AquaStress

Mitigation of Water Stress through new Approaches to Integrating Management, Technical, Economic and Institutional Instruments

Integrated Project

D4.4-5

WS-Framework

Water Stress Framework Tool

For the I^{3}S (Version 1.0)

Due date:	M48
Actual submission date:	M48
Start date of project:	1-02-05 Duration: 48 months
Deliverable Lead contractor: (Organisation name)	Deltares
WP Participant(s) (Partner short names)	Deltares and Cemagref
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Dissemination Level	RE
Deliverable Status:	Achieved

(1) (PU=PUblic, PP=Restricted to other Programmes Participants, RE=REstricted to a group specified by the consortium, CO=COnfidential only for members of the consortium)

Abstract

This document provides the manual of the WS-Framework tool, which is used to assess the level of water stress in a site or region. It is based on the scientific insights on participatory water stress assessment developed within WB2 of AquaStress.

The i³S Document Series

WS-Framework

Water Stress Framework Tool

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Mitigation of Water Stress through new Approaches to Integrating Management, Technical, Economic and Institutional Instruments

Contract FP6 511231

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Current version	V1.0
Date	12/01/2009
Status	Final © Aquastress
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Preface

AquaStress is a EU financed integrated project (2005-2008), within theme "6.3. Global Change and Ecosytems", of the Sixth Framework Programme. The overarching goal of AquaStress is to improve the understanding of water stress from an integrated multi-sectoral perspective. The project tackles one of the most challenging and intransigent problems facing water managers – how best to combine the wide variety of existing and new analysis, and mitigation options to deliver optimal and adaptable solutions. Scientific focus points within the project are the participatory process, water stress characterization and option assessment.

The AquaStress project is divided in different working blocks (WB) as specified in the project document (www.AquaStress.net). The mission of Working Block 4 (WB4) is to bring together the key science and knowledge outputs of AquaStress work blocks in a computer based infrastructure and to deliver these outputs to the user community and hence assist stakeholders resolve problems arising from water stress. Moreover, the mission of WB4 is to facilitate the selection process of water stress mitigation options by providing a suite of tools that can effectively support a variety of steps in such a process.

This document provides the manual of the WS-Framework tool, which is used to assess the level of water stress in a site or region. It is based on the scientific insights on participatory water stress assessment developed within WB2 of AquaStress.

Further information

Further information on the Aquastress project can be found on the project website: http://www.aquastress.net .

Contents

Introduction

Water Stress is as much about factual shortage of water of appropriate quality as it is about the implications of this shortage and the perceptions and opinions of water users. 'Perception' is easy to understand if one imagines the following indicator for domestic water stress: Available water per capita per day. In western countries 50l per capita per day will certainly be classified as water stress, since domestic water consumption typically lies well above 100l. However, people in deserts will certainly assess this amount as a water rich situation.

A key point of departure of the AquaStress project was the need to approach water stress in a participatory process. Essential for successful participatory processes is a common understanding of water stress and a joint effort to identify, evaluate and implement water stress mitigation options. Hence, when a local or regional water stress mitigation process is carried out in a participatory setting, it is important that the assessment of the water stress is carried out in a participatory setting. This implies that standard quantitative indicators to assess water stress are not appropriate, and local indicators need to be selected.

The second essential point of the AquaStress project was that the participatory approach should involve a broad range of stakeholders: e.g. originating from the agricultural, industrial, domestic, tourism sectors and last but not least the environmental sector, since 'nature' or 'ecology' is a 'stakeholder' as well. Consequently, when selecting indicators the different sectors need to be represented and balanced. Furthermore, one should sitinguish different domains within these sectors, such as quantity, quality, institutional & adaptive capacity, infrastructure and society & equity. These different domains reflect different aspects within a sector which provide insight in the water stress situation.

Since one cannot easily deal with all these different aspects AquaStress WB2 has developed a Water Stress Framework which allows balancing all these aspects into first of all spider diagrams which show severe water stress is, and second the AquaStress Water Stress Index, a single value representing the local water stress situation.

Researchers in WB2 were aware that the use of indicators and its application in the water sector is already a fact and has become very important. In particular, legislations such as the implementation of the EU Water Framework Directive (WFD) have given prominence to indicators as management tools in the water sector. There are many other water indicators in use today. Most of these are single indicators of water quality, which for a long time have been the area of water research. Some indicators have been combined as measures of various dimensions of water stress, including the widely used indicators relating the quantity of water available to the amount needed for certain activities. Two well known ones are, the "Water availability per capita per year" (this defines specific thresholds relating to water shortages : 1700 m3/capita/year or less: water stress, 1000 m3/capita/year or less : water scarcity), and "Water withdrawals" (this indicates the degree of stress in a location, but does not take account of water transferred from transboundary rivers or international interbasin transfers).

There are some frameworks, like the DPSIR (Drivers Pressures States Impacts Responses) for water indicators (Jesinghaus, 1998). Arguments have been made (European Environment Agency 1999), that the DPSIR approach permits the establishment of causal relationships between human activities, their environmental impacts, and the effects of societal responses. It is certainly true in some cases, that such cause and effects can be known (e.g. the link between lead emissions to the environment, and its impact on human health), and effective policy responses have been the result (e.g. the removal of lead from petrol). A number of authors have put forward several disadvantages of the DPSIR approach. In some cases, isolated chains of indicators may not be enough to reproduce the complexity of systems, which tend to behave more like a network rather than a linear chain (Bossel, 1999), (Rekolainen, Kämäri, & Hiltunen, 2003),(Caeiro, Patinho, Costa, & Ramos, 1999), (Jorge, Lourenço, Machado, & Rodrigues, 2002).

During the process of the literature review, and building on earlier work on index development (C. Sullivan, Meigh, & Lawrence, 2005; C. A. Sullivan, Meigh, & Fediw, 2002), it was observed that there was some dissatisfaction in the use of indices in general. Statements are sometimes made about an index being too simple, or not comprehensive enough, with the methodology not allowing a sufficient breadth of knowledge to be included.

As a result the objective of WB2 was to ease the management of water stress by providing a tool for a first assessment of the integral effect of measures taking by different sectors to combat water stress. We focused on the water system’s property to:

- characterize the water system,
- to describe the water stress situation in the different water sectors,
- to recognize the water stressors and
- to properly act with bundle mitigation options against water stress.

Chapter 0 briefly explains the theoretical basis of the Water Stress Framework. Chapter 0 provides the manual to the Water Stress Framework tool. Getting support is described in chapter 0.

Theory behind the Water Stress Framework

Theoretical background

The reason for building a matrix of information and knowledge, rather than simply providing a simple index value, is to provide all stakeholders with relevant information in an open and accessible way. Since it is widely recognised that knowledge is power, it is felt in this work that the conversion of disparate data into comprehensive knowledge is a worthwhile effort, and the dissemination of that knowledge to a wide range of users in an easy to understand way is a prerequisite for promoting more equitable decision making. Knowledge cannot always be quantified in such a way as to be used in a mathematical way, and so the use of a matrix as a vehicle for combination of different sorts of information will enable the knowledge generated through it to be more holistic and covering various disciplines. Furthermore this approach has the advantage that it takes into account not only hydrological and/or physical aspects of defining water stress but also social and economic dimension of water stress.

