

# **Derivation and Testing of the Water Poverty Index Phase 1.**

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## **Final Report May 2002**

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### **Volume 1- Overview**

**Dr C. A Sullivan, Dr J.R Meigh & Mr T.S Fediw**



**Centre for  
Ecology & Hydrology**

NATURAL ENVIRONMENT RESEARCH COUNCIL



**Derivation and Testing of the Water Poverty  
Index Phase 1.  
Final Report May 2002**

**Contract Number:** C24

**Project Manager:** Dr Caroline Sullivan

CEH Wallingford  
Maclean Building,  
Wallingford,  
Oxon.  
OX10 8BB  
Tel: 01491 692457  
Email: [csu@ceh.ac.uk](mailto:csu@ceh.ac.uk)

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## Project Team

This project has been managed by the Centre for Ecology and Hydrology (CEH), Wallingford, UK, on behalf of the UK Department for International Development, under contract number IUDDC24. The views here do not necessarily represent those of DFID. The project participants are:

### Core Group

Dr Caroline Sullivan	CEH Wallingford ( <b>Project Manager</b> )
Dr Jeremy Meigh	CEH Wallingford
Dr Mike Acreman	CEH Wallingford
Ms Anna-Maria Giacomello	CEH Wallingford
Mr Tim Fediw	CEH Wallingford
Ms. Emma Tate	CEH Wallingford
Dr Christel Prudhomme	CEH Wallingford
Mr Dermot O'Regan	CEH Wallingford
Mr Roger Calow	British Geological Survey
Mr Jude Cobbing	British Geological Survey
Mr Jeff Davies	British Geological Survey
Professor Mike Clark	GeoData Institute, Southampton
Dr Craig Hutton	GeoData Institute, Southampton
Ms IlseSteyl	GeoData Institute, Southampton
Dr Tony Allan	School of Oriental and African Studies University of London
Mr Alan Hall	HR Wallingford Ltd
Dr Caroline Hunt	London School of Hygiene and Tropical Medicine, UK
Dr Jackie King	Southern Waters Ecological Research and Consultancy
Dr Peter Lawrence	Keele University, Department of Economics
Dr Siyan Malomo	Commonwealth Science Council
Mr Steven Mlote	Commission for Science and Technology (Costech)Tanzania
Dr Madar Samad	International Water Management Institute, Sri Lanka
Professor Roland Schulze	School of Bioresources, Engineering & Environmental Hydrology, University of Natal, South Africa
Dr Barbara van Koppen	International Water Management Institute, Sri Lanka

### External Advisory Committee

Dr Sandy Cairncross	London School of Hygiene and Tropical Medicine, UK
Dr Bill Cosgrove	Ecoconsult, Canada
Dr Peter Gleick	Pacific Institute, USA
Dr Athar Hussain	Asia Research Centre, London School of Economics
Ms Sue Milner	Independent Consultant, UK
Dr Jerome Priscoli	Institute for Water Resources, US Army Corps of Engineers
Mr Ian Smout	Loughborough University

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1. Director General, Commission of Science and Technology, Tanzania
2. University of Dar es Salaam, Tanzania
3. Regional Water Engineer, Arusha, Tanzania
4. Arumeru District Water Engineer, Arusha, Tanzania
5. Arusha Urban Water Supply & Sewerage Authority, Tanzania
6. Arusha Urban Water Supply & Sewerage Authority/ Pangani Basin Authority, Tanzania
7. Open University, Milton Keynes, UK
8. Centre for Ecology and Hydrology, Wallingford, UK
9. Dept. of Economics, University of Warwick, UK
10. School of Bioengineering and Natural Resources, University of Natal, South Africa
11. National Water Supply & Drainage Board, Sri Lanka
12. Director (Economic Infrastructure), National Planning Dept, Sri Lanka
13. Dept of Water Affairs and Forestry, South Africa
14. Water Research Commission, South Africa.



## Summary

The project *'The Development and Testing of a Water Poverty Index'* has been designed to identify and evaluate a tool for assessing poverty in relation to water resource availability. The Water Poverty Index is an interdisciplinary management tool, which integrates outputs from both the physical and social sciences, within a structured framework. It takes existing monitoring programmes further by explicitly linking socio-economic indicators of poverty drivers with water resource assessments, enabling the identification of those communities where poverty may be closely tied to water stress. As a result, the links between poverty, social deprivation, health, environmental integrity and water availability become more explicit, enabling policy makers to identify appropriate mechanisms to deal with the causes of these problems.

A number of different approaches have been considered, with a view to producing an evaluation tool relating water resources to the demands placed upon them. By linking this work to that which gave rise to the development of the Human Development Index, it is anticipated that the WPI will sit neatly within the suite of policy tools available for both water management and poverty alleviation.

In the long run, the development and implementation of the WPI will promote:

1. community empowerment, through provision of better information on local water availability and demand,
2. potential for self-calculation of water stress by communities,
3. integrated datasets and a transparent methodology on which water development projects can be prioritised,
4. a comprehensive capacity building programme to enable calculation of the WPI by individual communities and countries,
5. more explicit identification of the natural capital entitlements of communities, and
6. linkages between cross-sectoral themes such as education, sustainability, ecological water demand, etc.

During this phase of the project, a number of approaches to calculating the Water Poverty Index have been developed. Following a wide process of consultation, it was concluded that a composite index approach is preferred. Using data generated through household surveys and from other sources, a testbed dataset has been created for twelve sites in three pilot countries<sup>1</sup>, and this has served as a means by which we have been able to test and compare the methods at the local level. For application at the national level, we have used data from publicly available datasets, and from this, we have been able to generate WPI scores for 141 countries.

In order to facilitate a wide level of participation in the design of the WPI tool, we have consulted with a range of water professionals at all levels. We have also tried to ensure that this approach promotes some sense of 'ownership' of the tool in the participating countries.

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<sup>1</sup> Tanzania, Sri Lanka and South Africa

On completion of the testing of the methods and the generation of the WPI scores, we have presented the information to representatives of the relevant authorities, through workshops held in each of the three pilot countries. We have also produced and tested training materials designed for the purpose of putting in place the appropriate capacity building that may be needed if the WPI were to be implemented. Samples of these materials are provided with this report.

The results of this phase of the WPI development process are encouraging. We have found that the WPI scores generated at the study sites were in keeping with what is known about those sites by local water managers. In each case, local water officials agreed that the generated values accurately reflected real differences between the various sites. In all locations, local and national water professionals stated that the WPI would be of use in improving management decisions, and in each country, government departments have clearly stated that they would like to see work on the WPI taken further in their countries.

The work done to calculate national level WPI scores has also been productive, and the WPI framework provides a means by which standardised assessments can be made in different countries. While such coarse evaluations at a country level can sometimes be of little use at the local level, they are of use to national policy makers, and to national and international donor organisations. Material on the WPI is to be included in the forthcoming United Nations World Water Development Report, and this is testimony to the fact that the tool is of interest to those seeking to promote more informed and equitable water management practices.

Representatives of countries not included in the pilot testing process have also expressed interest in using the WPI tool to improve water management. In addition, various research groups working on climate change and water security have expressed interest in using the WPI in their work. Amongst those consulted, there was a widely held view that the achievement of the type of integrated monitoring incorporated in the WPI will improve decisions in the water sector. There still remains, nevertheless, more work to do. It is certain that improvements can be made in the methodology, and the data on which it is based, but we do believe that many of these improvements will be achieved in the second phase of the project, when refinements in both methods and data can be made. In the longer term, such refinements will mean that the use of the WPI will enable us to explicitly take account of inequities in both the costs and benefits of water use, and of the need to maintain ecosystem integrity as a way of securing future livelihood opportunities.

## **1. Introduction**

This report attempts to summarise the very comprehensive work which has been carried out to develop and test the Water Poverty Index. This has involved a large team from some 20 local, national and international institutions working together over a 12 month period. The findings reflect the work of this team, and the ideas represent a consensus of opinion on what the Water Poverty Index is, and what it can do. The methodologies developed aim to be relatively simple to calculate and easy to use and explain. The vast majority of the many stakeholders consulted during this development process have been very enthusiastic about the work, and its relevance to their water management problems. The format of this report is as follows:

1. The WPI Phase 1 Final Report - Volume 1, Overview.
2. The WPI Phase 1 Final Report - Technical Appendices.
3. The WPI Phase 1 Final Report - Documentation.
4. The WPI Phase 2 Outline proposal document

In this Volume 1, Overview, an outline of the work and what has been achieved is described. Preliminary WPI values for the study sites are provided, as well as national level application of the WPI to 140 countries worldwide. Detailed technical information is attached in the appendices, and the reader is directed towards these where necessary. Suggestions are provided of how achievements reached so far can be extended, and what steps can be taken to promote the uptake of the tool.

Dissemination conducted widely so far has been successful, and a future workshop to promote information about the WPI methodology will be carried out on June 26<sup>th</sup> 2002, at the Commonwealth Secretariat, London. The audience for this workshop will represent a wide range of countries where the need to address both poverty and water issues is most pressing. Dissemination of the WPI concept will continue in the future, with presentations of the work planned to take place at the UNESCO/International Hydrological Programme's HELP conference in August, 2002, and the Climate Change Workshop being held in Colorado, also in August 2002.

While a significant start has been made on the work to develop and test the WPI, there is little doubt that there is much left to do. What we have achieved here is a demonstration of the possibility of applying a holistic decision-making framework to water management options. This reveals a richer reflection of the factors which influence the water sector than has been available before, but it must be regarded as a first step in the long process needed to influence the lifestyle choices and behaviour of individual people and institutions.

This report begins with an explanation of the theoretical background on which the work is based, followed by an outline of the methodologies that have been developed. An explanation of how and why data has been collected is provided, followed by various types of data analysis, testing the methodologies, both at a micro (community) and macro (national) scale. An account is provided of the consultation process which has been embodied throughout the life of the WPI project, and examples of materials used for capacity building for the WPI are included as hard copies. The project activities and outputs are evaluated, and recommendations for further development are made. A comprehensive Appendix to the report is provided, and must be taken as being an essential part of this Final Technical Report.

The progress achieved during the first phase of the Development and Testing of the Water Poverty Index has been good, since not only have methodologies now been developed, but they also have been tested in real field-conditions, and with real country-level data. A comprehensive range of water professionals from both municipal and national level offices have participated in WPI workshops in each of the pilot countries, and in each case government organisations have confirmed in writing that they would be keen to see the WPI developed further in their countries. There still remains much work to be done to refine the tool and its application, but it has already generated such interest that it seems likely that it has great potential for wide uptake. As an annex to this report, an outline proposal is provided to give some idea of what direction future work may take.

## 2. WPI theoretical background

The purpose of the project to develop and test a Water Poverty Index (WPI) is ‘*to develop an evaluation tool for assessing poverty in relation to water resource availability*’. In keeping with this objective, the project needs to be embedded in an appropriate theoretical framework. With respect to a theoretical understanding of poverty, the approach put forward by Townsend (1979) Sen (1981, 1983, 1995) and extended by Desai (1995) is adopted, and as such, poverty is defined as *capability deprivation*. Building on the basic needs approach first outlined by Pigou (1920), Sen has shown that poverty is the result of a lack of at least one of the basic skills and conditions that characterise a society, and as such, is a relative concept. The occurrence of poverty therefore not only depends on the conditions of life on which a person depends, but on the existence of a combination of circumstances or ‘functioning’ which gives rise to capabilities on which an individual can build. (See also Appendix 9.5.1 and 9.16).

These ideas have more recently been developed and Desai (1995) has attempted to show that such capability deprivation can be more clearly defined, and to some extent, can be quantified. As Desai puts it, ‘*as far as the measurement of poverty is concerned, we are interested in guaranteeing that people have certain capabilities i.e. they have the resources required to function in any of the several alternative ways possible*’ (Desai, 1995 P198). To some extent at least, this reduces the need to consider socio-cultural factors which may influence what activities people actually engage in, and leaves us free to consider what are the factors which enable people to have an equitable access to viable livelihood choices.

To maintain effective livelihood choices, five basic capabilities have been identified by Desai (1995, P193):

- Capability to stay alive/enjoy prolonged life
- Capability to ensure biological reproduction
- Capability for healthy living
- Capability for social interaction
- Capability to have knowledge and freedom of expression and thought.

Having access to adequate water supplies for domestic and productive use can clearly be linked to most of these capabilities. Not only are the first 3 addressed directly through better water management, but also the last 2 are incorporated within any participatory management structure that provides empowerment for communities to understand their own resource management problems. The conceptual structure of the WPI itself tries to incorporate some dimension of each of these livelihood capabilities, providing a holistic perspective on how poverty may be alleviated through more efficient and equitable water management.

When considering the economic development process, and how a tool such as the Water Poverty Index can contribute to this, we need to consider how development itself should be evaluated. It is no longer acceptable to think in terms of changes in per capita values of GDP, as it is now recognised that the development process impacts in various ways upon a place and a society, and attempts to assess all of these impacts must be made. In the conceptualisation process through which the WPI has been derived, attempts have been made to capture these dimensions through

incorporation of the concepts of capital types as outlined in the sustainable livelihoods framework (Scoones, 1998 Carney, 1998).

## 2.1: The Sustainable Livelihoods Framework

This approach provides a framework for analysis in which livelihoods provide the central core. The generation of livelihoods, and thus the alleviation of poverty, are analysed in terms of *capital entitlements*. These capital entitlements have been identified as:

- Natural capital
- Physical capital
- Financial capital
- Human capital
- Social capital.

