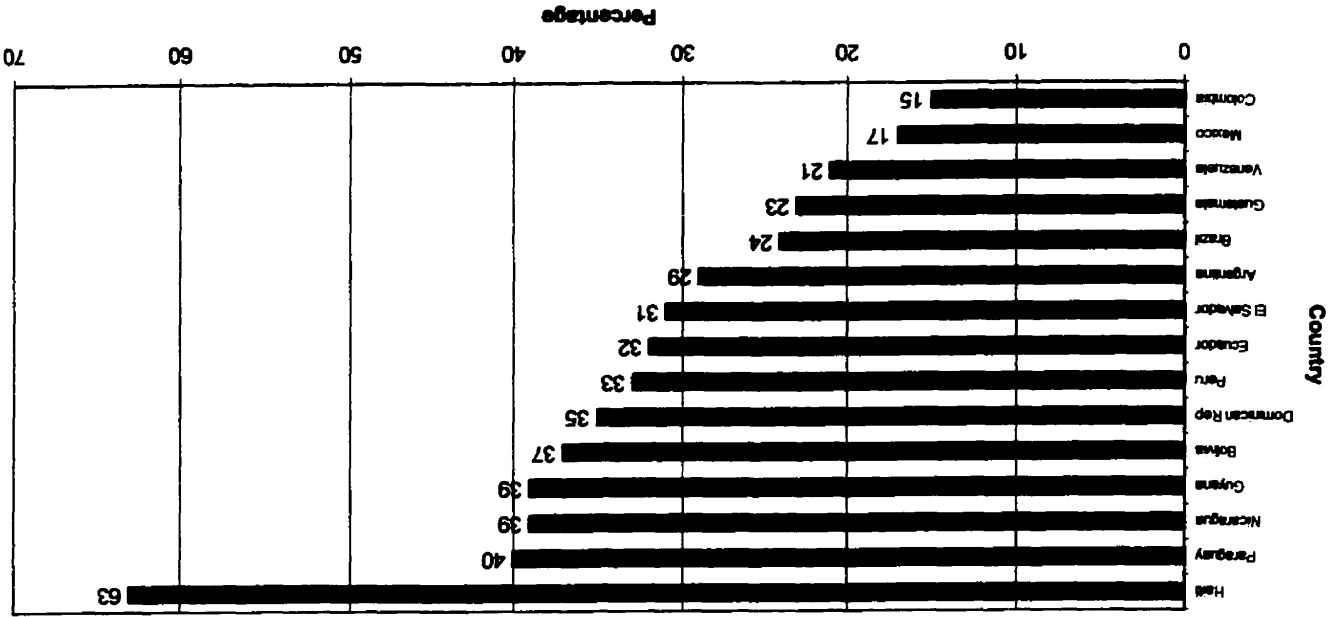


Latin America

Of the Latin American countries, Brazil, Mexico and Argentina represent the primary markets (Figure 4.2.6 and 4.2.7). There are several smaller population centres, however, where the population densities requiring assistance are large. The most significant of these are Haiti, Paraguay and Nicaragua.

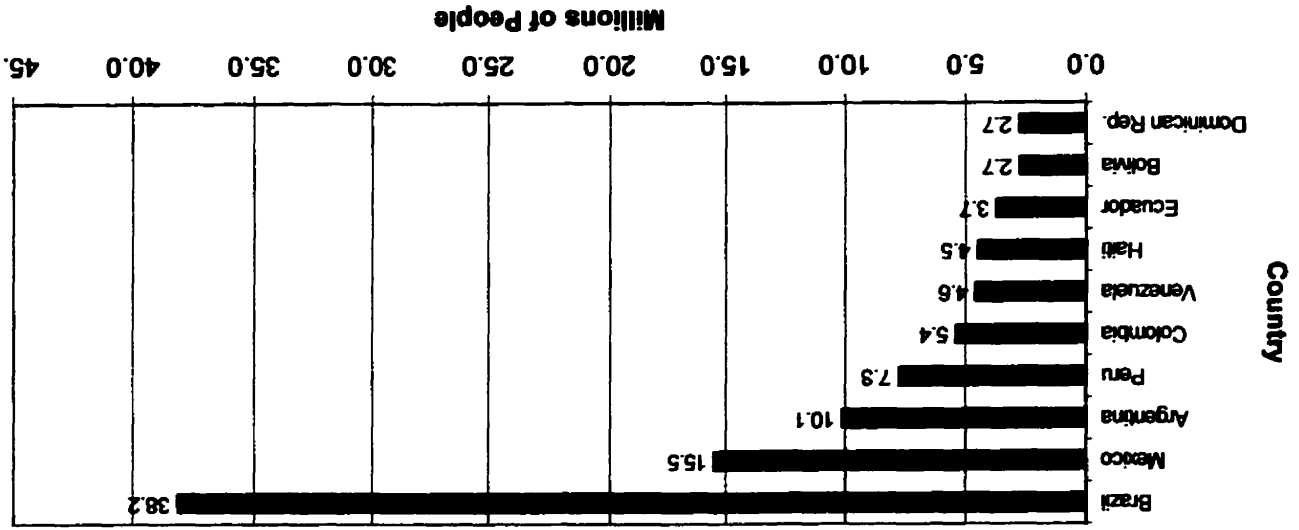
Figure 4.2.8
LATIN AMERICA & CARIBBEAN
Numbers of People Needing Clean Water





Source: UNDP Human Development Report 1998
 Percentage of Population with No Access to Clean Water

Figure 4.2.10



Source: United Nations Human Development Report 1998

LATIN AMERICA & CARIBBEAN
 TOP TEN COUNTRIES WITH PEOPLE LACKING ACCESS TO CLEAN WATER
 (1995)

Figure 4.2.9

Eastern Europe and The Arab States

In the Arab world, the people lacking access to clean water are located primarily in the region around the Eastern Mediterranean, in the countries of Morocco, Egypt, Algeria and Turkey. Turkey, not only has a large number of people, but also a large percentage of its population that needs clean water. Several of the states that formerly formed part of the Soviet Republic also have high percentages of their populations in need of clean water.

Figure 4.2.11

**EASTERN EUROPE & ARAB STATES
TOP TEN COUNTRIES WITH PEOPLE LACKING ACCESS TO CLEAN WATER (1996)**
Source: United Nations Human Development Report 1998

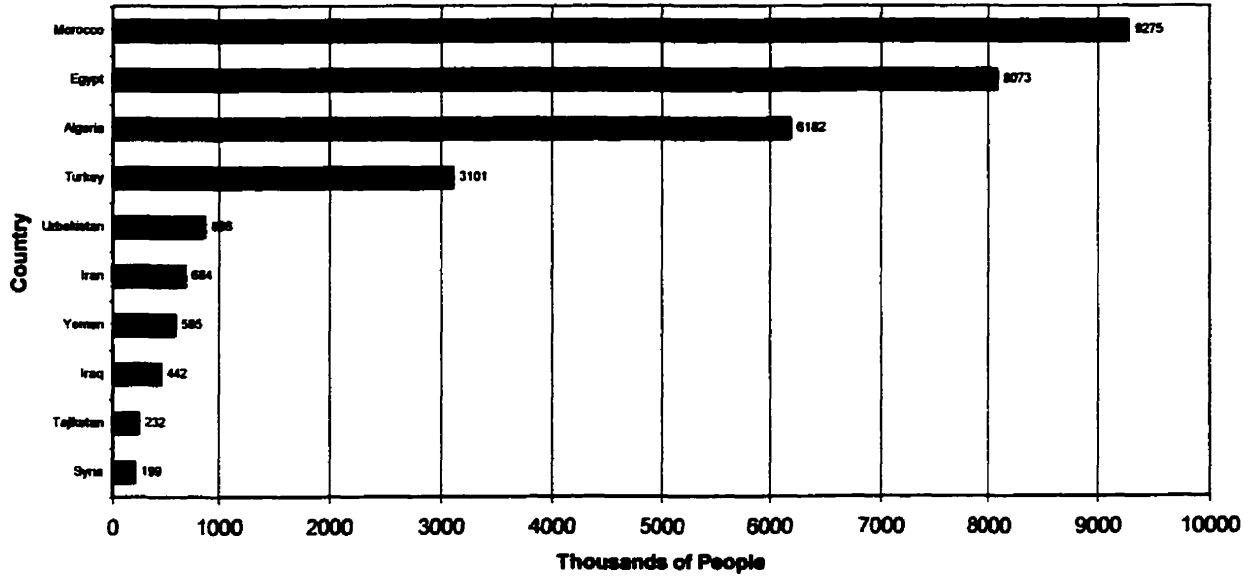
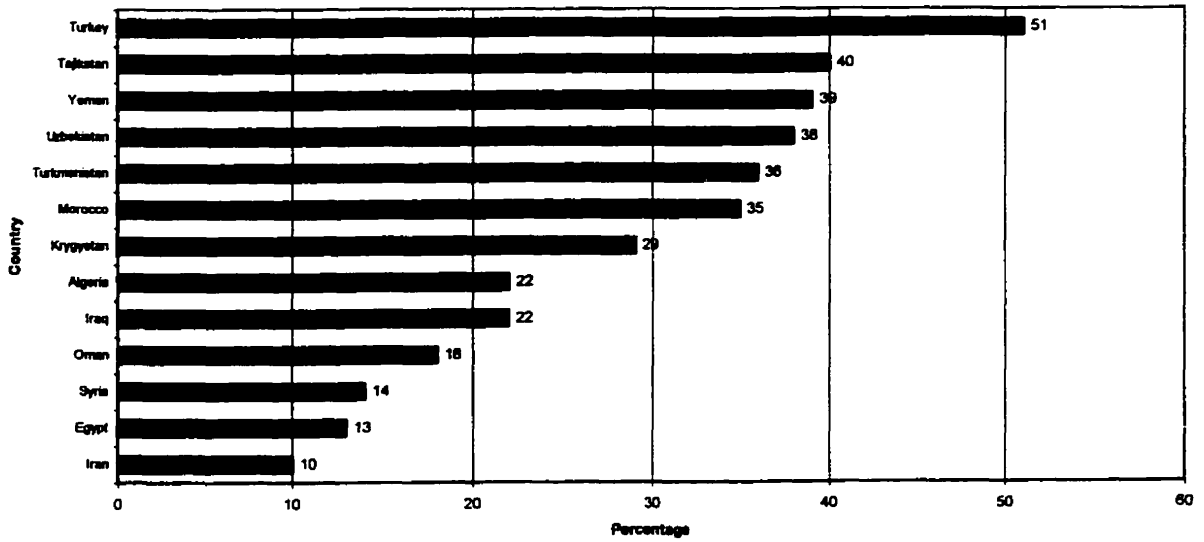


Figure 4.2.12

Percentage of Population with No Access to Clean Water: 1995
Source: UNDP Human Development Report 1998



Global Distribution

When viewed altogether, the countries can be categorised as shown in Table 4.2.1, Table 4.2.2 and Figures 4.2.13 and 4.2.14. The first two columns of Table 4.2.1 represent the top 18 countries of highest need with over 81% of the total estimated clean water requirements. As shown in Table 4.2.2 and Figure 4.2.15, almost all of these countries also have high population densities that require assistance. Consequently, further prioritization of countries will focus primarily on the total numbers of people, rather than on the percentages of country residents who need assistance.

