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2002/19

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Keele Economics Research Papers

KEELE UNIVERSITY

Keele ▪ October 2002 (March 2003)

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ISSN 1352-8955

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The Water Poverty Index: an International Comparison

by

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Date October 2002 (Revised March 2003)

Abstract This paper reports on the construction of an International Water Poverty Index, part of the first phase of a research project into building a locally based version of the index. The purpose of the Water Poverty Index is to express an interdisciplinary measure which links household welfare with water availability and indicates the degree to which water scarcity impacts on human populations. Such an index makes it possible to rank countries and communities within countries taking into account both physical and socio-economic factors associated with water scarcity. This enables national and international organisations concerned with water provision and management to monitor both the resources available and the socio-economic factors which impact on access and use of those resources. This paper presents details of the methodology used and the results obtained for 140 countries covering measures of resources, access, capacity, use and environment.

Keywords Indicators, water, environment, water poverty, income poverty

J.E.L. Class C43, I31, O13, Q25

Notes Our thanks to very helpful inputs from William Cosgrove, Richard Connor and many others at various meetings and workshops too numerous to list here. Discussions with Rivkka Kfir and her colleagues at the Water Research Commission, Pretoria, and Barbara Schreiner at DWAF Pretoria specifically led to indicators on water quality, governance and distribution being found and added to the index. Many others also made important contributions to the thinking behind this work, in particular the team members of the research project 'The development and testing of the Water Poverty Index'. This paper is an output of that research project funded by the Department for International Development (DFID), UK Knowledge and Research contract number C24. The views expressed here do not necessarily represent those of DFID.

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1 Introduction

Indicators of performance are an important part of the process of evaluating achievement. They have become an important management tool giving direction to managerial policy and the allocation of resources. They have also become an important political tool, allowing both professionals and the lay public the possibility of making judgements about the effectiveness of government policy. Performance indicators have come under academic scrutiny with questions being raised as to the degree to which a set of numbers should be allowed to drive policy. Nonetheless these indicators do offer a relative measure of achievement which can serve to direct policy towards the improvement of performance.

This paper reports on the results of the first phase of a research project into the development and testing of a Water Poverty Index. The purpose of the Water Poverty Index is to express an interdisciplinary measure which links household welfare with water availability and indicates the degree to which water scarcity impacts on human populations. Such an index makes it possible to rank countries and communities within countries taking into account both physical and socio-economic factors associated with water scarcity. This enables national and international organisations concerned with water provision and management to monitor both the resources available and the socio-economic factors which impact on access and use of those resources.

Most international indices are derived from available national aggregate data. This paper uses the conceptual framework developed over the first phase of the project to show how it can be used to construct an index for international comparisons based on aggregate national data. The ultimate objective of the project is to develop Water Poverty Indices at a range of scales, as well as to show how the results of small participatory local surveys can be used to build up a weighted national index which can replace or complement an index based on aggregate national data. Geographical variation is particularly important in water, with substantial differences in water availability and access sometimes being found even between adjoining villages or communities. Pilot surveys have been successfully carried out to examine the feasibility of developing a ‘bottom-up’ monitoring tool and the results of this work will be reported in a separate paper. However, in the present paper we concentrate only on the aggregate national aspects.

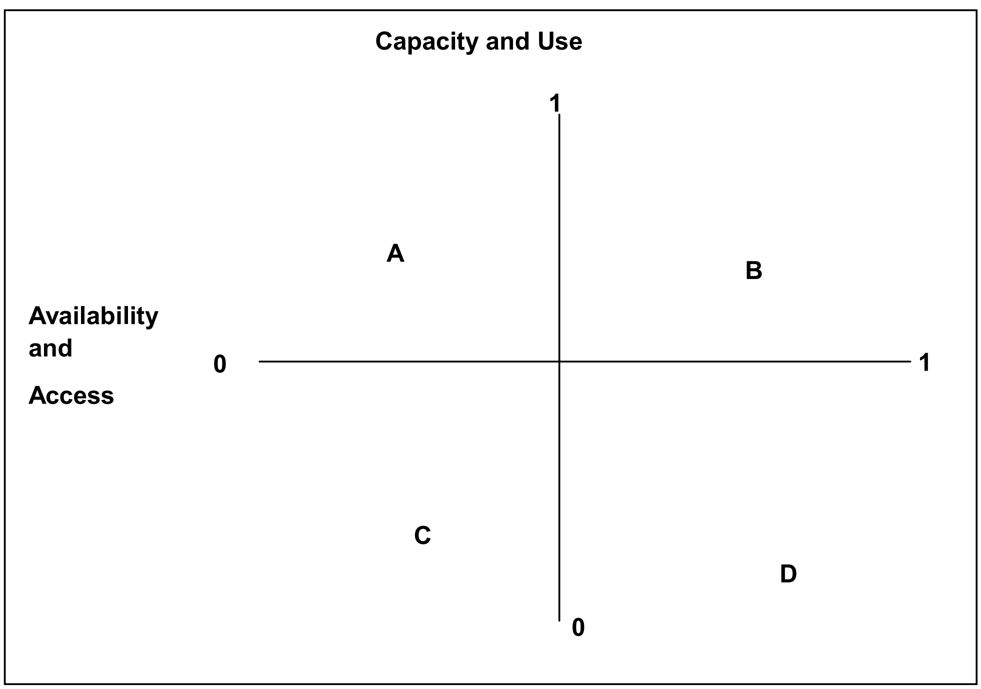
2 Conceptual Framework

The idea of a WPI is to combine measures of water availability and access with measures of people’s capacity to access water. People can be ‘water poor’ in the sense of not having sufficient water for their basic needs because it is not available. They may have to walk a long way to get it or even if they have access to water nearby, supplies may be limited for various reasons. People can also be ‘water poor’ because they are ‘income poor’; although water is available, they cannot afford to pay for it. The South African Minister of Water Affairs and Forestry noted how he began life as a Minister,