In one sense, these capital entitlements can be equated to the factors of production, and these equally have to be combined to generate livelihood support. For development to take place that provides opportunities for continued welfare growth, these capital types must be utilised without bringing about their irreversible depletion. Different combinations can produce similar outcomes, and a certain amount of capital substitution is possible, but to ensure a sustainable future, the constraints of earthsystem capacity must be respected.

Impoverished communities are by definition short of some or all of the livelihood capital types. Their local environmental, human and social capital have not been mobilised to create adequate physical (manufactured) and financial capital. As development occurs over time, there will be inevitable changes in the extent and availability of these livelihood capitals, and such changes can be illustrated as shown in Figure 1. To address any kind of poverty, access to these capital types must be redistributed to ensure that a more equitable outcome for all.

**Figure 1 How livelihood capital entitlements can change**

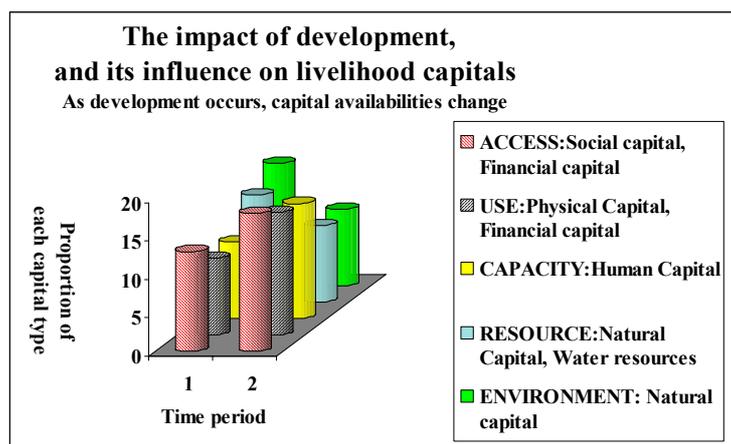


Figure 1 shows how the development process (shown as a shift from time period 1 to 2), can result in changes in the availability of different capital types. Developing tools to quantify these capitals will facilitate a better understanding, not only of the extent of developmental impacts, but also their distribution. Since the WPI has been

designed to incorporate these concepts, it will be able to contribute to this improved understanding.

By taking this more holistic approach to the evaluation of development progress, we are better able to appreciate the wider dimensions of developmental impacts, and as a result, promote a more equitable distribution of both its benefits, and its costs. In this way, it becomes much more likely that all sectors of society, including the poor, will benefit from the development process (Sen, 1999). In the past, this has not always been the case, and there are many examples where development has favoured the rich and powerful groups in society, at the expense of the poor. It is hoped that the development of the WPI will contribute to this process by providing more equitable outcomes from water sector developments.

## **2.2: Indicators as policy tools**

Indicators provide the means of measuring some aspect of performance or achievement. They have become important policy tools, providing guidance on issues which are difficult to represent or assess in other ways. They have also become important politically, by providing the opportunity for people to evaluate the effectiveness of resource allocation decisions. While there is some debate on their role in influencing government policy, indicators do offer a relative measure of achievement which can serve to direct policy towards the improvement of performance.

An indicator is usually constructed by combining information from a range of available data, with the resulting measure facilitating a comparison of performance relative to previous time periods, or to the performance of others. Some of the better known indices which are regularly used for government policy include the consumer price index and the index of industrial output, both of which measure some economic change over time. The Human Development Index and the Human Poverty Index are also composite indices which evaluate the performance of countries relative to each other, and over time.

Indices by their nature are not without problems. As time passes, the relative importance of various components can change, external factors can come into force and political priorities may change, but nevertheless, the use of indices as policy tools has become widespread. An example of this is provided by the Human Development Index, which has been created in response to dissatisfaction which has arisen with the use of per capita measures of Gross Domestic Product (GDP) as a measure of development, since this captures nothing about the quality of that development, or the distribution of its impacts. The HDI gives a measure of social and economic progress which is built from an average of three separate indicators: life expectancy at birth, educational attainment and GDP per capita at purchasing power parity (PPP) values. The individual indices which make up the HDI are also published, so that it is possible to see what is driving any changes which are taking place. Publishing the component parts of such an index can show where progress needs to be prioritised.

There is little doubt that the creation of the HDI has led to a re-evaluation of the development process, and to a change in the way donor organisations operate. Nevertheless, the HDI has been criticised because it lumps together in one index quite different elements with no common measure. A second criticism of the HDI is that most of its components are highly correlated with each other, thus reducing the

usefulness of the separate sub-indices. A third criticism is that human development cannot be encapsulated in a single number and that a range of indicators, or the sub-components, should be presented separately. In this project to develop a Water Poverty Index, attempts have been made to overcome some of these problems by carefully selecting sub-components, and by devising ways of presenting the results of the index values in such a way as to ensure the component values are clearly identified. More information on previous work on indicators can be found in Appendix 9.5.2.

Another aspect of social capital development which could be strengthened by the WPI is the contribution it can make to the evolution of more effective natural resource accounts (Proops, 93, Repetto et al., 1989). This is an essential element in the achievement of real sustainable development, as it is only when the full environmental cost of our behaviour is understood, can we hope to manage it effectively. If the WPI were to be implemented, the datasets which would be developed would also be of use to the offices of national statistics in the creation of more effective water accounts. For more information on the relationship between research into natural resource accounts and the WPI, see Simon, 2002, Appendix 9.15).

### **2.3: Political and institutional issues**

In the past, water problems have often been dealt with by providing engineering solutions, and to a large extent, this has been productive. Today however, with increasing public empowerment, devolution of responsibilities in the water sector, and an increasing awareness of ecological issues, such solutions are no longer adequate to address most water management problems.

Water shortages do not determine the levels of poverty or prosperity enjoyed by a community. However, communities that endure poverty will in almost all circumstances face problems in accessing sufficient safe water, both for domestic purposes, and for the generation of secure livelihoods. In analysing the reasons for water problems, it is important to recognise that water scarcity can be considered in two ways. *First order scarcity* is the shortage of water itself, while *Second order scarcity* is that resulting from lack of social adaptive capacity (Allan, 2002, see Appendix 9.2). The poor lack social adaptive capacity, and this suggests that this aspect of development in the water sector is most pertinent to poverty alleviation. It is now widely recognised that institutional issues are a crucial component of any water issue, and political will is a key factor in the success or failure of any attempt to address water problems. Some attempt has been made to incorporate this into the structure of the WPI, but once again, this is a preliminary attempt and there is much work to determine how institutional issues can be incorporated most effectively. In the next phase of the project it is proposed that the variables used to represent this issue be extended to capture it more effectively. This may include some measure of financial commitment to water development used as a proxy measure for political will.

Approximately half the land area of the world, and perhaps 70 percent of inhabitable land area, is in an international watershed, where river flows or lakes are shared (Wolf et al. 1999). Conflicts over water use have been increasing in recent years, and though there have been few international wars fought explicitly over water access, it is

increasingly recognised as being a possible source of conflict in the future, especially in areas of high population density and decreasing water resources in shared watercourses. Some attempts have been made to develop legally binding agreements between countries on how their waters can be allocated. These include the 1994 peace treaty between Israel and Jordan that explicitly addressed sharing water information, water allocations, and joint management policies for the Jordan River Basin. A similar example is provided by the formal treaty signed by India and Bangladesh that moves toward resolving the long-standing dispute over the Farraka Barrage and flow rates in the Ganges/Brahmaputra basins.

Another potential source of conflict in the future is that concerning water for food. Postel (1997) suggests that as annual water availability drops below 1,700 cubic meters per person, domestic food self-sufficiency becomes almost impossible, and countries must begin to import water in the form of grain. This has been referred to by the term *virtual water*, and an increasing number of countries are reaching the point where their water resources are inadequate to produce adequate food supplies, so some degree of dependence on such virtual water is likely to occur. It is hoped that by developing a more transparent and equitable framework for water management decisions, the WPI project will contribute to a more secure future by reducing potential conflicts over water use. For more details on this issue, see Gleick, 2002, in Appendix 9.7.

Another issue which is important to the structure of the WPI is that of gender. We have attempted to address this by taking account of the proportions of water carried by women for domestic use. From the data in this study, it is clear that women in particular spend considerable amounts of time in domestic water collection. For example, in South Africa, 73% of domestic water is collected by women, with 68% being collected by women in both Tanzania and Sri Lanka. Most of this water is carried by hand or head, and the labour costs to provide it are huge, especially in the dry season. In South Africa, women spend up to 119 minutes per day for this chore, while in Tanzania, it is as high as 416 minutes in the dry season. In Sri Lanka, the time inputs for a normal day are high, varying from 97 to 221 minutes, mostly as a result of queuing. In spite of this large amounts of time spent however, the volumes of water available per person per day in all sample villages are still way below the quantities recommended in Gleick (1996) of 50 litres per person per day. The fact that women are spending such a long time to meet household water needs prevents them from enjoying the opportunity of being able to generate a livelihood proportionate to the effort they have to invest.

Including gender in this way does not capture the full importance of women's role in the water sector, and we would like to see this recognized more fully in the future. As part of the capacity building element of the WPI, it is hoped to promote the training of both men and women in water management, but it also must be appreciated that in every household, women play a major role in how water is used. It is hoped that more information about other aspects of gender will be included in future iterations of the WPI. For more information on this subject, see Appendix 9.11, Malomo and Mapuranga, 2002, and Van Koppen, 2002 (Appendix 9.17).

## 2.4: Hydrological aspects of the WPI

Water shortages may relate to the inadequate ability of a society to access the small volumes of water needed for drinking and domestic purposes. They may also result from inadequate water availability for crop and livestock production in low rainfall areas. There may be

a local inadequacy of fresh surface water and groundwater to supplement (through irrigation schemes), or serve instead of, soil moisture, which provides the water needed in rain fed agricultural systems. Fresh water for such irrigation may be local in origin, or it may have to be moved by gravity from sources thousands of kilometres away. (see Allan, 2002, in appendix 9.2)

For a detailed account of how water availability is addressed in the WPI, see Meigh and Cobbing, 2002, in appendix 3. In order to provide a realistic definition of 'Resource' for use in the development of the Water Poverty Index, water availability can best be treated in two separate ways:

**Primary natural endowment (or primary availability of resource).** This is the quantity of water that is naturally available at or near the location of interest. By naturally we mean the situation which would have occurred before any significant human interventions or alterations to the streamflow regime or the groundwater aquifers. Thus, the effects of dams, diversions, water transfers or pollution are disregarded in making these estimates. Where substantial impacts on the natural regime from changes in land use or vegetation cover can be identified, it should, if feasible, be attempted to estimate the natural situation before the changes. When there is deep groundwater at the study site it should be included in the natural availability even if there are no boreholes, because it still represents a potential resource.

**Actual availability (or potential supply).** This is similar to the natural endowment, but the impacts of human intervention *are* taken into account. Human interventions can be of two types. Direct interventions affect flow quantity, seasonal regime or quality. The existing water resources infrastructure needs to be taken into account. There are many possible types of intervention. The most straightforward type, and the one that needs to be considered most often, is the water supply system which people actually use to get their water, whether a complex distribution system covering a whole city, or a small-scale system of a pipe and tank supplying a small village. Other examples might include a dam which diverts water for use for irrigation upstream, or a diversion for industrial use which returns polluted waters. Both these would decrease the availability compared to the natural endowment. An example which illustrates an increase in resource availability includes transfers by pipe or canal from a distant catchment to the location. In the case of this actual resource availability, groundwater is only considered when there are boreholes in place to supply the water, or a transfer system from a distant aquifer.

Indirect interventions can be characterised by changes to the catchment which can affect flows, and these also need to be considered. These could be changes in land use or vegetation cover (*eg.*, forestry, cropping types, overgrazing, etc). In many cases, such changes within the recent past will be relatively minor and the changes in water availability will not be significant. In others very substantial changes may have taken place and substantial impacts may have occurred. Where there is sufficient information, such impacts should be included in assessing the actual resource. However, in many cases the availability of data and the methodologies needed to

assess these impacts are likely to be lacking, and any assessment may have to be mostly descriptive.

Clearly, it is the actual resource availability that is most relevant in evaluating the WPI since it relates to the water that people are actually able to use. Nevertheless, the primary or natural availability is also of interest. It provides a context for the actual resource availability, describing the setting in which the assessment is being made, whether generally water abundant or water poor. It also gives some idea of the potential availability, indicating what might be available if the ideal infrastructure was in place and functioning correctly. This definition of water availability has considerable overlap with the evaluation of people's access to water, which is another component of the WPI process. However, the distinction is that water resource availability relates to the natural environment and water resources infrastructure, while access relates to people's ability to obtain that water to satisfy their needs, taking into account factors such as time and distance to collect water, rights of access and costs.

In assessing the availability of water it is implicit that its variability (seasonality and inter-annual) or reliability as well as its quality must be taken into account at time scales appropriate to the location and types of water use being considered. (The change in availability over time, as distinct to the variability, is also an issue, but this would be measured by change in the indicators from repeated assessments). With regard to water quality, different degrees of physical, chemical and biological contamination are important depending on the intended use of the water. For the WPI, the focus for this first iteration is on drinking water, although other uses are also considered, so availability is considered to be limited when the quality does not meet international or other drinking water standards. The assessment must also be at the appropriate scale. It is not clear how far outside the village, community or city area resources should be considered to be part of the natural availability. This cannot be specified in a general way, but will have to be decided in each case on an ad-hoc basis. In the next phase of the WPI work, it is hoped to develop a more standardised approach to this, developing further these techniques of small-scale water resource assessment which are needed for community level WPI assessment. In addition, developing the basin scale approach may overcome this difficulty.