Table 4.2.1
Global Distribution of People Lacking Access to Clean Water
Source: UNDP Human Development Report 1998

<u>Greater than 25 million</u>	<u>10 to 25 MM</u>	<u>5 to 10 MM</u>	<u>3 to 5 MM</u>	<u>1 to 3 MM</u>	<u>0.1 to 1MM</u>
China	Tanzania	Madagascar	Chad	Burundi	Saudi Arabia
India	Myanmar	Morocco	Niger	Sierra Leone	Cuba
Indonesia	Mexico	Japan	Venezuela	Laos	Lesotho
Nigeria	Sudan	Uzbekistan	Haiti	Bolivia	Bhutan
Ethiopia	Kenya	Egypt	Iraq	Dominican Rep.	Honduras
Viet Nam	Philippines	Nepal	Malaysia	Benin	Chile
Brazil	Uganda	Peru	S. Korea	Eritrea	Namibia
Pakistan	Argentina	Sri Lanka	Guinea	Cote d'Ivoire	Mauritania
Turkey		Angola	Ecuador	Guatemala	Gambia
Congo(Dem. Rep.)		Iran	Mali	Zimbabwe	Mongolia
		Cameroon	Bangladesh	Tajikistan	Guinea-Bissau
		Thailand	N.Korea	Burkina Faso	South Africa
		Mozambique	Papua N.Guinea	Cen.African Rep.	Oman
		Cambodia	Senegal	Syria	Swaziland
		Algeria		Moldova	Gabon
		Malawi		Paraguay	Jamaica
		Ghana		Togo	Guyana
		Zambia		El Salvador	Comoros
		Yemen		Congo	Cape Verde
		Colombia		Nicaragua	Panama
				Turkmenistan	Lebanon
				Kyrgyzstan	Tunisia
				Kazakhstan	Libya
					Uruguay
					Solomon Islands
					Costa Rica
					United Arab Emirates
					Jordan
					New Zealand
					Botswana

Figure 4.2.13
GLOBAL DISTRIBUTION OF PEOPLE WITHOUT ACCESS TO CLEAN WATER

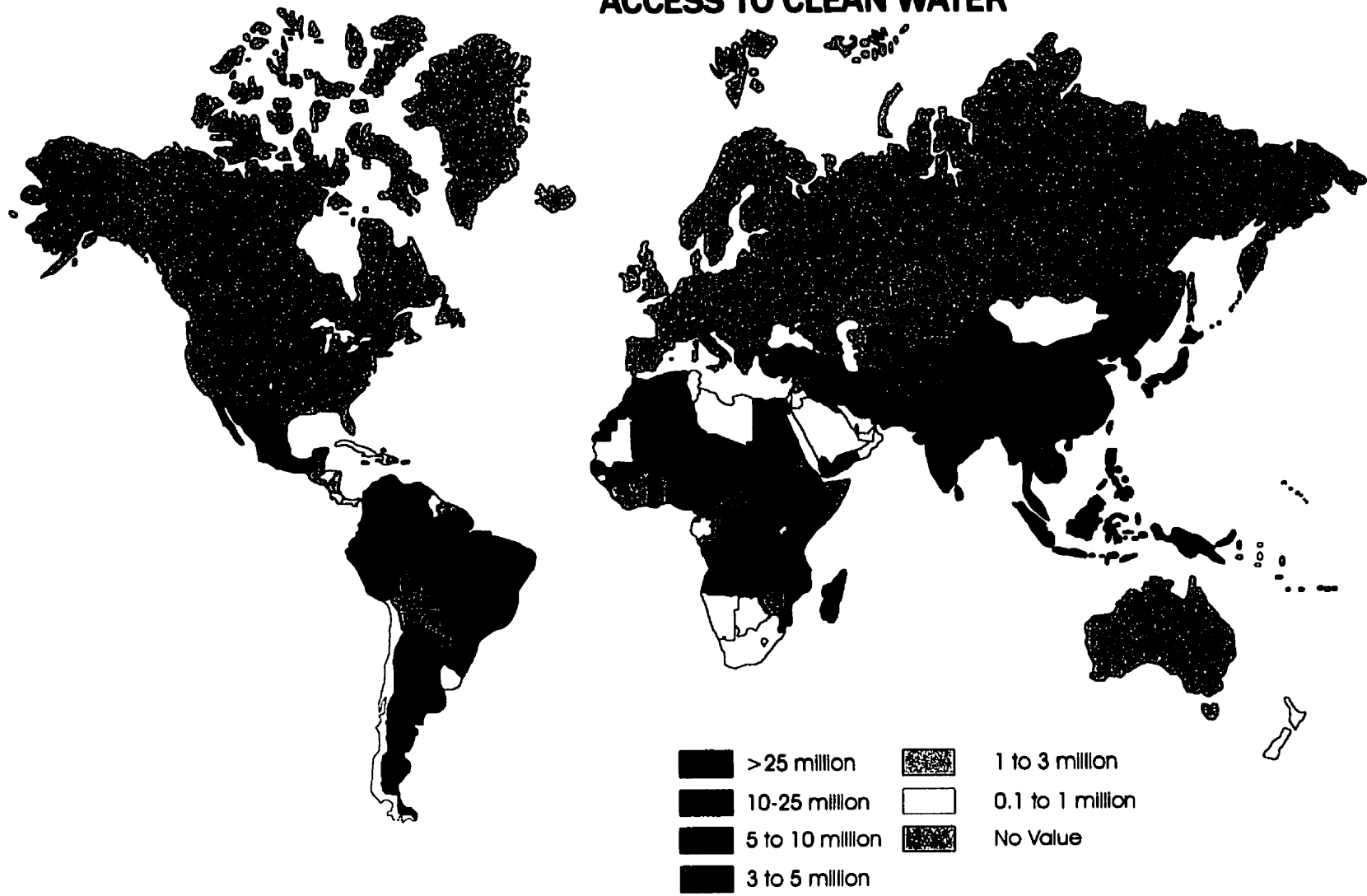
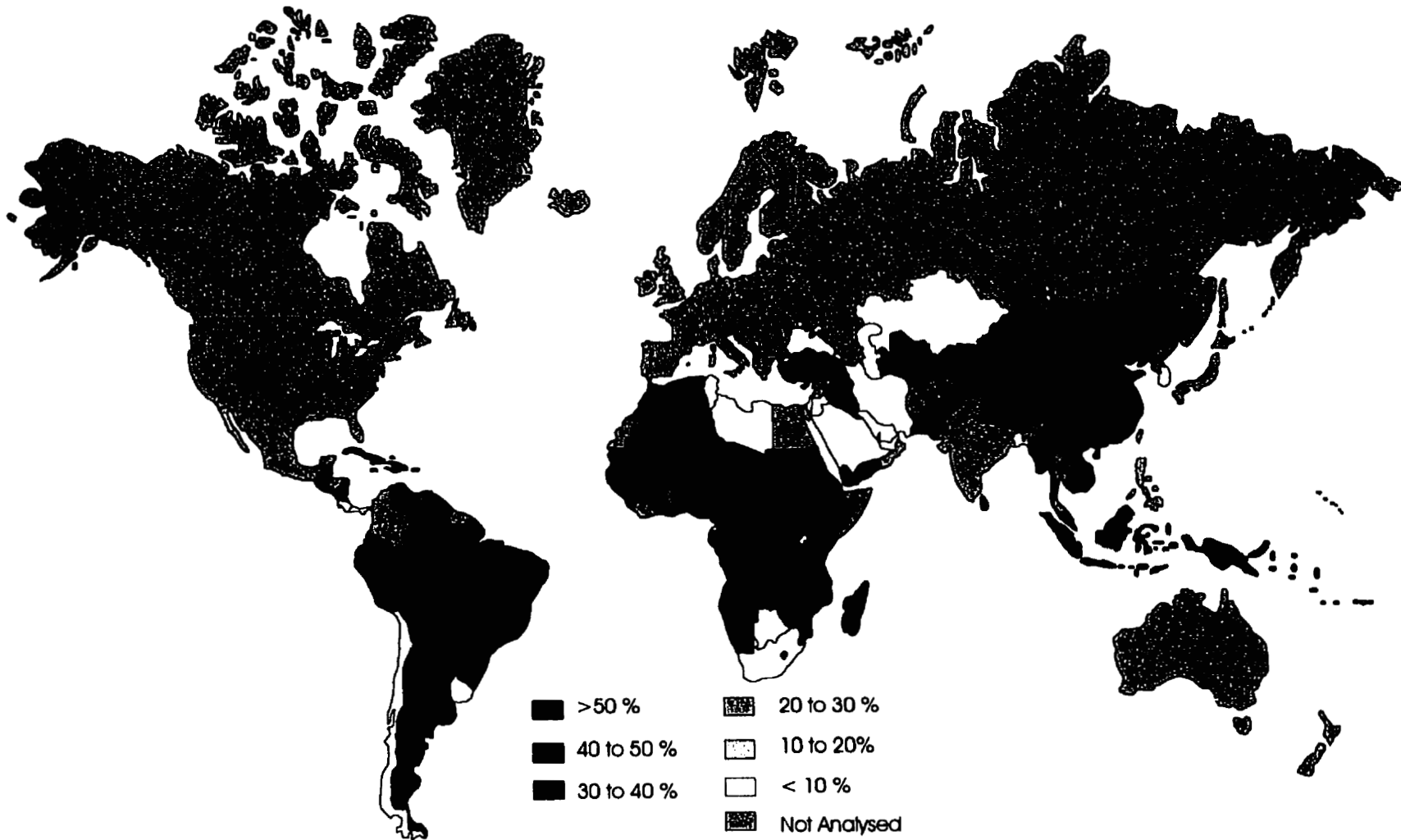


Table 4.2.2
Distribution of Countries with Percentage of Population Requiring Clean Water
Source: UNDP Human Development Report 1998

Country with > 10MM people Needing Clean Water					
<u>> 50 %</u>	<u>40 to 50%</u>	<u>30 to 40%</u>	<u>20 to 30%</u>	<u>10 to 20%</u>	<u>< 10%</u>
Eritrea	Cape Verde	SolomonIslands	Argentina	India	Botswana
Chad	Burundi	Guyana	Kyrgyzstan	Korea Dem	Cuba
Ethiopia	Comoros	Nicaragua	Mauritania	Cote d'Ivoire	Japan
Zambia	Kenya	Yemen	Pakistan	Oman	Kazakhstan
Pap NewGuinea	Moldova	Indonesia	Brazil	Sao Tome & Prin	Korea Rep.
Angola	Togo	Lesotho	Guatemala	Samoa	Panama
Congo	Sri Lanka	Uzbekistan	Algeria	Mexico	Lebanon
Madagascar	Namibia	Bolivia	Iraq	Philippines	Chile
Sierra Leone	Bhutan	Mozambique	Malaysia	Colombia	Equa Guinea
Cambodia	Guinea-Bissau	Nepal	Burkina Faso	Jamaica	Saudi Arabia
Haiti	Myanmar	Senegal	Zimbabwe	Syria	UnArabEmirates
Malawi	Paraguay	Turkmenistan	Venezuela	Honduras	Uruguay
Cen.African Rep.	Swaziland	Dominican Rep.	Mongolia	Vanuatu	Costa Rica
Tanzania	Tajikistan	Ghana		Egypt	Dominica
DemRepCongo		Morocco		Belize	Maldives
Viet Nam		Mali		Saint Vincent	Bangladesh
Laos		China		Thailand	Libya
Guinea		Peru		Djibouti	New Zealand
Uganda		Ecuador		Iran	Tdad & Tobago
Gambia		Gabon			Jordan
Niger		El Salvador			Mauritius
Turkey					Tunisia
Cameroon					South Africa
Benin					
Nigeria					
Sudan					

Figure 4.2.14
PERCENTAGE OF COUNTRY POPULATION
NEEDING CLEAN WATER



4.2.2 Rural Populations

As discussed in Section 3.6.1, the concrete filter technology is more suitable for rural populations than for urban settings, given the method of construction, the unsuitability for mass marketing techniques and the size and weight of the filter. The data presented in the previous section can therefore be further refined to illustrate the rural populations who need clean water, rather than just the total population.