…… with the shock of finding, in a village with a text book community water project, a young woman with her baby on her back, digging for water in a river bed, metres from the safe supply that we had provided. She was doing this because she had to choose between buying food or buying water. (Kasrils, 2000)

It is this kind of water poverty that the WPI constructed here is trying to capture alongside the more traditional definition of this condition. There is a strong link between 'water poverty', and 'income poverty' (Sullivan, 2002). A lack of adequate and reliable water supplies leads to low levels of output and health. Even where water supply is adequate and reliable, people's income may be too low to pay the user costs of clean water and drive them to use inadequate and unreliable sources of water supply. The underlying conceptual framework of the index therefore needs to encompass water availability, access to water, capacity for sustaining access, the use of water and the environmental factors which impact on water quality and the ecology which water sustains. Availability of water means the water resources, both surface and groundwater which can be drawn upon by communities and countries. Access means not simply safe water for drinking and cooking, but water for irrigating crops or for non-agricultural use. Capacity in the sense of income to allow purchase of improved water, and education and health which interact with income and indicate a capacity to lobby for and manage a water supply. Use means domestic, agricultural and non-agricultural use. Environmental factors which are likely to impact on regulation will affect capacity. This conceptual framework was developed as a consensus of opinion from a range of physical and social scientists, water practitioners, researchers and other stakeholders in order to ensure that all the relevant issues were included in the index.

Figure 1 A WPI quadrant or matrix approach



The conceptual framework for the index can be illustrated in the four quadrant diagram in Figure 1. Quadrant A indicates a country or community which scores relatively highly on capacity and use, but has a low score on availability and access. Quadrant B shows relatively high scores on both sets of factors. Quadrant C indicates both water and income poverty, while quadrant D covers relatively low capacity and use but high availability and access[1]. However, this is not a complete description of the framework because the fifth factor, environment, should also be included, but has been omitted here for presentational simplicity.

Indicators are usually presented in the form of an index derived from a range of available data. The resulting measure enables a judgement of performance relative to previous time periods, or to the performance of others. The consumer price index tracks the prices of a typical basket of goods for one country or region over time and is usually published monthly. Indices of industrial output track the output of a representative sample of industrial products over time. The terms of trade indices track the relative prices of imports and exports over time. The Human Development and Human Poverty Indices evaluate countries' performance relatively to each other.

All indices, however well established are not without problems. The consumer price index (CPI), established in the late nineteenth century, is based on the prices of a representative basket of goods. However, this basket of goods changes over time as new products come onto the market and other products disappear. The importance of individual items in the basket may change over time both because of changing consumption habits with rising income, and because of changes in relative prices. These problems are partly overcome by regular changes of base year and changes in the weights given to each item in the basket. However, although an imperfect representation of price changes in the long run, the single number CPI is widely used to deflate nominal Gross Domestic Product (GDP) in order to estimate real output growth over time, the traditional way of judging a country's rate of development.

Using GDP as a measure of levels of development and rates of growth of real GDP as a measure of progress was considered to be an unsatisfactory way to compare levels of development because it said nothing about the quality of that development. Increases in output might not necessarily mean that there were improvements in health or education or that the benefits of increased output were spread throughout the population. The search for more representative indicators led to the development of the Human Development Index (HDI).

The HDI is an average of three separate indicators: life expectancy at birth, educational attainment and GDP per capita at purchasing power parity (PPP) values. The educational attainment index comprises an index of adult literacy and of primary, secondary and tertiary educational enrolment in which adult literacy is given a two-thirds weighting and school enrolment one-third. The life expectancy index is constructed by taking the ratio of the differences between the actual value

[1] The authors owe this quadrant approach to the participants at the WPI workshop in Arusha, Tanzania in May 2001, and especially to J. Delli Priscoli. See also Sullivan, 2002.

for the country concerned and a fixed minimum (25 years), and a fixed maximum (85 years) and the fixed minimum. So a country with a life expectancy of 50 years would have an index of (50-25)/(85-25) = 0.417, while one with a life expectancy of 70 years would have an index of 0.75. Measures of educational attainment are straight percentages. The PPP measure of GDP per capita is adjusted by using log values in order to reduce the effect of very high incomes which are not necessary to attain a reasonable standard of living. The individual indices which make up the HDI are also published, so that it is possible to see what is driving any changes which take place.

The HDI gives a measure of social and economic progress which goes beyond the national income measures by which countries are usually compared. They encapsulate more than one measure of progress, averaged into a single number. The advantage of a single index is that it provides a measure which is uncomplicated and can clearly set one country's performance against that of others with which comparisons may wish to be made. Such comparisons will depend on the particular purposes of making them. Poor countries may wish to compare their position relative to rich countries, neighbouring countries may wish to show how much progress they are making relative to each other in order to convince their citizens that their governments are doing a good job. Failure to progress may push laggard regimes into making greater efforts, and may assist international organisations in pushing these regimes to progress. Publishing the component parts of the composite index can show where progress needs to be prioritised.