Key elements of information needed to quantify water stress can be integrated through the mathematical framework of a composite indices' framework. This framework is referred to here as the Aquastress Water Stress Framework (WSF). The values generated by this framework provide the foundation of how the level of water stress at any site can be evaluated. This level of water stress will be determined by an interaction of the supply of water (both local and imported), and the demand for that water from different sectors.

The WSF is generated through a combination of two parts: the *Integrated Sectoral Water Stress Index* (ISWSI), which is the part of the WSF able to capture the level of water stress resulting from sectoral demand, and the *Potential Margin (PM)*, which is an assessment of the available water resource supply. The potential margin indicates the degree of dependency on local and imported water, and the safety margins remaining available. By combining these two together, the WSF is derived as follow:

$$\mathrm{WSF} = \frac{\mathrm{ISWSI}}{\mathrm{PM}} \qquad [1]$$

The two components of the WSF thus incorporate the demand and the supply elements of the water situation, and are represented respectively by the ISWSI and Potential Margin (PM) (see Figure 1)

The *Integrated Sectoral Water Stress Index*, (ISWSI) shows the level of water stress across the different sectors and the type of stress associated with each sector. The major anthropogenic sectors to be considered within water management decisions are: domestic, agricultural, industrial, and tourism[1]. In addition to these four sectors the

[1] Tourism includes also services.

environment is included, to ensure that a certain degree of water is allocated to the environment to enable ecological integrity.

For each of these five sectors the possible sources of stress have been identified and summarised in five categories:

- Quantity
- Quality
- Institutional capacity,
- Infrastructure and
- Social and economic equity.

The ISWSI has been constructed using is a composite index[2] approach as shown in Equation 2:

$$ISWSI = \frac{w_D I_D + w_{Ag} I_{Ag} + w_I I_I + w_T I_T + w_E I_E}{w_D + w_{Ag} + w_i + w_T + w_E} \qquad [2]$$

Where w_i is the weight given to the sector i. We agreed that $0 < ISWSI < 1$

I_i is the water stress index for each of the component sectors, ie. Domestic (D), Agriculture (Ag), Industry (I) Tourism services (T) and the Environment (E).

The structure used here is that used in the construction of any composite index. The indicators are first normalised and then aggregated to form a *Sectoral Water Stress Index.*

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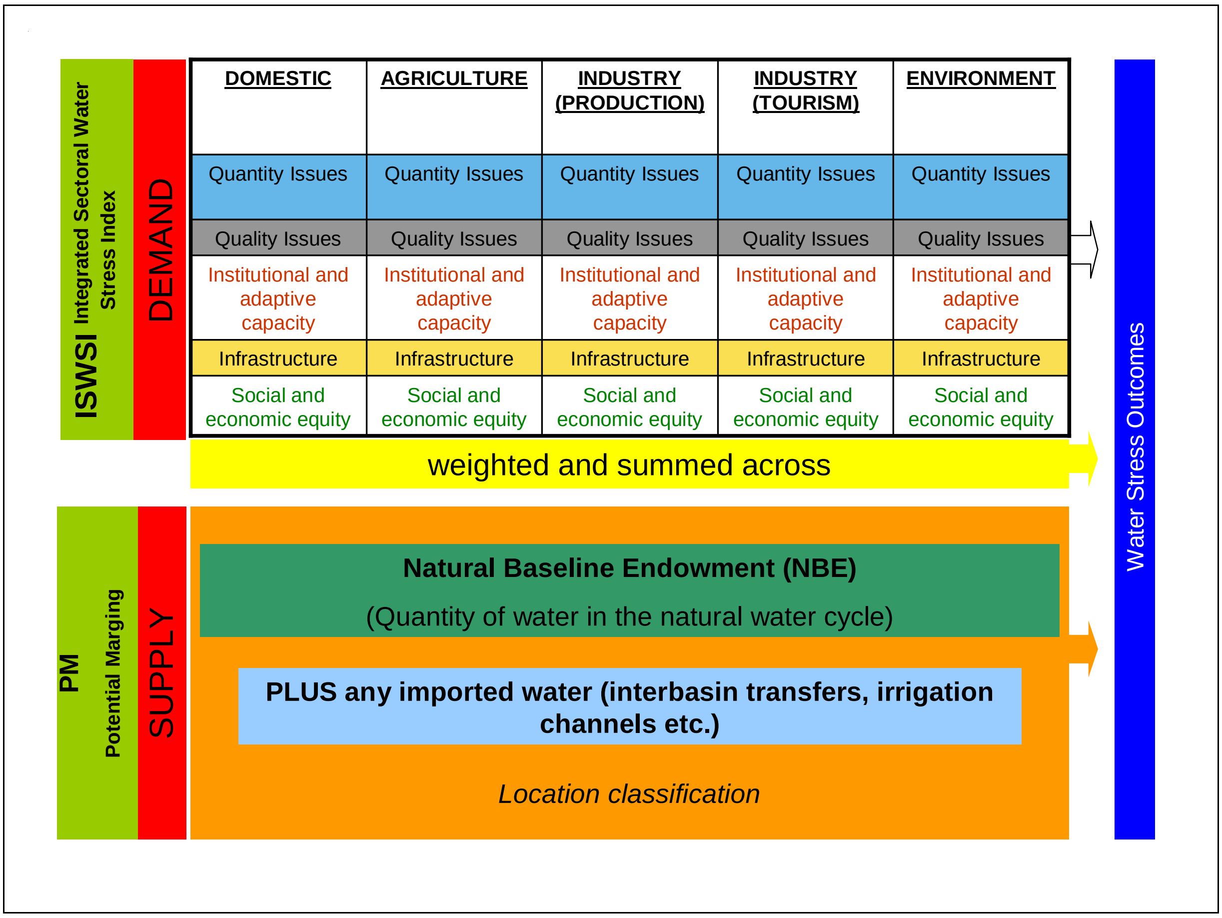
[2] The composite index is a weighted average. There is also the possibility of developing a non-linear format, and some discussion of this is illustrated in the attached appendix. It is suggested here that the linear solution is the most accessible by users, and so we prefer the formula shown here.

Figure 1: Water Stress Framework



The second piece of information required to calculate the AWSI is based on the concept of the *potential margin*. It aims to represent how close the water resources system is approaching its natural endowment limits, including, where relevant, any imported water. This measure is based on the components of a simple water balance. For the purpose of the calculation of the potential margin of the AWSI, the water balance at a test site can be summarised as follows:

$$NBE + IMP = TER + EXP + RRR$$

Where:

NBE = the total *Natural Baseline Endowment*. This refers to all naturally available water resources for any site or area, which should include both renewable surface water and groundwater. It should take into account all the components of the balance which are naturally available due to the effective precipitation inside the test site area, as well as all the waters which enter naturally into the system: river discharge from upstream, groundwater flow (potentially usable), spring discharge, etc. (see Box 2 for other descriptions and terms for this concept)

IMP = *imports* (geographical movement of water to the site). This includes the water which is imported from outside the test site (diversions, desalinated water etc).