Since no statistics on the rural populations lacking access to clean water could be found, an estimate of this distribution was made by multiplying the total country population without access to clean water by the percentage of rural residents in the country.

The resulting country distribution is shown in Table 4.2.3. The top five countries are still the same. The major difference in the top countries is Argentina. Brazil also moves from a ranking of 7 to 15, and Mexico moves from 13 to 28, all reflecting their high degree of urbanization.

Because of the similarity in the rankings of the countries when using either total population or estimated rural population who lack access to clean water, and because the rural population estimates are very rough estimates, the future analyses of the data use only the total population estimates.

Table 4.2.3
Global Distribution of Estimated Rural Populations Lacking Access to Clean Water
Source: UNDP Human Development Report 1998

Country with > 10MM people Needing Clean Water

<u>Greater than 25 million</u>	<u>10 to 25 MM</u>	<u>5 to 10 MM</u>	<u>3 to 5 MM</u>	<u>1 to 3 MM</u>	<u>0.1 to 1 MM</u>
China	Pakistan	Turkey	Philippines	Bangladesh	El Salvador
India	Congo	Uganda	Egypt	Iran	Moldova
Indonesia	Tanzania	Sudan	Morocco	Guinea	Syria
Ethiopia	Myanmar	Kenya	Mozambique	Algeria	Paraguay
Viet Nam		Brazil	Mexico	Burundi	Turkmenistan
Nigeria		Madagascar	Niger	Mali	Kyrgyzstan
		Nepal	Yemen	Papua N. Guinea	Congo
		Sri Lanka	Ghana	Peru	Bhutan
		Malawi	Chad	Lao s	Venezuela
		Thailand	Cameroon	Eritrea	Nicaragua
		Uzbekistan	Zambia	Malaysia	N.Korea
		Cambodia	Haiti	Burkina Faso	Lesotho
		Angola	Senegal	Japan	Kazakhstan
				Sierra Leone	Honduras
				Senegal	Namibia
				Benin	Gambia
				S. Korea	Guinea-Bissau
				Zimbabwe	Mauritania
				Tajikistan	Swaziland
				Ecuador	South Africa
				Guatemala	Guyana
				Colombia	Comoros
				Cote d'Ivoire	Mongolia
				Togo	Cuba
				Cen African Rep.	Gabon
				Argentina	Jamaica
				Iraq	Saudi Arabia
				Bolivia	Solomon Islands
				Dominican Rep.	Chile
					Oman

4.2.3 Availability of Surface Water

The BioSands technology is a water treatment technology. Consequently, it is most applicable where there are adequate supplies of fresh water, but where this water is contaminated; either on surface in the rivers and streams, in shallow underground aquifers or in the collection and distribution systems.



In countries where there is an extreme shortage of supply, like the drought prone countries of the Middle East and South Africa, more extreme solutions for water supply provision, such as desalination plants, are likely to be warranted. However, these treatment systems are extremely expensive, so that, even in these countries, use of the BioSands technology to treat the scarce surface water supplies may be applicable, even though these supplies are likely to be insufficient to meet the total need.

Nonetheless, Table 4.2 4 and Figure 4.2.15 categorise the developing countries previously listed, in accordance with the internal per capita renewable water resources of the country. These statistics, compiled by the UNDP, are broadly representative of the availability of surface water in the country.

The results indicate that of the ten countries with over 25 million people who lack access to clean water, The Democratic Republic of Congo has the most plentiful supplies of fresh water per capita, followed by Brazil, Indonesia, VietNam and Turkey. Because of their high population levels, China and India have approximately 2000m³ renewable water resources per person, as compared to Canada with 94,000m³ per person.

Of the top neediest countries, Kenya and Sudan are the two which may be considered for reduced focus because of the lack of surface water availability.

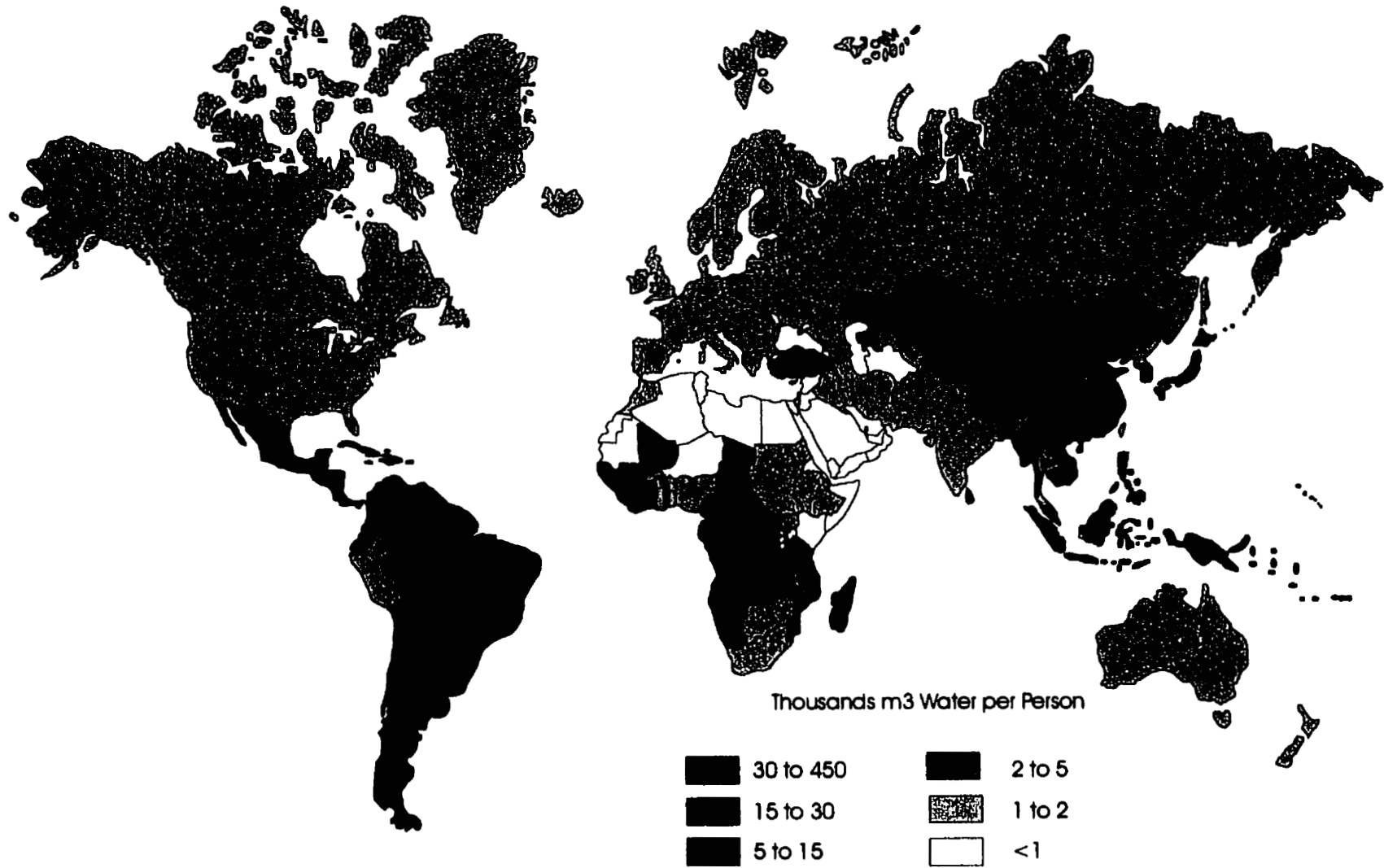
Table 4.2.4
Country Categorisation
Internal renewable Water Resources per Capita: 1998
Thousands m3/person

Country with > 10MM people Needing Clean Water

Source: UNDP Human Development Report 1998

<u>30 to 450</u>	<u>15 to 30</u>	<u>5 to 15</u>	<u>2 to 5</u>	<u>1 to 2</u>	<u>< 1</u>
Guyana	Guinea	Guinea-Bissau	Mali	India	Eritrea
Pap New Guinea	Colombia	Indonesia	Viet Nam	Botswana	Kenya
Gabon	Costa Rica	Bangladesh	Philippines	Thailand	Burundi
Solomon Islands	Ecuador	Kyrgyzstan	Japan	Uganda	Moldova
Congo	Myanmar	Guatemala	Namibia	Nigeria	Algeria
Equa Guinea	Malaysia	Tajikistan	Mexico	Ethiopia	Syria
Belize	Madagascar	Mongolia	Jamaica	Iran	Oman
Panama	Argentina	Zambia	El Salvador	Benin	Tunisia
Laos.	Congo	Honduras	Cuba	Malawi	Niger
Bhutan	Cameroon	Cambodia	Turkey	Pakistan	Yemen
Cen African Rep.	Uruguay	Nepal	Senegal	Iraq	Turkmenistan
Nicaragua	Paraguay	Kazakhstan	S.Korea	Peru	Mauritania
Bolivia	Angola	Mozambique	Swaziland	Ghana	Saudi Arabia
Venezuela		Cote d'Ivoire	Togo	Burkina Faso	Jordan
Sierra Leone			Gambia	Haiti	Libya
Fiji			Tanzania	N. Korea	Un Arab Emir
Chile			Dominican Rep.	Lebanon	
Brazil			Lesotho	Uzbekistan	
			Sri Lanka	Sudan	
			China	Zimbabwe	
			Chad	Morocco	
				South Africa	

Figure 4.2.15
DEVELOPING COUNTRIES
DISTRIBUTION OF RENEWABLE WATER RESOURCES



4.3.0 THE CAPABILITY

The capacity of indigenous NGOs within each country to implement the strategy envisioned and the willingness of the government to support their efforts are important considerations in the prioritization of Davnor's work. In sections 4.3.1. and 4.3.2. the available, applicable statistics on NGOs and governments are analysed to aid in the assessment of country priorities.

4.3.1 NGO Availability

Although it is obviously extremely difficult to determine individual NGO capabilities for such a wide study, an indication of the NGO density in each country may provide an indication of the ability of indigenous NGOs to carry out the implementation envisioned. However, there are several problems with the data on NGOs. Some estimates include only NGOs registered with the government, whereas others include more informal organizations. Table 4.3.1 summarises the data available on NGO density from Fisher (98). The data set presented is incomplete, but it represents a compilation of several data sources on NGOs which have been reviewed and refined by Fisher to enable a comparison across countries.