Nevertheless, the HDI, though now well-established, has been criticised on several grounds. Srinivasan (1994) is representative and has four main criticisms relevant to the present discussion. First, he argues (p.237) that 'income was never even the primary, let alone the sole, measure of development', as claimed by the first Human Development Report (UNDP, 1990). He notes that data on such measures as life expectancy at birth and infant mortality were used as measures of development from as early as the 1950s and that, for example, another single number index of 'international human suffering' already existed. Secondly, he takes issue with the conceptual framework underlying the HDI. The HDR distinguishes between the 'formation of human capabilities and the use people make of their acquired capabilities' (p.239). Countries can be compared internationally by measures of their real income based on values which are locally specific. This is not the case with such measures as life expectancy or educational attainment whose 'relative values may not be the same across individuals, countries and socio-economic groups' (p 240). Thirdly, most of its components are highly correlated with each other thus reducing the usefulness of the separate sub-indices in adding more information to the PPP income measure.[2] Finally, the data is weak, outdated or incomplete for many countries and therefore involves a large number of estimates.

Srinivasan is right to point to the prior existence of quality of life indicators. Nonetheless, until recently, the World Development Report in its statistical

[2] Ogwang (1996) on the basis of principal component analysis concludes that using life expectancy at birth as a single measure of human development would lose little information and give a simpler and lower-cost index.

appendices, ordered countries by GDP per capita, suggesting that this was at least the first statistic to be used in any assessment of development. The single number HDI was essentially an alternative way of making that primary assessment. As with GDP, any serious assessment of performance would still require looking at a range of indicators, both quantitative and qualitative. His other criticisms are also valid to some degree. However, these numbers are 'indicators' and not precise measures. Although different capabilities and uses might be valued differently across countries and groups of people within countries, the development objective has always been conceived in terms of a 'catching-up' process. So making comparisons in relative terms does encapsulate this concept of development. The correlations between the different variables are indeed, high. However, the rank orders of countries do change from PPP GDP to HDI, and so the 'league table' could be viewed as one of real income adjusted for the other indicators, which though highly correlated, are not perfectly correlated.

However imperfect a particular index, especially one which reduces a measure of development to a single number, the purpose is political rather than statistical. As Streeten (1994: 235) argues:

> *…such indices are useful in focusing attention and simplifying the problem. They have considerable political appeal. They have a stronger impact on the mind and draw public attention more powerfully than a long list of many indicators, combined with a qualitative discussion. They are eye-catching.*

3 An International Water Poverty Index (WPI)

Using a methodology comparable to that of the Human Development Index, we have constructed an index which measures countries' position relatively to each other in the provision of water. In order to do this, we construct an index consisting of five major components, each with several sub-components. Corresponding to the conceptual framework discussed above, the main components are:

- Resources
- Access
- Capacity
- Use
- Environment

The basic calculation, except where indicated below, is based on the following formula:

$x_i - x_{min} / x_{max} - x_{min}$

where x_i , x_{max} and x_{min} are the original values for country i, the highest value country, and the lowest value country respectively. The indices therefore show a country's relative position and for any one indicator this lies between 0 and 1. The maximum and minimum values are usually adjusted so as to avoid values of more than 1. Any remaining values above 1 or below zero are fixed at 1 and 0, respectively. Within each of the five components, sub-component indices are averaged to get the component index. Each of the five component indices is multiplied by 20 and then added together to get the final index score for the WPI, which is in the range 0 to 100.

A description of each sub-index follows.

Resources

This index combines two separate indices: one of *internal water resources* and the second of *external water inflows*. Both are calculated on a log scale to reduce the distortion caused by high values, and expressed on a per capita basis. External water inflow amounts are reduced by 50%; this is an arbitrary factor, but it is an attempt to give reduced weight to external water inflows because these resources are less secure than those generated internally within a country. The resources index is a basic indicator of water availability. A significant additional factor that affects availability is the reliability or variability of the resource; it should be included because the more variable the resource, the smaller is the proportion of the total resource that can actually be used. However, we were unable to find an indicator of variability that is available at the national scale, and this factor had to be omitted. Finally, water quality is also an important factor influencing the availability of the resource. Data on this were found, but have been included under the environment component (see below). To avoid duplication, it was not also considered as part of the resources component.

Access

There are three components to this index:

- percentage of the population with access to safe water
- percentage of the population with access to sanitation
- an index which relates irrigated land, as a proportion of arable land, to internal water resources. This is calculated by taking the percentage of irrigated land relative to the internal water resource index and then calculating the index of the result. The idea behind this method of calculation is that countries with a high proportion of irrigated land relative to low internal available water resources are rated more highly than countries with a high proportion of irrigated land relatively to high available internal water resources.

This index tries to take into account basic water and sanitation needs for relatively poor agriculturally-based countries, recognising that water availability for growing food is as important as for domestic and human consumption.

Capacity

There are four components to this index.

- Log GDP per capita (PPP) (US$). This is the average income per head of population adjusted for the purchasing power of the currency. This is considered to be a much more accurate measure of the average standard of living across countries. These data are presented in log form in order to reduce the impact of very high values.

- under-5 mortality rate (per 1000 live births). This is a well-established health indicator, and it is one that is closely related to access to clean water.
- UNDP education index from the *Human Development Report* 2001.
- the Gini coefficient. This is a well known measure of inequality based on the Lorenz curve which gives the distribution of income across the population.[3] Where the Gini coefficient is not reported, the Capacity index is based only on the first three sub-indices.

This index tries to capture those socio-economic variables which can impact on access to water or are a reflection of water access and quality. Introducing the Gini coefficient here is an attempt to adjust capacity to enjoy access to clean water by a measure of the unequal distribution of income.

Use

This index has three components:

- domestic water use per capita (m^3/cap/yr). This index takes 50 litres per person per day as a reasonable target for developing countries.[4] We then construct a two-way index such that countries at 50 litres = 1. Countries below the minimum have an index calculated such that the lower the value the more they are below the minimum. Countries above the minimum have a lower value on the index the higher they are above 50 litres.[5] This gives some measure of 'excessive' use.
- industrial water use per capita (m^3/cap/yr). Here the proportion of GDP derived from industry is divided by the proportion of water used by industry. The index is derived in the usual way: the higher the ratio of industrial value added share to industrial water use share, the higher the score on the index. This gives a crude measure of water use efficiency.
- agricultural water use per capita (m^3/cap/yr). The index is calculated in the same way as for industrial water use.