TER = *Total Exploited Resource.* It represents the water which is currently withdrawn for use (consumed or eventually given back to the system) inside the test site by human activities (domestic, industrial, agricultural). TER is the water which is actually withdrawn (diverted from spring, rivers, dams, or abstracted from aquifers) and distributed to human activities. The environmental water needs inside the test site should be included as well. This amount will depend on a 'political' decision, and it will affect ecological conditions locally; and downstream. Requirements to preserve environment downstream is included in the export (EXP) component.

EXP = *exports*. This considers the volume of water which is committed to downstream users including the environment.

RRR stands for *Residual Renewable Resource*. This is the amount of water in the test site that is left in the local system, which has not been yet consumed by local or downstream users. This amount is obtained subtracting both TER and EXP from *NBE* and IMP:

$$RRR = NBE + IMP \quad - (TER + EXP)$$

NBE + IMP is what would be defined in Economics as supply; and TER + EXP demand.

The Potential Margin (PM) is calculated as a ratio between the RRR (as defined above) and the supply side of the water balance (NBE+IMP):

$$PM = \frac{\mathrm{RRR}}{\mathrm{NBE} + \mathrm{IMP}} \qquad o < PM < 1$$

The WSF is obtained by combining equations [2] and [3] from above:

$$\mathrm{WSF} = \frac{\dfrac{w_D I_D + w_{Ag} I_{Ag} + w_I I_I + w_T I_T + w_E I_E}{w_D + w_{Ag} + w_I + w_T + w_E}}{\dfrac{\mathrm{RRR}}{\mathrm{NBE} + \mathrm{IMP}}} \qquad [4]$$

$$0 < \mathrm{WSF} < \infty$$

For each value of ISWSI (ranging between 0 and 1) a different curve is obtained.

For example

if ISWSI = 1 $\Rightarrow$ $\mathrm{WSF} = \dfrac{1}{\dfrac{\mathrm{RRR}}{\mathrm{NBE} + \mathrm{IMP}}}$

In this case

WSF = 1, then PM = 1, and as PM reduces to zero, WSF go to infinity.

In other words as ISWSI increases, the WSF increases; and as the potential margin reduces, WSF increases.

Water Stress Framework tool

Installation & Protection

The Water Stress Framework tool (or WS-Framework.xls) has been developed in Microsoft Excel ®, 2002 SP3. It hence does not need any special installation.

When opening the tool the user will be asked if macro's should be enabled. This is not required as long as no modifications are required in the definitions of indicators or raw data. However, not enabling the macro's will not allow to click on some help functions.

Most worksheet are protected to avoid editing. You are free to remove the protection at own risk (there is no password required). If you want to reinstate the protection for all sheets, use the macro "Protect_all_worksheets", via the menu's Tools > macro > macros > Protect_all_worksheets > run.

Getting started

When opening the WS-Framework.xls go to the very first sheet, called "General Information and Manual". If macro's are enabled, this will be automatically carried out. On this sheet you will find some basic information about the tool and a short version of this manual.

In 7 steps to all results

The WS-Framework tool requires 7 steps to obtain results. Most of these steps are very simple. However, the true effort when using the tool lies in

1. Getting agreement on the indicators to select

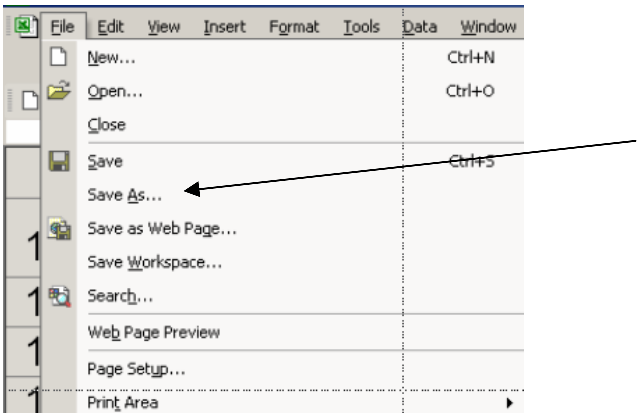
2. Collecting the required data.

Step 1: Saving / renaming your file

This tool is typically used in a site specific setting. Local data and preferences will be loaded into the tool. To avoid confusion about sites and versions it is recommended that you rename this file.

Note that when you print pages of the WS Framework tool the printed pages will show the filename, page numbers, sheet names.

Use the "Save As" function or equivalent in your language as depicted next:



Step 2: Selection of sectoral and domain indicators

Why	This tool offers a number of indicators for each domain-sector combination. Within your site, you may decide which indicators are relevant. If you want to calculate the AquaStress Water Stress Index (AWSI), you will need to select at least one indicator for each domain-sector combination.
Where	On the sheet "Indicator Selection"
How	For each combination of sectors (column headers) and domains (row headers), use the toggle button in the column headed "use", to select "Y" for selecting the indicator, or "N" for omitting the indicator. "Y" will turn the cell dark green. If in a sector-domain combination no indicators are selected a highlighted "0" will appear in the last row of a sector-domain combination. This must be avoided if you are interested to calculated the AWSI.
Other	Note that information about a specific indicator can be obtained by 'hovering' over the indicator name.

Illustration for selecting indicators

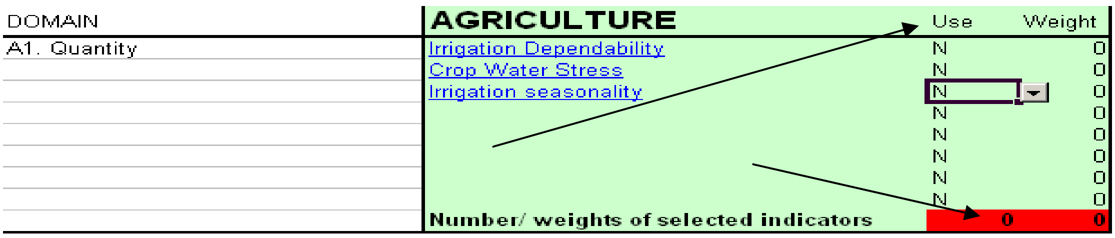
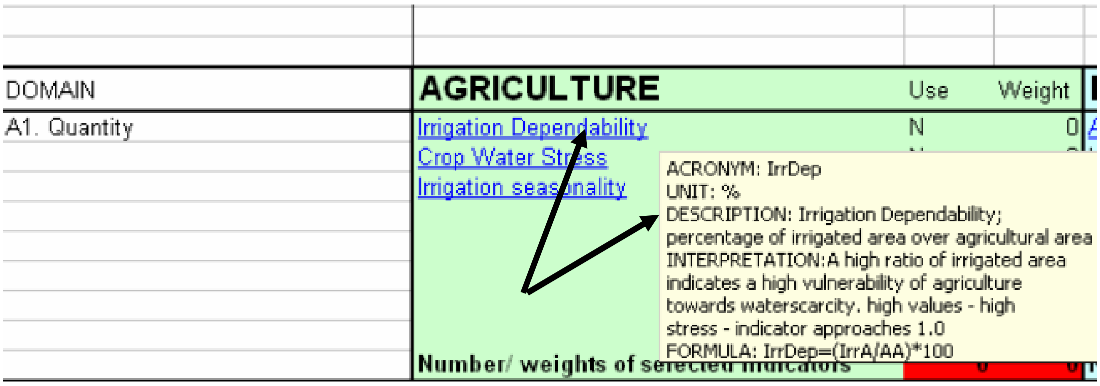