To calculate the water resources component of the WPI, three separate aspects of water availability are examined. For both primary and actual availability these are:

- Amount of water, expressed as per capita quantities (eg., litres/capita/day) for each source (both surface and ground water), or for the most important source where one is dominant.
- A measure of the variability or reliability. For the natural system (primary availability) it is the natural variability, both seasonal and inter-annual, that is most relevant, while for actual availability it is more the reliability of the relevant systems that need to be examined.
- A measure of water quality; generally only whether or not it is fit for drinking and washing is considered (fitness for other purposes is not included at this stage).

These three values can then be reduced to a single indicator for primary resource availability, and one for actual resource availability. An indicator on a scale of 0 to 10 is developed which gives a combined assessment of the three factors: amount,

variability/reliability, and quality of the water. While this single indicator gives an overall result for availability of the resource, the information relating to the three separate aspects is still valuable, and should be retained so that the impacts of the various components can be seen in the final result. A procedure by which this can be done is described in Meigh and Cobbing, 2002, in Appendix 3.

The approach used in any particular situation and the accuracy of the results will depend on the data availability and the amount of previous work, including modelling, that has been done in the area. Broadly speaking, much of the methodology will be the same whatever the data availability, but in situations which are richer in data and have been well studied, much more detailed modelling will be possible, and more accurate results may be obtained. When this is the case, results can be expressed numerically, either based on direct observations or on sophisticated modelling. For situations which are data poor a combination of more simplistic modelling with regional data and estimation, household/community surveys and field observation, is needed. Then it may be that only qualitative indicators can be determined, expressed on a scale from “good” to “poor”, for instance, but the estimates must always be made bearing in mind that the results should be assessments of both the primary (or natural) water resource availability, and the actual resource availability, as discussed earlier. In the applications of this methodology in the study sites, (see Appendix 3), two of the sites were relatively data poor, while in the South African case, detailed hydrological estimates based on sophisticated hydrological modelling have been produced, as illustrated by Schulze and Dlamini, 2002, in Appendix 9.14).

The indicator of ‘resource’ developed in this way will generally express the present situation (that is, at the time of making the estimates). For instance, present population figures would be used in estimating per capita quantities. However, it would also be possible to use this approach to examine possible future values of the indicators by considering scenarios of climate change in combination with projected populations for 10, 20 years ahead, etc. In addition, if the WPI were to be implemented at regular intervals, a time series dataset would be developed which would help future water managers to get a more detailed understanding of their water resources at a much more localised level. Again, more work on this needs to be done in the next Phase of the work to perfect these estimation techniques.

## **2.5: Addressing the needs of the environment**

All water used by human systems is diverted from water flows and storage capacity that were naturally in the environment before human intervention occurred. The main competition for water for human use is between big volumes of water, diverted from the environment for food production, and the even bigger volumes of water in the environment that sustain environmental services. These environmental goods and services support millions of people worldwide, and responsible water management must ensure that they are effectively maintained.

During this phase of the WPI development, attempts have been made to assimilate some measure of ecosystem needs. A specific question on natural resource use was incorporated into the household survey, and this revealed some variation in how people used such resources. In particular, the data tends to show that poorer households make more use of the environment, confirmation that the maintenance of ecosystem integrity is important for livelihood support.

In addition to this anthropocentric perspective on the importance of the environment, there is also the more ethical and philosophical dimension which promotes the argument that the ecosystem itself must be maintained, not for human ends, but to ensure the rights of other species to continue to survive. This is considered important since any one of them may be a 'key species', on which the integrity of the global biosphere itself may depend (WCED, 1987). By bringing about their extinction, human behaviour may be having an irreversible impact on the physical conditions on Earth as a whole, so in the absence of perfect information, the precautionary principle must apply. This more ecocentric perspective is also embodied in the structure of the Water Poverty Index, as water for the environment is considered as a fundamental prerequisite for sustainability and the principles of Agenda 21 (UNCED, 1992.)

For a more theoretical background on how ecological concerns may be addressed in the WPI, see Acreman and King, 2002, in appendix 9.1, and Appendix 1.2 and 1.5 for how this issue has been incorporated into the actual WPI calculations of the composite index approach. Testing of the methodology of incorporating ecosystems into the WPI as described in appendix 9.1 has not been completed during this Phase of the project, and this is an area of work for which there is a pressing need. The methods used to represent ecosystem water needs in the WPI structure at both the micro and macro level shown in Appendix 1 are far from satisfactory, as they are based only on proxy values which make no contribution to how well we understand how much water is needed by any specific ecosystem type. It is hoped that the new approach for terrestrial and aquatic systems, as described in Appendix 9.1, will be incorporated into the next iteration of the WPI project, and this will go some way to addressing the question of how environmental water demand can be assessed and incorporated into the WPI. This continues to be one of the most challenging areas for future work in this field, and a number of institutions involved in the consultation process during Phase 1 of the project have indicated that they are similarly challenged on how to address the issue of quantifying the environment. Only when this issue is clarified, can a more meaningful and accurate way of managing water for the environment be derived.

## **2.6: Participation and empowerment of local communities**

The development of the WPI has been an iterative process, involving the participation of several water professionals from many different countries (see Appendix 5). This has helped to identify key issues relevant to such users, and to ensure that they have, where possible, been included in the WPI structure. One of the most valuable aspects of a tool such as the WPI is that it can empower decision-makers to have confidence in the validity and justification of their own decisions. This is very important when considering the extent to which decision-making is being devolved in the water sector throughout the world, and the importance of the decisions such water managers are making.

Another important aspect that the WPI can provide if it were to be implemented is that of community empowerment. By developing a tool such as this, local communities can become more aware of their resource endowments, and this can enable them to bring pressure to bear on appropriate authorities if inequitable distributional arrangements exist. It is recognised that the occurrence of water conflicts are increasing significantly at the local level, (Gleick, 2002, see Appendix 9.7), and perhaps the development of a transparent decision-making process will go some way to reducing the sources of conflict over water use.

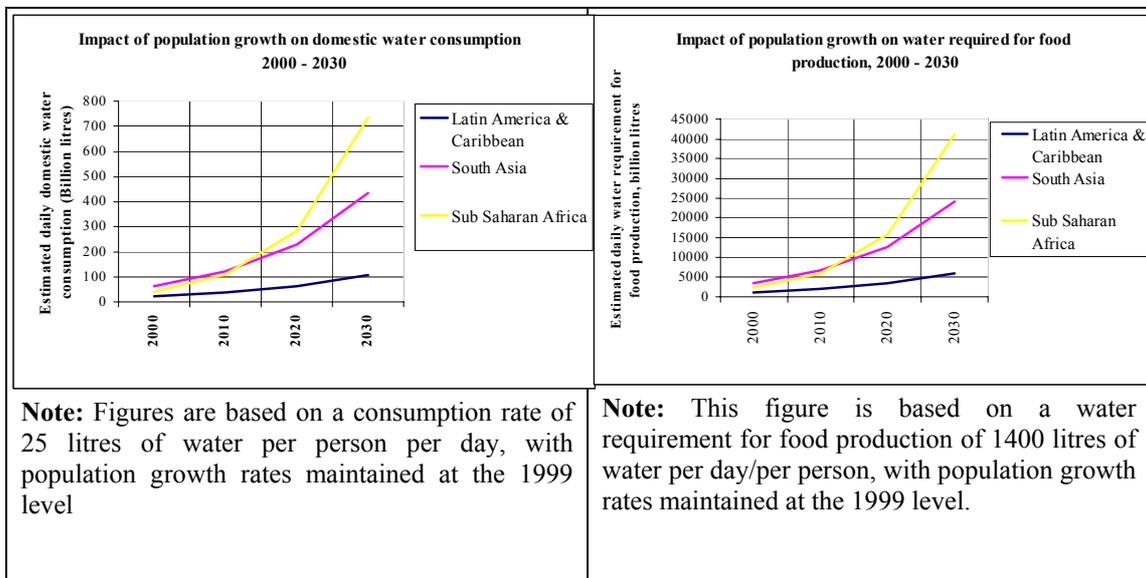
Another aspect of community empowerment can be generated if the community itself is involved in its own monitoring process. This is an important concept on which participatory research is founded (Pretty et al, 1995), and can be a way of promoting cross-cutting public policy, where for example, education costs are paid for ‘in kind’ by children contributing data about the local water situation as part of their normal educational activities. This is discussed in more detail in section 3.5.

**2.7: Climate change and population impacts on future water resources**

As we progress through the 21<sup>st</sup> century, we know already that we will be affected by changes in water resources, and the demands upon them. Changes in the global climate over the next hundred years are almost certain (IPPC, 2001), irrespective of whether they are human induced or otherwise. Such changes will impact on the spatial and temporal distributions of surface water resources, and may well be characterised by a more frequent occurrence of extreme events (Meigh et al., 1998, Arnell and King, 1998). This clearly suggests that the availability of freshwater resources will need to be more carefully managed in future, and the development of the WPI can be seen as a contribution to the achievement of this goal. Further discussion on this issue can be found in Appendix 9.13, Prudhomme, 2002)

The impact of human population growth is also a major issue when considering the future challenges for water management (Falkenmark, 1990). If we examine the effect that this will have on demand for water for both domestic use and food production, we can see that expected rises in demand for these uses are significant. This is illustrated by the graphs shown in Figure 2, which illustrate the likely increases in major water use over the next 50 years.

**Figure 2. Increasing demand for water as human populations rise.**



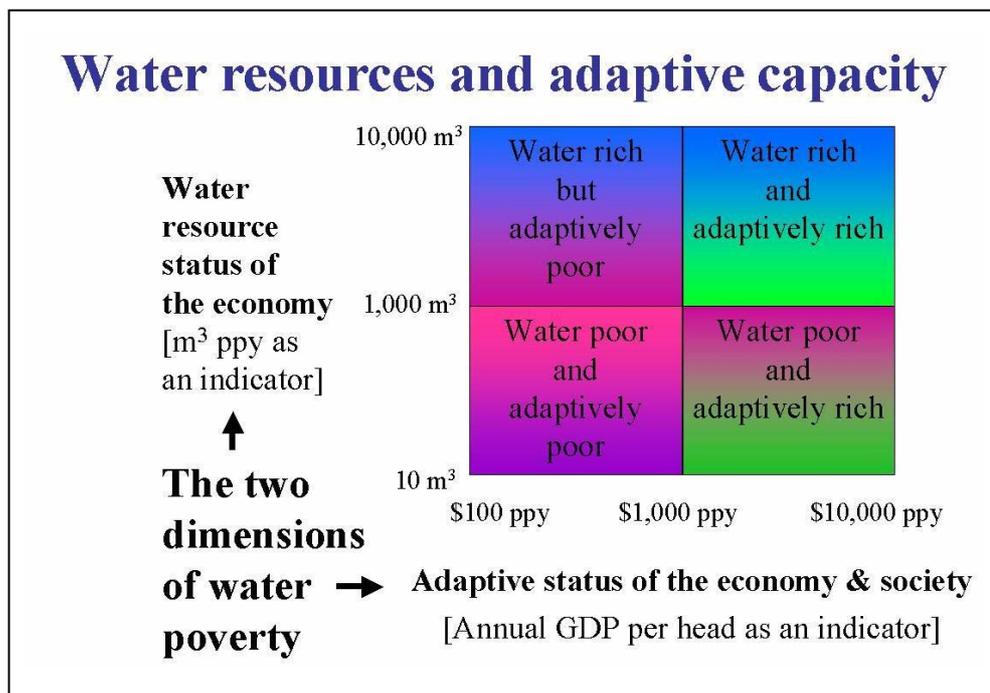
While both of these figures show an exponential rise in water requirements after 2015, the water required for food production to feed the rising human population represents a major proportion of accessible freshwater. These figures are both based on minimum estimates of water required for both domestic and agricultural use, and as the standard of living rises in many countries, the actual water consumption rates may

be much higher than these minimum, making the potential situation of water deficit much more serious. For this reason, the development of a decision-making tool such as the WPI is both appropriate and timely, and is something that will help water managers of the future to address these potentially difficult allocation decisions.

### 3. Conceptual Development of the WPI

Phase 1 of the project to develop and test a WPI has been conducted for a one year period, and in that time, numerous people have made a contribution to the process of identifying what is meant by the term water poverty, and how it may be measured. Physical and social scientists, water practitioners and researchers, academics and other stakeholders from a variety of different countries have had an input into the conceptualisation process for the WPI. The target beneficiaries of the WPI project are those who may be both water poor, in the sense that they physically have inadequate water supplies, or they may be adaptively poor (see Allan, 2002, Appendix 9.3). This is illustrated in Figure 3, and in the conceptualisation of the WPI itself, these issues were taken into account.

**Figure 3. Different dimensions of what may be meant by water poverty**



This hypothetical approach shows how communities and countries may fall into one of these four quadrants, but those groups who are both water poor and adaptively poor are the key target beneficiaries of the WPI work, and in global terms, they by far outnumber those who are relatively well served by water systems.