Environment

This index tries to capture a number of environmental indicators which reflect on water provision and management and which are included in the Environmental

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[3] Hicks (1997) constructs an 'inequality adjusted HDI which, for 20 countries, adjusts each of the component indices by a Gini coefficient for that indicator. He finds that there are 'losses on the HDI index score of up to 57%, and changes in rank go up to 3 negatively and 4 positively.

[4] see Gleick (1996) for a detailed rationale for adopting this standard

[5] For countries under the 50 litre target, the index *(I)* for country i is calculated by the formula $I = x_i / 50$, where x_i is per capita daily consumption in country *i.* The index for countries above 150 liters daily per capita consumption is calculated by the formula $I = 1-[(x_i - 150)/(x_{max} - 150)]$. Armenia and New Zealand with a daily mean domestic consumption of 684 and 653 liters per capita lie on and just above the zero mark respectively at the 'excess use' end of the scale, while Gambia and Haiti lie just above zero at the other end of the scale with respective consumption of 3 liters per capita per day.

Sustainability Index (ESI) (World Economic Forum et al, 2001). These indicators not only cover water quality and 'stress', but also the degree to which water and the environment generally, and related information, are given importance in a country's strategic and regulatory framework.

This index is calculated on the basis of an average of five component indices. These are:

- an index of *water quality* based on measures of
  - dissolved oxygen concentration,
  - phosphorus concentration,
  - suspended solids
  - electrical conductivity;
- an index of *water stress*[6] based on indices of
  - fertilizer consumption per hectare of arable land,
  - pesticide use per hectare of crop land,
  - industrial organic pollutants per available fresh water
  - the percentage of country's territory under severe water stress (again the ESI's terminology)
- an index of *regulation and management capacity* based on measures of
  - environmental regulatory stringency,
  - environmental regulatory innovation,
  - percent of land area under protected status
  - the number of sectoral EIA guidelines;

- an index of *informational capacity* based on measures of availability of sustainable development information at the national level, environmental strategies and action plans, and the percentage of ESI variables missing from public global data sets;
- an index of *biodiversity* based on the percentage of threatened mammals and birds.
- Table 1 provides a summary of the structure of the index and the data used to build it.

[6] This is the ESI's terminology, though what it describes is really an index of water pollution.

Table 1: Structure of Index and Data Used

WPI Component	Data Used
Resources	• internal Freshwater Flows • external Inflows • population
Access	• % population with access to clean water • % population with access to sanitation • % population with access to irrigation adjusted by per capita water resources
Capacity	• ppp per capita income • under-five mortality rates • education enrolment rates • Gini coefficients of income distribution
Use	• domestic water use in litres per day • share of water use by industry and agriculture adjusted by the sector's share of GDP
Environment	indices of: • water quality • water stress (pollution) • environmental regulation and management • informational capacity • biodiversity based on threatened species

Analysis

The resulting Water Poverty Index is presented in rank score order with the highest scoring country first (see Figure 2 and Appendix 1). The results show few surprises. Of the 147 countries with relatively complete data, most of the countries in the top half are either developed or richer developing. There are a few notable exceptions: Guyana scores highly on resources, access and use to get into fifth position, while Belgium is 56th in the list, having scored low on resources and on environment. The US and New Zealand, though they score relatively highly on Environment score very low on use. South Africa, low on the resources index, is relatively high on the other sub-indices reflecting its progressive policies on access and management. The index as presented does suggest areas of current future policy concentration with the overall performance. Data are also provided in

Appendix 1 on the Falkenmark index measure: that is, water resources per capita per year. The correlation between the Falkenmark index of water stress and our Water Poverty Index is only 0.35 which suggests that the WPI does add to the information available in assessing progress towards sustainable water provision[7].

Table 2 below shows the correlation matrix for the five indices and the WPI. There is very little correlation between the different sub-indices, with the exception of access and capacity. Although intuitively, a strong association between these two indicators is to be expected, we might have expected a stronger negative correlation between resources and use (the more scarce the resources, the better use is made of them), and a negative association between resources and environment (the more scarce the resources, the more attention is paid to conservation generally).

Table 2: Correlation Matrix: sub-indices WPI and HDI

	Resources	Access	Capacity	Use	Environ -ment	HDI	WPI
Access	0.05						
Capacity	-0.06	0.82					
Use	-0.01	-0.06	-0.11				
Environment	0.28	0.27	0.28	-0.28			
HDI	0.03	0.87	0.94	-0.12	0.31		
WPI	0.46	0.85	0.77	0.12	0.46	0.81	
Falkenmark	0.58	0.14	0.11	-0.04	0.06	0.11	0.35

Access and capacity are relatively highly correlated with the WPI. In this respect, the index does not entirely avoid one of the main criticisms levied at the HDI, and further work is required here. The Table also shows the correlation between the WPI and its sub-indices and the HDI. There is a strong positive association between the HDI and capacity, which is to be expected given that our capacity index is partly based on the HDI. The other sub-indices are not strongly correlated with the HDI, and overall, there is a moderately positive correlation between the WPI and HDI. The correlation coefficient of 0.81 means that 65% of the variation in WPI can be explained by the HDI. Thus, there are some distinct differences in water issues at the national level compared to general development status as measured by the HDI.