Illustration of the effect of "hovering" (tooltips)



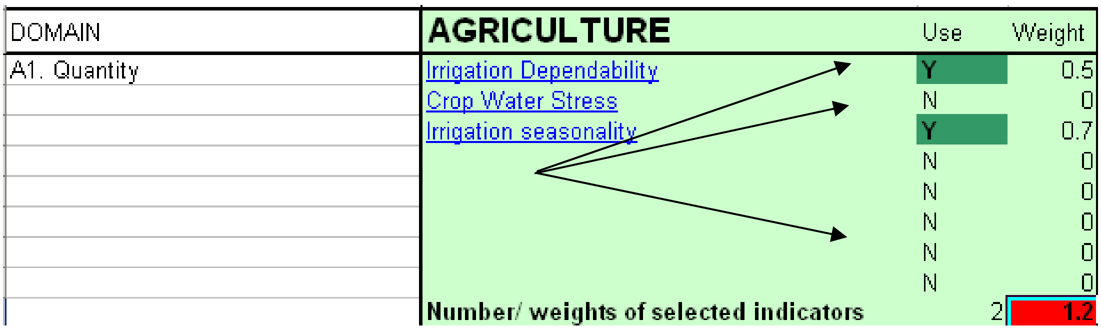
Step 3: Setting within sector-domain weights

Why The aggregated indicator value for each sector-domain combination consists of only one value. Hence you will need to insert weights such that the individual values are properly aggregated to one value.

Where On the sheet "Indicator Selection"

How If you only selected one indicator, please insert 1.0 in the column "weight". If you selected more than one, enter values between 0 and one for each selected indicator, such that the add up to 1.0, and only if you have selected more than one indicator in a sector-domain combination, you need to specify the weight of each indicator, such that the aggregate can be properly calculated.
If weights are not adding up to 1.0 this is visualized by a red field at the bottom of the 'Weight' column.

Illustration for setting sector and domain weights



Step 4: Inserting data

Why

Of course you are interested to calculate the AWSI for your local situation. This means you need to insert local data into the tool. Based on the selected indicators, raw data are required, for example the total agricultural area (AA). The tool works with time-series, but data are not required for each year. The earliest value that can be inserted is 1985. Where data are not available, the data of the nearest previous year is used, e.g. if data is available for 2005 and 2008, the years 2006 and 2007 will be equal to the value of 2005.
A 'start value' needs to be specified. This value will be used for up till the first available year, e.g. if the first actual value is 1990, the value used for 1985-1989 will be equal to the start value.

Where

On the sheet "Raw Data". Click to go!

How

For all parameters where 'Y' is shown in the column 'IS_ Required' do the following:
1) Insert in the columns headed RAW_1985, RAW_1986, etc, the values you have. Leave fields empty if you do not have data.
2) Insert in the column 'Start value' a best estimate for 1984, either a value preceding that year or the first value you have after 1984.

Hovering above the parameter name will present a tooltip with information about the parameter.

On the sheet there are two help buttons for specific columns.

Help on data availability

The column Data Availability provides a quick and dirty assessment of the appropriateness of data, solely based on the number of data available:

Less or equal to 2 values: POOR

Between 3 and 5 values: MODERATE

More than 5 values: GOOD

Note that the time spacing between values is not taken into account. This implies that an equally time-spaced MODERATE data set (1985, 1990, 1995, 2000, 2005) may be more appropriate than a GOOD set which only contains yearly data between 1985 and 1992.

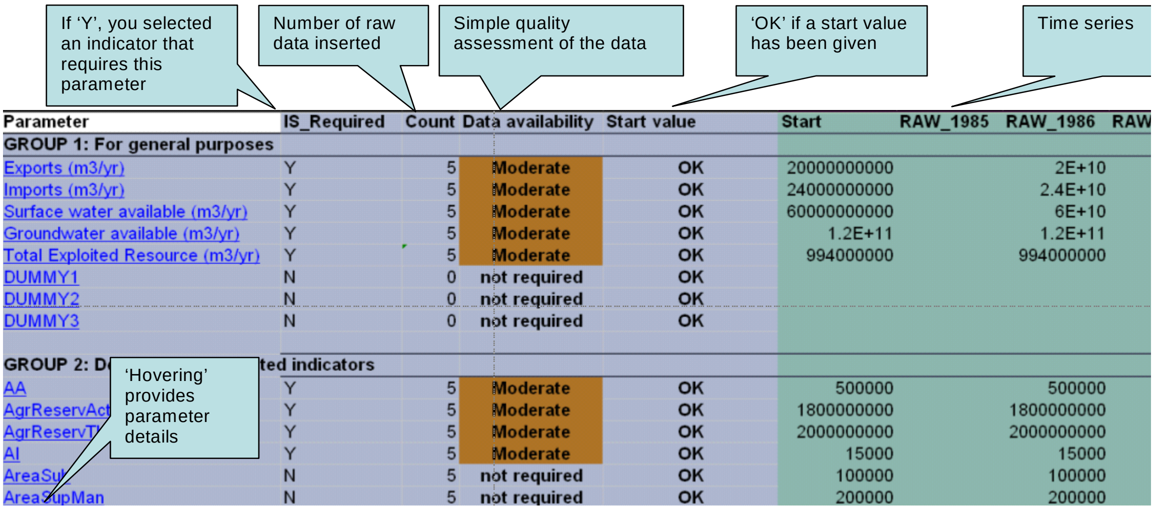
Help on start value:

Missing data in a time series are replaced by the most recent value. "E.g., if a value for 1990 is not available, the value for 1989 will be used if that value is available.

This method implies however that a first value is available. Hence, in this column a start value for the variable needs to be inserted. This value can be the value closest to the first year of data.

In case no previous data are available, you may want to insert the first data point available, e.g. 1990.

Illustration for inserting raw data



Parameter	IS_Required	Count	Data availability	Start value	Start	RAW_1985	RAW_1986	RAW
GROUP 1: For general purposes								
Exports (m3/yr)	Y	5	Moderate	OK	20000000000		2E+10	
Imports (m3/yr)	Y	5	Moderate	OK	24000000000		2.4E+10	
Surface water available (m3/yr)	Y	5	Moderate	OK	60000000000		6E+10	
Groundwater available (m3/yr)	Y	5	Moderate	OK	1.2E+11		1.2E+11	
Total Exploited Resource (m3/yr)	Y	5	Moderate	OK	994000000		994000000	
DUMMY1	N	0	not required	OK				
DUMMY2	N	0	not required	OK				
DUMMY3	N	0	not required	OK				
GROUP 2: D… ted indicators								
AA	Y	5	Moderate	OK	500000		500000	
AgrReservAc…	Y	5	Moderate	OK	1800000000		1800000000	
AgrReservT…	Y	5	Moderate	OK	2000000000		2000000000	
AI	Y	5	Moderate	OK	15000		15000	
AreaSu…	N	5	not required	OK	100000		100000	
AreaSupMan	N	5	not required	OK	200000		200000	

The WS-Framework tool now automatically calculates:

1) The missing values - These values can be found on the sheet "Raw Data", columns AP onwards.
2) The indicator values - these are calculated, but rescaling still needs to be carried out. Values can be found on 'Calcindicators tab'.
For more information see the section internal workings of the WS-Framework tool.