Table 4.3.1
Country NGO Density
Numbers of NGOs per million population
Source: Fisher 98

>100	50 to 100	25 to 50	15 to 25	10 to 15	5 to 10	<5
Tunisia	Costa Rica	UArabEmirates	Benin	Zambia	Senegal	Indonesia
Lebanon	Philippines	Syria	Togo	Uganda	Jamaica	Gabon
South Africa	Cape Verde	Mauritius	Haiti	Burkina Faso	Rwanda	Tanzania
Egypt	Gambia	Peru	Dom Republic	India	Oman	Cameroon
Jordan	Bolivia	Colombia	Congo	Grenada	Sierra Leone	Cote d'Ivoire
El Salvador	Nicaragua	Guinea-Bissau	Honduras	Panama	Niger	Thailand
Bahrain	Guatemala	Ghana	Yemen	Mali	Mexico	Mauritania
St. Vincent	Swaziland	Uruguay	Venezuela	Guinea	Nepal	Angola
San Tome and Principe	Lesotho	Sri Lanka	Kuwait	C.Africa Rep	Zaire	Burundi
St. Lucia	Belize	Ecuador	Kenya	Bangladesh	Morocco	Nigeria
Namibia	Chile	Argentina	Liberia	Zimbabwe	Saudi Arabia	Malawi
	Paraguay		T'dad & T'go	Sudan	Qatar	Mozambique
				Brazil		Ethiopia

The results indicate the difficulties one might encounter in providing concrete filter technology via local NGOs in the countries where it may be most applicable. Indonesia, Tanzania, Nigeria and Ethiopia, some of the countries most in need, have very low numbers of NGOs, while other countries with large NGO populations such as Tunisia, Lebanon and South Africa all have less than half a million people in need of clean water access.

The countries which show the greatest overlap between the populations who require clean water and the availability of NGOs are The Philippines, Argentina, Congo, Kenya and India. These countries may be able to benefit most from their NGOs.

4.3.2 Governmental Support

Estimating the level of support, which may be expected from individual country governments is a reasonably difficult task. However, two broad measures were considered to be adequate to allow a rough comparison of the various developing countries in this regard.

The first is a measure presented in the United Nations Human Development Report: the percentage of the national GDP devoted to expenditures on public health. This indicator is used to compare a country's willingness to invest in social expenditures of 'human priority'.

The results illustrated in Table 4.3.2 indicate the extent of the challenge facing Davnor. Not surprisingly the countries with the highest needs, China, India, Indonesia, Nigeria, VietNam and Pakistan are among those whose governments spend the least on public health. The major exceptions to this trend are Brazil, Turkey, Mexico, Argentina and Kenya.

Table 4.3.2
Public Expenditure on Health (as % of GDP)1996-98
Source:UNDP Human Development Report: June 2000
Country with > 10MM people Needing Clean Water

<u>>4 %</u>	<u>3 to 4%</u>	<u>2 to 3 %</u>	<u>1 to 2%</u>	<u><1 %</u>
Cuba	Namibia	Turkey	Mauritius	Pakistan
Costa Rica	Jordan	Eritrea	Cen. African Rep.	China
Tajikstan	Lesotho	Mexico	Egypt	Indonesia
Saudi Arabia	Turkmenistan	Cape Verde	Mauritania	Gabon
Panama	Brazil	Malawi	Uganda	India
Belarus	Uzbekistan	Krygystan	Thailand	Burundi
Samoa	Algeria	Honduras	Philippines	VietNam
Moldova	Bulgaria	Botswana	Iran	Myanmar
Guyana	South Africa	Paraguay	Sierra Leone	Nigeria
Solomon Islands	Bhutan	El Salvador	Dom. Rep	
	Armenia	Papua New Guinea	Ghana	
	Zimbabwe	Guinea	Bangladesh	
	Lebanon	Senegal	Benin	
	Tunisia	Ecuador	Ethiopia	
		Swaziland	Colombia	
		Chad	Guatemala	
		Jamaica	Sri Lanka	
		Zambia	Cote d'Ivoire	
		Kenya	Gambia	
		Peru	Malaysia	
		Kazakhstan	Morocco	
		Oman	Nepal	
		Rwanda	Haiti	
		Mozambique	Tanzania	
		Mali	Nigeria	
			Azerbaijan	
			Lao	
			Yemen	
			Congo, Dem. Rep.	
			Guinea	
			Burkina Faso	
			Bolivia	
			Madagascar	
			Togo	
			Guinea-Bissau	
			Venezuela	
			Cameroon	

The primary meaning of democracy is that all who are affected by a decision should have the right to participate in making that decision, either directly or through chosen representatives...to exclude the losing groups from participation in decision making clearly violates the primary meaning of democracy.

Arthur Lewis, Nobel Prize Winner
In UNDP Human Development
Report 2000

Another potential indicator of government support as well as the level of development of civil society within the country is the prevailing political regime. Fisher (98) suggests that democratic societies are unlikely to have extremely low NGO ratings; that 'some degree of civil society appears to be a necessary if not sufficient condition for democracy.' Furthermore, assessment of political risk is generally based on the premise that the more democratic the society is, the more accountable it is; and the more accountable it is, the less susceptible it is to sudden or explosive shocks.

'Democracy is the only form of political regime compatible with respecting all five categories of rights- economic, social, political, civil and cultural.'(UNDP 2000). Since 1972, Freedom House, a non partisan, non profit agency has published country ratings which compare the degree to which a country can be described as democratic. These ratings are based on the organization's analysis of the political rights and civil liberties available to the country's citizenry.

Using this comparison, which is summarised in Figure 4.3.1. the most democratic of the top ten neediest countries is India which is rated as a free country. This is followed by Brazil, Nigeria, Indonesia, Tanzania, Turkey and Ethiopia, which are all rated partially free and then by Pakistan, China, Congo and VietNam, rated as not free. VietNam is listed as the least democratic nation of the world.

Figure 4.3.1
Country Democracy Rating, 1999
Developing Countries
Source: Freedom House, 2000

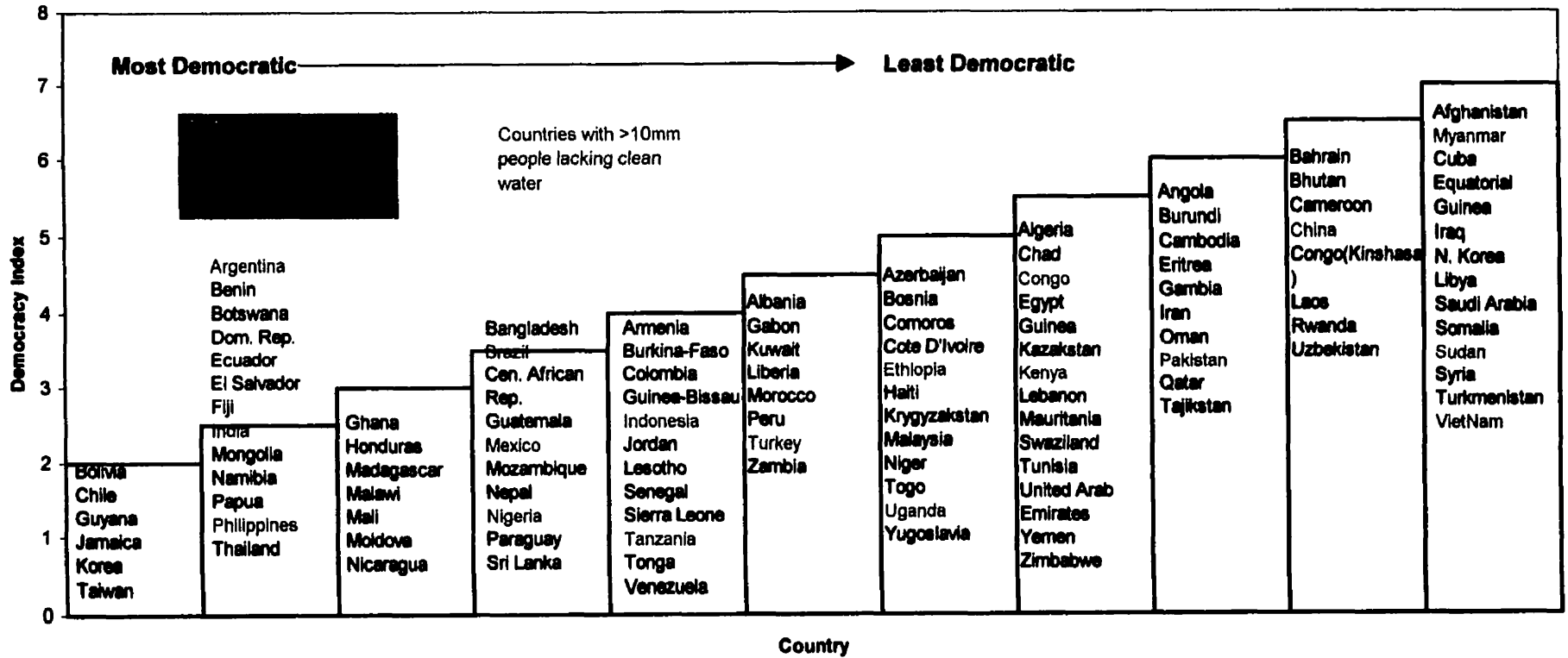
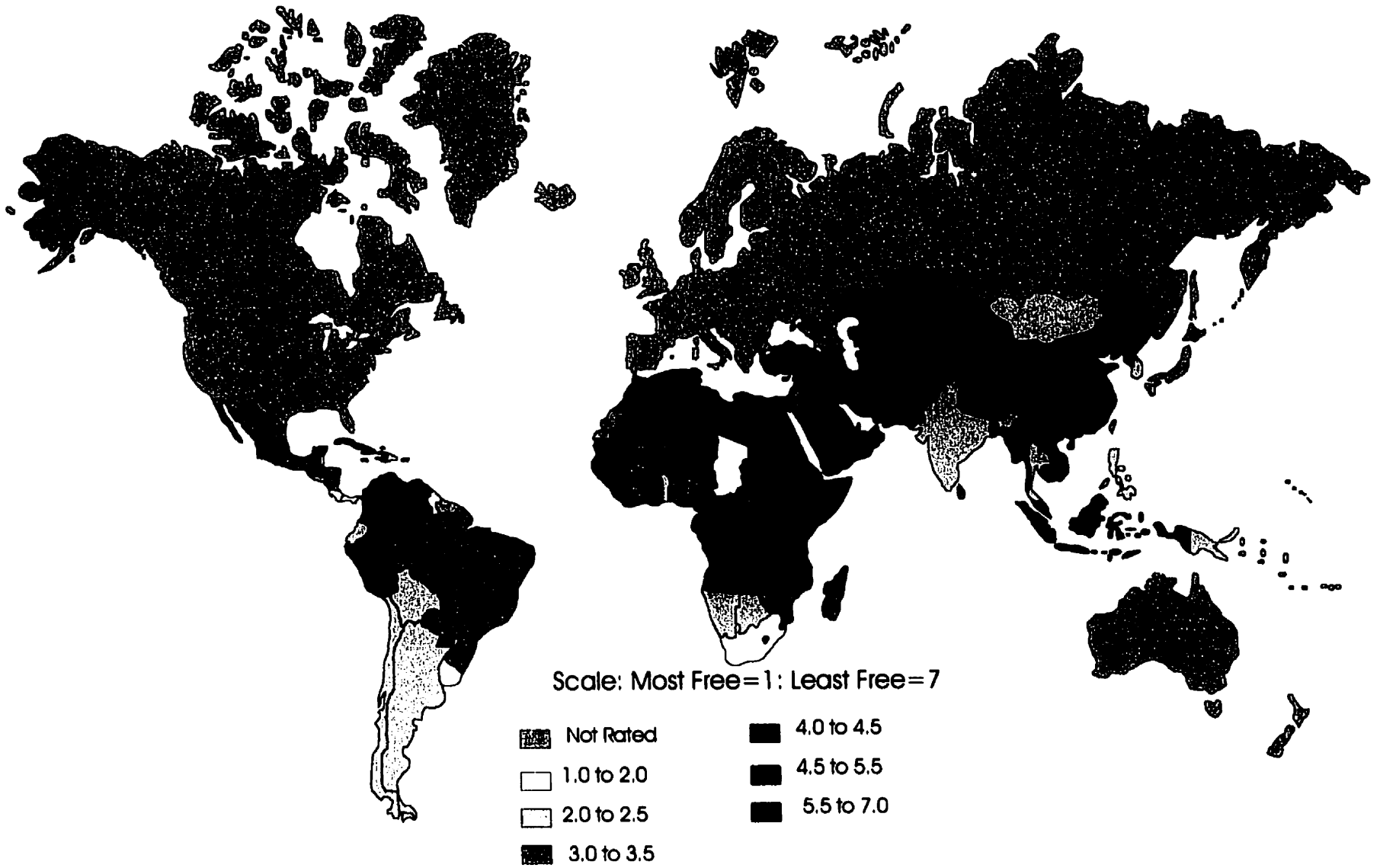


Figure 4.3.2
COUNTRY FREEDOM RATINGS



4.4.0 BUSINESS CLIMATE

The environment required for the effective and efficient conduct of a local business depends on several variables. These variables are generally categorised in three main areas- political, financial and economic.

