INDICATORS

The Namibian Government is committed to improving the livelihood of its people and to sustainable use of the Nation's natural resources. Meeting this challenge requires an understanding of the factors governing the distribution and abundance of national natural resources, the patterns of resource use, and a programme to monitor resource condition to guide management and policy decisions. Without this adaptive approach to natural resource management, there is little hope for ensuring sustainable resource use and the long-term well-being of Namibia's citizens.

Without some sort of monitoring and information dissemination network in place, policy makers will continue to be reactive rather than proactive in response to environmental problems. Hence, some means of measuring the status and usage patterns of environmental resources such as water is needed. An indicator, a measure of some variable of interest, whether it be environmental (depth to groundwater table), economic (water cost), or social (per capita incidence of water-borne disease), provides such a means. As the name suggests, indicators are measures, which are symptomatic of particular situations. The current numerical value of an indicator may be determined by a simple measurement (i.e. dipping a well to measure the depth to water) or derived from an equation, which incorporates measurements of several variables.

WHY DO WE NEED INDICATORS?

The value of indicators to the management of natural resources in Namibia becomes clear when viewed in the context of Namibia's "Information and Communication Service for Sustainable Development in Namibia" program, of which this report is a part. This programme is managed from the Directorate of Environmental Affairs, Ministry of Environment and Tourism and funded by the Government of Finland. If this programme is to be effective, it must:

- determine the status of resources
- discern changes and trends
- provide an understanding of processes
- provide early warning of emerging problems
- measure the effectiveness of environmental policies.

The measurement and interpretation of key indicators are central to the success of such a program. Indicators used in a national program for monitoring environmental resources must address the fundamental questions of:

- Is the environment getting better, worse or holding steady?
- Why (what are the causes of change)?
- What can we do about it (do we understand the stressors involved)?

While the measurement and interpretation of indicators is clearly crucial, which ones should we use and how should we use them? Two general types of indicators can be defined: core and developmental. Core indicators are those in which the data collection and evaluation methodologies are well defined, and existing data series provide a historic record in support of future analyses. Developmental indicators are those in which further testing of sampling and evaluation methods is still needed, and historic data series do not exist. Both types of indicators are important components of a long-term monitoring program for Namibia's water sector. Once selected, the overall health of Namibia's water sector may be determined through a critical evaluation of indicator scores relative to reference conditions.

DETECTING POLICY-RELEVANT TRENDS

A primary goal of this report is to identify key indicators, which are relevant for assessing trends at the national level. These trends may affect policy or be affected by policy at the national, regional or local level. Indicators of trends must have a direct and easily-recognised relationship to socio-economic or environmental well-being, and have the social and political impact to catch the attention of and demand action from policy-makers. The development of appropriate indicators is a key step in addressing questions about the existence or magnitude of trends in natural resources such as water. What constitutes a policy-relevant trend and how well can we measure or detect it?

While a trend may be defined as a long-term change in the mean value of a series of measurements, an equally or more important trend may be a shift in the variance. Rainfall patterns provide a key example, wherein a small change in the mean over time could be associated with a significant increase in the variance. The relevant indicator in this case would not be the mean itself, but rather the variance, as an increase in rainfall variability could have an enormous impact on the Namibian economy.

Although the concepts of trend and change are familiar to many, the issues associated with their analysis, and accurate and timely detection, are subtler. First, the term "trend" is difficult to precisely and objectively define. The term trend describes the continuing directional change in the value of an indicator over time, generally upwards or downwards. Effective trend detection is entirely dependent on the availability of data collected over a period of time in a consistent and reliable manner. Monotonic trends, continual increases or decreases, are commonly detected in the evaluation of long-term data series. Such trends may occur gradually over time, or in abrupt "steps." Step trends may occur in a data series in direct response to a specific event, such as the introduction of a contaminant to a water source, resulting in a sudden change in the variable of interest (Hirsch et al. 1991).

What constitutes long-term, when considering a trend, is subjective and depends upon the dynamics associated with the system under study. A basic understanding of the variability of Namibia's climate only begins to emerge after many decades of study. Long-term data are essential for detecting environmental trends and for putting the present into perspective (Magnuson 1990). Data from a single year, such as rainfall in Khorixas in 1995, reveal little information. Similarly, only a few years of water table measurements from the Kuiseb River aquifer tell us little regarding infrequent recharge events.

In the same way that variation from one year to the next may complicate our recognition of trends, so too may high levels of variation from one site to another during any given year. This spatial variation, which typifies Namibia's natural resources, adds another complexity to our definition of trend. What constitutes the appropriate coverage in a given space, such as a particular region within the country? While groundwater monitoring may be intensive at a single (sentinel) site, we cannot assume that that site is representative of a larger area. Identification of regional trends will probably require more complete data, sampled across a range of sites. Thus our definition of trends must include both change over time, as well as change over space in target regions. It should thus be immediately clear that data sets of short duration and limited spatial coverage are not adequate to recognize trends accurately.

HOW OFTEN DO WE MONITOR?

Determining the optimal frequency and distribution of surveys is a key issue in effectively monitoring the status of Namibia's resources. Given the limited resources for monitoring, the longest survey cycle, which still meets the needs of early and accurate detection, must be identified. The main goal in achieving this optimal frequency is avoiding both unnecessary cost and regulation, while preventing the development of any serious environmental problem. Groundwater dynamics provide a useful example. The depth to the water table is a simple and useful indicator, which is responsive to a number of stressors. However, recharge events occur infrequently and are associated with high-magnitude rainfall and surface flows. What is the optimal frequency for measurement? The DWA views abstraction rates which, result in a continuous fall over a five year period without recovery during periods of reasonable rain as unsustainable. In such a case, measurement of the water table more frequently than once in five years is necessary.

Costs and logistical challenges associated with the maintenance of a large number of monitoring sites dictate that prioritization of site selection will be necessary - we have neither the time nor money to sample as broadly as we would like. One approach explored within this report is the use of sentinel sites. The sentinel site approach uses a relatively small number of , which are chosen for intensive study. Each location is selected under the assumption that it is representative of a larger region or class of systems, such as a particular aquifer type or ecosystem. Sentinel sites can be selected for several reasons, including their perceived sensitivity to environmental change and their importance to Namibian society as a whole. Negative changes in sentinel sites may alert us to the urgent need to resample ancillary associated sites to verify long term changes.

MOVING FROM DETECTION TO CAUSATION

Once detected, determining the cause of a trend is important so that appropriate policy changes and management can be instituted. Assigning causality is a key challenge in environmental monitoring programs. While our chosen indicator may be a reliable measure of a given resource, in the absence of any measurements of change in suspected stressors, we may be unable to assign causality and determine whether the trends are "natural" or caused by human activities. Natural resource monitoring programmes commonly emphasize effects-oriented monitoring, which provides a direct measure of a resource (e.g. groundwater storage). However, early detection of changes in resources through stressor-oriented monitoring (e.g. water demand) may be a more effective means of ensuring sustainable resource use. Monitoring changes in stressors is key to successful adaptive management, and the prevention of serious resource degradation.

A key challenge associated with natural resource monitoring programs is to isolate the effect of interest from noise introduced by natural spatial and temporal variability. If the size of an impact from a human disturbance is small relative to natural variability, it will be difficult to detect with any degree of confidence (Osenberg et al. 1994). This challenge of distinguishing natural from anthropogenic variability is at the heart of Namibia's attempts to monitor and ensure the sustainable use and development of its finite water resources. Namibia's arid climate is highly variable, with large variations in rainfall and riverflow between years at any given location. For any data series, the ability to detect trends is a function of three characteristics: (1) the magnitude of the signal, (2) the variance of the data, and (3) the sample size. In an arid country like Namibia, where the variance of water-related data may be very high, one fact is thus readily apparent - only a large change in resource condition is likely to be detected in the absence of a long-term data set.