Step 5: Rescaling indicator values

Why

High water stress is defined as a value approaching 1.0, whereas no water stress is equal to 0.0. If 'water available per inhabitant' is in one year 20l/day and in another year 100 l/day. Most will agree that 20 l/day indicates water stress (and hence the water stress indicator should be 1.0, and 110l/day indicates (almost) no water stress (indicator value equals 0.0.

The raw indicator values need to be rescaled to values between 0.0 and 1.0, and in the aforementioned example, this means that high values in the time series need to be closer to 0.0, and low values in the time series need to be closer to 1.0.

To do this rescaling the tool requires 2 bits of information:

1. The relationship: "high values - high stress - indicator approaches 1.0" OR "low values - high stress - indicator approaches 1.0". This information is already present on the sheet "Indicator definition"

2. A lower and upper bound values: E.g. in the aforementioned case we assume that we talk about severe stress (=1.0) when per capita water availability is below 60l/day, and no stress if per capita water availability is above 120l/day. The tool will use this information to determine (a) that the value of 20/l per day indicates severe water stress and the indicator value is rescaled to

0.0, and (b) that 100 l/day is rescaled to an indicator value of (110-60)/(120-60) = 0.83

Where On the sheet "CalcIndicators" (click to go to first boundary value)

How Alter the values in the two columns called "Lower Boundary" and Upper Boundary", but always in such a way that the lower boundary value is lower than the upper boundary value, hence disregarding the direction of the relationship, which is either "high values - high stress - indicator approaches 1.0"or "ow values - high stress - indicator approaches 1.0".

You only need to adapt those boundaries which are in lines were "Is selected" is 'Y'.

o help you the columns "Minimum value" and "Maximum value" provide some insight in your dataset.

In case you disagree with the interpretation of the indicator, meaning that in your situation for a given indicator the given interpretation "high values - high stress - indicator approaches 1.0" is not correct, you can alter this direction on the sheet "Indicator definitions".

SHORTNAME	Selected	Interpretation-2	Unit	Minimum Value	Maximum Value	Lower Boundary	Upper Boundary
Irrigation Dependability	Y	high values - high stress - indicator approaches 1.0	%	40.00	50.00	20	80
Crop Water Stress	N	low values - high stress - indicator approaches 1.0	%	-18.55	0.00	20	80
Irrigation seasonality	Y	high values - high stress - indicator approaches 1.0	-	0.50	0.50	0	1

Step 6: Setting years to output

Why The WS-Framework tool allows you to select 4 years to output.

Where On the sheet "Results 1"

How By inserting the years in the top fields (cells C1 to F1)

Step 7: Viewing and sector-domain results

Why The numerical values per indicator should be reviewed to check if they meet expectations. Though all indicators should be reviewed, the indicators which indicate high stress are visualized in sheet "results 1"

Note that for each indicator an advice field is presented. Hovering over the field will show some advice on how to reduce the stress based on information contained in sheet "Indicator definitions"

Where On the sheet Results 1

Step 8: Viewing IWSI, WSF, Spider

The computed values of the WSF can be represented for a better and easy understanding as a spider-graph.

All results should now be available and visible on “sheet Results 2”.

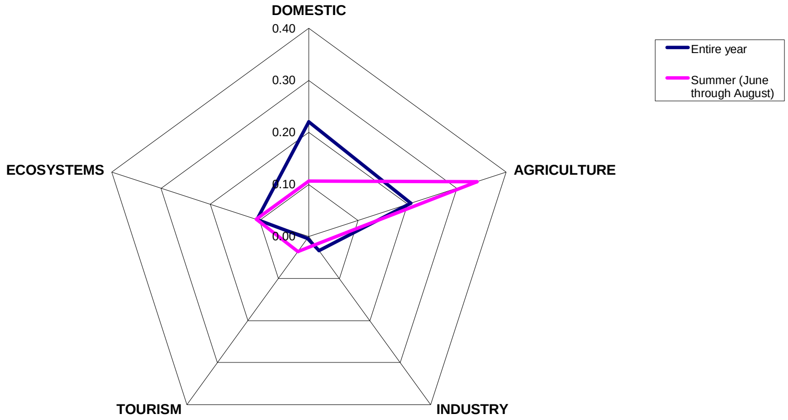
As a practical example, we present the results of the calculations done for the Sardinian case study. For this case study following indicators were chosen:

	DOMESTIC	AGRICULTURE	INDUSTRY (PRODUCTION)	INDUSTRY (TOURISM)	ENVIRONMENT
Quantity Issues	**Drinking water**	**Irrigation dependability**	**Water quality**	**Water use intensity**	**Deviance from natural flow**
Quality Issues	**Quality norms**	**Salinity**	**Water treatment**	**Quality norms**	**Waste water polluted load**
Institutional and adaptive capacity	**Water regulation**	**Water saving technologies**	**Recycling**	**Water saving technologies**	**Protected areas**
Infrastructure	**Supply interruptions**	**Supply dependability**	**Supply interruptions**	**Water treatment**	**River fragmentation**
Social and economic equity	**Economy of water suppliers**	**Farm size dispersion**	**Labour-related water intensity**	**Labour-related water intensity**	**Nature protection**

The sectoral indicators were weighted and summed to ISWSF. The environmental sector was assigned a weight of 1, while the remaining sectors were weighted according to their water use as a fraction of the total. These relative water uses were 46% for the domestic sector, 48% for agriculture, 5% for industry, and 1% for tourism. The resulting ISWSF was 0.57.

ISWSF divided by the potential margin yields the WSF. The calculated potential margin ranged from 0.02 to 0.18, and turned out to be greatly influenced by assumptions of (notably) evapotranspiration. As a consequence, the resulting WSF varies by a factor 9. It is concluded that WSF is very sensitive to the potential margin and uncertainties therein, notably at low values. Conversely, a change in the value of one single indicator does not affect the overall result to a great extent, because the effect is dampened out by the weighting procedure. This provides the WSF-approach with some degree of robustness, provided that values for a sufficient number of meaningful indicators can be retrieved.

The sensitivity of the WSF to seasonality was also assessed, by considering only the summer period (June through August) in stead of the entire year. While the overall effect on WSF remains limited to an increase of 7%, it clearly changes the sectoral contributions,. Agriculture and tourism become more important, illustrating the importance of carefully choosing the proper period for analysis.



Editing indicator, raw data and advice descriptions

Editing indicator and advice descriptions

On the sheet ‘indicator description’ you can edit columns F, G, H, I, J. In column L these changes are visualized.

In column S you can change the advice, which is than represented in column T.

If you now run the macro Indicatortooltip all tooltips for indicators and advice in the other sheets are updated.