The usual cautions need to be made here. First the data and the results based on them are, as always, to be used with care. Coverage is not 100 per cent and so some key measures are missing for some countries. This may affect their position

[7] The Falkenmark water stress index measures per capita water availability and considers that a per capita water availability of between 1000 and 1600 m^3 indicates water stress, 500–1000 m^3 indicates chronic water scarcity, while a per capita water availability below 500 m^3 indicates a country or region beyond the 'water barrier' of manageable capability (Falkenmark and Widstrand, 1992)

in the ranking, although not by very much, since there are 17 components to the five sub-indices and some of these are themselves an average of two or more measures.

There is some implicit weighting in the overall index in that each sub-index has a different number of component indices, but for the results presented so far, we have weighted the five sub-indices equally. It could be argued that less weight should be given to resources and more to use, access and environment in that resources are given and it is their management and distribution that is most important. The index does allow for different weights, but the information is in the components rather than the final single number, and as with the Human Development Index, it is possible that a straight average is as useful as a weighted one. The issue of weights is something that should be addressed in future research.

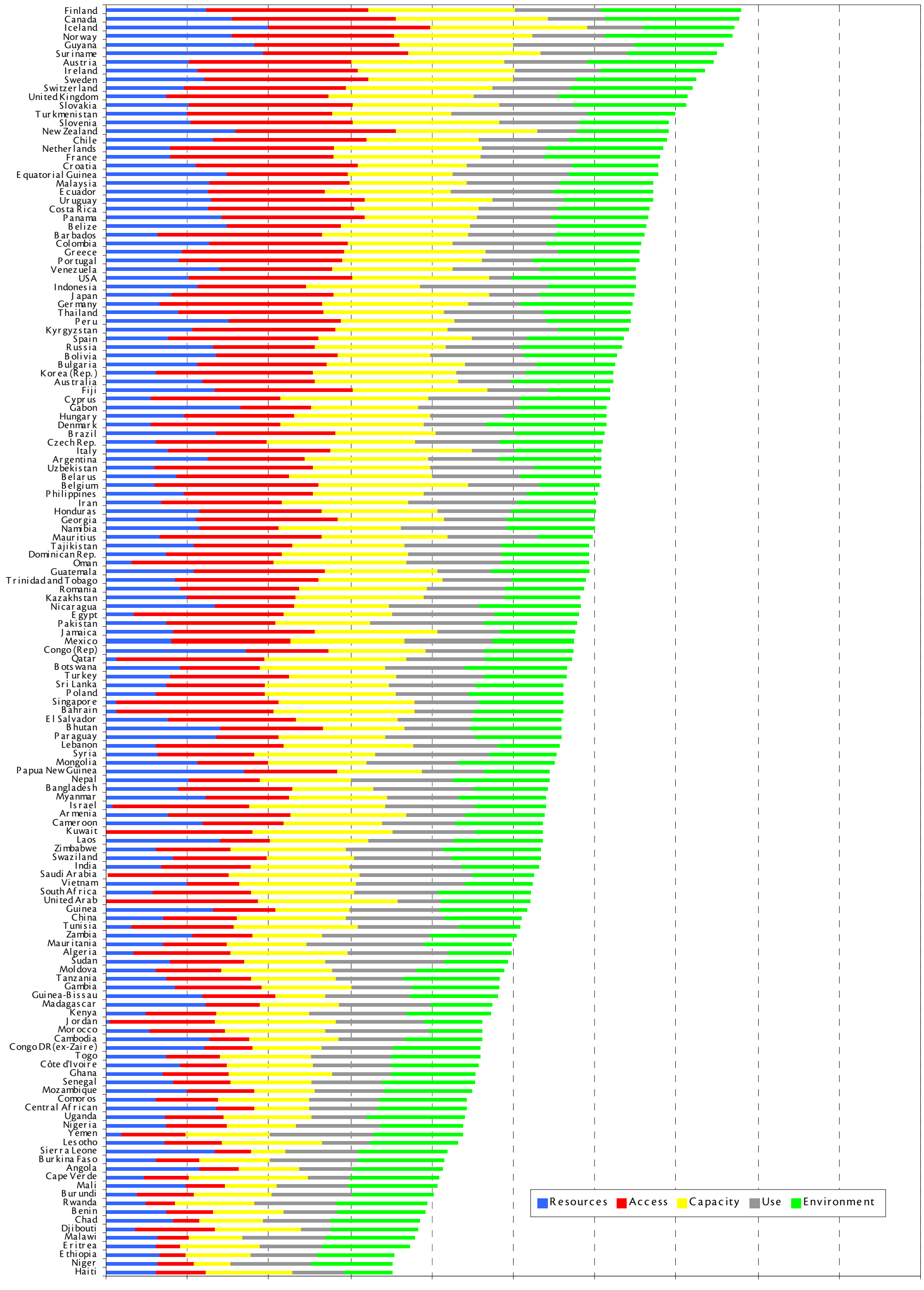
4 Conclusions

This water poverty index is a first pass at trying to establish an international measure comparing performance in the water sector across countries in a holistic way that brings in the diverse aspects and issues that are relevant. It does seem to give some sensible results but it does not pretend to be definitive nor offer a totally accurate measure of the situation. No one single figure or set of figures could do this, especially when they are meant to be representative of the progress or otherwise of a whole country. This is, however a start. There are other data that could have been included, if available, the most important of which is some relative measure of investment in water. Several more countries could have been included if data had been available.

Similar criticisms to those made of the HDI can be made of this index, with the exception that most of the sub-indices are not correlated with each other. The data itself needs more investigation, since there are sometimes differences between reputable estimates of the same variable, as in the case of water resources (see Appendix 2). Finally, the data does combine components that can be priced and ones that cannot be given a comparative value. However, it is argued that what this index is essentially doing is providing a measure of water availability and access that is adjusted by socio-economic and environmental factors and in showing the components of the index is making clear which apples are combined with which pears.