This issue of separating natural from human-induced change is of particular significance in Namibia, given the high levels of variation, both over space and time, in many resources. Monitoring programs are often piecemeal, intermittent, and short term. They generally have not provided the continuous long-term information about temporal and spatial variation necessary to distinguish natural from human-induced change. This distinction may be best made with a combination of stressor-oriented and effects-oriented monitoring. Ultimately, monitoring trends in both effects and stressors can improve the interpretability of observed changes. The status of an aquifer provides a simple example, in which the effect is a change in the water table in response to multiple stressors, such as changes in water demand (withdrawals) and recharge. In such cases, the choice of appropriate response variables (indicators) is dependent upon our knowledge of the dynamics of the system.

WHAT ARE THE CHARACTERISTICS OF A GOOD INDICATOR?

To be effective, an indicator must be:

- efficient (i.e. easily measured and analyzed using existing data)
- effective (i.e. sensitive to change and clearly linked to causative factors)
- economically and logistically feasible (e.g. already being measured)
- reliable (i.e. accurate and continuous).

A key issue in the development and application of indicators is the feasibility, technical, financial and environmental, of gathering the information required. While an indicator may have great potential for monitoring policy-relevant trends, the logistical, technical, and economic realities of collecting and analyzing the information required for its determination will dictate its use. While some indicators may have great utility, technical and financial constraints may preclude their use.

INDICATOR NAME	Mean Annual Rainfall
Definition	The indicator of mean annual rainfall is defined in two ways: 1) As the total volume of rain falling on Namibia divided by the country's surface area for the season under review, and 2) the 20 year running mean of the annual total volume of rain falling on Namibia divided by the country's surface area.
Measurement	The volume of rain falling over the whole country is calculated using the annual rainfall depths recorded at as many rainfall stations as possible. A surface is fitted over these depths and the volume under the surface calculated. This is done for the year under review (for 1) above) and for each of the last 20 years for 2) above.
SIGNIFICANCE OF THE INDICATOR	
Purpose	This indicator gives an indication of 1) how rainfall for the season under review for the entire country compares with the long-term mean, and 2) how rainfall over the past twenty years compares with the long-term mean. In this way trends may be identified in an objective way.
Relevance	As a key element in the hydrological cycle rainfall is extremely important. Surface water runoff, groundwater recharge and the availability of water in general are related to rainfall.
Underlying Variables And Definitions	The key underlying variable is the rainfall record as recorded at the individual rain gauges. The volume of rainfall falling over the whole country is calculated by fitting a surface over all the recorded rainfall depths. The volume of rainfall is expressed as an equivalent depth by dividing the volume by the area of the country. The result is expressed in millimetres.
Limitations Of The Indicator	The limitations of "mean" have been discussed in the report, and it should be remembered that, although useful, the mean is only one way of characterising rainfall. It would be possible to repeat this exercise using median or rainfall variability.

Linkages To Other Indicators	As a fundamental element of the hydrological cycle rainfall, and therefore "mean annual rainfall" has links with any indicators which describe either surface or groundwater. While good rainfall does not always result immediately in good runoff and groundwater recharge, in the long-term, it does.
Calculation And Updating Of Indicator	Once NMS has the individual rain gauge data available, the values are plotted on a map and a surface fitted to them using specialised surface-fitting computer software. This software is also used to calculate the volume of rainfall under the surface. For 1) the value is calculated only for the season just finished. For 2) the value is calculated for the season just finished and the previous 19 years. The running mean value for the most recent year is calculated by adding the volumes for the twenty years and dividing by 20. Two volumetric results are therefore obtained, one for 1) and one for 2). These results are each divided by the surface area of Namibia to obtain and equivalent depth of rainfall.
Past Performance	The past performance of this indicator has been summarised in the attached notes.
Interpretation	Care should be taken in the application of this indicator since the calculation of the rainfall values still relies on data for the entire country. Certain areas of the country have very poor rainfall coverage.
INDICATOR DATA	
Data Requirements	Rainfall data are collected and archived by Namibia Meteorological Services; Hydrology Division, DWA; and Desert Research Foundation. These agencies would be required to process their data and to make it available for the volumetric calculation.
Responsibility For Collecting And Processing The Data, And How Frequently	Each of the data collection agencies would be responsible for providing the necessary data for all functioning gauges. NMS calculates the volumetric figure from the aggregated data.

Reliability And Quality Of Data	The reliability of the rainfall data and therefore the indicator should be satisfactory.
Where The Data Are Lodged And In What Format	The data are lodged with the three identified agencies. The NMS would calculate a single figure number for the volume of rainfall for this and previous years. These volumes are currently stored on spreadsheet.
Availability Of The Data	The data are available at no cost from the three agencies.

Additional Notes to Indicator Table

PAST PERFORMANCE

The indicator value for Volumetric depth of rainfall (Namibia Average Precipitation (NAP) for the 1996/97 season was 241 mm. This compares with the long-term mean of 276mm.

This second indicator simply states the current status of the twenty year running mean compared with the 1996/97 baseline long-term mean precipitation for the whole country. The indicator reports the percentage difference by which the 20 year running mean differs from the long term mean. The value can be either positive or negative. This idea is illustrated in Figure 1.

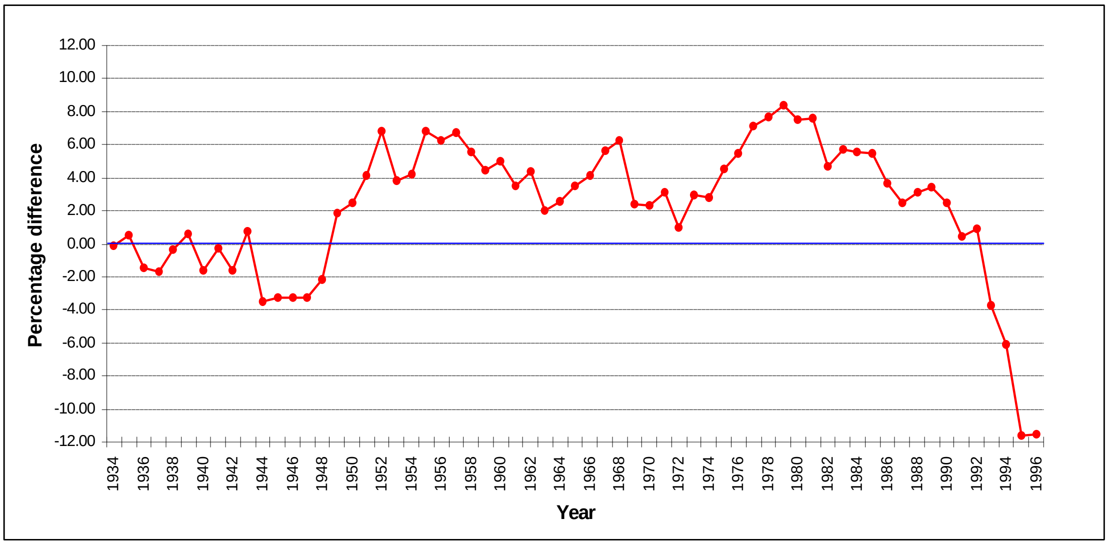

Figure 1: *Using the twenty year running mean value and comparing it with the baseline (1996/97) long-term mean provides an indicator which is both meaningful and relatively easy to update. It is clear that the indicator value has decreased steadily over the past four years. If this trend were to continue for many years there would be reason to suspect that the long-term mean precipitation had actually decreased. The indicator value for 1995/96 was –11.59% and increased slightly to –11.52% after the 1996/97 season. If climate change were not to have any effect on rainfall, it should be expected that the value will return to zero eventually.*

INDICATOR NAME	Data Collection Effort
Definition	The number of rain gauges in Namibia for which useful rainfall data are being collected.
Measurement	This simple indicator measures the level of effort being put into collection of rainfall data, which is fundamental to water environment studies.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To monitor the status of the essential data collection efforts being made by those involved in the collection of climate data.
Relevance	In view of the fact that many scientific and technical investigations and much research work relies on adequate accurate data, and that important decisions are made based on these investigations and research findings, it is clear that an indicator of how well data collection is being carried out is important. Rainfall data are used for this indicator since they are often the most important and extensively collected of climate data, especially in relation to water sector studies. Because of the large number of stations involved, a major effort with respect to logistics and management is required on the part of the data collection agencies and this indicator therefore provides a good reflection of this.
Underlying Variables And Definitions	This indicator simply sums the number of rain gauges, operated by all data collection agencies, for which acceptable data have been collected. Only the agencies are in a position to decide at the end of each year whether a particular station has operated satisfactorily.