### 3.1: Identification of key concepts to be included in a holistic WPI measure

The consultation process adopted during this development phase of the project has enabled the development of a holistic approach to the assessment of water provision. Consensus has been achieved on what the key issues are, and there is much agreement that institutional issues, adaptive capacity and the maintenance of ecological integrity are essential components of any tool which attempts to promote equitable and sustainable water management. As a result, the structure of the WPI has been designed to include these issues, in addition to the more conventionally used water availability measures provided by hydrological science. As a result, key components of the WPI have been identified as:

- Resource - Physical availability of surface and ground water
- Access The extent of access to this water for human use
- Capacity The effectiveness of people's ability to manage water
- Use The ways in which water is used for different purposes
- Environment The need to allocate water for ecological services

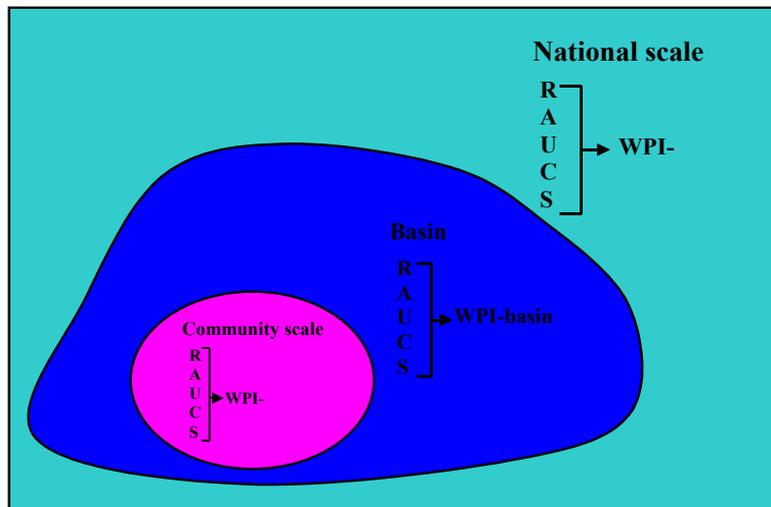
Through the inclusion of these dimensions, we are able to capture some measure of the complexity of water management in a more transparent and meaningful way. By producing a standardised framework which incorporates these issues, we provide a way of addressing the water allocation problem on a consistent basis, and provide water managers with structured evaluation tool which can include not only information on water availability, but also demands on that water, and constraints to its use. To some extent at least, this overcomes the problems that arise through the use of relatively crude hydrological assessments that take little account of the temporal and spatial variability of water systems.

### 3.2: Overview and scales of application

For most effective use of the WPI as a management tool, its application at different scales is considered important. For this reason, a standardised framework for the WPI has been developed, with a view to this being applied at different scales. This is shown in Figure 4. At this stage, it is clear that there may be difficulties in identifying appropriate variables to represent the five components at each scale, but as time progresses, and if political will exists, it is possible to foresee the time when this structure can be fully implemented, eventually generating nested values of the WPI at different scales. This undoubtedly would go some way to highlighting current inequities, and could provide a means to address the existing situation in the world where huge numbers of people are not adequately supplied with water, even though the cost of meeting basic needs is relatively small in global terms. In this phase of the WPI project, we have focussed our attention on community level application, effectively to provide a decision support tool for water managers at the local level. In addition, we have shown how the methodology can be applied at the national level. Basin level assessments are more complex in some ways, as although hydrological assessment may be easier (since basins are a natural hydrological unit), assessment of socio-economic and political/institutional issues are much more complex. For this reason, and the short time frame available in this phase of the project, basin level assessment of WPI values have not been attempted. On the basis of feedback from the consultation process, it has been suggested that this scale of application of the WPI would be very useful as a contribution to the achievement of integrated water

resources management, fast becoming a key component in national water management plans throughout the world. It has also been suggested that the WPI tool could be of use in situations of shared watercourses, as its transparency could enable different stakeholders to appreciate the conditions of all relevant water user groups.

**Figure 4. Applying the WPI structure at various scales.**



### 3.3: Development of the test-bed dataset from three countries

In order to create a standardised dataset on which the WPI methodologies can be tested, data was collected from four pilot study sites in three countries. Half of these sites are rural, and half are urban or peri-urban, and the countries involved are Tanzania, Sri Lanka and South Africa. These countries were selected on the basis that the first two represent some dimension of situations in Africa and Asia where both water and poverty are important policy issues. South Africa was additionally selected as it has a strong capacity in water research, data generation and management, and as such, represents a country where the potential to understand water management issues more explicitly already exists. Furthermore, institutional developments in that country mean that the foundation has already been laid for the practical implementation of new policy tools, such as the WPI, in the future.

During the Conceptualisation workshop in Arusha in May 2000, the issues of access, use, capacity, resource (availability) and the environment were identified as the key components of the WPI structure. A questionnaire was designed at that workshop which tried to capture various dimensions of these components, and this was revised through an iterative process before being taken to the field. Pilot trials and enumerator training was carried out (see Appendix 2.4.1). Some differences in the wording of the questions were required by cultural conditions in the different countries, and some respondents interpreted questions in different ways according to socio-political conditions. Since it was necessary to comply with the short time frame set by the project contracted time table, the data collection exercise had to be started before the explicit need for specific variables had been identified. Community level data was collected using household surveys and PRA techniques, while national level data was collected from many different regional and national government departments. (For more details on the study sites and data collection, see Appendix 2).

A total of 1521 households were surveyed in the three countries, with data being collected on a whole range of issues including sources of water, institutional issues, demographic characteristics, time spent collecting water, use of ecosystems etc. Once again it must be stressed that this data was collected purely to enable testing of the WPI methodologies, and it is anticipated that in the case of actual implementation of the WPI in practice, much of the data needed would be available from existing sources. This means that the main task of implementation is to gather appropriate data from existing datasets in various government departments, and supplement this with a very small number of specific questions which can be collected from the target communities. Suggestions of how this can be done are addressed in Appendix 2.4.3.

Much of the collected data has been georeferenced for the purpose of creating GIS databases which provide a means of integration of data from different sources. Developing such datasets does provide the opportunity to investigate a wide range of different variables and their spatial relationships, but it is a time consuming process and work on this aspect is still ongoing. It is hoped in due course to be able to create a detailed picture of the data from the study sites, incorporated with hydrological data and other physical features. See Appendix 4 for more details on the use of GIS.

## **4. Practical application of the WPI methodologies**

Indices are by definition measures of something which is not easily measured, and as such, there is some trade-off between the accuracy of what the index may represent, and the usefulness it may have as a policy tool. In this work, we have tried to develop a useful policy tool which captures a reasonable measure of poverty and water use, with a view to providing policy makers with a tool which can help them to both prioritise expenditure in the water sector, and monitor its progress. More details on other work on indices is provided in Appendix 9.5.2. In keeping with the project proposal document, the practical utility of the WPI tool has been assessed at small pilot sites in three countries. In addition, the methodology developed in the composite indicator section of our work has been applied at a national level, using publicly available datasets.

### **4.1: The composite index approach**

The WPI is primarily designed to provide a tool by which water managers can evaluate the water situation in different locations in a holistic way. Such a tool will allow comparisons to be made between communities, and this will enable decisions to be made in a transparent and consultative way. In addition, if implemented in such a way as to generate time series data, the tool can be used to monitor progress over time.

The composite index approach draws on the structure and methodologies used by the Human Development Index, and it is based on the idea that a combination of relevant variables can provide a more comprehensive insight into a particular situation than can a single one. In this way, sub variables to represent the 5 key components (Resource, Access, Capacity, Use and the Environment) are collected and summed, to generate a holistic value of the WPI. To avoid the problem of incommensurability, each sub-component is scaled as an index itself, based on the range of values on each

variable in that location. The mathematical structure on which the composite index version of the WPI is based, is expressed as follows:

$$WPI_i = \frac{\sum_{i=1}^N w_{x,i} X_i}{\sum_{i=1}^N w_{x,i}} \quad [1]$$

where  $WPI_i$  the Water Poverty Index value for a particular region, is the weighted sum of five components **Resource**, ( $R$ ) **Access** ( $A$ ) **Use** ( $U$ ) **Capacity** ( $C$ ) and **Environment** ( $E$ ), each having a value ranging between 0 and 100. The weight  $w$  is applied to each component ( $X$ ) of the WPI structure, for that region, with  $X$  referring to the value of each component.

To standardise the result and produce a WPI value of between 0 and 100, the sum needs to be divided by the sum of weights as shown:

$$WPI_i = \frac{w_r R + w_a A + w_c C + w_u U + w_e E}{w_r + w_a + w_c + w_u + w_e} \quad [2]$$

A detailed account of the composite index approach to calculating the WPI is provided in Appendix 1.2.

#### **4.1.1: Local scale application of the composite index approach**

In the case of community level assessment using the composite index approach, the standard WPI framework is applied in each of the pilot countries, using the testbed datasets. (For technical details see Appendix 1.2, Giacomello and Sullivan, 2002). On this basis, we have generated WPI values for each of the study sites. Where possible, the same variables have been used in each case, but due to differences between the sites, this has not always been possible. For example, some of the indicators used for the environmental attribute are not representative of the state found in urban areas, whereas they are appropriate for the rural areas. The differences between urban and rural sites mean that although the same WPI framework can be used, some of the sub-components are different, making direct comparisons of the values less reliable between urban and rural sites. As long as these differences are highlighted however, it is still possible to make some comparison of the generated WPI values from these sites.

Table 1 shows the WPI values generated in urban and rural areas in each of the pilot countries. For simplicity, these values reflect a score where each of the components used in the WPI framework are given equal weights, where  $w = 1$  for all variables. It is of course possible to apply weights to emphasise certain issues, if that were to be considered worthwhile by the users. It is important however that the baseline (equal weighted) values are computed first, to ensure that the impact of applying weights is made explicit to policy makers and stakeholders.

**Table 1. WPI values for urban locations in the pilot sites, dry and wet seasons**  
**a. Dry season**

Village	Component values (Dry season)					WPI
(Urban)	Resources	Access	Capacity	Use	Environment	
Wembezi (informal)	50.0	48.8	46.1	18.0	39.1	40.4
Wembezi (formal)	50.0	86.5	78.0	38.1		63.2
Majengo	10.0	32.7	62.9	15.0	98.4	43.8
Kijenge	20.0	53.9	68.3	21.6		41.0
Awarakotuwa	10.0	35.2	79.6	21.2	28.1	34.8
Tharawaththa	20.0	26.5	50.6	16.2	42.2	31.1

**Note: All data presented in these tables represent the situation that existed when the data was collected, ie. 2001.**

**b. Wet season**

Village	Component values (Wet season)					WPI
(Urban)	Resources	Access	Capacity	Use	Environment	
Wembezi (informal)	50.0	47.0	46.1	18.0	39.1	40.0
Wembezi (formal)	50.0	86.5	78.0	38.1		63.1
Majengo	10.0	42.2	62.9	15.0	98.4	45.7
Kijenge	20.0	54.6	68.3	21.6		41.1
Awarakotuwa	10.0	45.0	79.6	21.2	28.1	36.8
Tharawaththa	20.0	34.5	50.6	16.2	42.2	32.7

From the information showing these seasonal WPI values for urban areas, we can see that during the wet season, much better access rates brings the WPI scores up. This is because in some areas, water supply points become unreliable in the dry season, generating lower WPI values.

**Table 2 WPI values for rural locations in the pilot sites, dry and wet seasons**  
**a. Dry Season**

Village	Component values (Dry season)					WPI
(Rural)	Resources	Access	Capacity	Use	Environment	
Ethembeni	50.0	36.6	59.8	41.5	27.7	43.1
Latha	20.0	17.0	42.1	24.5	28.9	26.5
Nkoaranga	30.0	39.5	59.4	65.3	69.9	52.8
Samaria	20.0	20.9	44.7	37.7	56.1	35.9
Agarauda	20.0	38.3	64.7	74.9	34.2	46.4
Tissawa	20.0	47.3	52.0	50.0	38.5	41.6

**b. Wet season**

Village (Rural)	Component values (Wet season)					
	Resources	Access	Capacity	Use	Environment	WPI
Ethembeni	50.0	34.6	59.8	41.5	27.7	42.7
Latha	20.0	13.0	42.1	24.5	28.9	25.7
Nkoaranga	30.0	47.5	59.4	65.3	69.9	54.4
Samaria	20.0	20.9	44.7	37.7	56.1	35.9
Agarauda	20.0	38.4	64.7	74.9	34.2	46.4
Tissawa	20.0	45.4	52.0	50.0	38.5	41.2

These figures give some indication of how the WPI scores may vary between communities. The communities presented here are fairly representative of thousands of communities in Africa and South Asia, in urban and rural areas. From this information we can see that on this measure, the WPI scores range from 31.1 to 63.2 for urban areas in the dry season, while in rural areas, WPI scores range between 26.5 to 52.8 for the same period. As would be expected, wet season scores tend to be higher (better), tending to provide evidence supporting the robustness of the WPI methodology. It has to be restated however, that this work represents the first iteration of this approach, and it is hoped that future work will refine and improve the methodology. This is especially true with respect to future improvements in data, which hopefully will become more reliable, accurate and standardised.

