2

A Framework for Assessing vulnerability

2.1 Definitions

The degree to which a system is susceptible to, or unable to cope with, adverse effects of environmental change defines its **vulnerability**. With regard to climate change, the vulnerability of a natural, socio-economic system is determined by the character, magnitude and rate of climatic variation on one side, and the sensitivity and adaptive capacity of the system on the other (IPCC, 2001). Spatial and temporal changes in precipitation are of particular concern and relevance to discussions on the vulnerability of freshwater systems.

In many African countries, water demand outstrips available freshwater resources. Countries or regions where such conditions limit development are said to experience **water stress**. Water stress may cause the deterioration of freshwater resources in terms of quantity (overexploitation, environmental degradation, etc.) and quality (eutrophication, pollution, saline intrusion, etc.). Withdrawals that exceed 20% of renewable water supply have been used as an indicator of water stress (IPCC, 2001). Annual renewable freshwater availability of less than 1,000 m^3 per person is defined by hydrologists as **water scarcity**. Such vulnerability issues call for well informed, carefully planned and closely coordinated water resource legislation and management.

2.2 The Basin Perspective

The increasing incidence of water stress has brought about the adoption of new approaches to managing water resources in an holistic and integrated manner. The Rio+10 and Dublin conferences have led to a fundamental paradigm shift from water resource management based on administrative boundaries to management based on hydrological boundaries.

For this study, the river/lake/groundwater basin was chosen as the primary unit for assessment. The basin represents a hydrologic unit that comprises both surface water and groundwater and thus takes into account different components of the hydrological cycle. It incorporates watersheds or catchments, which are defined as "topographically delineated areas drained by stream systems – that is the total land area above some point on a stream or river that drains past that point."

The basin perspective helps to achieve a balance between the interdependent roles of resource protection and resource utilization (Ashton, 2000). It incorporates the principles of sustainability, development, participation and integrated water management, and seeks to promote desirable collective goals such as equity, stakeholder engagement, self-reliance and a healthy environment (Turton and Henwood, 2002). In effect, the basin perspective seeks to maintain a balance between the competing pressures exerted by the need to maintain long-term resource integrity, the compelling call for social advancement, and the desire for continuous economic growth and sustainable use of environmental resources.

The basin perspective represents a progression from supply-oriented water resource development to water demand management (Turton and Henwood, 2002). This progression develops where water demand continues to outstrip supply, even when all available water sources have been developed or are prohibitively expensive to develop, resulting in competition between water uses and users. At this point, water scarcity reaches such a level that the exploitation limits become evident and finding the best possible use of water becomes imperative (Turton and Ohlsson, 2000).

2.3 Parameters and Indicators

For the purposes of this study, parameters and related indicators for assessing the vulnerability of water resources to environmental change were grouped into physiographic (natural), socio-economic (anthropogenic), and management clusters (see Table 2.1). They are linked to sub-clusters and should be applied to various temporal and spatial scales. Please note that the table is not exhaustive, but aims to provide an overview of those

parameters and indicators for which data and information are relatively easily available and accessible. Chapter 3 discusses the parameters and indicators for the four regions in more detail.

Table 2.1: Parameters and vulnerability indicators

Cluster		Parameter*	Vulnerability Indicator*	
Physiography	**Climate**	• Rainfall • Evapotranspiration	• Aridity	**Water Scarcity**
	Ecosystems	• Water dependency • Land use • Landcover	• Water availability • Desertification • Storage and supply infrastructure	
	Hydrology	• Stream flow		
		• Storage • Quality		
	Hydrogeology	• Yield • Recharge		
Socio- Economy	**Demography**	• Population size and distribution • HIV/AIDS, water-related diseases	• Population density and growth • Poverty	
	Economy	• Water demand • Water supply • Value of water	• Access to water • Water use • Conflicts	
Management	**Legislation**	• Policies • Acts • Regulations • Guidelines	• Sector reform • Implementation and adaptive capacity	
	Institutional	• Adherence to IWRM principles • Human resources		
	Knowledge	• Literature/reports	• Data availability, gaps and quality	

*Temporal and spatial variability and trends

2.4 The Three-Tiered Assessment Approach

The level of detail of a vulnerability assessment is determined by the study objective and the availability of resources (human resources, finances, data and information, etc.). For the sake of harmonising future assessments, the following basic three-tiered approach is proposed:

- Rapid: summarised overview, including inventory of sources of data and information;
- Intermediate: a more detailed overview; and
- Comprehensive: in-depth analysis, likely at a smaller spatial scale (pilot areas).

It is our experience that it takes about one month for one person to carry out a rapid vulnerability assessment of one large river/lake/groundwater basin. The subsequent intermediate assessment may take about six months, depending upon the study objectives, whereas a comprehensive assessment may take one year or more.

A **rapid assessment** is carried out according to the following procedure:

Stage 1: Define the spatial scale of assessment using biophysical and socio-economic boundaries;
Stage 2: Define the temporal scale, incorporating current and potential environmental changes;
Stage 3: Collect data and information on the relevant biophysical characteristics of the study area;
Stage 4: Collect data and information on the socio-economic and management characteristics of the area;
Stage 5: Provide a summarised overview.

Having been collected nationally, country-by-country, information in Africa is generally compiled and available according to administrative rather than hydrological boundaries. Information therefore needs to be synthesised. Geographical Information Systems (GIS) offer an opportunity to capture and compile information at the basin scale.