NOTE: You can also change the ‘Acronym’ (column D) and ‘Shortname’ (column E). However, in that case you will need to alter the acronyms and shortnames at several places in the tool (which will however show in values showing N/A or similar). If you want to change such fields, please also read the ‘section adding new indicators’.

Editing raw data descriptions

On the sheet ‘DataNeedandAvailability’ you can edit columns E-K. In column L these changes are visualized.

If you now run the macro RawDatatooltip all tooltips for raw data are updated.

NOTE: Like for editing indicator short names and acronyms, it is unwise to alter the parameter name (column A), since this will affect some lookup functions and names are used repeatedly. If you want to change names, please also read the ‘section adding new indicators’.

Adding new indicators

For 2009 the author of the tool is willing to support insertion of new indicators. You can receive this support by filling out the sheet ‘New Indicator Request’ and send it to the author.

However, the following steps should allow you to do this yourself:

1) Read section “Some inner workings of the tool” to gain some insight in the working of the tool

2) Fill in the form ‘New Indicator Request’

3) On the sheet ‘Indicator definitions’, go to the domain sector combination for this new indicator. Search for the first empty cells in column D and E and fill in that row.

4) On the sheet ‘Indicator selection’ fill in the short name of the new indicator on the appropriate position (domain – sector).

5) Likewise on sheet ‘Results 1’)

6) On the sheet ‘Raw data definitions’, insert all raw data, replacing lines which are called ‘Dummy’. For raw data definitions which are already available, copy the appropriate lines.

7) On the sheet ‘DataNeedandAvailability’ insert only those raw data which are new, filling in all relevant fields, replacing dummies at the end of the table (Row 117 and following).

8) For those raw data which are already defined, only add to those lines where they are defined for which indicator they are used. (Columns ‘Required for’)

9) On the sheet ‘Raw data’ the new raw data names should now show at the bottom end of the table.

10) Select in the raw data sheet the ‘step trend data’ (Range AR:BV). Use the menu ‘Insert’> ‘Names’ > ‘Define’ to give the range the name of the parameter. Repeat this for each parameter.

11) On the sheet ‘IndicatorCalc’ fill in the short name of the new indicator on the appropriate position (domain – sector).

12) Insert the formula to calculate the indicator in range AR:BV. Note that the Excel settings menu “Tools”>”Options”>”Calculation”>”Accept Labels in Formula’s” needs to be checked.

Some inner workings of the tool

With few exceptions most inner working of the tool is by referencing, information is as much as possible not repeated by retyping, but by referencing such as

"+CellReference", or utilizing lookup functions such as V-lookup. In some cases this was not possible and information was re-entered. This in particular has been done in the sheet 'DataNeedAndAvailability', where for each raw data type a set of indicators for which this raw data is required is presented. This sheet has been developed as a basis for the tooltips on raw data, which can be found in column L of the sheet 'DataNeedAndAvailability'. In contrast the tooltip for the indicators can be found in column L of the 'Indicator definition' sheet.

To avoid using macro's (and forms) the tooltips have been developed using the 'hyperlink function' of in excel. Typically this function is used to link to other cells or to external data-source. In this case the hyperlink points to the same cell. But, a hyperlink can have a tooltip, meaning that when 'hovering' over the cell some explanation will be presented.

This trick is used for all information on indicators and raw data in the various sheets. It is also used for the 'advice' function in the 'results 1' sheet. Two macro's are available to update such information in case that descriptions of indicators and raw data are changed.

Rawdatatooltip	Based on the information provided in sheet "Raw data definition", this macro creates appropriate tooltips in the sheet "Raw Data". The macro only needs to be executed if information regarding raw data, e.g. the descriptions have been altered
Indicatortooltip	Based on the information provided in sheet "Indicator definitions", this macro creates appropriate tooltips with respect to indicators. The macro only needs to be executed if information regarding indicators, e.g. the descriptions have been altered. The macro also adapts the advice field in 'results 1'.

At various places you will find 'Dummy' entries. These entries are included to allow insertion of new indicators.

So how does the tool work when applied with the current indicators and raw data?

13) On sheet 'Indicator selection', the indicators to use are selected.

14) Based on this information the need of raw data is automatically presented on the sheet DataNeedandAvailablility, in column B, rows 16 and higher. As you can see there is a complex lookup function that outputs 'Y' or 'N' for each raw data item based on a lookup function.
Note that the rows before 16 are reserved for raw data which are always required, regardless the selected indicators. Currently these are the data required for e.g. calculating the Water Exploitation Index. it is automatically determined.

15) This information is than simply copied (+CellReference) into sheet 'Raw data', column B.

16) When raw data are entered in the appropriate fields in the ‘raw data’ sheet (notably range G6:AK150, the column C (headed ‘count’) automatically presents the number of data inserted, and column D (headed ‘Data availability’) is updated according to the count and the need for data. IF Data is required
    Count <= 2 “Poor”
    Count <= 5 “Moderate”
    Count >5 "Good"
    If data is not required than the field will show : “not required")

17) As long as there is no starting value inserted (column F) for required raw data, column ‘start value’ will show ‘Missing start value’. It will automatically turn to OK when a value is entered.

18) In the range AR6:BV150 (‘raw data’ sheet) the step trended data are automatically created using simple rules: E.g. If there is no value for a parameter in 1985, the start value is used. If there is no value for 1986, the value of 1985 is used, which in turn is the value of 1985 if no start value is provided. If a value is available for 1986, obviously that value is used.
    NOTE 1: Each row-range (E.g. AR6: BV6) has been given a name via the name function of Excel.
    NOTE 2: If you would prefer linearization between two data points, the way to proceed is to insert the linearised data into the raw data range!

19) On ‘CalcIndicators’ sheet, the range AR4:BV200 calculates the raw indicator values by using the name fields on sheet ‘raw data’. It is very important not to change the columns AR-BV, since they need to be consistent with the columns on sheet ‘raw data’.

20) In the range L4: AP200 the scaled values for the indicators are automatically computed, using straight forward arithmetics and the information contained in Lower Boundary (Column J) and Upper Boundary (Column K). Changing these boundaries automatically results in rescaled indicators.

21) On sheet ‘Results 1’ the range C1:F1 determines for which years the results are presented both on ‘Results 1’ and ‘Results 2’. Via simple lookup functions the results are numerically presented in ‘Results 1’. Via conditional formatting the high stress situations are highlighted, where high stress is defined as any value above 0.75.

22) Similarily, via lookup functions and highlighting ‘Results 2’ is created.

Getting support

If you require assistance using the tool you may contact Michiel Blind. For the scientific content please consult the references.