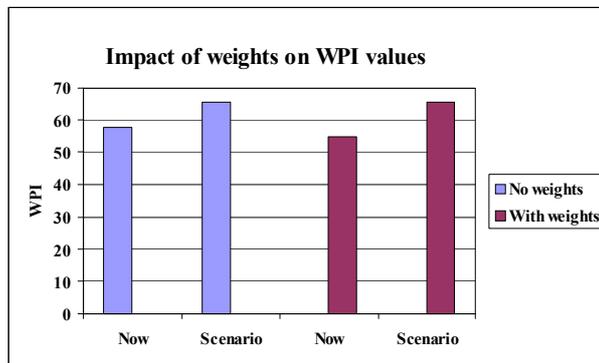
**4.1.2: Applying weights to the WPI structure.**

Weights are used in an index to change the relative importance of various components. This is usually done to put emphasis on issues which are considered most important for policy goals etc. The technicalities of how weights can be applied to the WPI framework is an area of further work which needs to be addressed in the next phase of the project, but a hypothetical look-up table of how weights may be applied is shown in Table 3, and an example of the impact of adding weights to the structure is illustrated in Figure 5 This information shows how weights may be applied to put emphasis on a particular component, given a specific set of national priorities.

**Table 3. A hypothetical lookup table to provide guidance on adding weights to the WPI structure**

Local condition descriptors			Variable weights				
Hydrological condition	Economic condition	National priorities	R <sub>i</sub>	A <sub>i</sub>	C <sub>i</sub>	U <sub>i</sub>	E <sub>i</sub>
VG	U	Ag, Ind, & Soc	1	2	2	3	1
A	A	Soc	1	2	2	1	1
VG	G	Env & Soc	1	2	2	1	2
U	U	Ind & Ag	1	2	2	2	1

**Figure 5. The impacts of adding weights to the WPI structure (hypothetical values)**



#### **4.1.3: The impacts of using a different mathematical structure for the process of addition of sub-components.**

The way sub-components are added together in a composite index can have an effect on the final score. This is because the number of sub-components which make each component (such as use, access etc) is likely to be different, and if the 5 major components are constrained to a 20% share of the total WPI score, there will be a different implicit weighting attributed to each sub-component score.

In order to investigate this, we have referred to the method we have used to calculate the WPI in 4.1.1 as the ‘unbalanced approach’, while this alternative approach will be referred to as the ‘balanced approach’. The rationale for this is that it provides a methodology where every aspect of the index and all of its sub-components has an equal weight. While this method changes the values for each community by only a small amount, we feel it is a more accurate representation of equally weighted component variables. The formula for this approach is expressed as follows:

$$WPI = \sum_{i=1}^N w_i subC_i = \sum_{i=1}^{N_1} w_i A_i + \sum_{i=N_1+1}^{N_2} w_i C_i + \sum_{i=N_2+1}^{N_3} w_i U_i + \sum_{i=N_3+1}^{N_4} w_i E_i \quad [3]$$

where

$subC_i$  are the all the subcomponents used in *Access*, *Capacity*, *Use* and *Environment* components;

$A_i$  are the subcomponents used in the *Access* component;

$C_i$  are the subcomponents used in the *Capacity* component;

$U_i$  are the subcomponents used in the *Use* component;

$E_i$  are the subcomponents used in the *Environment* component.

$N$  is the total number of subcomponent used to create the WPI that have got a value; in our case the maximum number is 21; however for Wembezi (formal)  $N$  is equal to 12 as few of its subcomponents have not a value for this village.

$N_1$  is the total number of subcomponent used to obtain the *Access* component;

$N_2$  is the total number of subcomponent used to obtain the *Capacity* component;

$N_3$  is the total number of subcomponent used to obtain the *Use* component;

$N_4$  is the total number of subcomponent used to obtain the Environment component.

$w_i$  are the weight associated with each subcomponent. They are subject to the following constraint:

$$\sum_{i=1}^N w_i = 1 \quad [4]$$

More discussion on this issue is included in Appendix 1.2, and the impact of using this ‘balanced approach’ is shown in Table 4.

**Table 4. Dry season values for all sites, using the ‘balanced’ WPI approach**

Village	Resources	Access	Capacity	Use	Environment	WPI
Ethembeni	2.8	11.8	13.3	9.2	3.1	40.2
Latha	1.1	5.5	9.4	5.4	3.2	24.6
Wembezi (informal)	2.8	15.4	10.2	4.0	4.3	36.8
Wembezi (formal)	4.2	33.3	19.5	6.3		63.3
Nkoaranga	1.4	12.6	17.0	12.4	6.7	50.1
Samaria	1.0	6.1	12.8	7.2	5.3	32.3
Majengo	0.6	11.5	18.5	2.6	5.8	39.0
Kijenge	1.3	19.6	21.4	4.1		46.3
Agaranda	1.0	11.5	18.5	14.3	3.3	48.4
Awarakotuwa	0.6	11.0	24.9	2.6	1.8	40.9
Tharawaththa	1.3	9.3	15.8	2.0	2.6	31.0
Tissawa	1.0	14.2	14.8	9.5	3.7	43.2

Using this approach, we would in fact be able to generate a base-line value for water poverty assessment. This would be particularly of use if the WPI were to be used for international comparison. On one hand, it could be the standard used for that purpose, while a weighted value could be used for the purpose of contributing to national policy goals.

In addition to exploring this issue more fully during future work, a procedure needs to be devised to provide a way of representing any gap in the data for any particular location. This is because there will inevitably be some variation in the data and its coverage level between countries. If the WPI were to be implemented on a large scale, a long-term goal would be to devise an appropriate standardised framework for the definition and collection of specific data items, to eventually overcome the incompatibility of global water data which is so frequently observed today. [In addition, to take advantage of improvements in the field of computer science, such data should be stored in an *object orientated* format (see Appendix 9.9, Jackson and Sullivan, 2002). The advantage of this is that such a database system can evolve over time, and as new information is revealed, this can be integrated in an ‘intelligent’ way. In addition, not requiring a highly rigid conceptual structure (as is found in a relational database), this approach enables us to assimilate new relationships into our knowledge-base, (Coad and Yourdon, 1990), as science uncovers them.

#### **4.1.4: Cost effective water data collection**

Data appropriate for the WPI needs to be collected at a variety of levels. In order to generate appropriate data for community-level water poverty assessments, we propose

that this could be achieved through the introduction of a ‘*water module*’ into the school curriculum. Such a module can be written to address key issues of importance in the water sector, and be designed for delivery to school children aged between 12 and 14. These children, especially in rural areas, are very likely to be involved in domestic water provision, and will be familiar with location of water points etc. They are also future water consumers and managers, so to instil them with an understanding of water issues in their youth, lays the foundation for the development of a well-informed future public. As part of this interdisciplinary module, geographical and other information about domestic and other water uses can be collected by the pupils, who of course represent households. This data can then be collated by the students and teachers together, and the teacher could be given the responsibility to complete a pre-prepared form to record the community data in a standardised way<sup>2</sup>. Since there already exist institutional links between schools and the national statistics office, (as required by the submission of school enrolment rates), it would be a relatively simple process to deliver this community water information to the office responsible for the collation of national datasets.

This national statistics office is also that office responsible for conducting the national census. In addition to the decadal census carried out in most countries, there are several other surveys carried out at various levels in most countries of the world today. To produce cost effective WPI data, it would be possible to integrate 2 or 3 key questions into one of such surveys, and the marginal cost of this data would be relatively low. If this marginal cost could be funded by donor agencies, this would provide the means by which standardised and integrated datasets could be generated within the existing macroeconomic databases.

Questions to include in a national census or health survey could be:

1. *How much time (in minutes) does it take your household each day to collect water for domestic use?(households with a supply to identify themselves as such)*
2. *What proportion of the time is your most frequently used water source reliable?*
  - a. *never reliable,*
  - b. *reliable one quarter of the time,*
  - c. *reliable half the time*
  - d. *reliable three quarters of the time*
  - e. *reliable all the time*

Both of these ways of generating data have been discussed with representatives<sup>3</sup> of the Ministry of Education, Economic Planning Offices, water authorities and statistical offices in each of the pilot countries, and in all cases, support for these novel approaches was expressed. It was also clearly stated that incorporating new questions into these surveys was not a problem, as long as the stakeholders in the national datasets expressed their desire to do so, and the cost of that work were covered from some reliable source.

It is clear that there is considerable interest in this facet of the Water Poverty Index work. There is a need for detailed data, and this is one way it can be obtained, and

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<sup>2</sup> If it were considered appropriate, a tiny sum could be allocated to the teacher for each household coverage, and this would not only build a sense of ownership in the database, but would provide the opportunity for teachers to receive a small supplement to their income in return for their role in the data collection.

<sup>3</sup> For details of individuals consulted in each country, see Appendix 5.

while this is far from perfect, the errors resulting from the methodology of data collection itself can be estimated and minimised. It is anticipated that the question of how to develop these water poverty datasets will be addressed in the next phase of this work.

#### **4.1.5: National Scale application of the composite index approach**

The same composite WPI framework has been applied to national level data collected from public datasets, in order to generate national WPI values for 140 countries. The spatial variability of water resources and people's ability to access them does make national values rather meaningless, except for the purpose of general comparison. As with any national values, the usefulness of such data for internal policy use is limited, but they do provide a means of comparison of different countries, and can be of use to donor agencies and international organisations, particularly with respect to progress in the water sector, and towards development targets.

How the WPI values have been computed at the national level is shown in detail in Appendix 9.10, (Lawrence, Meigh and Sullivan, 2002). In this approach, we have identified variables from existing datasets that are appropriate for inclusion in the WPI framework. Where possible we have tried to link these to other international monitoring tools, and in particular we have used data on water supply and sanitation from the UNICEF/WHO Joint Monitoring Programme (UNICEF/WHO 2000), for capacity variables we have used those from the Human Development Index, (World Bank, 2001), and for the environmental component we have used data from the Environmental Sustainability Index. (World Economic Forum, 2001). Some examples of national level WPI values are shown in Table 5, and it must be noted that these values are of a preliminary nature as there are many modifications which could be made to refine the validity and reliability of these measures. One example of such an improvement would be the inclusion of data relating to per capita investment in the water sector, as a proportion of per capita total fixed capital investment. This would provide some indicator of a nation's commitment and political will towards making real changes to physical water management systems. To date, information on this has only been identified for some 40 countries, and so it is hoped that future work would address this and other possible refinements to the national level WPI framework. Table 5 shows the highest and lowest WPI scores calculated using this approach, and a selection of countries in between.

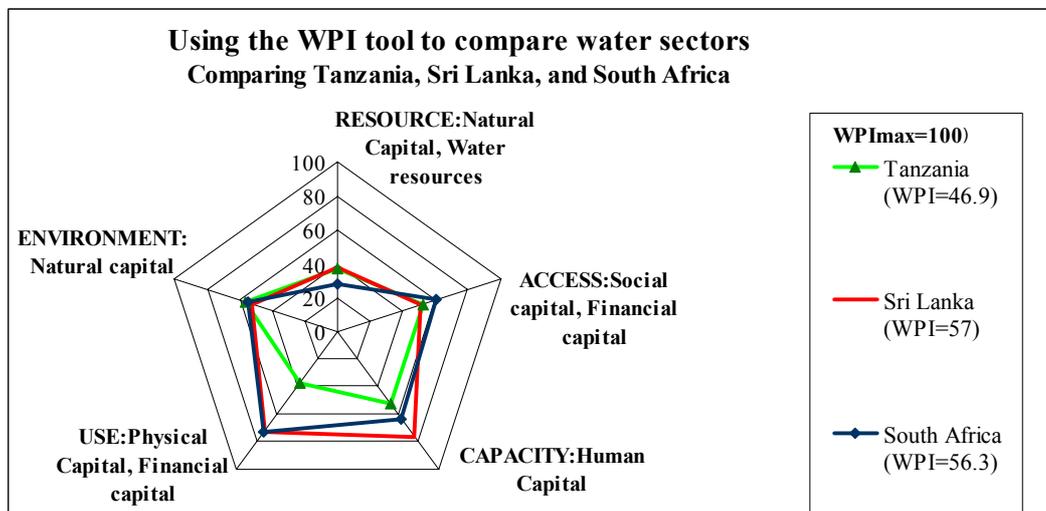
**Table 5. National level WPI values for selected countries.**

Country	Resource	Access	Capacity	Use	Environmen	WPI
Finland	61.0	67.5	90.0	96.5	87.0	80.4
Guyana	90.5	68.5	70.0	82.0	52.0	72.6
Switzerland	47.5	68.5	90.0	58.5	75.0	67.9
Australia	59.5	68.5	88.0	43.0	66.0	65.0
Sri Lanka	37.5	50.5	76.5	72.5	52.5	57.9
South Africa	28.0	60.5	63.5	73.5	55.5	56.2
Jordan	2.0	64.5	74.5	91.0	27.5	51.9
Tanzania	37.0	52.0	52.0	37.0	57.0	47.0
Haiti	30.5	24.0	52.5	17.0	35.0	31.8

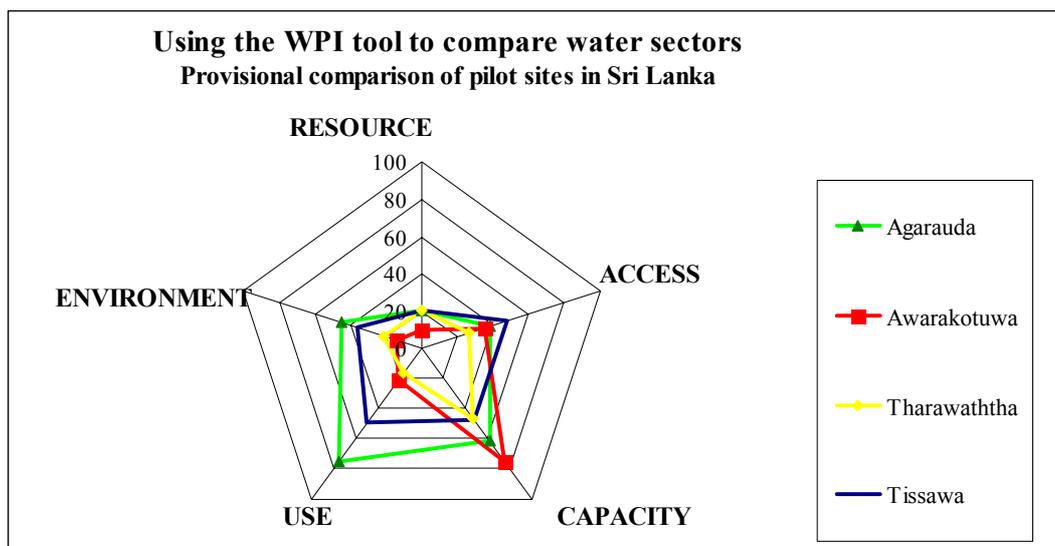
**4.1.6: Expressing composite WPI values for use by policy makers**

One of the strengths of a composite index system is that it can incorporate a variety of values representing many different dimensions of the water management problem. This actually constitutes quite a complex information set, and it is important to consider how this information can be passed to policy-makers and other users in an easy-to-understand way. To address this, a ‘pentagram’ diagram has been developed, which simultaneously shows the values of the five WPI components. This provides a visual display, highlighting differences in component values, and directing attention to those areas of the water sector which most need policy attention. Figure 6 provides an example of such a pentagram, illustrating the WPI component values for the three pilot study countries, while Figure 7 shows the values for the four pilot sites in Sri Lanka.