Political Environment

For a business to plan and strategise effectively, a stable political environment is required. The PRS group, a professional organization that specializes in the analysis of country risks which are relevant to businesses and industry, and compares the political risks of various countries, identifies the components of a country's political environment as follows:

Government Stability	A measure of both the government's ability to carry out its declared programs and its ability to stay in office.
Socioeconomic Conditions	A measure of general public satisfaction or dissatisfaction with the government's economic policies
Investment Profile	A measure of the government's attitude to inward investment as determined by <ol style="list-style-type: none">1. Risk to operations2. Taxation3. Repatriation4. Labour Costs
Internal Conflict	Assessment of political violence in the country and its actual or potential impact on governance
External Conflict	Assessment of both the risk to the incumbent government and to inward investment
Corruption	A measure of corruption within the political system
Military in Politics	Military involvement in politics is a diminution of democratic accountability.
Religious Tensions	Religious tensions may stem from the domination of society and/or governance by a single religious group that seeks to replace civil law by religious law and to exclude other religions from the political and/ or

	social process.
Law and Order	An assessment of the strength and impartiality of the legal system as well as popular observance of the law.
Ethnic Tensions	Degree of tension attributable to racial, nationality, or language divisions.
Democratic Accountability	A measure of how responsive a government is to its people
Bureaucracy Quality	The institutional strength and quality of the bureaucracy is a shock absorber that tends to minimise revisions when governments change.

The results of the PRS assessments indicate that although China and VietNam are not rated very highly in terms of democratic process, as discussed in Section 4.3.2, the assessed political risks relevant to the formation of a local business, are among the lowest for the top ten neediest countries. In addition, as expected from the democracy analysis, Argentina, the Philippines, Mexico and Tanzania are all politically stable environments for a local business while Indonesia, Congo and Sudan present the maximum political threats to a business.

Financial Stability

The success of a business is also dependent on the financial stability of a country. This is the ability of the country to pay its way i.e. to finance its official, commercial and trade debt obligations. The components that PRS uses to assess the financial risk of a country generally include:

- Foreign Debt as a percentage of GDP
- Foreign Debt Service as a percentage of Exports of Goods and Services
- Current Account as a percentage of Goods and Services
- Net International Liquidity
- Exchange Rate Stability

Their analysis indicates that China is one of the most financially stable of the developing countries. India also represents a low risk in terms of financial stability. Nigeria, Indonesia, Turkey and Pakistan are generally able to pay their way and are considered moderate risks, while Brazil and Ethiopia are high risks with Congo and Tanzania viewed as very high risk countries in terms of financial stability.

Economic Potential

The success of the Davnor business will also be dependent on the ability of the business to grow. This growth potential is reflective of the economic strengths and weaknesses of the country. These, in turn, are generally measured by external indicators of potential such as:

- GDP Per Head
- Real GDP Growth
- Annual Inflation Rate
- Budget Balance as a percentage of GDP
- Current Account as a percentage of GDP

When analysed in this manner, China represents a developing country with very high economic potential, followed by some of the resource rich African countries, Tanzania, Nigeria and Ethiopia. India, Turkey and Pakistan and Viet Nam represent increasing degrees of economic risk, while Indonesia is assigned the highest economic risk of the ten neediest countries.

Overall Business Climate

A composite index, which weighs all three components-political, financial and economic has been used by PRS to determine, what they consider to be the overall business climate of a country. To calculate this index, the political stability was given a 50% rating, while both the financial and economic indices were each assigned a 25% rating.

The combined results presented in Table 4.4.1, indicate that China is not only in need of clean water, it also presents a good opportunity to build a local business. India and Turkey also possess moderately positive business environments. However, Davnor would need to exercise some caution in developing local businesses in Ethiopia, VietNam, Pakistan, Tanzania, Nigeria, Indonesia and Congo.

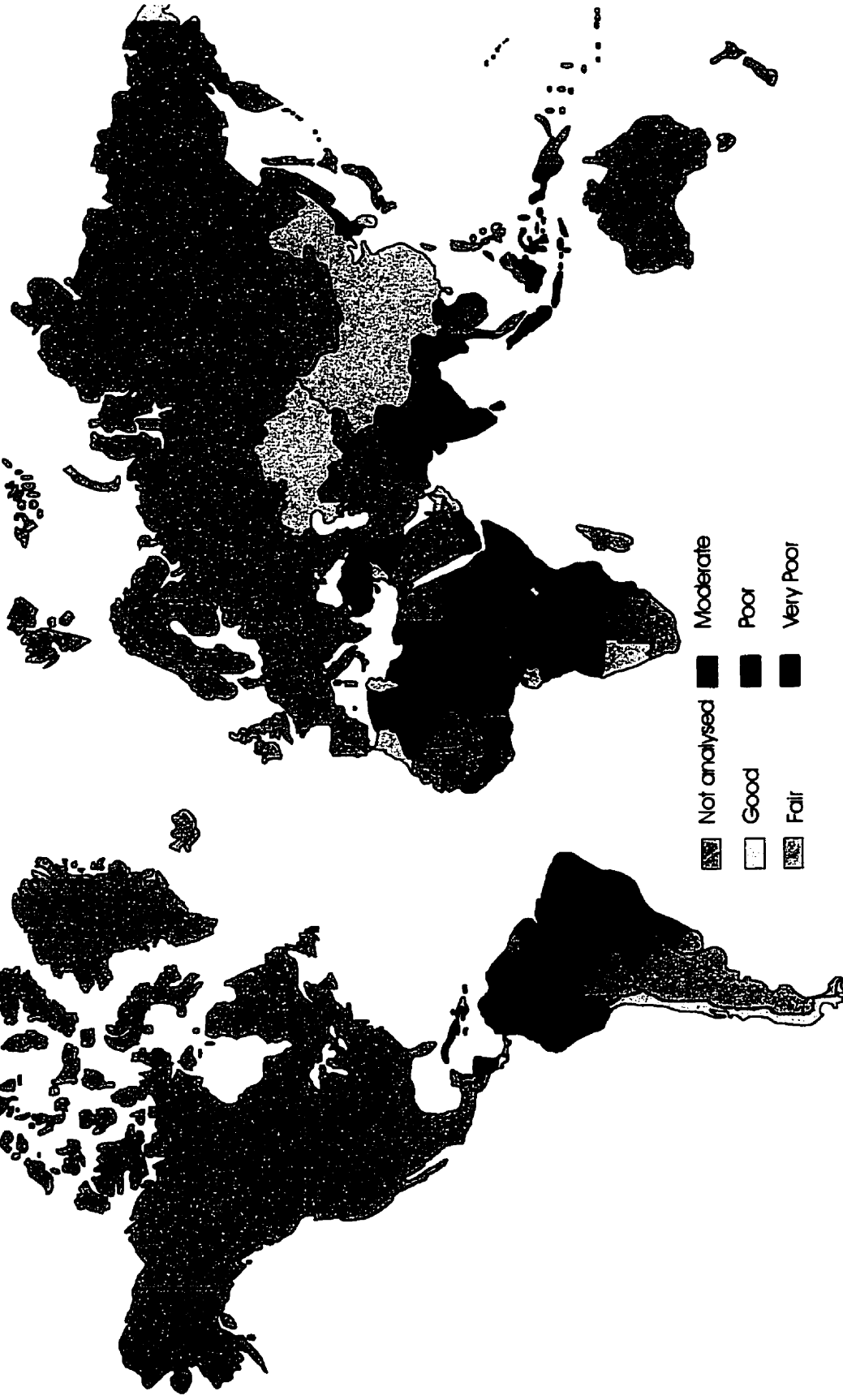
Table 4.4.1
Overall Business Climate Indicator
Source: The PRS Group 1999

Country with > 10MM people Needing Clean Water

Good Climate 70 to 80	Fair Climate 65 to 70	Moderate Climate 60 to 65	Poor Climate 50 to 60	Very Poor Climate 0 to 50
El Salvador	Argentina	Peru	Honduras	Zimbabwe
Namibia	Egypt	Guyana	Malawi	Nicaragua
Un Arab Emirates	Malaysia	India	Guinea	Sudan
Costa Rica	Philippines	Senegal	Niger	Liberia
Kazakhstan	Uruguay	Kenya	Paraguay	Iraq
Chile	Iran	Yemen	Ethiopia	Angola
Korea Rep. of	Guatemala	Pap New Guinea	Viet Nam	Congo
China	Saudi Arabia	Libya	Pakistan	Yugoslavia
Morocco	Bolivia	Cote d'Ivoire	Colombia	Korea Dem People's of
Oman	Thailand	Cameroon	Ecuador	Somalia
Panama	Madagascar	Bangladesh	Brazil	Sierra Leone
Dominican Rep	Jordan	Sri Lanka	Mozambique	
Bahrain	Mexico	Uganda	Tanzania U. Rep.	
Tunisia	South Africa	Ghana	Azerbaijan	
Gambia	Mongolia	Togo	Haiti	
Gabon	Mali	Venezuela	Nigeria	
Syria	Burkina Faso	Cuba	Zambia	
Jamaica		Turkey	Myanmar	
			Lebanon	
			Algeria	
			Indonesia	
			Moldova	
			Guinea-Bissau	
			Dem. Rep. Congo	

Figure 4.4.1

DEVELOPING COUNTRIES: BUSINESS CLIMATE



4.5.0 CONCLUSIONS

Of the countries with over ten million people requiring clean water, the primary target markets for the concrete filter technology are as follows:

Group I: China and India:

Not only do these countries far supersede any other countries in terms of need, they also represent reasonably stable environments in which to develop local business joint ventures. The availability of NGOs to implement the construction at the field level in China is unknown, but India is reputed to have several local NGOs to facilitate implementation.

Group II: Brazil, Turkey, Mexico, Kenya, Philippines and Argentina

In these countries, the need is high, the political climate is reasonably encouraging, the NGO densities are fair and there is a good chance of being able to form an effective local business.

Group III: Indonesia, Ethiopia, Nigeria, VietNam and Pakistan

Over 40 million people in each of these countries need clean water. However, the political and business climates are not as welcoming as the Group II countries and it may be very risky to initiate a local business joint venture.

Group IV : Congo, Tanzania, Myanmar and Sudan

These countries have smaller populations requiring assistance than the countries listed in Group III with similar or worse political and business risks.

There are several other countries with significant populations who need clean water where the appropriate business and political climate may be present. Principal among these are

- Madagascar
- Morocco
- Egypt
- Peru
- Iran
- Thailand

These countries also require serious consideration when formulating the overall strategic plan.