References

- Alcamo, J., Henrich, T., Rsch, T., 2000. World Water in 2025 Global modelling and scenario analysis for the World Commission on Water for the 21st Century. Report A0002, Centre for Environmental System Research, University of Kassel, Germany.
- Anderson, V. (1991) Alternative Economic Indicators. Routledge, London and New York.
- AWWArf. Report, #90817. Socioeconomic Impacts of Water Conservation, 2001.
- Baumann, D. D., Boland, J. J., Haneman, W. M., 1998. Urban water demand management and planning. Mcgraw-Hill.
- Bos, M. G., D. H. Murray Rust, et al. (1994). Methodologies for assessing performance of irrigation and drainage management. Irrigation and Drainage System 7: 231-261.
- CH2M Hill, July 2003, Water Use in Industries of the Future
- Connolly, C. and Chisholm, M. (1999), The use of indicators for targeting public expenditure: the Index of Local Deprivation, Environment and Planning C: Government and Policy, 17: 463-482.
- Cosgrove W. & Rijbersman F. (2002) The World Water Vision. Earthscan Publications Ltd., London.
- D2.1-1, Auastress project, August 2005, WB2: Bauer, Inman, Manez, Moors, Pahl-Wostl, Sullivan, Tarnacki, van den Wyngaert, Vurro et al. Common Framework for the Characterization of Water Stress
- Degreene .K. B (1994): The Rocky Path to Complex-Systems Indicators. Technological Forecasting and Social Change, Vol 47(2), Oct. 1994.
- Department of the Environment UK (1996) Indicators of Sustainable Development for the UK. HMSO, London.
- EC, European Commission - Integrated Pollution Prevention and Control (IPPC) Reference Documents on Best Available Techniques
- Edgeworth, F.Y. (1925) The Plurality of Index Numbers The Economic Journal 35:139:379-388
- EEA - European Environmental Agency, (2003). Dobris report - Environmental Assessment Report 10.
- EEA 2000b: Environment in the European Union at the turn of the century, Chapter 3.5 Water Stress
- EEA, 1999: Sustainable water use in Europe, Part 1 - Sectoral use of water, Environmental assessment report No 1
- EEA, 2000a: Sustainable use of Europe s water? State, prospects and issues, Environmental assessment series No 7

• EEA, 2001: Sustainable water use in Europe, Part 2 Demand Management, Environmental issue report No 19

• EEA, 2003 European Environment Agency indicator reports http://themes.eea.eu.int/indicators/allindicatorsbox

• EEA, 2003: Europes water: An indicator based assessment, Topic report 1/2003

• EEA. Sustainable water use in Europe Part 2: Demand Management. Environmental issue report No.19., 2001.

• Falkenmark, M. (1986). Fresh water - time for a modified approach. Ambio., 15, 192200.

• Falkenmark, M. and G. Lindh, (1974) Impact of Water Resources on Population Swedish contribution to the UN World Population Conference, Bucharest.

• Finkelstein, J.M.; Schafer, R.E. (1971). Improved Goodness-of-Fit Tests.Biometrika, 58(3), pp. 641-645.

• Fisher, I. (1922) The Making of Index Numbers. Journal of the American Statistical Association.

• Freeman, D.H and T.R. Holford (1990) Summary rates, Biometrics, 36: 195-205.

• Fritsch J.M. (2001) Time variability of the hydrological cycle and implications for water resources management. Int.Conf. on Hydrological Challenges in Transboundary Water Resources Management. Koblenz, Fed.Rep.Germany, 25-27 Septembr 2001.

• Gash, J.H.C., E.O Odada, L Oyebande, R.E. Schulze (1999) - Freshwater Resources in Africa - Workshop Proceedings, 1999 - Start.org Nairobi

• Gleick P. (2002) The worlds water. The Biennial Report on Freshwater Resources. 2002-2003. Island Press, 334 p.

• Gleick, P. H., 1996. Basic water requirements for human activities: Meeting basic needs. Water International 21 2 8192.

• Gustavson .K.R, Lonergan .S.C, Ruitenbeek .H.J (1999): Selection and Modelling of Sustainable Development Indicators: a Case Study of the Fraser River Basin, British Columbia. Ecological Economics, Vol.28(1), Jan 1999.

• Hammond, A., A. Adriaanse, E. Rodenburg, D. Bryant, and R. Woodward (1995), Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development, Baltimore: World Resources Institute.

• Henninger (1998): Mapping and Geographic Analysis of Human Welfare and Poverty- Review and Assessment. World Resources Institute, Washington, D.C, U.S.A

• Hentschel, .J, Lanjouw P.(1998): Household Welfare Measurement and the Pricing of Basic Services. World Bank, Washington D.C

• Howarth, D., Butler, S., Communicating water conservation: How can the public be engaged? Water Supply, 2004, 4, (3). 33-34.

• Howarth, D., Privatisation - A help or a hindrance in managing water demand. Water Resources Update, 1999, 114, Winter.

• http://www.nao.org.uk/publications/naoreports/9900971.pdf ???

• Jacobs, H.E., 2004. A conceptual end-use model for residential water demand and return flow. PhD thesis, Rand Afrikaans University.

• Jamati, C., 2003. Casablanca (Morocco): An Example of Public-Private Partnership. International Journal of Water Resources Development 19 (2).

• Jesinghaus, J. (1998), A European System of Environmental Pressure Indices, First volume of the Environmental Pressure Indices Handbook: The Indicators. Luxembourg: European Commission.

• Jimenez-Beltran, D., 2005: The EEA and the Industry The State of the Environment in Europe and the EU, Annual NGOs Meeting with the Commission

• Kanakoudis, V. K., 2001 - Urban water use conservation measures. Journal or Water Supply Research and Technology AQUA, 51 (3). 153.

• Keller, A. A. and J. Keller (1995). Effective efficiency: a water use efficiency concept for allocating fresh water ressources, Discussion paper No.22, Center for Economic Policy Studies: Winrock International.

• Keller, A. A., J. Keller, et al. (1996). Integrated water ressources systems:theory and policy implication, Research report No.3, International Water Management Institute, Colombo, Sri Lanka.

• Lens, P. (2002): Lens, P., Hulshoff Pol, L., Wilderer, P., Asano, T Water Recycling and Resources Recovery in Industry, IWA Publishing, 2002

• Maddaus, L.A., 2001. Effects of Metering on Residential Water Demand. MSc Thesis, UC Davis, California

• Michelson, A.M., McGuckin, J.T., Stumpf, D. Non-price water conservation programs as a demand management tool. JAWWA, 1999, 35, (3). 593-602.

• Mitchell, V.G., Modelling the Urban Water Cycle. Environmental. Modelling and Software, 2001, 16 (7) 615-629

• Molden, D., R. Sakkthivadivel, et al. (1997). Indicators for comparing performance of irrigated agricultural systems. Colombo, Sri Lanka, IWMI - Research report N 20: 27p.

• Murphy, John J. (1999)Technical Analysis of the Financial Markets. Institute of Finance, New York

• NAO, 2000 National Audit Office. Leakage and water efficiency. Report by the controller and auditor general - HC 971 Session 1999-2000: 1 December 2000.

• Noble, M., G. Smith, B. Penhale, G. Wright, C. Dibben, T. Owen and M. Lloyd (2000), Measuring Multiple Deprivation at the Local Level: The Indices of Deprivation 2000, DETR.London.

• OECD: Measuring Development Progress, A Working Set of Core Indicators, http://www1.oecd.org/dac/Indicators/htm/slides.htm

• Ofwat, 2000a. Patterns of Demand for Water in England and Wales: 1989-1999.