**Figure 6. A WPI pentagram for Tanzania, Sri Lanka and South Africa.**



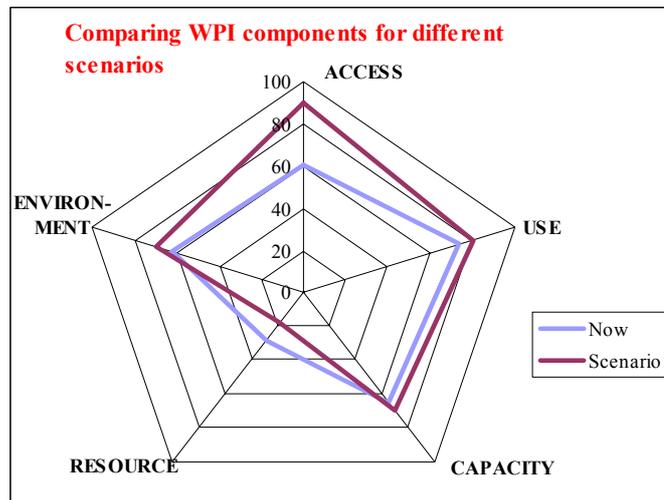
**Figure 7. A WPI pentagram for pilot sites in Sri Lanka**



The WPI methodology, and this way of providing information, is also suited to exploring potential future changes. If for example, one wanted to consider the

impacts of climate change, WPI components can be adjusted by a change factor, to produce scenarios of potential outcomes. This would be useful to policy makers as a way of examining the possible impacts of alternative water development options. An example of this is shown in Figure 8. An important consideration for any policy tool, this is an area of application that needs more work in the future.

**Figure 8. Using the WPI framework to examine scenarios of future change.**



#### 4.2: Time-analysis approach

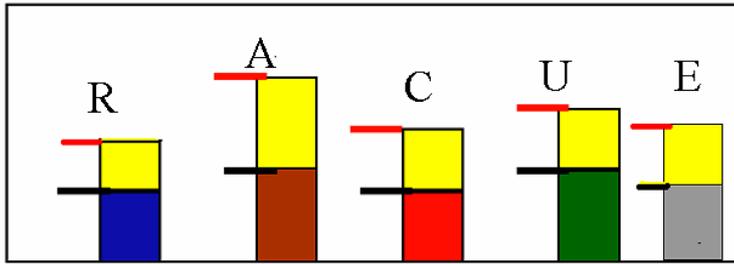
In this method, the WPI value is calculated simply on the basis of the time taken by a household to collect its domestic water supply. While this appears to be a very simple option, it does still require household level data on water collection, and provides no information on other issues such as the availability of water supplies, the ecological impact of water use, or anything to do with either industrial or agricultural water use. Nevertheless, it does provide some insight into welfare differences between households with respect to water provision. More details of the methodology are given in Appendix 1.3.

#### 4.3: A 'Gap' approach

This approach is based on the concept of the 'poverty gap', a system of poverty measurement used by many economists. In this approach, a minimum standard needs to be defined for a variety of issues, and this is then compared to the actual standard found in the location in question. In this method, the WPI is measured by the difference between the Predetermined standard ( █ ) and the actual measured value ( █ ) on a variety of criteria. This is shown hypothetically in Figure 9, and more details are given in Appendix 1.4.

**Figure 9. Applying a Gap approach to calculating the WPI**

Note: In this method, the WPI 'gap' is shown by the yellow boxes



Note: R= resource, A = access, C = capacity, U = use, and E = environment

Inadequate time has been available to explore this approach more fully, although preliminary consultation with water professionals and practitioners in the three pilot countries has generated a potential set of variables on which the gap can be assessed. The consensus seems to be that the method has potential for further exploration, and the use of the same key components as is used in the composite approach has been suggested. While some of the variables to represent this have been identified, the level of what would be used as the minimum standard for each of them has yet to be determined. It was also suggested that this could be a good way to present the results of the composite index approach. More work on this approach could be included in the next phase of the project.

**4.4: Other approaches**

During the conceptualisation meeting in Arusha, the idea of using some kind of grid or matrix was discussed at some length. It was from this idea that the WPI pentagram has evolved, as this serves the function of providing clear information on a range of issues relevant to examining links between water and poverty. It was suggested that this approach could be considered as a way of illustrating WPI values based on the five already identified components, and perhaps even based on the WPI values calculated using the composite index approach. Showing WPI information in other ways using diagrammatic approaches will be explored in later work.

Another approach considered during Phase 1 of this project is a composite index approach based on the Jarman Index of Social Deprivation used by British social services departments. The formal expression of this approach is as follows:

$$WPI = 1/n \sum_{i=1}^n I_{ij} . \quad [5]$$

where index indicator **I<sub>ij</sub>** for each variable is defined as follows:

$$I_{ij} = \frac{\text{Max}(X_{jk})/k - (X_{ij})}{\text{Max}(X_{jk})/k - \text{Min}(X_{ij})/k} \quad [6]$$

In this approach deprivation levels will range between 0 and 1.

More detail is given on this approach in Appendix 9.11, Malomo and Mapuranga, 2002, which shows some examples of WPI values calculated on the basis of government data from Tanzania. Due to lack of time, however, this interesting approach was not tested to the same extent as the other composite approach. In the next phase of the project, it would be interesting to calculate the 'Jarman' WPI values for the pilot sites, and compare the results to the other community level composite values.

Another approach which has briefly been examined is based on an econometrics approach, where data from the household surveys has been analysed using a logit/probit approach. In this work, ill health is used as an outcome of water poverty, and attempts have been made to identify key variables which may influence that outcome. One of the problems of this approach however is to differentiate endogenous and exogenous variables, since water management issues are so interrelated. Some suggestions on how to address the WPI using this approach is provided in Appendix 9.18, where appropriate formulae to analyse the data using this approach are described.

More detail on this approach can be found in Appendix 9.6.

## **5. Evaluation and discussion**

This project has covered a lot of material, and has produced a number of tangible and intangible outputs. A table of contracted outputs is shown in Appendix 8, but some evaluation of some aspects of the project is provided here.

### **5.1 Evaluation of methods tested**

In order to evaluate something, we need to have some kind of standard to measure it by, and this is difficult in this case as there is at present no real alternative measure to assess the links between water and poverty with which we can compare our work. We have however produced a preliminary assessment of six different approaches to calculating a Water Poverty Index which in themselves can be compared.

According to the decisions made at the consultative conceptualisation workshop held in Arusha in May 2001, the composite approach was preferred, and so the majority of the time spent in analysis has been devoted to that approach. We have created an integrated framework incorporating several indicators representing characteristics of the water sector, and on this basis we have devised a methodology by which such an approach can be used to compare situations at both the micro and macro level. To a lesser degree, we have also examined the other approaches discussed at the conceptualisation workshop, and some analysis of these is provided.

### *Advantages and disadvantages of methods examined*

The composite approach is well tried and tested, as it provides the basis for the now widely accepted *Human Development Index* and many others. One of the main problems of using a composite index approach is that there are situations when data of different types has to be combined. For example, we want to combine a measure of monetary value with one of child mortality, along with several other measures. To avoid the problem of incommensurability, sub-components used in the composite approach have all been converted so some index value of between 1 and 100, thus enabling variables to be combined.

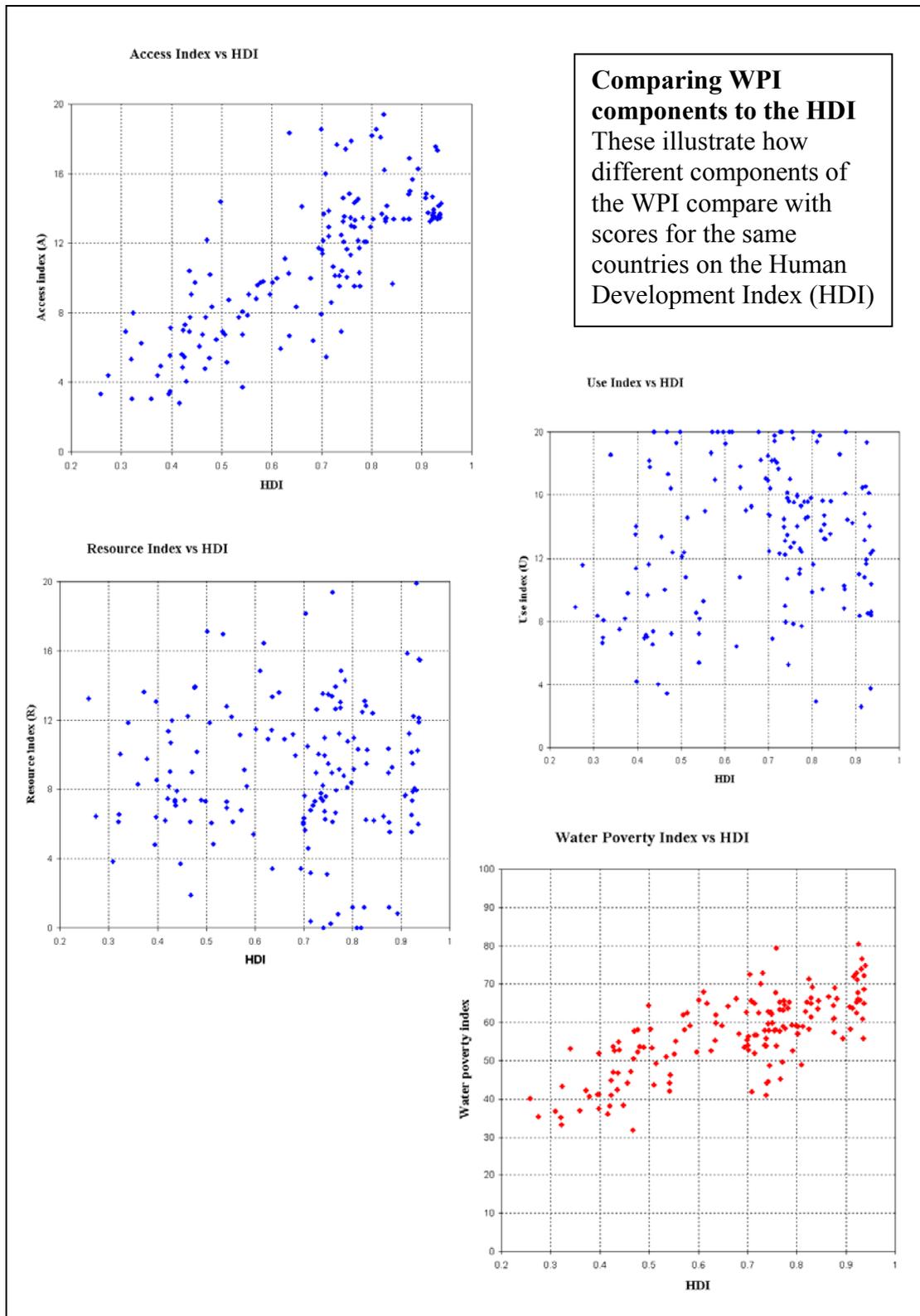
A further problem may arise from the the fact that all the different components and sub-components are combined by averaging. This means that extremes tend to be compressed, creating the misleading impression of greater homogeneity between sites. This problem is reduced if the number of variables used to structure the WPI can be reduced. For this reason it would be worth the effort to investigate this possibility in future. This can be done by examining the degree of correlation between the variables, revealing potential variables to discard. Another criticism of the HDI is that there is quite a high correlation between the variables used in its structure. We have tried to overcome this by attempting to select variables which do not appear highly correlated. In addition, we have tried to develop a framework which produces a result which does not reproduce the HDI, so correlations between the HDI and WPI will not necessarily be found. Figure 10 shows examples of how the use, access and resource variables of the WPI correlate to the HDI, while Figure 11 shows the relationship between the national level WPI values and the HDI. This is an interesting aspect to consider when we refer to the national level WPI values generated by applying the WPI framework to data available in the public domain. Details of how this has been done are explained in Appendix 9.10, Lawrence, Meigh and Sullivan, 2002, and provisional WPI values are shown graphically in Figure 12. Here, the bars of different colour represent each of the five WPI components, and the final WPI value is the sum of those five. Comparisons between countries can be made using this approach, but it must be noted that some anomalies may arise when data from certain sources is missing or in some way flawed.