5.0 THE ACTION PLAN

The actions which need to be undertaken by Davnor to implement the recommended strategy in the key markets identified in the previous section are developed and discussed.

5.0 THE ACTION PLAN	152
5.1.0 Primary Strategy	153
5.1.1 Engender Stakeholder Commitment	153
5.1.2 Develop Appropriate Corporate Culture	154
5.1.3 Choose the Right Joint Venture Partner	157
5.1.4 Performance and Processes	161
5.1.5 Conclusions	162
5.2.0 Secondary Strategies	162
5.3.0 Conclusions	163

5.1.0 THE PRIMARY STRATEGY

The principal recommended strategy for the humanitarian distribution of the technology worldwide is through local businesses. These businesses, which form part of the overall commercial, international business development strategy, are being created to produce and market the commercial products, and should also be used as a vehicle for distribution of the humanitarian technology to indigenous NGOs worldwide.

What, therefore are the next steps which should be taken by the corporation to implement this strategy?

5.1.1 Engender Stakeholder Commitment

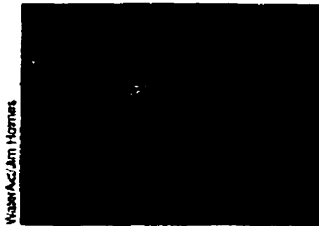
The first priority is to obtain corporate commitment for the recommended strategy from all the key stakeholders of the organization. These stakeholders include shareholders, members of the board and the executive staff.

To date, Davnor has publicly demonstrated its commitment to distribution of the concrete filter by

- Investing its own resources on the research and development of the concrete filter technology.
- Developing training programs and training manuals for NGOs who wish to use the technology.
- Providing the technology royalty free to appropriate organizations and agencies.

These efforts are the result of the dedication and vision of the technology developer, Dr David Manz. And this leadership is essential to the continued success of the humanitarian technology distribution. Judith Tendler (89) points out that, from her analysis, one of the major characteristics of successful poverty alleviation programs was that all the leaders were strong and driven individuals who, through class or previous work experience, had links to important political figures and powerful institutions in the public and private sector. All, moreover, had founded their organizations. It was the energy of the single founding leader that drove the successful expansion of the programs, and not just the force of a particular organizational model.

But although the world admired these strong and charismatic leaders, they perpetually worried about whether the organization could suffer their loss. Would the leaders learn to delegate? Could they build strength in their managerial staff? Consequently, as Davnor grows as



a corporation, it needs to engender the same commitment for the humanitarian effort in its key stakeholders, as it presently has from its leader. It needs to develop a clearly enunciated and public, corporate commitment to the provision of the concrete filter technology as an integral part of the overall business strategy.

The first priority is the board of directors. The Toronto and Montreal Stock Exchanges identified five key responsibilities to be included in the mandate of boards of publicly listed companies:

- Strategic planning for the organization
- Risk identification and management
- Management effectiveness and succession
- Communications with Stakeholders
- Internal Control and Management Information Systems

Given the potential impact of the technology on the lives of the poor, as leaders of the company, the board of directors must be convinced of their responsibility to allow its use by those who cannot afford to pay. Then, they need to put into place the safeguards that are required to mitigate the risks that this strategy imposes on the organization.

Because they are accountable for the implementation of the defined strategy, the corporate executive management must also be convinced of the viability of the proposed strategic plan.

5.1.2 Develop the Appropriate Corporate Culture



Kenya, 1998

The successful execution of the plan requires the creation of a unique corporate culture, one which attempts to balance three main dimensions:

- 1. Humanitarian and Commercial Objectives**
- 2. Localization and Globalization**
- 3. Technical Integrity and Universal Product Usage**

The importance of corporate culture in the achievement of the desired results in today's corporations is being increasingly recognized. There is growing acceptance that competitive advantages are increasingly changing from harder efficiency sources to 'softer' effectiveness sources. The argument as summarised by Redding and Baldwin in Hoecklin (95) runs as follows:

- *'In the early stages the winners are those who can get access to key resources (until anybody can).*
- *In the next stage, the winners are those who can master production efficiency (until anybody can).*
- *At this point the winners are those who can master market sensitivity (until anybody can).*
- *In the final stages, the winners are those who can offer a distinct and unique product or service that the customer*



Media Preparation
Rwanda, 2000

values (and-if this is based on, or delivered by virtue of, a distinct and unique corporate culture- then nobody else can).'

In this way a company's culture, meaning its unique capabilities to manage and create value from its people, attitudes, shared values and cooperative behaviour, becomes an increasingly important strategic weapon.

Davnor has that unique product which is of great value to the customer. Now it needs to create the culture that would allow delivery of the vision. This technology makes economically possible distributed water treatment on very small scales. It could revolutionise the water supply industry in the same way that cellular phones changed the telecommunications industry. Water supply does not benefit from the economies of scale, when compared to other industries such as electricity or telecommunications. And even in these industries, decentralization is the wave of the future.

Hoecklin (95) advises that organizations throughout the world must have three basic characteristics if they are to survive and prosper.

They need:

1. Cohesion among their members about common purpose.
2. Cooperation between various parts of the organization.
3. Some form of hierarchical order that is recognized as legitimate, acceptable, proper and preferably motivating.

Recognizing the increasing importance of new forms of 'glue' or cohesion in global operations, the appropriateness of the strategy recommended within this report will depend on the degree of commitment to building and reinforcing a common set of values, both at Davnor Canada and worldwide, and the extent to which these shared values actually exist.

In order to create the corporate culture, which would achieve Davnor's desired balance between the three main dimensions, Davnor needs to articulate its specific corporate values. This would mean implicitly stating the values that are undesirable. In this regard, O' Neill in Hoecklin (95) advises:

'If you reduce the tenets of a corporate culture to the lowest common denominator, then you have a vague philosophical statement which doesn't distinguish you from any other major corporation. They all say the same thing: 'our success depends on our people', 'customer satisfaction is our first priority.' So, in fact what is required is to create a bracket that will hold the tensions, which are operating in different directions, together.

Hoecklin (95) suggests that there are at least four strategies employed by internationally operating 'Western' organizations for managing cultural differences globally.

1. Building a strong corporate culture internationally e.g. Ikea
The steering, so to say, must be more ideological; related to some basic values. You have to have something in common and feel that you are valued, that you want to participate. Personally, I want to be a part of a company that stands for something.

Goran Carstedt
Head, North American Ops
Ikea

2. Developing a common technical or professional culture worldwide e.g Elf Aquitaine.

Technical knowledge, competence and skills are absolutely vital in our organization. They are the glue that holds our group together.

Jacques Casanova
Elf Aquitaine

3. Relying on strong financial or planning systems e.g. Emerson Electric.

Simply put, what makes us tick at Emerson is an effective management process. We believe that we can shape our future through careful planning and strong follow-up. The shared values of the organization across cultures are financial.

Charles F Knight
CEO, Emerson

4. Leaving each culture alone e.g. Buhrmann-Tetterode.

Entrepreneurship is the key to success. The operating companies are highly autonomous. We define only the parameters of the field on which the game is going to be played. From there on in, the companies do whatever they consider to be prudent, given the local market conditions. We have no strong prescriptions.

Robert van Oordt,
President & CEO
Buhrmann-Tetterode

It is very likely that the Davnor culture needs to involve a synthesis of all these strategies as well as some new and innovative thinking.

1. The continued delivery of the humanitarian services globally would require the development of a compelling, corporate ideological base.
2. The technology itself requires the formation of a strong technical culture to preserve its effectiveness and integrity. Technical input is required during the design phases of the varying treatment systems for different applications and water qualities. In addition, technical consumer support is needed to ensure that the systems are being used in the manner for which they were designed.
3. As Hoecklin (95) points out, each one of the strategies above, used individually, fails to create an organization that can utilise the best that is available from each culture and country globally. None strives to create synergies at the global, operational level and to use the cultural differences between countries strategically.

- The dangers involved in pursuing a strong singular

Hofstede's four dimensions of culture related values

- *Power distance is the extent to which a pecking order or hierarchy is seen as an irreducible fact of life.*
- *Uncertainty avoidance is the lack of tolerance for ambiguity and the need for formal rules.*
- *Individualism is a concern for yourself as an individual as opposed to concern for the priorities and rules of the group to which you belong.*
- *Masculinity refers to the extent of emphasis on work goals (earnings, advancement), as opposed to personal goals (friendly atmosphere, getting along) and nurturance.*

Hoecklin 95

culture across all national boundaries are considerable: a tendency for group think, a propensity to focus inward and an unquestioning acceptance of the 'status quo'.

- Building a strong technical, professional culture or planning systems as means of control both assume that technical or procedural mechanisms can overcome cultural differences globally.
- Leaving each culture alone, the strategy of creating joint venture corporations, which are completely independent, does not attempt to control or promote any particular culture, but neither does it derive any benefit from being global.

A critical test of a truly globally managed company might reside in its ability to generate specific and lasting competitive advantages across the local marketplaces and differing national cultures through the effective and practical coordination of a worldwide pool of critical resources.

And so, the Davnor culture required and the path forward is anything but clear. The pace of change and the new complexity of globally operating companies create the need for harmonizing seemingly opposing forces

- Thinking global..... Acting local
- Decentralization..... Centralization
- Planned..... Opportunistic
- Differentiation.....Integration
- Change.....Continuity
- Top-down..... Bottom up
- Delegation.....Control
- CompetitionPartnership

Evans and Doz (in Hoecklin 95) advises that such forces should be considered as complementary, so that an organization, instead of maximizing anything should seek to ensure that it maintains a minimum threshold of desirable attributes. The organization's growth, prosperity and survival depend on striking a dynamic balance between these complementary dualities.

'There is no one best way, not even the best way of finding the best way' (Hoecklin 95). The first step, though, is to articulate the desired outcome or vision.

5.1.3 Choose The Right Joint Venture Partner

The cornerstone of both the recommended humanitarian strategy and the commercial strategy is the creation of the right joint venture partnership.

Strategic alliances or joint ventures have increasingly become a critical component of global business. Initially these alliances were used principally to provide market access. But now, strategic joint ventures are used not only to increase markets, but to draw resources, either skills or products, into the company.

The high probability of failure in joint venture arrangements is now common knowledge. Numerous studies (in Morosini 97, Collins/Doorley 91 and Hoecklin 95) all indicate that the estimates of success in cross border alliances or joint ventures range from one third to one half.

The common causes of these joint venture failures have been attributed to: (Bain & Co, Buchanan & Berman in Hoecklin 95)

- Inadequate up-front planning on such issues as structure, ownership, control and exit options.
- Mismanaged expectations of the alliance partners, of the alliance itself and of the outside world.
- Lack of balance between the relative contributions to, and dependence on, the outcome of the alliance.
- Inadequate strategic rationale
- Conflict over markets/ products .

Morosini (97), however, proposes that all empirical evidence suggests that the real reasons leading to failure are not the technical issues outlined above, but rather the interrelationship problems during the implementation of international JVs and alliances.

But regardless of the potential pitfalls, corporations enter into global joint ventures because **they need to. Few firms have the human, financial and technical resources to 'go it alone' in every market and with every product.**

Perhaps the truly global company is still a generation away. Perhaps it cannot be originated in a country, which is so economically dominant as to encourage the arrogance of colonialists.

It is encouraging, however, that more and more organizations are appreciating the need, and there is increasing of the means by which international diversity can be positioned to provide competitive advantage.