- Ofwat, 2002 - International comparison of water and sewage services 2000-2001
- Ohlsson, L. (1998) Water and Social Resource Scarcity. FAO issue paper, FAO, Rome.
- Raskin, P., Gleick, P., Kirshen, P., Pontius, G., Strzepek, K. (1997). Water futures: Assessment of long-range patterns and problems. Stockholm: Swedish Environment Institute/United Nations.
- Read, C., Better buildings design for water efficiency, by Caroline Read, 2005. Published by Green Alliance, London.
- Rennings, K. and H. Wiggering (1997), Steps towards indicators of sustainable development: Linking economic and ecological concepts, Ecological Economics 20, 25-36.
- Renwick, M.E., Archibald, S.O., Demand-side management policies for residential water use: Who bares the conservation burden? Land Economics, 1998, 74, (3). 343-359.
- Rogers, P.R., Jalal, K.F. Lohani, B.N. Owens, G.M., Chang-Ching Yu, Dufournaud, C.M and J.Bi (1997): Measuring Environmental Quality in Asia. Harvard University Press, Harvard.
- Saaty, T.L. (1980) The Analytical Hierarchy Process. McGraw-Hill, New York.
- Salameh, E. (2000) Redefining the Water Poverty Index. Water International 25 no.3 Pp 469-473
- Sen .A.K (1983): Poor, Relatively Speaking.. Oxford Economic Papers, No.35.
- Senior, M. (2002), Deprivation Indicators, in P. Rees and D. Martin (eds), The Census Data System, pp.123-139.
- Shiklomanov I.A. et al., (1997). Assessment of water resources and water availability of the world. Part of the Comprehensive Assessment of the Freshwater Resources of the World, World Meteorological Organization, Geneva.
- Schulze, R.E. (2000) Modelling Hydrological Responses to Land Use and Climate Change: A Southern African Perspective Ambio, 29:1
- Shuval, H., 1992. A regional water for peace plan. Water International 17 3, 133143.
- Small, L. E. and M. Svendsen (1990). A framework for assessing irrigation performance. Irrigation and Drainage System 4: 283-312.
- Somlyody L. (1995) - Water quality management: can we improve integration to face future problems? Wat.Sci.Tech. Vol.31 No.8 pp 249-259, 1995.Sophocleous M. (2000) - From safe yield to sustainable development of water resourcesthe Kansas experience. Journal of Hydrology 235 (2000) 2743.
- Streeten, P.P. (1996) Human Development the Debate about the Index, International Journal of the Social Sciences
- Sullivan C.A. (2002). Calculating a Water Poverty Index. World Development, 30, 1195-1210

- Sullivan C.A. (2004) Presentations to WB 2 on the concept of the potential Water Stress Matrix as an alternative to an index. Porto, Osnabruck
- Sullivan C.A. and Meigh, J.R. (2005) Targeting attention on local vulnerabilities using an integrated indicator approach: the example of the Climate Vulnerability Index. Water Science and Technology, Special Issue on Climate Change Vol 51 No 5 pp 6978
- Sullivan C.A. and Meigh, J.R. (2006 in press) Integration of the biophysical and social sciences using an indicator approach: Addressing water problems at different scales Journal Water Resources Management
- Sullivan C.A., Meigh J.R., Giacomello A.M., Fediw T., Lawrence P., Samad M., Mlote S., Hutton C., Allan J.A., Schulze R.E., Dlamini, D.J.M., Cosgrove W., Delli Priscoli J., Gleick P., Smout I., CobbingJ., Calow R., Hunt C., Hussain A., Acreman M.C., King J., Malomo S., Tate E.L., ORegan D., Milner S. and Steyl I. (2003) The Water Poverty Index: Development and application at the community scale. Natural Resources 27:189-199
- Sullivan, C.A. (2003) The Water Poverty Index: A new tool for prioritisation in water management. World Finance. 32-34
- Sullivan, C.A., Meigh, J.R., Fediw, T., 2002. Developing and Testing the Water Poverty Index: Phase 1 Final Report. Report to DfID, CEH, Wallingford, UK
- Townsend .P (1985): A Sociological; Approach to the Measurement of Poverty: A Rejoinder to Professor Amartya Sen. . Oxford Economic Papers, No.37.
- UK Environment Agency, Saving Water: Taking Action The Responses to the Consultation Report on Water Conservation and Demand Management, prepared from the National Water Demand Management Centre, 1997.
- UNICEF (1995): Monitoring Progress Toward the Goals of the World Summit for Children: A Practical Handbook for Multiple-Indicator Surveys.
- UNICEF (1997): Evaluation of Multiple Indicator Cluster Surveys: Division of Evaluation, Policy and Planning.
- United Nations Statistical Office (1993) Handbook of national Accounting. Integrated Environmental and Economic Accounting. Studies in Methods. Series F, No.61. United Nations Statistical Office, New York.
- United Nations. 1997. Commission on Sustainable Development. Comprehensive assessment of the freshwater resources of the world. Fifth session, April 5-25. Accessed at <http://www.un.org/>.
- USEPA, Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs. United States Environmental Protection Agency Office of Water (4204M), EPA832-B-02-003. July, 2002 www.epa.gov/owm/water-efficiency/index.htm
- Uvin, P. (1994): The International Organisation of Hunger. Kegan Paul, London.
- Van de Worp, 2002, Sustainable water management in industry in: Water Recycling and Resource Recovery in Industry, IWA Publishing

- Van der Gaag, (1988): Confronting Poverty in Developing Countries: Definitions, Information and Policies. LSMS Working Paper No 48. World Bank, Washington, DC.
- Vörösmarty, C.J. 2002. Global water assessment and potential contributions from Earth Systems science. Aquatic Sciences 64: 328-51.
- Walmsley, J (2002): Overview: Sustainability Indicators for Catchment Management in South Africa. Water Research Commission, South Africa.
- WHO/UNICEF, 2002. Joint Monitoring Programme for Water Supply and Sanitation
- Wilhite, D.A., 2005. Drought and Water Crises: Science, technology and management issues. Taylor & Francis, New York.
- World Bank (1996) A Guide to LSMS Surveys and their Datasets. World Bank, Washington DC.
- World Bank (1996a): Poverty Monitoring and Analysis Systems. World Bank, Washington DC.
- World Bank (1997) Expanding the Measure of Wealth Indicators of Environmentally Sustainable Development. Rio+5 Edition, discussion draft. World Bank, Washington DC.
- World Bank (1998) Standardised Welfare Indicators World Bank, Washington DC.
- World Bank (2005). Reengaging in agricultural water management: Chalenges, opportunities, and trade-offs. World bank Report No. 32731-GLB, Agriculture and rural department, The World Bank, Washington D.C.: 146.
- World Health Organisation (1992): Health for All Database. WHO, Geneva.
- World Health Organisation: Environmental Health Indicators: Framework and Methodologies, p2. See: http://www.northampton.ac.uk/ncr/who/index.html
- World Resources Institute (2000): Linking Environment and Health: Indicators of Environmental Threats to Health.
- WSSTP, 2005, Water Supply and Sanitation Technology Platform, Technical Working Group: Water and Industry (TWG 3), Vision Document