The index produced here is intended to focus attention at international level on improving water management performance across the world, and as Streeten wrote of the HDI it is also intended to ‘contribute to a muscle therapy that helps us to avoid analytical cramps’ (Streeten, 1994:235).

Figure 2: National Values for the Water Poverty Index



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Appendix 1

The Water Poverty Index and Sub-Indices Compared with the Falkenmark and the Human Development Indices (Preliminary Estimates)

	Res-ources	**Access**	**Cap-city**	**Use**	**Environ-ment**	**WPI**	**HDI**	**Falken-mark***
Algeria	3.4	11.7	14.5	12.2	7.8	49.7	0.693	0.4
Angola	11.3	5.0	7.4	6.7	10.9	41.3	0.422	14.3
Argentina	12.4	11.9	15.3	8.5	12.8	60.9	0.842	22.8
Armenia	7.6	15.1	14.2	7.1	9.8	53.8	0.745	2.8
Australia	11.9	13.7	17.6	6.5	12.5	62.3	0.936	18.2
Austria	10.1	20.0	18.8	10.1	15.6	74.6	0.921	8.5
Bahrain	1.2	19.4	17.4	7.3	10.9	56.1	0.824	0.2
Bangladesh	9.0	13.8	10.1	12.3	9.0	54.2	0.470	5.1
Barbados	6.4	20.0	18.0	10.7	10.9	66.0	0.864	1.7
Belarus	8.8	13.7	17.5	10.8	10.0	60.8	0.782	4.7
Belgium	6.0	20.0	18.5	8.8	7.3	60.6	0.935	1.4
Belize	14.9	14.0	15.9	10.6	10.9	66.3	0.776	66.4
Benin	7.5	5.6	8.7	6.6	10.9	39.3	0.420	2.6
Bhutan	14.0	12.8	9.9	8.1	11.2	55.9	0.477	44.7
Bolivia	13.6	14.7	11.6	11.4	11.4	62.7	0.648	37.9
Botswana	9.1	9.7	15.4	9.7	12.6	56.6	0.577	5.4
Brazil	13.5	14.6	12.5	9.7	11.0	61.2	0.750	36.4
Bulgaria	11.2	16.0	16.9	8.7	9.8	62.5	0.772	13.6
Burkina Faso	6.1	5.4	8.6	10.9	10.5	41.5	0.320	1.5
Burundi	3.8	7.0	9.4	10.0	9.9	40.2	0.309	0.5
Cambodia	12.8	4.9	10.8	8.1	9.5	46.2	0.541	26.7
Cameroon	11.8	10.0	12.1	8.7	10.9	53.6	0.506	17.8
Canada	15.5	20.0	18.7	6.9	16.5	77.7	0.936	88.8
Cape Verde	4.6	5.6	14.5	5.2	10.9	40.8	0.708	0.8
Central African Rep.	13.6	4.6	6.7	8.4	10.9	44.2	0.372	39.0
Chad	8.3	3.1	7.8	8.4	10.9	38.5	0.359	3.8
Chile	13.1	18.8	13.8	11.0	12.1	68.9	0.825	30.8
China	7.1	9.1	13.2	12.1	9.7	51.1	0.718	2.2
Colombia	12.6	17.0	12.9	11.6	11.5	65.7	0.765	25.3
Comoros	6.1	7.6	11.3	8.6	10.9	44.4	0.510	1.4
Congo (Rep.)	17.1	10.3	11.8	7.3	10.9	57.3	0.502	179.0
Congo DR (ex-Zaire)	12.0	6.0	8.4	8.7	10.9	46.0	0.429	18.9
Costa Rica	12.5	18.0	15.2	9.8	11.3	66.8	0.821	23.6
Côte d'Ivoire	9.0	5.7	10.6	9.5	10.9	45.7	0.426	5.2
Croatia	11.0	20.0	13.3	12.9	10.6	67.7	0.803	12.2
Cyprus	5.5	15.9	18.1	11.3	10.9	61.8	0.877	1.1
Czech Rep.	6.2	13.5	18.2	10.4	12.7	61.0	0.844	1.5
Denmark	5.5	15.9	17.6	7.6	14.7	61.3	0.921	1.1
Djibouti	3.7	9.7	10.6	3.5	10.9	38.4	0.447	0.5
Dominican Rep.	7.3	14.3	15.4	11.4	10.9	59.4	0.722	2.5
Ecuador	12.6	14.4	15.4	12.4	12.3	67.1	0.726	24.8
Egypt	3.4	18.3	13.3	12.5	10.5	58.0	0.635	0.4