Limitations Of The Indicator	This indicator has been calculated using only rainfall gauges. It does therefore not necessarily provide a true indication of how well other data collection activities or data processing are being carried out. The indicator provides a national figure only. The importance of looking at how evenly data collection efforts are spread over the country is not included in the indicator value. However, as background to the indicator, the number of rain gauges operating in each region is also drawn up. The values in this table could be considered as sub-indicators or regional data collection indicators.
Linkages To Other Indicators	Although this indicator is not directly linked to other indicators, it's value should be borne in mind when using other indicators. A low value, or a continuous negative trend may be an indication of generally deteriorating data collection efforts, which may cast doubt on the usefulness of other indicators.
Calculation And Updating Of Indicator	At the end of each hydrological season (end September), each of the data collection agencies will review the rainfall stations in its network and state whether or not each station has been operating satisfactorily and whether the data have been collected successfully. The indicator will then be calculated by summing the number of operational stations. This is to be carried out on an annual basis.
Past Performance	The past performance of this indicator has been summarised in the attached notes. It should be noted that only for 1997/98 can the data be considered really accurate since for previous years it has not always been possible to accurately verify the statistics.
Interpretation	Care should be taken in the application of this indicator. Although it is assumed that the effort that goes into rainfall data collection may provide an indication of the effort made on the collection of other parameters, this is only an indication that would require further investigation.

INDICATOR DATA	
Data Requirements	Rainfall data are collected and archived by Namibia Meteorological Services; Hydrology Division, DWA; and Desert Research Foundation. These agencies would be required to review their stations and indicate the status of data collected at each station and in which region the station lies.
Responsibility For Collecting And Processing The Data, And How Frequently	Each of the data collection agencies would be responsible for providing the necessary data on the status of their rain gauge networks.
Reliability And Quality Of Data	The reliability of the rain gauge count should be good, although it does depend on an honest statement from the data collection agencies.
Where The Data Are Lodged And In What Format	The data are lodged with the three identified agencies. The values are in the format of a simple integer.
Availability Of The Data	The data are available at no cost from the three agencies. The counts will be available by April in the following season.

Additional Notes to Indicator Table

PAST PERFORMANCE

A series of useful rainfall records were compiled as part of an earlier study using Namibia Meteorological Services records updated by this study. Figure 2 is based on these records and shows that there were only 315 rainfall stations operating in 1996 down from a maximum of 345 in 1963. WMO standards indicate that there should be between 500 and 600 rain gauges to provide minimum coverage. Some areas in Namibia have very few or no rain gauges. The indicator value stands now at 315, and every effort needs to be made to see that this figure rises as quickly as possible, particularly in areas that are currently under supplied.

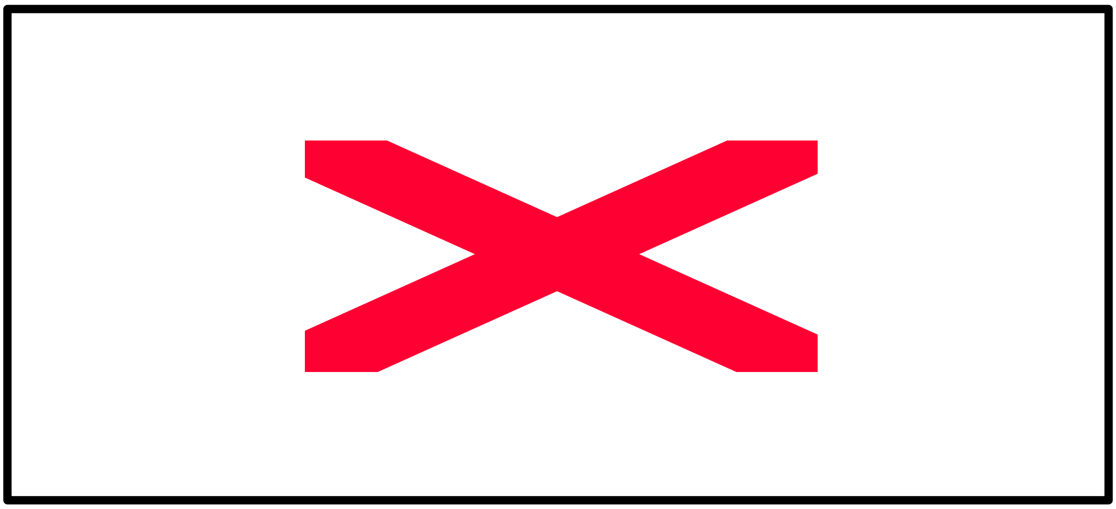

Figure 2 : Past Performance of Indicator

It is also useful to look at this indicator on a regional basis. ***Table 1*** *provides a breakdown of the number of rain gauges operating in each region.*

Table 1 : Regional Analysis of Rain Gauge Numbers

Region	Area of Region (km²)	Number of Gauges suggested by WMO	Number of gauges operating in Namibia
Caprivi*	19 532	14	1
Okavango*	43 418	31	7
Kunene*	144 255	104	16
Omusati*	13 638	10	4
Oshana*	5 291	4	2
Oshikoto*	26 607	19	12
Ohangwena	10 582	8	0
Otjozondjupa	105 328	76	66
Erongo	63 720	46	27
Khomas	36 805	26	46
Omaheke	84 732	87	33
Hardap	109 888	79	54
Karas	161 325	116	47
Totals	**825 121**	**598**	**315**

DATA REQUIREMENTS

Rainfall (precipitation) data in Namibia are collected by a number of organisations, the most important of which are :

Namibia Meteorological Services (NMS)
Hydrology Division in the Department of Water Affairs (DWA)
Desert Research Foundation of Namibia (DRFN)

In addition to its 15 manned multi-sensor weather stations (1998 figure), the NMS receives daily rainfall data from a large number of volunteer observers. Over the years data have been collected and stored for more than 1 000 stations. DWA currently (1998 figure) operates 36 autographic rainfall stations. The DRFN collects precipitation data for seven (1998 figure) stations in the Namib Desert. It is the sum of these satisfactorily operating gauges that is used to determine the indicator.

INDICATOR NAME	Annual Runoff
Definition	The percentage of the identified key runoff stations for which runoff was above or below average for the season under review.
Measurement	Runoff is measured at key runoff stations by the Hydrology Division in DWA on a continuous basis. These stations are either surface water storage dams or gauging weirs.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To give an indication of whether runoff in the country's ephemeral and perennial rivers has been above or below average for the season under review.
Relevance	While the investigation of rainfall parameters such as mean annual rainfall is fundamental for all water resources, it is also important to have an indication of surface runoff levels. High surface water runoff levels in the ephemeral rivers is likely to indicate that the country's main water supply dams are receiving inflow. Namibia is dependant on surface water resources for the majority of its bulk water needs, and it is therefore essential to monitor their status.
Underlying Variables And Definitions	Water levels are recorded at Namibia's major dams and at more than one hundred river gauging stations countrywide. From these stations, 15 key stations have been selected, representative of the main perennial and ephemeral rivers. These water level data are converted into volumetric flow data, which are then used to calculate the indicator.

Limitations Of The Indicator	The indicator only covers a selection of Namibia's river basins. Due to the great spatial variation of rainfall in Namibia, it is very possible for rain to fall heavily causing floods in one catchment, but for the adjacent rivers catchments to receive little or no rain.
Linkages To Other Indicators	Clearly the runoff indicator has linkages with the mean annual rainfall indicator. However, high levels of runoff in the ephemeral rivers without high rainfall can occur and may indicate a deterioration in catchment conditions (e.g. poor ground cover from over-grazing).
Calculation And Updating Of Indicator	The majority of the key stations are either storage dams or perennial river stations for which the proccessing of runoff data is almost immediate. For the handful of key stations which are ordinary gauging stations on ephemeral rivers, processing will normally only be carried out by around December, or three months after the end of the hydrological season. The indicator should be updated on an annual basis.
Past Performance	The performance of this for 1997/98 is summarised in the attached additional notes.
Interpretation	Care should be taken in the application of this indicator. As already stated, high levels of runoff without unusually high rainfall may indicate a deterioration in catchment health.
INDICATOR DATA	
Data Requirements	A considerable amount of data have to be collected by the hydrology Division to calculate this indicator. These data would be in the form of a single runoff volume per key station for the year in question, together with a long-term mean value.