When collecting the dataset for this macro level WPI calculation, we noted that some variable values were not reliable from some sources. In the calculations included in this report, attempts have been made to reduce potential errors resulting from this data uncertainty, but there is little doubt that the measure would become both more valid, and reliable, if better, more accurate data was available. It is for this reason that we have considered and discussed the possibility of alternative approaches to data generation. (see section 3.5) Another problem with the composite approach is that it is not obvious which direction some of the components should go, eg., increasing water use is good, but after a certain point it becomes wasteful and is therefore bad. Where possible, we have tried to build this into the structure of the calculations to overcome this, but scope for improvement still remains.

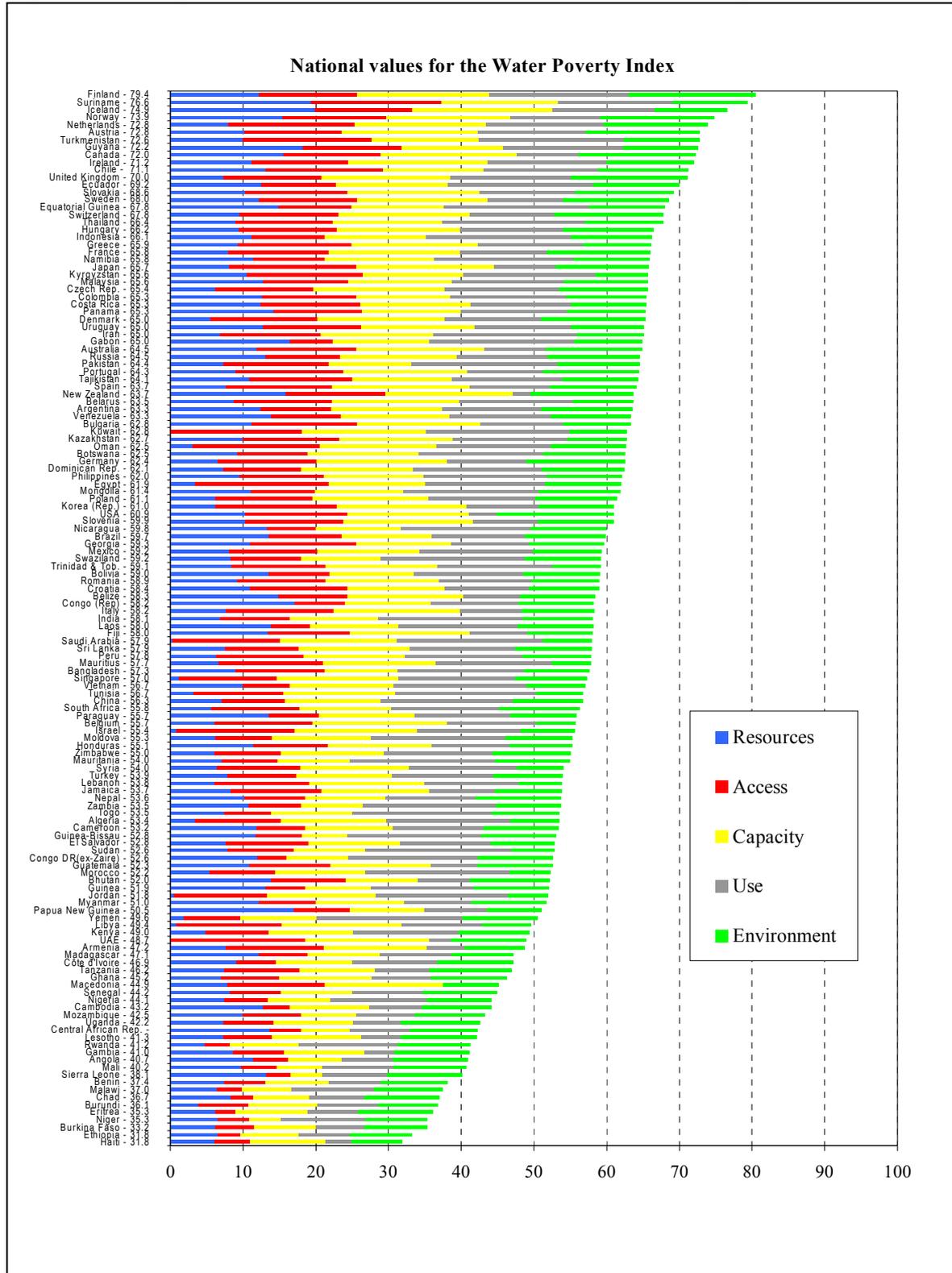
The Gap approach may provide a different type of insight into the problem, providing a more thorough understanding of the extent of incidence of water poverty. This is because it should be possible to be able to calculate how many people actually fall into the 'gap' used to refer to the situation of water poverty. For example, a national value for the WPI in a large country (like India or China) may not tell us very much, but if this was illustrated by the gap approach, this may identify that several millions

of people fall into the *water poverty gap*, and are thus inadequately served by the water sector.

**Figure 10. Comparing WPI components with HDI scores**



**Figure 11. Component values of the national level WPI scores compared**



In both of these approaches, the possibility of including different sub-components makes it possible to adapt the method to different situations (urban, rural) and different countries. This however does bring with it problems of maintaining comparability across different communities. The major disadvantage of the gap

approach is that it involves the need to set standards, on which the gap itself is based. This clearly must be locally determined to be appropriate and relevant, so that individual countries can set their own base line standards. This of course in itself is not without problems, but it could be investigated further by consulting with “expert groups” to define levels within a certain range for each component attribute which makes up the ‘gap’.

With the time analysis approach, the big advantage is that it is very simple, and does not require much detailed data, but the problem is that it doesn’t reflect sufficient complexity of the situation. For example, it omits some of the aspects that we want to examine when considering the alleviation of poverty through more sustainable and effective water management strategies. The time value could be calculated for those with piped supplies on the basis of the labour time requirement needed to pay the associated water charges, but problems would arise because of different price relationships between water and labour which will inevitably exist in different areas. With this method, issues such as water quality or environmental impacts are not addressed, which means that any policy resulting from this type of evaluation cannot be said to be founded on principles of sustainability. It is interesting to note however how this approach does correlate quite well with the more comprehensive composite index approach. For more details on this, see Appendix 1.3.

The Jarman approach has been briefly examined and this has shown that there is merit in examining it further to see what specific advantages this approach has over the others. Due to the short time period in this first phase of the project, it was not possible to make a comparison of this method using the test-bed dataset. Future work should explore any possible advantages and disadvantages this approach may have. Similarly in the case of the econometrics approach, we have made some progress in determining an appropriate methodological approach using a logit model, and the model has been developed and preliminary tests have been made.

The sixth approach to developing a WPI that we have explored relates to the use of GIS as an integrating tool. Progress in this aspect of the work has been slow, but there now exists a comprehensive georeferenced dataset from each pilot country, and from this, spatial relationships between different aspects of the water sector can be investigated. Novel findings may arise from this, but as yet, more work needs to be done.

The matrix concept discussed at the Arusha workshop has evolved into a method of displaying the WPI results, rather than as a method of calculating its value. From this idea we have developed the five-dimensional diagram we have referred to as the ‘pentagram’. This has proved to be an extremely productive way of displaying the complexities of the WPI information in a very simple and transparent way. These diagrams must be taken to be an essential part of the WPI score, as they offer the opportunity to examine each of the component values.

While each of the approaches outlined here has its advantages and disadvantages, it seems that the best approach to take for refining the WPI, is to use a composite approach for calculating a set of baseline data, from which the value of a *Water Poverty Gap* could be generated. The matrix approach would be implemented in the form of the analytical pentagram. Preliminary work suggests that there is strong correlation between the results of the composite approach and the time analysis approach. Possibly the time-analysis approach coupled with GIS could be used as a

way of facilitating scaling up, since this could provide proxy WPI values for much wider areas. This would enable widespread application of the methodology at a level more appropriate for national policy application.

### **5.2: Evaluation of the WPI by key stakeholders in pilot countries**

During the consultation and dissemination process, many opportunities for feedback were given to participants. At the workshops held in Tanzania, Sri Lanka and South Africa, appraisal sheets were distributed and comments sought. These can be examined in Appendix 7.2. Local participants who were actually from the study areas commented that the representation produced by the WPI values did reflect the nature of the communities represented. In almost all cases of those consulted, very positive feedback was received.

The general consensus of opinion is that the WPI provides a useful structure that can help all stakeholders to have a better understanding about how water needs to be managed. It was stated that to be useful, the tool must be locally relevant, and easy to use and explain to others. It was felt that these criteria could be met by the WPI, and in the study countries, government officials and representatives of NGOs suggested that specific areas should be identified for more intensive pilot testing of the WPI, with a view to appraising its value as a national policy tool. Letters outlining some of the suggestions of how this could be done, can be seen in Appendix 7.2.4. There is little doubt that this process of developing the WPI is timely, and such a tool is considered useful and worthwhile, both by local water managers, and by national policy makers. With such a degree of local support and institutional interest, an opportunity would be lost if the chance to implement the WPI, and develop it further, were to be missed.

### **5.3: Evaluation of project achievements**

A lot has been achieved in the 12-month period of the Phase 1 of the development and testing of the Water Poverty Index. All of the contracted outputs have been delivered, and much foundation has been laid for the future continuation of this work. A considerable degree of awareness-building has been conducted in the pilot countries during this time, and this has laid the foundation for a more open atmosphere of cooperation between the different government agencies which would be involved in the implementation of the WPI at regional or national level. Building such cross-cutting institutional networks during phase 1 of the project has put in place a core of the human and social capital that would be involved in the implementation of the WPI.

Dissemination of the project outputs has been widespread, and is continuing. Detailed information about the WPI tool and its application have been provided to stakeholders at dissemination and consultation workshops. Feedback from these has been positive, and institutions in all of the pilot countries have indicated that they would like to see the implementation of the WPI taking place there. It is interesting to note that participants at those workshops who were from the pilot site areas, judged the rating of the sample villages produced by the community level WPI, as being a good representation of the actual reality. An additional dissemination workshop is planned to take place at the Commonwealth Secretariat on June 26<sup>th</sup>, 2002, and this will provide the opportunity for information about the WPI to be disseminated widely to

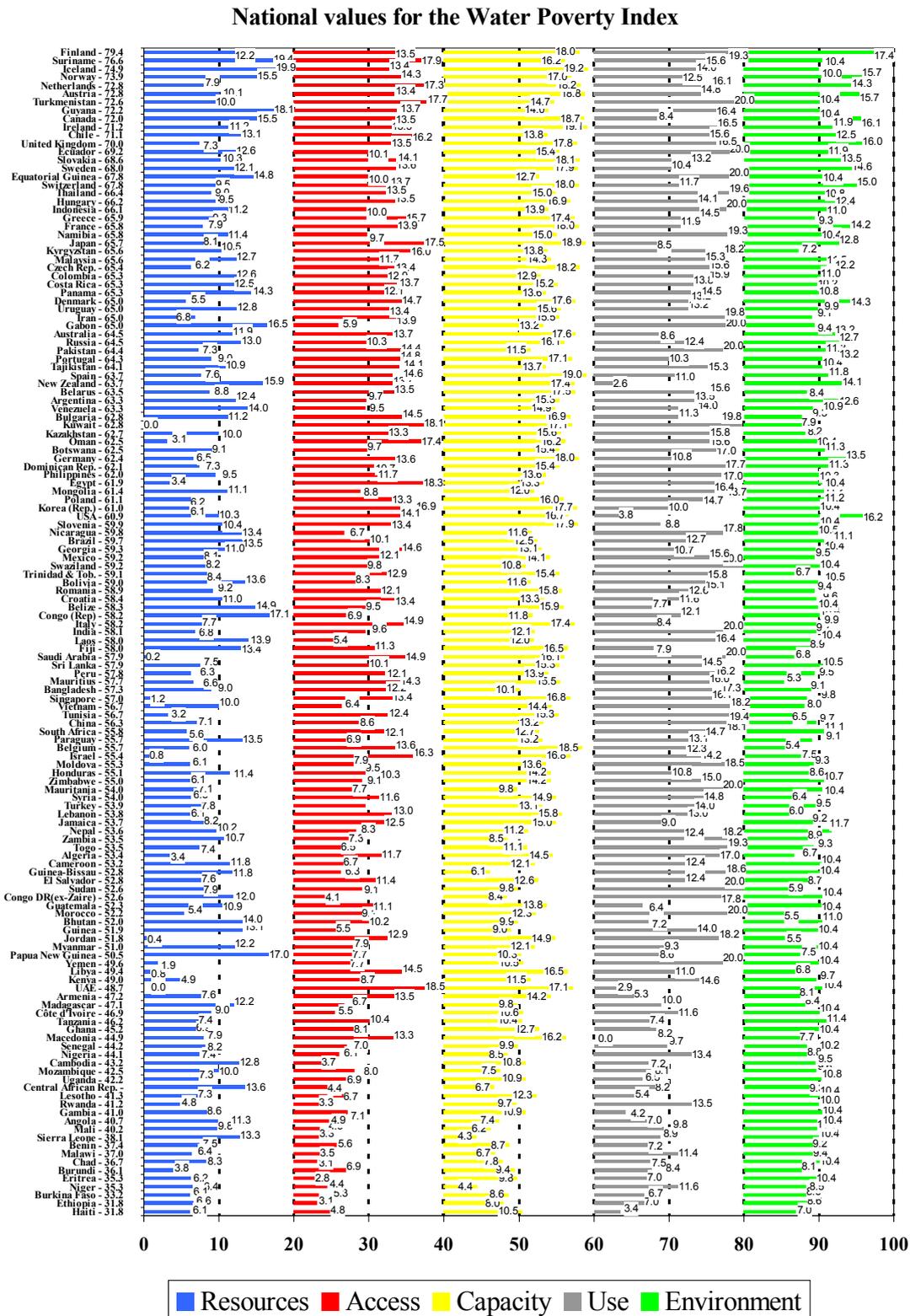
representatives of governments of a number of countries to whom the implementation of the WPI could be particularly relevant. (For more details on workshops, see appendix 5 and 6).