Hoecklin 95

Studies done by management consultants McKinsey & Company and Bleeke and Ernst as reported in Hoecklin 95 and Morosini 97 provide several recommendations for successful alliances. Cross border joint ventures should:

- Be between companies of equal strength.
- Be in core business areas.
- Have minimal geographic overlap.
- Have equal ownership.
- Be flexible, able to resolve conflicts.
- Have strong, independent management.

With joint ventures between equally strong companies and furthermore, if the alliance is in each partner's core business, the importance placed on the venture's success and the ensuing pressure and involvement from each partner are likely to be significant.

Now of course many people say it is impossible. Can you have so many profit centres? Can you control all these national organizations? Don't you fight internally? Don't you get lots of duplication with all these companies trying to do the same thing? How can you achieve economies of scale? The art is not in the concept because if you could write down how to do all that in three pages, then anyone could do it. The thing lies in execution. Implementation. Actually doing it. Not getting stuck.

Barnevik, Asea Brown Boveri
In Morosini 97.

Ten Reasons for Global Partnerships

- *Build global market capabilities*
- *Cope with escalating technology and R&D costs*
- *Pre-empt competitive threats*
- *Speed innovation and product introduction.*
- *Cope with integration of technologies and markets*
- *Build world class capabilities*
- *Establish global standards*
- *Jump market barriers in emerging markets and regional trading blocs*
- *Cut exit costs*
- *Tap opportunities from the greening of global business.*

Cauley de la Sierra 94

Consistently, studies of acquisitions, mergers and alliances of all types have emphasized the need for extensive preparation, a relationship of trust between the parties and a long period of post alliance consolidation. 'It is a difficult business, at its most successful, when the two parties are alike, and showing progressively less chance as differences of all kinds widen.' (Hoecklin 95)

Cauley de la Sierra (94) advises that the first, critical step in forming a successful partnership is understanding why you need the partnership. Sorting out the whys in the equation will in turn dictate the answers to key questions such as with whom you want to collaborate, how the partners will combine their strengths and how the venture will be managed.

The three main criteria for choosing a successful partner have been summarised by Cauley de la Sierra as:

- **Compatibility:** No matter how elegant the strategic business concept behind a cooperative deal or how capable the participants, the partners have to be able to work together. '*At the end of the day, partnerships are determined by whether you can work with someone or not.*'
- **Capability:** The ability to contribute complementary strengths and resources to the partnership.
- **Commitment:** The willingness to commit the time, energy and resources to make the partnership a success.

His recommendations as to the critical questions to be answered before entering into a partnership are listed in Table 5.1.1.

Table 5.1.1
Choosing a Partner: Critical Questions
Source: Cauley de la Sierra; 1994

- What are you looking for- technology, market access, manufacturing capabilities, distribution channels?
- Can an existing relationship be extended?
- Have you examined a number of potential candidates?
- How will you go about determining compatibility? **Focus on compatibility, not similarity.**
- Is there any 'chemistry' between your senior and middle management?
- Are your corporate cultures compatible? Could you blend the two cultures? How?
- Does your partner have previous experience in collaborative ventures? How does its track record stand up?
- Are there conflicts of interest? Does your partner have any alliances with competitors? Can they affect you? How will you cope with that situation?
- Do you and your partner have complementary capabilities in technology, market access, manufacturing, distribution and so on?
- Have you thoroughly researched your partner's capabilities? Some companies have been burned when a partner's technology or market prowess proved considerably weaker than originally expected.
- How committed will each partner be to the venture? Does the partner appear willing to contribute the resources and skills that are necessary to make the alliance a success?
- Is the activity central to your businesses? If not, what are the chances that the venture will be relegated to the sidelines by one of you?
- Are you trying to forge too many alliances at the same time and consequently overlooking critical issues and problems that may disrupt the relationships? Is your emphasis on the quality not the quantity of alliances?
- How difficult will it be for your partner to withdraw from the venture?
- What benefits will the partner derive from the venture? Are they greater than yours? Can you keep them equal?
- What are the partner's direct costs?
- How much can you learn from your partners? How do you plan to transfer any new knowledge, technology and/ or skills from partners and the venture to the parent company?
- How much does the partner need the alliance to meet its tactical or strategic objectives?
- Is the venture in a business segment that the partner must have for growth or survival purposes?
- How willing and able will the partner be to devote additional resources- capital, human, technologies, time- to the venture?
- What are the alternative strategies available to your company and to the potential partners?
- What are the external and internal barriers to the partner's participation?
- What is the price of failure?

The obvious challenge is to find organizations that, not only have the same commitment to the humanitarian efforts as Davnor, but also have enough technical expertise and experience to understand the implications of this new and innovative technology. The appropriateness and effectiveness of the technology for water treatment in developing countries needs to be fully understood and appreciated by the joint venture partner. The newness of the technology and its lack of widespread use, even in the home North American market, means that **the local partner needs to understand the alternative technologies presently available, to fully appreciate what this new technology has to offer.**



The term joint venture covers a variety of business relationships. The difference between an equity joint venture, the type envisioned by Davnor, and others is in the extent of the power shared. Once the agreement is signed, management is handed over to an executive team, which must make the venture a success in its own right and ensure that the interests of the shareholders are fairly served. But inevitably, circumstances and objectives change. The chances of any one partner being fully satisfied diminish with time. 'Equity joint ventures are therefore inherently unstable and the anticipated benefits all too often turn out to be elusive' (Collins and Doorley 91). Companies contemplating partnerships need to consider how different partnership structures can satisfy their different partnership strategies and provide enough flexibility to change with time.

In summary, the success of the humanitarian technology distribution is dependent on the success of the local joint venture and the success of the joint venture is highly dependent on having the right partner, and the right partner is one which has the same humanitarian ideals and similar water treatment technical expertise as does Davnor. The challenge is making clear the rationale for the partnership, seeking and selecting potential partners, determining the most appropriate partnership structure, crafting a negotiating strategy and structuring the agreement.

5.1.4 Performance and Processes

The performance standards for the humanitarian division need to be clearly defined.

Firstly, the concrete product should be considered as one of the several Davnor product lines, and the performance expected from these products should be in keeping with the corporate standards. Consequently, processes to ensure appropriate quality control, maintaining adequate connections with the field implementing agencies and ensuring the quality and level of the training need to be

Grameen tries to build a problem solving attitude among its people.

- *Every problem has a simple solution. A problem and its solution are two sides of the same coin. They are always together.*
- *A problem is only half the truth. A problem and its solution make up the whole truth. Discover the whole truth.*
- *If you don't find the solution to the problem, it's because you don't understand the problem.*
- *If you can comprehend the problem properly you are half-way to the solution.*
- *The solution is born in the womb of the problem. Artificial solutions do not last long.*
- *A solution cannot be found away from the problem itself.*
- *You must immerse yourself totally into the problem before you can start touching the surface of the solution.*
- *As you go deep into the problem you come close to the solution. This is the sure route to the solution.*
- *Neither can I solve your problem, nor can you solve mine. If it appears that I have solved your problem, it was possible, only because I made your problem mine.*
- *Look for the solution where the problem is. It is intermeshed with the problem itself.*
- *Each problem may have many solutions, but there is one which is the best. Keep trying to get the best.*
- *A problem is a state of a particular configuration of events.*

Yunus 89

formulated and implemented.

Furthermore, appropriate accounting or other procedures are required to ensure that the division is adequately covering its costs or meeting the monetary requirements defined by the corporate management.

Conclusions

The next steps to be taken in order to implement the recommended primary strategy for the humanitarian distribution of the technology involve :

1. Actively seeking the commitment of the major stakeholders in the corporation- the board of directors, the shareholders and the senior management to inclusion of the humanitarian technology distribution as an integral part of the corporate business strategy.
2. Developing and explicitly stating the corporate values which would lead to the desired balance between:
 - Providing the technology to those most in need without jeopardizing the commercial profitability of the business.
 - Acting in accordance with local cultures while at the same time creating synergies at the global scale.
 - Ensuring technical integrity and filter effectiveness of products being used daily by individuals and families.
3. Proactively seeking out local companies to form joint venture partnerships. These companies, in addition to providing Davnor local market access, ideally should be able to offer Davnor strategic advantages or skills and should also be similar to Davnor, in terms of corporate values, commitment to the humanitarian effort and technical expertise.
4. Evaluating other, less permanent forms of strategic partnerships, besides formal equity joint ventures, as possible means of achieving the corporate objectives.
5. Focussing efforts on the major markets identified in the previous chapter, while being open to the opportunities that present themselves at the door.
6. Developing performance standards and procedures for the humanitarian division.

5.2.0 SECONDARY STRATEGIES

It is clear from the previous discussions that the principal plan of creating local joint ventures is, of necessity, a longer term strategy. In the shorter term, given the current status of the overall corporate maturity, the expansion of the more lucrative North American market represents the key to survival, and consequently a more immediate

focus for allocation of scarce corporate resources. Not only would the North American market expansion provide financial resources, it would also allow Davnor to develop the technical credibility and technology acceptance required for overseas market development in a familiar and less expensive arena.



WaterAid, Caracas, 1988

Consequently, the development of secondary, shorter term international strategies to supplement the main focus is required. One of the obvious actions is to continue the current practice of offering training in the concrete filter construction to those international NGOs, who wish to use the filter in their development work. This strategy has resulted in the technology spread to over thirty countries to date. The work of Samaritan's Purse and others has been impressive and should be continued and supported. So, although its application may be limited in terms of the numbers of people one can reach and the sustainability of the technology introduction, it is still a viable tactic. This avenue also provides Davnor Canada with direct international experience, training field implementers in the concrete filter technology, experience that is very valuable in the design of innovations and adaptations of present practices.



WaterAid, Lima, 1988

In addition to this action, Davnor should also take the opportunity to introduce the concrete filter, as part of its overall product line, to multi lateral and bilateral funding agencies such as the World Bank, the United Nations Development Program and the Canadian International Development Agency (CIDA). A recommendation by these agencies to organizations implementing water projects would, not only, accelerate the distribution of the technology, but it would do a great deal to establish its credibility and acceptance throughout the world, and this is the major challenge that Davnor faces at the present time.

5.3.0 CONCLUSIONS

In addition to the actions outlined in Section 5.1.4 required to pursue the long term strategy of the distribution of the humanitarian technology through the local businesses developed for commercial purposes, Davnor should also continue its training programs and assistance to International NGOs operating in developing countries. Furthermore it should promote the concrete filter technology in all its discussions with organizations such as the World Bank and the United Nations.