Responsibility For Collecting And Processing The Data, And How Frequently	The Hydrology Division and NamWater (dams) are responsible for the collection and processing of these data. Processing of most of the data is carried out on an ongoing basis. Finalisation of the data would be carried out during the three months following the end of each hydrological season.
Reliability And Quality Of Data	The reliability of the data is generally good.
Where The Data Are Lodged And In What Format	The data are lodged with the Hydrology Division (DWA) and NamWater.
Availability Of The Data	The data are available at no cost from the two.

INDICATOR NAME	Pollution of groundwater
Definition	The number of sites where unacceptable levels of concentration of contaminants have been measured expressed as a proportion of the total number of sites monitored.
Measurement	Analysis for site-specific determinants in groundwater samples collected at specific monitoring sites.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To show whether pollution control is effective in areas of high contamination risk.
Relevance	If monitoring of this indicator shows a steadily worsening situation a need for stricter control measures will be evident. Where a balance is maintained and the situation remains stable this will show that the current measures are adequate.
Underlying Variables And Definitions	Acceptable levels of concentration for numerous contaminants are listed by the Department of Water Affairs. Samples are to be analysed for site-specific determinants and the acceptability, or compliance of the results with the given levels of acceptability recorded. Each sample will thus be recorded as acceptable or not and the total number of acceptable samples expressed as a proportion of the whole given as the indicator. This proportion will be in actual numbers so that the number of monitoring sites is shown.
Limitations Of The Indicator	This indicator will be limited by the number of monitoring sites used and will give no indication of the severity of pollution at any one site.
Linkages To Other Indicators	

Calculation And Updating Of Indicator	Annually at the end of each hydrological season (end September) samples should be collected from each of the monitoring boreholes and submitted to the NamWater laboratory for analysis.
Past Performance	No data are available on which to assess the past performance of this indicator.
Interpretation	Contaminant levels must be compared to a single set of standards and uniform analytical techniques must be applied in the laboratory so that changes measured are real and not induced.
INDICATOR DATA	
Data Requirements	Analyses for site-specific determinants from samples collected at sentinel boreholes.
Responsibility For Collecting And Processing The Data, And How Frequently	The Department of Water Affairs should assume responsibility for the collection of samples and the processing of data on an annual basis. Analyses should be carried out at the NamWater laboratory.
Reliability And Quality Of Data	Analyses for determinants will be reliant on the detection limitations of the methods applied in the laboratory. Analytical methods should conform to internationally accepted standards (eg. ISO or SABS).
Where The Data Are Lodged And In What Format	Copies of the analytical results will be retained by the laboratory, sent to the originator of the samples and should be circulated to the office of the Environmental Commissioner.
Availability Of The Data	Data are currently not available but will involve some cost for sample collection and analysis.

INDICATOR NAME	**Routine monitoring of water levels in the non-strategic, regional aquifers**
Definition	Measurements of changes in rest water levels in non-strategic aquifers.
Measurement	The depth from surface to the rest water level is to be measured in sentinel boreholes designated for this purpose. As the frequency of this monitoring is to be annual it is recommended that measurement be carried out manually.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To monitor changes in rest water level that may show depletion or replenishment of regional aquifers. As these aquifers support rural farming communities the measurements will provide an early indication of resource stress which will enable decision-makers to proactively manage usage.
Relevance	Declining water levels show a reduction in the stored amount of groundwater in a given area, which may result from natural causes such as periods of below average recharge, or from over abstraction. Conversely rising water levels show an increase in the amount of stored groundwater.
Underlying Variables And Definitions	Rest water level is recorded at the time a borehole is drilled and subsequent measurements are often compared to this. The only datum level applied is the ground surface or collar height. Rising or falling water levels are therefore only a measure of change relative to some previously recorded level. Measurement of changing levels over time will thus only provide a qualitative indication of improving or worsening conditions.

Limitations Of The Indicator	For this indicator to be reliable it is imperative that monitoring boreholes are far from areas where abstraction is taking place. The appropriate distance from a producing borehole should be determined in accordance with the prevailing aquifer parameters to ensure that it is the regional water table that is measured, not the effect of changed water levels in a limited area.
Linkages To Other Indicators	
Calculation And Updating Of Indicator	If evidence for annual recharge exists then it is recommended that rest water levels are measured at the end of the usual period of recharge. Where no such evidence exists it is suggested that measurements take place annually at a regular time.
Past Performance	Insufficient data are available for this indicator to illustrate meaningful trends.
Interpretation	Rest water levels cannot be viewed as absolute but must be assessed as part of a trend, from a number of years of data.
INDICATOR DATA	
Data Requirements	Rest water level measurements from sentinel monitoring boreholes.
Responsibility For Collecting And Processing The Data, And How Frequently	Routine collection of this data should be introduced into the programme of the Rural Water Supply Directorate of the Department of Water Affairs. When monitoring boreholes have been selected each extension officer in whose area they lie should be given specific instruction to measure and record the rest water level at a pre-determined time each year. If this is worked into existing extension programmes then no significant extra cost is likely. Data should be sent through to the monitoring section of the Geohydrology Division for entry into the existing monitoring database.

Reliability And Quality Of Data	Care should be exercised in the maintenance of water level measuring equipment. In the past boreholes have been replaced and monitoring records are unbroken, continuing from the previous borehole to the replacement (e.g. in the Karstland monitoring programme). It is essential that the records from individual boreholes do not become confused in any way.
Where The Data Are Lodged And In What Format	Data is to be entered on the monitoring section of the Groundwater Database maintained by the Geohydrology Division of the Department of Water Affairs.
Availability Of The Data	Data are freely available from the Department of Water Affairs.

INDICATOR NAME	Months of adequate abstraction in strategic aquifers
Definition	Calculation of the number of months it would take, at current levels of abstraction, to deplete a strategic aquifer assuming no recharge.
Measurement	The geometry and aquifer parameters are known for strategic aquifers and thus a volume of stored groundwater that may be abstracted can be calculated from measurement of rest water levels. Volumes of water pumped are continually monitored and therefore the rate of abstraction can be averaged for certain intervals. Using these two values it is possible to calculate the time it would take to deplete the aquifer.
SIGNIFICANCE OF THE INDICATOR	
Purpose	With knowledge of the statistical likelihood of significant recharge within a given time (the depletion period) it is possible to forecast the security of supply to strategic users.
Relevance	Where months of adequate abstraction indicate likely depletion, it becomes clear that drastic changes in aquifer management are required to protect the strategic resource. Although climate or increased demand may induce depletion, strict demand management may help counter it.
Underlying Variables And Definitions	During the establishment of wellfields for bulk water supply, geohydrological investigations are aimed at a comprehensive understanding of aquifers. Data collected help to assemble a geometric model of the aquifer and measured hydraulic parameters provide a means of calculating the stored volume of groundwater. The only variable used in this calculation is the rest water level, which is measured periodically in order to re-calculate the volume. The other variable is the rate of abstraction, which varies with demand.

Limitations Of The Indicator	This indicator is based on the calculated volume of stored water in individual aquifers. One major limitation to this indicator is therefore the reliability of calculated volumes and measured variables.
Linkages To Other Indicators	Not Applicable
Calculation And Updating Of Indicator	Water levels and abstraction data are continually recorded by NamWater and used to re-calculate stored volumes and months of adequate abstraction.
Past Performance	Previously the stored volume held in strategic aquifers was reported but in recent years this has expanded to yield a 'months of adequate abstraction' figure. Thus data exist for a limited number of years only.
Interpretation	Months of adequate abstraction in each strategic aquifer are a direct measure of the security of supply at a specific time. As such this cannot be viewed against a meaningful datum and time related trends may not be of much use.
INDICATOR DATA	
Data Requirements	None (NamWater collect and process the required data)
Responsibility For Collecting And Processing The Data, And How Frequently	NamWater monitor rest water levels, which are used to re-calculate stored volumes. These are reported on a quarterly basis and should be made available to the Environmental Commissioner on a regular basis.
Reliability And Quality Of Data	Data collection and recording are carried out accurately and continually.