	Res-ources	Access	Cap-city	Use	Environ-ment	WPI	HDI	Falken-mark*
El Salvador	7.6	15.6	12.6	9.1	11.0	55.9	0.701	2.8
Equatorial Guinea	14.8	14.9	12.7	14.3	10.9	67.7	0.610	66.2
Eritrea	6.2	2.8	9.8	7.6	10.9	37.4	0.416	1.5
Ethiopia	6.6	3.1	8.0	8.1	9.5	35.4	0.321	1.8
Fiji	13.4	16.9	16.5	7.4	7.7	61.9	0.757	35.0
Finland	12.2	20.0	18.0	10.6	17.1	78.0	0.925	21.0
France	7.9	20.0	18.0	8.0	14.1	68.0	0.924	3.1
Gabon	16.5	8.8	13.2	12.2	10.8	61.5	0.617	133.8
Gambia	8.6	10.6	10.9	7.3	10.9	48.3	0.398	4.2
Georgia	11.0	17.5	13.1	7.6	10.9	60.0	0.742	12.2
Germany	6.5	20.0	18.0	6.2	13.7	64.5	0.921	1.7
Ghana	6.9	8.1	12.7	7.2	10.4	45.3	0.542	2.1
Greece	9.3	20.0	17.4	8.9	10.0	65.6	0.881	5.8
Guatemala	10.9	16.0	13.8	6.6	12.0	59.3	0.626	11.8
Guinea	13.1	7.7	9.0	11.0	10.9	51.7	0.397	30.4
Guinea-Bissau	11.8	8.9	6.1	10.3	10.9	48.1	0.339	17.7
Guyana	18.1	17.9	14.0	14.9	10.9	75.8	0.704	279.9
Haiti	6.1	6.2	10.5	6.5	5.8	35.1	0.467	1.5
Honduras	11.4	15.0	14.2	9.2	10.5	60.2	0.634	14.8
Hungary	9.5	13.5	16.9	8.9	12.6	61.4	0.829	6.3
Iceland	19.9	20.0	19.2	6.7	11.2	77.1	0.932	605.0
India	6.8	11.0	12.1	13.8	9.5	53.2	0.571	1.9
Indonesia	11.2	13.4	13.9	15.7	10.7	64.9	0.677	13.4
Iran	6.8	14.8	15.5	13.5	9.8	60.3	0.714	2.0
Ireland	11.2	19.8	19.1	10.5	12.8	73.4	0.916	13.5
Israel	0.8	16.7	16.8	10.9	8.6	53.9	0.893	0.1
Italy	7.7	19.8	17.4	5.3	10.7	60.9	0.909	2.9
Jamaica	8.2	17.5	15.0	7.5	9.5	57.7	0.738	3.6
Japan	8.1	20.0	18.9	6.2	11.6	64.8	0.928	3.4
Jordan	0.4	13.0	14.9	10.8	7.3	46.3	0.714	0.1
Kazakhstan	10.0	13.3	15.6	10.1	9.4	58.3	0.742	7.8
Kenya	4.9	8.7	11.5	11.7	10.5	47.3	0.514	0.8
Korea (Rep.)	6.1	19.3	17.7	8.4	10.9	62.4	0.875	1.4
Kuwait	0.0	18.1	17.1	10.3	8.1	53.5	0.818	0.0
Kyrgyzstan	10.5	17.7	13.8	13.5	8.8	64.2	0.707	9.9
Laos	13.9	6.2	12.0	10.5	10.9	53.5	0.476	43.4
Lebanon	6.1	15.7	15.8	10.5	7.7	55.8	0.758	1.5
Lesotho	7.3	6.8	12.3	5.9	10.9	43.2	0.541	2.4
Madagascar	12.2	6.6	9.8	11.2	7.6	47.5	0.462	21.1
Malawi	6.4	3.7	6.7	10.1	11.1	38.0	0.397	1.7
Malaysia	12.7	17.2	14.3	11.6	11.5	67.3	0.774	26.1
Mali	9.8	5.0	6.2	8.7	11.1	40.6	0.378	7.1
Mauritania	7.1	7.7	9.8	14.3	10.9	49.8	0.437	2.2
Mauritius	6.6	19.8	15.5	11.1	6.8	59.8	0.765	1.8
Mexico	8.1	14.5	14.1	10.7	10.1	57.5	0.790	3.5

	Res-ources	Access	Cap-acity	Use	Environ-ment	WPI	HDI	Falken-mark*
Moldova	6.1	8.0	13.6	10.4	10.8	48.9	0.699	1.4
Mongolia	11.1	8.8	12.0	11.2	11.8	55.0	0.569	13.1
Morocco	5.4	9.3	12.3	12.5	6.7	46.2	0.596	1.1
Mozambique	10.0	8.1	7.5	8.5	10.7	44.9	0.323	8.0
Myanmar	12.2	10.3	12.1	8.5	10.9	54.0	0.551	20.7
Namibia	11.4	9.7	15.0	12.9	10.9	60.0	0.601	15.0
Nepal	10.2	8.7	11.2	12.6	11.8	54.4	0.480	8.5
Netherlands	7.9	20.0	18.2	8.0	14.4	68.5	0.931	3.2
New Zealand	15.9	19.7	17.4	4.8	11.3	69.1	0.913	102.8
Nicaragua	13.4	9.7	11.6	11.2	12.3	58.2	0.635	34.5
Niger	6.4	4.4	4.4	9.9	10.0	35.2	0.274	1.7
Nigeria	7.4	7.5	8.5	10.4	10.1	43.9	0.455	2.6
Norway	15.5	20.0	17.0	8.8	15.8	77.0	0.939	86.8
Oman	3.1	17.5	16.2	11.7	10.9	59.4	0.747	0.4
Pakistan	7.3	13.5	11.5	14.0	11.5	57.8	0.498	2.4
Panama	14.3	17.6	13.6	9.2	11.8	66.5	0.784	51.6
Papua New Guinea	17.0	11.5	10.3	7.7	8.1	54.5	0.534	166.6
Paraguay	13.5	7.7	13.2	11.0	10.5	55.9	0.738	37.1
Peru	15.0	13.9	13.9	11.3	10.3	64.3	0.743	71.0
Philippines	9.5	15.9	13.6	12.7	8.8	60.5	0.749	6.3
Poland	6.2	13.4	16.0	8.9	11.8	56.2	0.828	1.5
Portugal	9.0	20.0	17.1	6.3	13.0	65.4	0.874	5.1
Qatar	1.2	18.4	17.4	9.4	10.9	57.2	0.801	0.2
Romania	9.2	14.5	15.8	9.4	9.8	58.7	0.772	5.5
Russia	13.0	12.6	16.1	9.1	12.5	63.4	0.775	30.0
Rwanda	4.8	3.7	9.7	9.9	11.3	39.4	0.395	0.8
Saudi Arabia	0.2	14.9	16.1	13.7	7.7	52.6	0.754	0.1
Senegal	8.2	7.2	9.9	8.7	11.3	45.3	0.423	3.6
Sierra Leone	13.3	4.5	4.3	9.0	10.9	41.9	0.258	33.0
Singapore	1.2	20.0	16.8	7.8	10.3	56.2	0.876	0.2
Slovakia	10.3	20.0	18.1	9.1	13.8	71.2	0.831	8.9
Slovenia	10.4	20.0	17.9	9.7	11.2	69.1	0.874	9.3
South Africa	5.6	12.2	12.7	10.1	11.6	52.2	0.702	1.2
Spain	7.6	18.3	19.0	6.8	11.8	63.6	0.908	2.8
Sri Lanka	7.5	12.0	15.3	10.6	10.8	56.2	0.735	2.7
Sudan	7.9	9.1	9.8	14.6	7.9	49.4	0.439	3.2
Suriname	19.4	17.8	16.2	10.7	10.9	74.9	0.758	479.6
Swaziland	8.2	11.4	10.8	12.0	10.9	53.3	0.583	3.6
Sweden	12.1	20.0	17.9	7.6	14.8	72.4	0.936	20.0
Switzerland	9.5	20.0	18.0	9.6	15.1	72.1	0.924	6.3
Syria	6.3	11.8	14.9	14.0	8.1	55.2	0.700	1.6
Tajikistan	10.9	12.0	13.7	11.9	10.9	59.4	0.660	11.8
Tanzania	7.4	10.5	10.4	8.2	11.8	48.3	0.436	2.5
Thailand	9.0	17.7	15.0	11.9	10.8	64.4	0.757	5.0
Togo	7.4	6.6	11.1	9.8	11.0	46.0	0.489	2.5