Training materials have been prepared and tested in the dissemination workshops, and a compilation has been produced in the form of a preliminary WPI training manual '*Water Poverty Index Implementation: An Introduction* (draft version). This manual could provide the basis of WPI capacity building workshops which would be required if the WPI was to be implemented, but more work is needed to refine it. Additional training material is provided by a WPI primer, entitled '*Evaluating your water*' which is designed as a background reference document for the use of junior and middle level management.. Its purpose is to provide such people with a general overview of key issues, which are relevant to the implementation of the WPI. This document has been reviewed as part of the consultation process, and it has been appraised by over 20 such people in each pilot site. It has generated very positive feedback, and was seen as a very useful publication (See Appendix 5.2, 6.2 and 6.7). During the next phase of the project, it is intended to incorporate all of the suggestions collected from the appraisals by stakeholders, and produce a final version for distribution.

Other publications which have been generated by the WPI work include two refereed journal papers, in *Water International*, and *World Development* (See Appendix 6.5). A conference presentation was given at the Tanzanian Water Experts Conference, in Arusha 2002, (See Appendix 7.2.3), and the project has also been referred to in the popular press in Tanzania. A widely disseminated poster on the WPI was first presented at the Dundee Water Law conference in 2001, and another is being prepared for the Help conference in Sweden in August 2002. A paper on the WPI has also been invited for the forthcoming climate change workshop in August 2002, Colorado. (For examples of these publications, see Appendix 6). An example of how the WPI has been seen as having relevance to other work is provided by the interest in the WPI expressed by the Hadley Centre (UK Met. Office). Furthermore, approaches have been made by the Climate Change challenge programme to apply the WPI methodology as a way of identifying areas of key impacts of climate change, for which change in water availability is seen as a key indicator.

Information about the Water Poverty Index will be included in the *World Water Development Report*, to be published in 2003. Material on the WPI composite index approach will be included in the indicators section of the report, and it is likely it may feature in other sections. WPI scores have been rearranged to show individual component scores more clearly, as shown in Figure 12.

Figure 12.



Three of the leaders of the case studies being carried out for the WWDR requested that assistance be given on how to apply the WPI to their locations, but at this point in

time, this has not been implemented. This is another potential dimension for any next phase of the project.

#### **5.4: Evaluation of capacity building**

Throughout this project, capacity building has been incorporated at the core of the work. In the case of the data collection at the survey sites, over 20 students and young professionals were involved in data collection, and that involved training in appropriate survey procedures, delivered by staff from the Geodata Institute at the University of Southampton. Ilse Steyl, a research student from South Africa has been able to join in this training process and has enriched her knowledge of many of the theoretical and practical challenges of field data collection. Dennis Dlamini (from Swaziland) has been able to contribute to the development of the hydrological work on the WPI at the University of Natal, South Africa, and he is hoping to continue with this to doctorate level in the future.

Through the dissemination and consultation workshops held in each country, over 60 water professionals from government departments and NGOs participated in 2 day workshops on introductory concepts of the WPI and its calculation. Materials used in these workshops are presented in Appendix 6.2. One of these is designed as a concise reference work, entitled *Evaluating your Water: a Management Primer for the Water Poverty Index*, which provides background information relevant to the introduction of the WPI, while the other, *WPI Implementation – an Introduction*, provides a structured workbook outlining how the WPI can be calculated. Hardcopy examples of these are included with this report (Appendix 11). Feedback from these workshop attendees has been very positive, both on the primer, and on the workshop contents. Documentation of this is provided in Appendix 7. In the future, the many useful suggestions from these delegates will be incorporated into the primer booklet.

Scores of other people have also benefited from interaction with the WPI team. Numerous enquiries have been received, and this work has provoked much debate and discussion among a wide range of people. This debate has now entered the academic domain through the publication of journal papers on the Water Poverty Index (Sullivan, 2001 and 2002), and the conference paper on the application of the WPI in Tanzania, delivered by Mr. Steven Mlote at the AWAC conference in January 2002 (See Appendix 7.2.3). The project members themselves have also increased their own capacity through intense involvement with the work and all of its challenges. Last but not least, the wide range of householders who participated in the household surveys have been exposed to new ideas which may well encourage them to seek solutions to some of their own water problems.

One of the main objectives of the task of developing a Water Poverty Index is to develop a tool that can be calculated and used by countries themselves, without the need for external assistance. Clearly, to put such a system in place, a core of WPI expertise will be needed, and a start has been made with this in the form of the WPI consultation/dissemination workshops. If the WPI tool were to be implemented more formally, there would clearly be the need for more capacity building, and the introductory materials mentioned above, have been provided for this purpose.

## 6. Scope for implementation of the WPI

While this methodology certainly has potential for application in any location, by individual water managers or researchers, it is also likely that an important contribution to water management could be achieved through widespread application of the WPI approach. Such larger scale applications need to be approached with much sensitivity and caution, since success of the process itself depends on an effective degree of cooperation between different agencies in the country.

Those Institutions consulted during the dissemination and secondary data collection visit to Tanzania provide an example of the range of institutions that would be likely to be involved, if implementation of the WPI were to occur. These were:

- Ministry of Science and Technology,
- Ministry of Water and Livestock,
- Environment Division, Office of the Vice President,
- Poverty Monitoring Programme, Office of the Vice President,
- National Statistics Bureau,
- National Planning Office,
- Ministry of Health,
- Ministry of Education,
- Institute of Water Research,
- University of Dar es Salaam,
- Institute of Resource Assessment,
- Arumeru District Council.
- Arusha Urban Water Supply Office
- DFID Tanzania, (water, education and social development advisors consulted).

The development of cooperative links between these organizations would be an important part of the implementation process.

### 6.1: Implementation in pilot countries

In Phase 1 of the project, specially generated household level data were used to derive the WPI for four communities in each of three countries. In the next phase of the project it is intended to move towards implementation of the WPI over much larger areas. Depending on the country and situation the larger areas could be districts, provinces or basins – in any case, the aim is to cover a significant area of land that would generally include a few hundred communities. The step from pilot testing in very few communities using detailed surveys to practical implementation is a major one, and not to be taken lightly. There has to be a clear mandate that the tool will be of use and relevant for policy issues, and efforts have to be taken to make sure the procedure is carried out in such a way as to minimise both sources of error, and implementation costs.

Such implementation at a wider scale will require a substantial period of consultation and development, and detailed specification of the process. This would be done differently in each the countries in order to adapt the WPI to the needs of the individual countries and proceed in a way that is responsive to their particular cultural, social and economic situations. In this way a WPI that is appropriate for the specific needs of individual countries will be developed. We envisage that the following steps would be needed:

- Set up a network of the relevant government agencies and NGOs in each country that would be responsible for the development and application of the WPI.
- Carry out consultation and discussion through this network to develop in detail the specific approach needed in each country. This would need to cover:
  - selection of the specific information that would be collected (based on the research done in Phase 1, a reduced set of key information can be suggested, but this may be adapted for each country);
  - examination of existing data to decide what is useful, who has it, how it is collected, and how it should be accessed;
  - selection of methods that would be used to collect household data (eg, whether by surveys, censuses, schools, etc);
  - selection of methods to transmit, store, process and integrate the data from all the different sources;
  - determination of particular methodology for estimating the water resources component (this requires a different approach to other types of data because of the scale issue; see below);
  - determine the specific region or part of the country which would be studied – naturally, it is likely that the focus will be on areas that are thought to have the most severe water problems.

The three countries included in the pilot phase – Tanzania, Sri Lanka and South Africa – have all expressed a strong interest in developing the work further. Letters to that effect have been received, and copies can be found in Appendix 7.2.4. We therefore propose to continue the work in each of these countries to the level of preliminary implementation as described above. There is much value in continuing successful collaborations already established, and the different circumstances (geographical, social, cultural, economic, institutional, and in terms of data availability) mean that these are all interesting and worthwhile examples for further work. In order to allow maximum capacity building at each level, it is anticipated that in the next phase of the work, each case would be led by one main local partner, but would also bring in a wide range of others in a network. Other tasks which would need to be done to achieve widespread implementation, would include:

- Preparation of a detailed specification and work plan for the work identified in each country.
- Carry out the implementation in each country
- Examine and report on the results, by cross-checking with sample surveys.
- Produce a realistic proposal (methodology and practical mechanisms) for extension of the WPI to provide national coverage in each country.

## **6.2: Implementation in untested countries**

In addition to developing procedures to take the work forward in the pilot countries, it is proposed that the approach should be tested in at least one more country where the preliminary study has not been done. This would provide a test of how the approach could be established and developed to level of preliminary implementation without the preparatory phase. The proposed country is Bolivia (Lake Titicaca basin), where keen interest has been shown in taking on the WPI work, and which is an area

suffering from poverty and water scarcity problems, but provides a different set of circumstances to those studied in Phase 1. Another possible case could be the Philippines, where water researchers and managers have also shown much interest in the work. There is also the possibility of testing the method in small island states or specific ecosystem types. Given sufficient interest and support (from the countries and international agencies) there is enormous scope for the idea to be taken up at all levels, ranging from direct community involvement (communities making their own calculations, perhaps with NGOs), to country programmes, or even to a more sophisticated international assessment with UN support.

## 7. Conclusion and recommendations

This phase of the WPI project has been conducted over a 12 month period, but in spite of that short time, good progress has been made in both developing the methodologies of calculating a WPI, and in testing them. From a test-bed of specially collected data, WPI scores have been calculated for 12 different locations in three countries, and this demonstrates the generic applicability of the tool. The application of the composite framework to public datasets to generate national scores has been an interesting part of this testing, as it has enabled provisional WPI scores to be generated for 140 countries. This has provided stimulus for discussion of the composite approach. During the consultation process, it became clear that the composite index approach was preferred, as it was felt that this could go some way to capturing the complexity of the water management problem. Concern was expressed over the need for caution in using existing data, and combining datasets, and while care was taken in data selection, there is scope for improvement in the next phase of the work.

The WPI tool can provide decision-makers with a transparent framework on which their decisions can be based. During the project, a number of other ways in which the WPI can be of use have been identified. These include:

- as a tool for prioritisation of need according to a standardised transparent method,
- as an evaluation tool to be applied at a variety of scales, including the national scale and at the community level, enabling more informed decisions to be made.
- as a tool for monitoring progress over time (assuming the WPI is implemented and updated over time),
- as a way of understanding more about the complexities of water management,
- as a tool to empower communities and decision-makers by giving them the opportunity to participate in knowledge-building about the natural resource base on which they depend.
- as a means of reducing potential conflicts by increasing the confidence of people in the rationale behind water management decisions.

The data from which an effective Water Poverty Index can be built does already exist to a large extent. In every country, numerous surveys are carried out by a range of government departments, and census data is collected regularly. In most countries, this data is generated from 'enumerator districts' which can vary in size, but usually are collected together to represent a local administrative unit. By making use of this type of data in the WPI, much finer resolution information can be generated, and this can be used to build the WPI database from which the values can be calculated. The

main challenge to implement the WPI in practice is to bring together this information, and supplement it with a few extra locally-generated details to capture the site-specific nature of the water allocation problem. Our recommendation is that the development and testing of the WPI continues into the second phase, thus giving the chance to refine the approach, and put in place the institutional networks to facilitate the collation and analysis of WPI data at the implementation sites. This generation and integration of community level water-relevant data is something which is of wide interest, and it is likely that improvements in quality and availability of data will bring about better water management in the future. For more details on what future work is suggested, see the outline proposal attached as a separate section of this report, entitled *Water Poverty Index, Phase II, Laying the groundwork for implementation*.

All indexes of physical, social and economic activity attempt to simplify the extremely complex. The Water Poverty Index has been developed by an interdisciplinary team of environmental and social scientists, engineers and water resource professionals. Throughout the project, we have taken into account the complexity of linking multidimensional aspects of water management together, in such a way as to construct a holistic water management tool to address the problems of poverty, and its relation to water access and use. We have successfully tested this methodology in a range of locations and at both at the local and national levels, and this has shown that there is great potential for the useful application of the WPI in a variety of locations.

During the short time we have been working on this first phase of the Water Poverty Index, we have attempted to put in place a foundation on which progress can be built. There is much work still to be done to refine aspects of the structure, and on the process by which it could become part of a nation's water management strategy. By highlighting the fact that integration of different attributes is possible and useful, the development of the WPI raises the possibility of really addressing some of the root causes of inequalities associated with water use, which ultimately could prevent the achievement of a secure and sustainable future.

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