Where The Data Are Lodged And In What Format	The Geohydrology section of NamWater compiles a quarterly aquifer management report. Calculated months of adequate abstraction may presumably be supplied in digital format free of charge if requested.
Availability Of The Data	Data are freely available at NamWater

INDICATOR NAME	Monitoring of ambient changes in water quality
Definition	Changes in ambient water quality are to be monitored through major ion analyses of samples taken from sentinel production boreholes in strategic aquifers.
Measurement	Samples of water are to be taken from sentinel boreholes annually at the end of the dry season and analysed at the NamWater laboratory for major ions.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To measure changes in groundwater salinity which would indicate possible deterioration of a resource.
Relevance	Early detection of changes in salinity will make it possible to activate remedial measures to prevent long lasting deterioration of resources.
Underlying Variables And Definitions	Original water quality (as shown by TDS) recorded when a borehole was drilled and tested is taken as the datum. Subsequent measurements will show the influence of the quality of water replenishing the aquifer in response to abstraction.
Limitations Of The Indicator	In certain alluvial aquifers seasonal variations in water quality are profound and it might not be possible to detect more gradual long-term changes.
Linkages To Other Indicators	Not Applicable
Calculation And Updating Of Indicator	Not Applicable
Past Performance	Not Applicable
Interpretation	Not Applicable

INDICATOR DATA	
Data Requirements	Not Applicable
Responsibility For Collecting And Processing The Data, And How Frequently	It will be necessary that samples be collected from sentinel boreholes and subjected to a standard water quality analysis (at NamWater laboratories) on an annual basis at the end of the dry season. It is suggested that this responsibility be given to NamWater. Sentinel boreholes are to be selected for this purpose in each of the strategic aquifers. Changes in TDS level are to be monitored and where these are noted comparison with earlier analyses will show which salts are mainly responsible.
Reliability And Quality Of Data	Not Applicable
Where The Data Are Lodged And In What Format	Data will be held by the laboratory and circulated to the Department of Water Affairs and the Environmental Commissioner. A tabulation of annual TDS levels for each borehole is to be maintained by the Geohydrology Division.
Availability Of The Data	NamWater will charge a fee for analyses requested by outside parties.

INDICATOR NAME	NamWater Cost Recovery
Definition	The ratio of "full cost" unit tariffs to existing tariffs.
Measurement	The measurement appears as a percentage such that 50% means that 50% of costs are covered by current NamWater tariffs. The range will be from 0-100% where 100% represents full cost recovery.
SIGNIFICANCE OF THE INDICATOR	
Purpose	Measures the extent to which NamWater is covering its costs and its consumers are paying the full cost of water, and hence the extent of implicit subsidisation.
Relevance	With movements towards cost recovery occurring as a matter of policy, and the WASP recommending economic tariffs, monitoring compliance with the cost recovery policy is highly relevant.
Underlying Variables And Definitions	The "full cost" represents the capital, operations and maintenance costs incurred by NamWater in supplying water. The existing tariff is the current level of the tariff. The indicator could be found as a weighted average (weighted by water consumption) for the entire country or as a weighted average for the different regions, thereby showing regional variations.
Limitations Of The Indicator	The definition of "full cost" is important for this indicator. Currently NamWater is in the process of changing the nature of its definition for full costs meaning that the current indicator could change. It is suggested that new indicators be backcast replacing the current ones if full cost definitions change in the future. A national indicator does not indicate the regional variations, which are large. Furthermore, the extent of subsidisation from the government is ignored by this measure as is the extent of non-payment, currently at around N$40m. Once cost recovery is achieved, Namwater may make a profit. The indicator may be greater than 100%, and become more a measure of profits.

Linkages To Other Indicators	Obviously the percentage of full costs represented in the tariffs, taken from 100% represents the percentage unit subsidisation.
Calculation And Updating Of Indicator	The NamWater tariffs for each water point are published in the government gazette annually. The calculation can be made from this, weighted by the water production in each place.
Past Performance	Taking the current definition and value of full cost as the correct definition, cost recovery has increased steadily from 40% in 1996 to 67% in 1999.
Interpretation	Full cost recovery is being approached by NamWater. However, a strict eye must also be kept on the extent of non-payment. It is apparent for full cost recovery to be attained by 2000 a 33% rise in tariff is necessary in the coming year.
INDICATOR DATA	
Data Requirements	Full cost and existing tariffs and water production for each water point.
Responsibility For Collecting And Processing The Data, And How Frequently	NamWater must publish its tariffs every year. The water production can be obtained from NamWater. Both of these pieces of data are published in NamWater's annual report. It is not certain who will process this data.
Reliability And Quality Of Data	Reliable
Where The Data Are Lodged And In What Format	Data from NamWater. In hard form in the Gov't Gazette or digital form from NamWater.
Availability Of The Data	Available from NamWater free of charge.

Additional Notes to Indicator Table

Table 1 shows the weighted average NamWater cost recovery tariff and current tariff. The percentage of costs covered also shown.

Table 1: Weighted Average of Namwater Tariffs and Full Cost Recovery Tariffs.

	1995/6	1996/7	1997/8	1998/9	1999/2000
Tariff	N$1.20	N$1.50	N$1.63	N$2.26	N$2.47
Full Cost Tariff	N$2.36	N$2.36	N$2.96	N$2.41	N$2.65
% Cost Recovery	51%	64%	55%	94%	93%

The regional variations in percentage of costs covered is indicated in Table 2.

Table 2: Regional Variation in percentage of NamWater Costs Recovered.

WATER REGION	% Cost Recovery .	
	1998/9	1999/2000
Brandberg	79%	86%
Cuvelai	78%	87%
Hardap	95%	102%
Karas	98%	106%
Khomas	91%	97%
Kunene	53%	60%
Namib	111%	123%
Okavango	121%	129%
Omaheke	35%	43%
Waterberg	93%	102%

INDICATOR NAME	Unaccounted for Water
Definition	The amount of unaccounted for water in an urban centre as a % of total supply to that centre.
Measurement	A comparison needs to be made between the production figures for an urban centre and the level of consumption therein. The figures should be compared to international norms, or at least to Windhoek where monitoring of water is currently of a high standard.
SIGNIFICANCE OF THE INDICATOR	
Purpose	Indicates the amount of water lost from the system and therefore gives an indication of the level of management in urban centres, and the state of repair of the reticulation system. It also indicates where significant water saving can be made.
Relevance	With many water resources being tapped to their full capacity, and with increased supply options being very expensive, unaccounted for water can be isolated as one possible area for management improvement. As a result unaccounted for water can be a proxy measure of the success of existing management.
Underlying Variables And Definitions	The supply of water to an urban centre is the total of bulk water supplied. The level of consumption in the town is registered on meters by the local authority for all of the consumers.
Limitations Of The Indicator	Unaccounted for water as a % tells us nothing about how this unaccounted for water arises. Therefore the indicator alone gives us no guidance on policy prescriptions.
Linkages To Other Indicators	Not Applicable

Calculation And Updating Of Indicator	The indicator is calculated by taking the difference between supply and consumption and relating this as a % of supply. Updating of the indicator will be sporadic in all but the major urban centres of Windhoek, Swakopmund and Walvis Bay. These centres have computerised water accounts which make the calculation easy. This is not the case elsewhere and as such comprehensive updating could be a problem.
Past Performance	Not Applicable
Interpretation	Tells us something about the effectiveness of the water management regime, maintenance and state of infrastructure.
INDICATOR DATA	
Data Requirements	Water supply and consumption.
Responsibility For Collecting And Processing The Data, And How Frequently	Responsibility for these figures does not lie in specific institutions. Windhoek municipality will provide the figures, as may Walvis Bay and Swakopmund, on an annual basis. The responsibility of data collection in the other urban centres has previously been with research projects like the IUCN WDM study, although it is in the interests of the population centres to know this information. It is unclear what will happen in the future. For this reason it seems reasonable that the data could only be updated every 5 years.
Reliability And Quality Of Data	Unclear. Currently some of the figures are estimated due to lack of information on consumption levels. Quality of data will improve with the quality of water management.
Where The Data Are Lodged And In What Format	In Windhoek, Swakopmund and Walvis Bay the data are computerised. The NamWater production figures are available in hard form from NamWater. The urban consumption figures elsewhere are available only from the local authorities, from meter cards.