	Res-ources	Access	Cap-acity	Use	Environ-ment	WPI	HDI	Falken-mark*
Trinidad and Tobago	8.4	17.6	15.4	8.3	9.2	59.0	0.798	3.9
Tunisia	3.2	12.4	15.3	12.2	7.8	50.9	0.714	0.4
Turkey	7.8	14.8	13.1	10.7	10.1	56.5	0.735	3.0
Turkmenistan	10.0	17.7	14.7	16.7	10.9	70.0	0.730	8.0
Uganda	7.3	7.1	10.9	6.7	12.0	44.0	0.435	2.4
United Arab Emirates	0.0	18.6	17.1	5.5	10.9	52.0	0.809	0.1
United Kingdom	7.3	20.0	17.8	10.3	16.0	71.5	0.923	2.5
Uruguay	12.8	19.0	15.6	8.8	10.8	67.1	0.828	27.4
USA	10.3	20.0	16.7	2.8	15.3	65.0	0.934	8.9
Uzbekistan	6.0	19.3	14.6	12.7	8.2	60.8	0.698	1.4
Venezuela	14.0	13.7	14.9	10.5	11.9	65.0	0.765	44.7
Vietnam	10.0	6.4	14.4	13.3	8.3	52.3	0.682	7.9
Yemen	1.9	7.8	10.5	12.8	10.9	43.8	0.468	0.2
Zambia	10.7	7.4	8.5	13.4	10.5	50.4	0.427	10.7
Zimbabwe	6.1	9.1	14.2	11.8	12.1	53.4	0.554	1.5

*Falkenmark Index is expressed as thousands of m^3 per capita per year

Appendix 2: Sources of the Data

Population

World Resources Institute, 2000 Tables HD.1 and SCI.1 and HDR, 2001

Resources

World Resources Institute, 2000 Table FW.1, and Gleick, 2000. Shiklomanov (1997) has compiled a comparison of water resources data for a selected, but large, range of countries from different sources, including the WRI, Gleick and his own State Hydrological Institute. There are a number of discrepancies between the various estimates of water resources. Where the discrepancies are relatively minor, the WRI estimate was accepted. In the case of major discrepancies, most likely value was selected by making simple hydrological comparisons of neighbouring countries which are broadly similar in terms of physiographic, climatic and hydrological characteristics. The most striking discrepancy was in the case of Peru, which WRI says has 1746 billion cubic metres of internal freshwater flows, while all other estimates have 40 billion cubic metres. Calculating the resources as millimetres depth over the country in comparison with neighbouring countries shows, for instance, Colombia 2054 mm, Ecuador 1597 mm, Peru (using the WRI figure) 1364 mm, Brazil 641 mm. This fits in well with the expected pattern for these countries, while taking Peru's resource as 40 billion cubic metres is clearly in error. Therefore the WRI value was accepted as correct in this case.

Access

World Resources Institute, 2000 Table HD.3, and HDR 1999

Irrigation - World Resources Institute, 2000 Table AF.2. and Gleick 2000 (irrigation) with cropland areas from *World Resources Institute (2000) 2000-01* Table SCI.1.

Capacity

GDP - HDR 2001

Under-5 mortality - World Resources Institute, 2000 Tables HD.2 and SCI.1

Education - HDR 2001

Use

Gleick, 2000 and World Resources Institute, 2000

World Bank, 2001

Environment

World Economic Forum, Yale Center for Environmental Law and Policy, and Center for International Earth Science Information Network, Columbia University, *2001 Environmental Sustainability Index* (http://www.ciesin.columbia.edu/indicators/ESI), January 2001

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ISSN 1352-8955

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