WaterAid, Caracas, 1988

REFERENCES

- Alfonso, Arelis with Borton, Nan and Castello, Carlos, The Association of Solidarity Groups of Colombia: Governance and Services, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994
- Bellamy, W.D., Hendricks, D.W. and Logsdon, G.S.. Slow Sand Filtration Influences of Selected Process Variables, American Water Works Association Journal, 77: 12: 62, 1985b).
- Bellamy, W.D., Silverman, G.P., Hendricks, D.W. and Logsdon. Removing Giardia Cysts with Slow Sand Filtration, , American Water Works Association Journal, 77: 2:52, 1985(a).
- Bernarde, M.A. and Johnson, B. Schistosome Cercariae Removal By Sand Filtration, American Waterworks Association Journal, 63:7:449
- Black, M., 1978-1998 Learning What Works.; A 20 year Retrospective View on International Water and Sanitation Cooperation- UNDP-World Bank Water and Sanitation Program, 1998
- Boomgard, James J., and Angell, Kenneth J., Bank Rakyat Indonesia's Unit Desa System: Achievements and Replicability, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994
- Boot, Marieke T., Just Stir Gently, The way to mix hygiene education with water supply and sanitation, Technical Paper Series No. 29, IRC International Water and Sanitation Centre, Netherlands, 1991
- Brikke, F. et al, Linking Technology Choice with Operation and Maintenance (for Low Cost Water Supply and Sanitation), IRC International Water and Sanitation Centre and World Health Organization, 1997
- Brock, T. and Madigan, M.T. Biology of Microorganisms, 6th edition, Prentice Hall, New Jersey. 91
- Brock, T.: Brock, K.; Ward, D. Basic Microbiology. Prentice-Jall: New Jersey, 1986.
- Buzunis, Byron. Intermittently Operated Slow Sand Filtration: A New Water Treatment Process, Master's Thesis, Department of Civil Engineering, University of Calgary, 1995
- Cairncross and Feachem. Environmental Health Engineering in the Tropics, 2nd edition, Wiley, Chichester.
- Cauley de la Sierra, M. Managing Global Alliances, Key Steps for Successful Collaboration. Addison- Wesley Publishing Company, 1994
- Carr, Marilyn, Institutional Aspects of Microenterprise Promotion, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Carvajal Jaime, Microenterprise as a Social Investment, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Chadha, G.K., Adoption of Improved Technology in India's Cottage Industries: Constraints and Impact, in ed. R. Islam, Transfer, Adoption and Diffusion of Technology for Small and Cottage Industries, International Labour Office, 1992

Chandavarkar, Anand, Informal Credit Markets in Support of Micro-business, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Chanlett, Emil T. Environmental Protection. McGraw-Hill: New York, 1973.

Charsombut, Pradit and Islam, Rizwanul, Adoption and Diffusion of New Technology in Cottage Industries of Rural Thailand: A Study of Basketry and Silk Industries, in ed. R. Islam, Transfer, Adoption and Diffusion of Technology for Small and Cottage Industries, International Labour Office, 1992

Chaves, Rodrigo and Gonzalez-Vega, Claudio, Principles of Regulation and Prudential Supervision and Their Relevance for Microenterprise Finance Organizations, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Christopher, J.L.; Murray, Alan D. The Global Burden of Disease. Harvard University Press., 1996

CIDA, Water: Global Needs for the 21st Century 99

Clark, John. The Relationship Between the State and the Voluntary Sector, <http://www.worldbank.org.html/extdr/hmp/hddflash/hcwp/hwrpo018.html> October 1993

Collignon, Bernard. The Potential and the Limits of Private Water Providers: Working Paper Series, UNDP-World Bank Water and Sanitation Program, Jan. 1999

Cosway, Nancy and Isaak Margaret. Ghana, Women and Water Supply- A Partnership, in ed., Pickford, Water and Sanitation for All- Partnerships and Innovations, WEDC, Loughborough University, 1998.

De Soto, Hernando. Structural Adjustment and the Informal Sector, in , ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

DeVilliers, Marq. Water Stoddart Publishing, 1999

DeWilde, Ton and Scheurs, Stintje with Richman, Arleen, Opening the Marketplace to Small Enterprise- Where Magic Ends and Development Begins, IT Publications, 1991

DFID, Department for International Development, Guidance Manual on water supply and sanitation programmes, WELL Water and Environmental Health at London and Loughborough, UK, 1998.

Droste, Ronald L., Theory and Practice of Water and Wastewater Treatment. John Wiley & sons Inc., 1997

Edgcomb, Elaine and Cawley James, The Process of Institutional Development, : Assisting Small Enterprise Institutions Become More Effective, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Fernando, Sunimal, Technology Transfer for Small and Cottage Industries: The Sri Lankan Experience, in ed. R. Islam, Transfer, Adoption and Diffusion of Technology for Small and Cottage Industries, International Labour Office, 1992

Ferroukhi & Chokkakula, Indigenous Knowledge of Water Management, Reaching the Unreached, Challenges for the 21s' Century, IT Publications, UK, 1997.

Fisher, Julie, Non Governments, NGOs and the Political Development of the Third World, Kumarian Press, 1998

Foster, Vivien. Considerations for Regulating Water Services While Reinforcing Social Interests, Working Paper Series, UNDP-World Bank Water and Sanitation Program, October 1998

Gadgil, A., Drinking Water in Developing Countries, Annual Review Energy, Environment, Vol.23 pp 253-286, 1998

Gamser, Matthew and Almond, Frank, The Role of Technology in Microenterprise Development, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Glosser, Amy J., The Creation of BancoSol in Bolivia, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Grenall, David and Rovere, Darin, Engaging Stakeholders and Business-NGO Partnerships in Developing Countries, The Centre for Innovation in Corporate Responsibility, 1999

Harper, Malcolm and Finnegan, Gerry, Value for Money? Impact of Small Enterprise Development, IT Publications, 1998

Harper, Malcolm, Training and Technical Assistance for Microenterprises, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Hendricks, Bellamy et al, 91

Holt, Sharon, The Village Bank Methodology: Performance and Prospects, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Hoy, Paula, Players and Issues in International Aid, Kumarian Press, 1998

Islam, Rizwanul, Transfer, Dissemination and Adoption of Technology for Small and Cottage Industries: An Overview, in ed. R. Islam, Transfer, Adoption and Diffusion of Technology for Small and Cottage Industries, International Labour Office, 1992

Jackelen, Henry L., Banking on the Informal Sector, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Kaiser, Nate & Chang, David. Report on the Lai Yen Water Filter Project and Sustainability Analysis. Samaritan's Purse. 1998

Kathuria, Sanjay, Transfer of Small Scale Industrial Technology from India to Africa and other Less Developed Regions- Experience and Potential, in ed. R. Islam, Transfer, Adoption and Diffusion of Technology for Small and Cottage Industries, International Labour Office, 1992

Kiarasarn, Arun, Transfer of Small and Cottage Industry Technology from Thailand: Potentials and Experiences-, in ed. R. Islam, Transfer, Adoption and Diffusion of Technology for Small and Cottage Industries, International Labour Office, 1992

Koenig, Bonnie. The Management of international non-governmental organizations in the 1990s, Transnational Associations, 2/1996, 66-72

Korten, David, C., When Corporations Rule the World, Kumarian Press, 1995

Kwadzokpo, Kwan. Community Management in ed., Pickford, Water and Sanitation for All- Partnerships and Innovations, WEDC, Loughborough University, 1998.

Liang, Kaida, Agua de Saude, A Report on the BioSand Water Filter Project in the Amazon Basin, Samaritan's Purse 1998

Manz, D.H. and Buzunis, B.J. Nicaragua Community Scale Household Filter Project, University of Calgary, Department of Civil Engineering, University of Calgary, Canada. 1995

Martinussen, John, Society, State & Market- A guide to Competing Theories of Development. Zed Books, London & New Jersey, 1997

Masun, Muhammad, Transfer of Technology to Small and Cottage Industries, The Bangladesh Experience, in ed. R. Islam, Transfer, Adoption and Diffusion of Technology for Small and Cottage Industries, International Labour Office, 1992

Merle, Marcel. A legal tangle: the Status of non-governmental international organizations between international laws and national laws, Transnational Associations, 5/1995, p266-272

Meyer, Richrad L., Financial Services for Microenterprises: Programmess or Markets?, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Miller, Boiling drinking water: a critical look, Waterlines, Vol 5, No 1, IT Publications, UK, 1986

Mukhopadhyay, Swapna, Adoption of New Technology in the Cottage Industries of Low Income Countries: A Framework, in ed. R. Islam, Transfer, Adoption and Diffusion of Technology for Small and Cottage Industries, International Labour Office, 1992

Mutua, Albert Kimanthi, The Juhudi Credit Scheme: From a traditional Integrated Method to a Financial Systems Approach, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994.

Narayan, D, Participatory Evaluation: Tools for managing Change, World Bank Technical Paper No 207, World Bank, Washington,DC

National Centre for Infectious Diseases, <http://www.cdc.gov/health/disease.htm>

Okelo, Mary E., Support for Women in Microenterprises in Africa, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Okuni, P. and Rockhold, P. An Approach for community based sustainability, Sustainability of Water and Sanitation Systems, ed. by John Pickford et al, IT Publications, UK, 1996.

Otero, Maria, Benefits, Costs, and Sustainability of Microenterprise Programmes, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Otero, Maria, The Evolution of Non Governmental Organizations Toward Financial Intermediation. , in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Ott, Richard, Creating Demand- Powerful Tips and Tactics for Marketing your Product or Service, Irwin Inc., USA, 1992

Panayotou, T., Bridges to Sustainability; The Role of the Private Sector in Sustainable Infrastructure Development, UNDP-World Bank W&S Projects, 1998

Pickford, J., The Worth of Water, Technical Briefs on Health, Water & Sanitation, IT Publications, UK, 1991

Reed, Larry R., and Befus, David R., Transformation Lending: Helping Microenterprises Become Small Businesses, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Rhyne, Elisabeth and Otero, Maria, Financial Services for Microenterprises: Principles and Institutions, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Rhyne, Elisabeth, A New View of Finance Program Evaluation, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Rice, A.E. and Ritchie, C. Relationships between international non governmental organizations and the United Nations, July 1995, ECOSOC, Department of Public Information

Richards, Patricia L., Communicating the Cause: Applying Social Psychological Theories of Information Processing to the Development of Social Marketing Communications, A Masters Project, Communications Studies, University of Calgary, April 1996.

Rifkin, Jeremy. The End of Work- The Decline of the Global Force and the Dawn of the Post-Market Era, Putnam, New York, 1996

Robinson, Marguerite, Savings Mobilization and Microenterprise Finance: The Indonesian Experience, in ed., Otero and Rhyne, The New World of Microenterprise Finance, Kumarian Press, 1994

Sansom, K., Water Engineers and Community Management, Reaching the Unreached, Challenges for the 21st Century, IT Publications, UK, 1997.

Schuler, P.F. and Ghosh, M.M. Slow Sand Filtration of Cysts and Other Particulates, Proceedings of The American Water Works Association Annual Conference, Water Quality for the New Decade, Philadelphia, PA, June23-27.1991

Schulz, Christopher and Okun, Daniel. Surface Water Treatment for Communities in Developing Countries. John Wiley & Sons. 1984

Scott, G.R. Short History of Filter Construction and Operation, American Water Works Journal, August,1955

Seibel, Hans Dieter, Linking Informal and Formal Financial Institutions in Africa and Asia, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Shaw, R., ed., Running Water, More Technical Briefs on Health, Water & Sanitation, IT Publications, 1999

Singh, V.P. and Chaudhuri, M., A Performance Evaluation and Modification of the UNICEF upward-flow water filter, Waterlines, Vol.12, No 2, IT Publications, UK, 1993

Smillie, Ian, The Alms Bazaar- Altruism Under Fire- Non Profit Organizations and International Development, IT Publications, 1995

Smout and Parry-Jones, Lessons Learned form NGO Experiences in the W & S sector, WEDC, Loughborough University, UK, 1999

Snell, S., Water and Sanitation Services for the Urban Poor: Small Scale Providers: Typology and profiles; UNDP-World Bank W &S Program, 1998

Snell, Suzanne. Water and Sanitation Services for the Urban Poor, Working Paper Series, UNDP-World Bank Water and Sanitation Program, Dec.1998

Tendler, Judith, What happened to Poverty Alleviation, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989

Thurow, Lester C., Building Wealth- The New Rules for Individuals, Companies, and Knowledge-Based Economy, Harper Collins, USA, 1999

Timberg, Thomas A., Comparative Experience with Microenterprise Projects, ed. J. Levitsky, Microenterprises in Developing Countries, Intermediate Technology Publications, UK, 1989