Availability Of The Data	Requires looking at meter cards in local authorities which are open to such investigation. NamWater is also open to supplying this information.

Additional Notes to Indicators

There are some towns which perform badly according to the data. Khorixas and Opuwo are the worst performers with 58% and 47% unaccounted for water respectively. Windhoek, which currently has a pipe monitoring program and computerised accounts has 10% unaccounted for water. This could be seen as a bench mark for Namibia. If Outjo, Otjiwarongo and Omaruru figures are accurate, they too could be considered benchmarks.

Table 4. Unaccounted for Water in the Main Urban Centres of Namibia.

Local Authority Area.	Unaccounted for water %
Arandis	35.0 +
Gobabis	7.7
Grootfontein	20.9
Henties Bay	9.0
Karasburg	18.0
Karibib	n/a
Katima Mulilo	35.0 +
Keetmanshoop	17.0
Khorixas	58.0
Luderitz	22.0
Mariental	9.4
Okahandja	16.0
Omaruru	7.0
Ondangwa	35.0 +
Ongwediva	35.0 +
Opuwo	47
Oshakati	35.0 +
Otjiwarongo	7.5
Outjo	7.7
Rehoboth	35.0 +
Rundu	38.0
Swakopmund	12.0
Tsumeb	15.0
Usakos	31.1
Walvis Bay	14.5
Windhoek	10.0

INDICATOR NAME	Water Consumption by Resource Type
Definition	Water consumed as percentage of sustainable supply potential for each of ephemeral, perennial, ground and unconventional water resources.
Measurement	Measurement is made by summing up national consumption of water from the four sources and calculating these totals as a percentage of the established and accepted sustainable yield.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To identify whether sources are nearing the maximum sustainable level of usage.
Relevance	This indicator is very relevant in view of the need to avoid non-sustainable and environmentally unacceptable use of any water resource.
Underlying Variables And Definitions	Ephemeral water sources are defined as the storage dams on the ephemeral rivers which are used for bulk water supply. They do not include Omdel Dam which is part of a groundwater supply source. Perennial water supply is defined as the bulk water abstraction from the perennial river systems (Zambezi River and tributaries, Okavango River, Kunene River and Orange River) plus an estimate of the water abstracted directly for use by riverside communities. Ground water supply is defined as the total water abstracted for bulk water supply. Unconventional water supply is defined as recycled water or other non-primary sources. The total sustainable potential of the various sources follows definition use by DWA for both surface water (95% assured yield) and ground water. The availability of perennial water is determined by international agreements between the riparian states.
Limitations Of The Indicator	The indicator should be used as a broad outline only since it is dependent on source data which is difficult to calculate accurately both in terms of level of use and sustainable potential.

Linkages To Other Indicators	This indicator is linked to other indicators. The level of perennial water consumption relates to both the “dependence on shared resources” and “level of international co-operation” indicators. There are also links with the annual runoff and ground water indicators.
Calculation And Updating Of Indicator	Sustainable supply estimates are updated by both Hydrology (NamWater and DWA) and Geohydrology Divisions (DWA). DWA also has knowledge of agreed abstraction levels from the perennial rivers. Annual consumption figures would have to be summed through consultation with DWA and NamWater.
Past Performance	The value of this indicator for 1997 has been calculated and details are presented in the additional notes.
Interpretation	As already stated, care should be taken in the application of this indicator, which is a warning light indicator only. An increasing value may merely warn that further investigations and research are required to check the assumed values.
INDICATOR DATA	
Data Requirements	Data on water supply and water supply potential are collected and regularly updated by the Hydrology, Planning and Geohydrology Divisions in NamWater and DWA. Data on unconventional water are available from municipalities.
Responsibility For Collecting And Processing The Data, And How Frequently	The Ministry of Environment and Tourism would have to request that the necessary data are monitored at the appropriate level of accuracy by both DWA and NamWater, and any other agencies.
Reliability And Quality Of Data	The data will in some cases be estimates made by experienced officials.
Where The Data Are Lodged And In What Format	The data are lodged with the already identified agencies. The values are in the format of two simple numbers for each of the four souces.

Availability Of The Data	The data are available at no cost from the three agencies but for the availability to be timeous it is suggested that MET discuss the need for the data in advance with DWA and NamWater.

Additional Notes to Indicator Table

PAST PERFORMANCE

Table 1 shows the calculated percentage values for the indicator for 1997/98. As a new source, no value has been calculated for unconventional sources.

Table 1 : Water Consumption by Resource Type

Resource Type	Current Consumption Mm^3/annum	Potential Yield Mm^3/annum	Indicator Value (%)[1]
Groundwater	136	300	45.3
Ephemeral Rivers	53	200	26.5
Unconventional	N/a	N/a	
Perennial	107	600[2]	17.8

[1]*(Current consumption/Potential sustainable yield) x 100*
[2]*Estimated Long-term agreed quota*

INDICATOR NAME	Value Added
Definition	The contribution to GDP per m^3 of water used in different economic sectors.
Measurement	Measured in N$/$m^3$. The higher the better.
SIGNIFICANCE OF THE INDICATOR	
Purpose	Gives an estimate of the value of water in different economic sectors, indicates something of the ability to pay for water in these sectors, and gives an idea as to how economic development should be focussed given scarce water.
Relevance	Namibia is the most arid country in sub-Saharan Africa. Water is one of the major constraints to development in Namibia. In determining government policy it is paramount that the economic value of water, and the opportunity costs, are considered. Value-added is a useful indicator in this sense.
Underlying Variables And Definitions	The value-added for each of the economic sectors is the contribution to GDP. Water used in each sector is another variable which influences this indicator.

Limitations Of The Indicator	There are other aspects of economic sectors which are useful to consider. Employment is one notable factor. Although strictly value-added incorporates the value added by labour, the value added per m^3 emphasises the water aspect above other aspects. There are constraints to development in sectors other than water. Furthermore there are assumptions about water consumption in unmetered sectors which make the tracking of this indicator over time potentially meaningless. In the future however, techniques may improve to eliminate this limitation. Water measurements are influenced by the unaccounted for water in some instances. Improvements here will improve the indicator reading. Lastly the spatial elements to water usage are not represented here. In some regions of Namibia the potential uses for water are limited. For example it may not be possible to use water for increased mining along the Orange River if Haib and Skorpion Mines do not materialise, whilst irrigation, a low value use, is possible. The opportunity cost of water is low here.
Linkages To Other Indicators	Not Applicable
Calculation And Updating Of Indicator	The value added figures are obtained from the national accounts. The water usage figures in each sector are based on a variety of assumptions. These figures and the value added per m^3 are updated regularly by the Department of Environmental Affairs Natural Resource Accounting Program.
Past Performance	Not Available
Interpretation	Can be interpreted as a measure of the productive efficiency of water in different sectors.
INDICATOR DATA	
Data Requirements	Value added and water consumption in each sector.

Responsibility For Collecting And Processing The Data, And How Frequently	The value added data are collected annually by the central statistical office (CSO). The water consumption statistics are calculated by the DEA for the Natural Resource Accounting program. So far this has been done for 1993 and 1996. The frequency of value added/m^3 calculations may be increased.
Reliability And Quality Of Data	Reliable for most sectors. Assumptions made for livestock and human consumption in rural areas are subject to debate.
Where The Data Are Lodged And In What Format	Department of Environmental Affairs.
Availability Of The Data	Freely available from the DEA and CSO.

PAST PERFORMANCE

Over time it may be illustrative to monitor the average value added for the whole economy. In 1996 this was N$51/$m^3$, whilst in 1993 this value was N$47/$m^3$. This shows an improvement in the productivity of water, which could occur for a variety of reasons. These figures represent weighted averages for the economy, including household use. Households are excluded from the table since they are incompatible with the value-added statistics.

Table 1 : Value added per cubic metre of water by sector 1996

Economic Sector	Value added 1996 (millions of N$)	Water use 1996 (millions of cubic metres	Value added per cubic metre of water 1996 (N$/$m^3$)
Agriculture	1,029	142.9	7.2
Commercial	650	92.9	7.0
Subsistence	379	50.0	7.6
Mining	1,654	25.2	65.6
Diamond mining	1,169	13.6	86.0
Other mining	485	11.6	41.8
Manufacturing	1,552	5.3	292.8
Fish processing	354	0.5	708.0
Other manufacturing	1,198	4.8	249.6
Services	3,215	5.5	574.5
Hotels and restaurants	226	1.2	188.3
Transportation	252	0.8	315.0
Other services	2737	3.5	782.0
Whole economy	**11,796**	**231.2**	**51.0**

INDICATOR NAME	Integrated Water Resource Management in population centres
Definition	The level of awareness and level of implementation of components of integrated water resource management (IWRM) in centres using water from various sources in Namibia
Measurement	This simple indicator measures the level of effort being put into basic components of water demand management, as a part of integrated water resource management, and the level of awareness of authorities with respect to components underlying iwrm.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To monitor the level of awareness and the level of implementation of components of iwrm in population centres in Namibia.
Relevance	Effective and efficient use of water is essential in an arid country such as Namibia. While supply of water has taken precedence in the past, more effective and efficient use of that water currently available will reduce the need for additional water and the rate at which additional water must be supplied. This indicator would reflect other components of iwrm such as appropriate pricing and policies of NamWater as the bulk water supplier to these urban centres.
Underlying Variables And Definitions	Not Applicable.
Limitations Of The Indicator	Awareness of a component of iwrm or ineffective application of iwrm need not contribute to effective and efficient use of water. This assumption must be made, however, until this developmental indicator can be refined and quantitative rather than qualitative measures can be applied.

Linkages To Other Indicators	This indicator is closely linked to the indicator from chapter 5 providing a measure of unaccounted for water. Low values of unaccounted for water could be explained by aspects included in this indicator or could be explained by the presence of better quality infrastructure, greater levels of funding available, better qualified water managers or more appropriate water pricing.
Calculation And Updating Of Indicator	The Water Demand Management (WDM) Study funded by the IUCN is the basis for this indicator. Updating would require a regular survey which could be done by post when urban water managers have been made aware of the concepts involved. Inclusion of additional areas may require visits to the population centres in question or other, prelimary awareness raising amongst water managers.
Past Performance	A baseline study for this indicator was undertaken during the WDM study funded by the IUCN. Previous performance is not available but could be established for most centres.
Interpretation	Using simple yes and no values provides an indication of level of awareness but not necessarily level of effectiveness of iwrm in urban areas. Even when all 'yes' answers are recorded, this indicator must be combined with the indicator recording unaccounted for water to provide a clear indication of overall effectiveness of iwrm and wdm.
INDICATOR DATA	
Data Requirements	An annual or less frequent survey would be required.
Responsibility For Collecting And Processing The Data, And How Frequently	This information is not collected at present. Data collection and processing could be implemented through the Association of Local Authorities of Namibia (ALAN) or the bulk supplier, NamWater.

Reliability And Quality Of Data	The reliability and quality of the data will probably be fairly low. However, collection of this information would raise awareness of iwrm and improved information and improved water management can be expected in combination with other components of iwrm and wdm such as pricing.
Where The Data Are Lodged And In What Format	ALAN, NamWater or DWA should be designated.
Availability Of The Data	The data are not available unless a special survey is made.

Additional Notes to Indicator

PAST PERFORMANCE

During compilation of this State of the Environment Report a parallel study was being undertaken on Water Demand Management in Namibia by the Municipality of Windhoek and the Department of Water Affairs. A questionnaire survey of various urban areas provided the following information concerning water demand management. The first three components of the table: Metre Replacement Programme, Pipe Replacement Programme and Use of Purified effluent reflect the presence of active steps to reduce water loss and improve water efficiency. The last three components of the table: Water Regulations Promulgated, Community Awareness Programme and awareness by the authorities of the WASP Policy reflect awareness of the need for Integrated Water Resource Management and Water Demand Management even if it is not being implemented.

Table 1 : Water Demand Management in Urban Areas
(IUCN Water Demand Management Country Study – Namibia 1998, page 4.3)

Town	Water Source	Met. Repl. Prog.	Pipe Repl. Prog.	Use purified effluent	Water Reg. (Dec, 1996)	Comm. Aware.	Wasp Policy
Gobabis	NamWater	Yes	Yes	Yes	Yes	Yes	Yes
Grootfontein	Boreholes	Yes	Yes	No	No	No	Yes
Henties Bay	NamWater	Yes	No	No	No	No	Yes
Karasburg	NamWater	Yes	No	No	Yes	No	No
Karibib	NamWater	Yes	No	Yes	No	No	No
Keetmanshoop	NamWater/Boreholes	Yes	No	No	No	No	No
Khorixas	NamWater	No	No	No	No	No	No
Luderitz	NamWater	No	No	No	Yes	No	Yes
Mariental	NamWater/Boreholes	No	Yes	Yes	No	No	Yes
Okahandja	NamWater/Boreholes	No	No	Yes	No	Yes	Yes
Omaruru	Boreholes	No	No	No	No	No	No
Opuwo	NamWater	No	No	No	No	No	No
Oranjemund	Boreholes	Yes	Yes	Yes	No	No	No
Otavi	NamWater	Yes	No	No	No	No	No
Otjiwarongo	NamWater	No	No	Yes	No	No	No
Outjo	Boreholes	No	Yes	No	Yes	No	Yes
Rehoboth	NamWater	No	No	No	Yes	No	No
Rundu	NamWater	No	No	No	No	No	No

Swakopmund	NamWater	No	No	Yes	Yes	Yes	Yes
Tsumeb	Boreholes	Yes	Yes	Yes	Yes	No	Yes
Usakos	NamWater/Boreholes	No	No	No	No	No	Yes
Walvis Bay	NamWater	Yes	Yes	Yes	No	No	Yes
Windhoek	NamWater/Boreholes	Yes	Yes	Yes	Yes	Yes	Yes

Pipe Repl. Prog. = Pipe Replacement Programme
Met. Repl. Prog. = Meter Replacement Programme
Water Reg. = Water Supply Regulations
Comm. Aware. = Community Awareness Programme

INDICATOR NAME	Effectiveness of Community Based Management
Definition	The number of times Water Point Committees or other community based committees require the assistance of the Directorate of Rural Water Supply to maintain supply of water.
Measurement	This simple indicator measures the effectiveness of the Water Point Committees or other community based committees to maintain the supply of water to the community for which they are responsible.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To monitor the abilities of communities to operate and maintain their own water supply systems.
Relevance	The WASP document and the Community Based Management process are directed toward developing independence of communities to operate and maintain their own water supply system. This approach focuses on reducing or removing the onus and the operational input from the DRWS and placing it with the communities for whom water is required. This indicator is also a measure of the effectiveness of the training programmes (e.g. for water point caretakers, water point committees) of the DRWS and of the appropriateness (e.g. ease of repair, functional simplicity and robust character of the equipment) of the technical solutions supplied to communities by the DRWS. It may also reflect the results of general awareness campaigns as they address vandalism, theft and prevention of illegal connections.
Underlying Variables And Definitions	Not Applicable.

Limitations Of The Indicator	This indicator will depend on the effectiveness of the MIS being established by DRWS. In particular, it will rely on accurate reporting on the part of individuals filling in the appropriate forms. Requests for assistance from communities will have to be clearly classified and recorded to assure an accurate data set.
Linkages To Other Indicators	This indicator is not directly linked to other indicators specifically recommended in this SOER.
Calculation And Updating Of Indicator	On a regular basis, preferably monthly but at the least on a yearly basis, the number of requests for assistance from a particular community should be tabulated. Similarly, the number of requests made to a particular section of DRWS should be tabulated on a regional basis. If the MIS is appropriately established, updating of this indicator should take place without additional effort.
Past Performance	This is a new, developmental indicator suggested as an addition to the MIS being established by DRWS. There is no record of past performance.
Interpretation	As indicated above, this indicator would represent a synthesis of the effectiveness of the communities involved and of the DRWS programme to establish independence of communities with respect to their own water supply. By comparing results between individual communities and between sections of DRWS, the roles of communities and of DRWS could be factored out.
INDICATOR DATA	
Data Requirements	Data will be collected on a routine basis by DRWS through their newly established MIS. Monthly regional summaries and an annual national summary would help ensure that data are being collected, recorded and tabulated in an appropriate manner.
Responsibility For Collecting And Processing The Data, And How Frequently	DRWS through their contacts with communities and their records as entered into the MIS.

Reliability And Quality Of Data	This would depend entirely on the reliability and effectiveness of the MIS currently being established.
Where The Data Are Lodged And In What Format	The data are lodged with DRWS on their computerised MIS. Summary tabulations should be lodged with regional and national offices of DRWS.
Availability Of The Data	The data would be collected at no additional cost as they form a part of the existing MIS. Monthly and annual tabulations should be readily available from DRWS offices from their computerised records.

INDICATOR NAME	White Paper on Water and new Water Act
Definition	A White Paper on Water and new Water Act that includes allocation of water to an environmental reserve and focuses on sustainability of water use.
Measurement	Measurement of this simple indicator would consist of the presence of a carefully considered White Paper on water and a new Water Act.
SIGNIFICANCE OF THE INDICATOR	
Purpose	To monitor the status of legislation on water and its compliance with the tenet of sustainability.
Relevance	Namibia is still using the Water Act 54 of 1956 that is not in agreement with the Constitution of the Republic of Namibia. In particular this Act does not recognise the water requirements of an ecological reserve nor does it promote the sustainable use of water in Namibia.
Underlying Variables And Definitions	Not applicable.
Limitations Of The Indicator	This indicator has a limited range of values, either the White Paper and the new Water Act are prepared and adopted or they are not.
Linkages To Other Indicators	Although this indicator is not directly linked to other indicators, it would have an influence on all other indicators. A White Paper and a new Water Act that supported sustainability of use of natural resources, and particularly water, would encourage use of the other indicators related to sustainable development of Namibia's limited resources.

Calculation And Updating Of Indicator	Presence or absence of the policy and the act is all that would be necessary. .
Past Performance	Not applicable.
Interpretation	The absence of a White Paper and a new Water Act do not necessarily mean that water is used in a totally unsustainable way. The Minister does have powers that could lead to more sustainable use of water, but these have often not yet been invoked.
INDICATOR DATA	
Data Requirements	Presence or absence.
Responsibility For Collecting And Processing The Data, And How Frequently	DWA
Reliability And Quality Of Data	Not applicable.
Where The Data Are Lodged And In What Format	Not applicable.
Availability Of The Data	Readily available.

INDICATOR NAME	Dependence on Shared Resources
Definition	Defined in two ways for this indicator. 1) The quantity of water abstracted from the shared perennial rivers as a percentage of the total agreed allocation to Namibia and 2) The quantity of water abstracted from the shared perennial rivers as a percentage of total water consumed in the country.
Measurement	Measurement is made by summing up the total water abstracted by bulk water suppliers and abstraction by riverside dwellers (estimated as accurately as possible).
SIGNIFICANCE OF THE INDICATOR	
Purpose	The two ways of calculating the indicator have significantly different purposes. The purpose of 1) is to provide an indication of whether Namibia is getting close to using its full allocation of water from shared resources, these allocations being the result of agreements with neighbouring states. The purpose of 2) is to indicate to what extent Namibia is dependent on the shared resources. It may be considered inadvisable to be too dependant upon sources of water originating outside the borders of the country.
Relevance	The indicator is relevant to decision makers in the water sector, especially those responsible for co-operating with and negotiating agreements with neighbouring countries.
Underlying Variables And Definitions	The definition of shared resources with respect to this indicator is any of the perennial border rivers (Zambezi, Kwando system, Okavango, Kunene and Orange). The total water consumed in the country is as calculated by DWA Planning Division and other decision-makers. This value is clearly an estimate only. The term “allocation” refers to the annual quantity of water that Namibia may abstract in terms of an agreement with the other riparian states for each of the perennial rivers.

Limitations Of The Indicator	The indicator should be used as a broad outline only, since it is dependent on source data which is difficult to calculate accurately both in terms of level of use and sustainable potential.
Linkages To Other Indicators	This indicator links with the indicator on level of Agreement and Co-operation with Riparian States. It also links with the Indicator on Water Consumption by Resource Type.
Calculation And Updating Of Indicator	At the end of each year, as soon as national consumption figures are available from the various supply agencies, this indicator can be calculated. The indicator should be updated on an annual basis, but it should be borne in mind that small variations should not be seen as significant in view of the error margin of the indicator.
Past Performance	Not Applicable
Interpretation	As already stated, care should be taken in the application of this indicator, which is a warning-light indicator only. An increasing value of 1) may mean that efforts to negotiate allocation agreements with neighbouring countries should be increased.
INDICATOR DATA	
Data Requirements	The data required for this indicator are simply three totals as calculated by DWA and other agencies.
Responsibility For Collecting And Processing The Data, And How Frequently	DWA and NamWater are responsible for keeping records on the total amount of water supplied to users. Planning, Rural Water Supply and other Divisions of DWA are tasked with estimating water consumption figures countrywide.
Reliability And Quality Of Data	The Data will largely be derived from known supply figures and estimates made by experienced officials.

Where The Data Are Lodged And In What Format	The data are not lodged with any specific agency. See "Responsibility For Collecting And Processing The Data" above.
Availability Of The Data	The data are available at no cost. Availability will depend on whether the agencies are in a position to make the necessary estimates. This may sometimes be a low priority task.

INDICATOR NAME	Co-operation with Neighbouring Riparian States
Definition	Co-operation with neighbouring riparian states is defined by the number of co-operation and allocation agreements in place between Namibia and the relevant states on a basin by basin basis.
Measurement	Measurment is made by taking each of the six basins and giving points (a score) if there is a firm or provisional co-operation agreement in place, and additional points if there is a firm or provisional allocation agreement in place.
SIGNIFICANCE OF THE INDICATOR	
Purpose	The indicator provides an objective way of measuring progress towards co-operation with riparian states with which Namibia shares the resource. The purpose is only met, however, if the agreements are being implemented and honoured.
Relevance	The indicator is relevant to decision makers in the water sector, especially those responsible for co-operating with and negotiating agreements with neighbouring countries.
Underlying Variables And Definitions	There are two underlying variables for each of the six shared river basins, with the exception of the Cuvelai River for which there is only one. The first variable is the co-operation agreement which usually takes the form of a Joint Technical Commission. The second variable is the allocation agreement. This agreement is sometimes only provisional, dependent on further studies, or it may be a firm agreement. In both cases it must be approved by all riparian states.
Limitations Of The Indicator	Not Applicable.
Linkages To Other Indicators	This indicator links with the “Dependence on Shared Resources” Indicator.

Calculation And Updating Of Indicator	Of the six river systems co-operation agreements are possible and useful for all six. For each agreement 2 points are allocated. If a provisional agreement is in place then 1 point is allocated. With respect to allocation agreements, such agreements are only possible for the perennial, border rivers. It would not be realistic to have an agreement for the Cuvelai River System. For the five perennial systems, 2 points are given for each firm allocation agreement and 1 for each provisional agreement. The maximum number of points is therefore 22. The indicator is expressed as a percentage of this possible total.
Past Performance	The current value for this indicator has been calculated and details are presented in the additional notes.
Interpretation	An increase in the value of this indicator indicates improved co-operation between Namibia and its fellow riparian states.
INDICATOR DATA	
Data Requirements	Not Applicable.
Responsibility For Collecting And Processing The Data, And How Frequently	DWA will normally be the government ministry involved in the negotiation of agreements and will be fully informed as to their status.
Reliability And Quality Of Data	Reliable.
Where The Data Are Lodged And In What Format	The information should be available from DWA.
Availability Of The Data	The information should be readily available at no cost.