SECTION 4

Management Responses and Stewardship

Balancing the increasing competition among the diverse and different water using sectors and the demands of upstream and downstream users – whether within or between countries – is a challenge in watersheds worldwide. Decisions on water allocations have to be made at different scales, based not only on the various demands for water, but taking into account its many values as well.

Though the urgency of many water problems means that effective actions are needed now, water management approaches must also be forward-looking in their ability to deal with changing contexts, such as climate variability and its impact on water-related hazards, namely floods and droughts. The capacity to adapt and to make wise decisions depends upon preparedness, which depends in turn on a sound knowledge base; the complexity of water issues requires a more effective policy framework that builds, maintains, extends and shares our knowledge and uses of water resources, and respects the values we place on them.

Global Map 7: *The Climate Moisture Index Coefficient of Variation*
Global Map 8: *The Water Reuse Index*

Chapter 10 – **Managing Risks: Securing the Gains of Development** (WMO & UN-ISDR)

The climate is changing, thus increasing the occurrence and intensity of water-related natural disasters and creating greater burdens on human and environmental development. Employing an integrated approach, this chapter explores some of the ways of better reducing human vulnerabilities and examines the recent developments in risk reduction strategies.

Chapter 11 – **Sharing Water** (UNESCO)

Increasing competition for water resources can have potentially divisive effects. Mechanisms for cooperation and shared governance among users must be further developed in order to ensure that the resource become a catalyst for cooperation and a medium for deterring political tensions, while encouraging equitable and sustainable development.

Chapter 12 – **Valuing and Charging for Water** (UNDESA)

Water has a range of values that must be recognized in selecting governance strategies. Valuation techniques inform decision-making for water allocation, which promote not only sustainable social, environmental and economic development but also transparency and accountability in governance. This chapter reviews techniques of economic valuation and the use of these tools in water policy development and charging for water services.

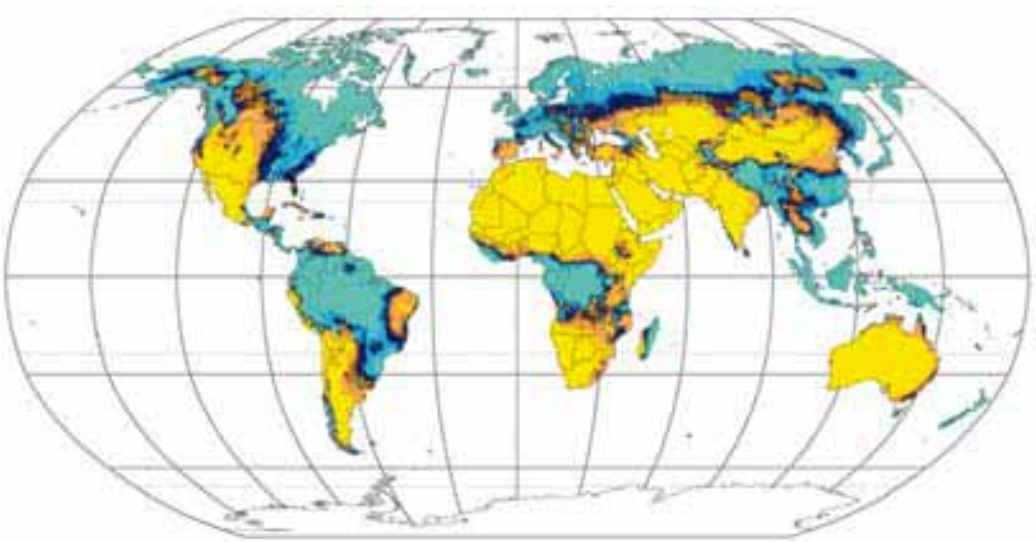
Chapter 13 – **Enhancing Knowledge and Capacity** (UNESCO)

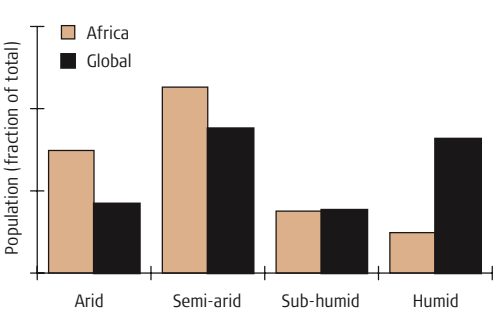
The collection, dissemination and exchange of water-related data, information and know-how are imbalanced and, in many cases, deteriorating. It is now more urgent than ever to improve the state of knowledge concerning water-related issues through an effective global network of research, training and data collection and the implementation of more adaptive, informed and participatory approaches at all levels.

The Climate Moisture Index Coefficient of Variation (CMI-CV)

Water scarcity, in part, is determined by the availability of renewable fresh water supply. One useful measure of available water is the Climatic Moisture Index (CMI) (Willmott and Feddema, 1992), a measure of the balance between annual precipitation and evaporation and a function of climate. The CMI ranges from +1 to –1 with wet climates showing positive values and dry climates negative values. The variability of CMI over multiple years, critical to determining the reliability of water supplies, is measured by the Coefficient of Variation (CV), defined as the ratio of annual deviation to the long-term annual mean. A CMI-CV value < 0.25 is considered low variability, while 0.25 to 0.75 is moderate and > 0.75 high. Increased climate variability indicates larger year-to-year fluctuations, and hence, less predictability in the climate. As shown in the map below, variability is low in the most humid regions (i.e., the tropics) as well as the most arid regions (i.e., major deserts) of the world. Increased CMI variability often occurs along the interfaces between different climate zones, for instance, between the dry Sahelian region of North Africa and the humid tropical zone of southern west Africa, or in the Great Plains region of the United States. These areas are well known for periodic severe droughts and water scarcity.

Climate Moisture Index CV





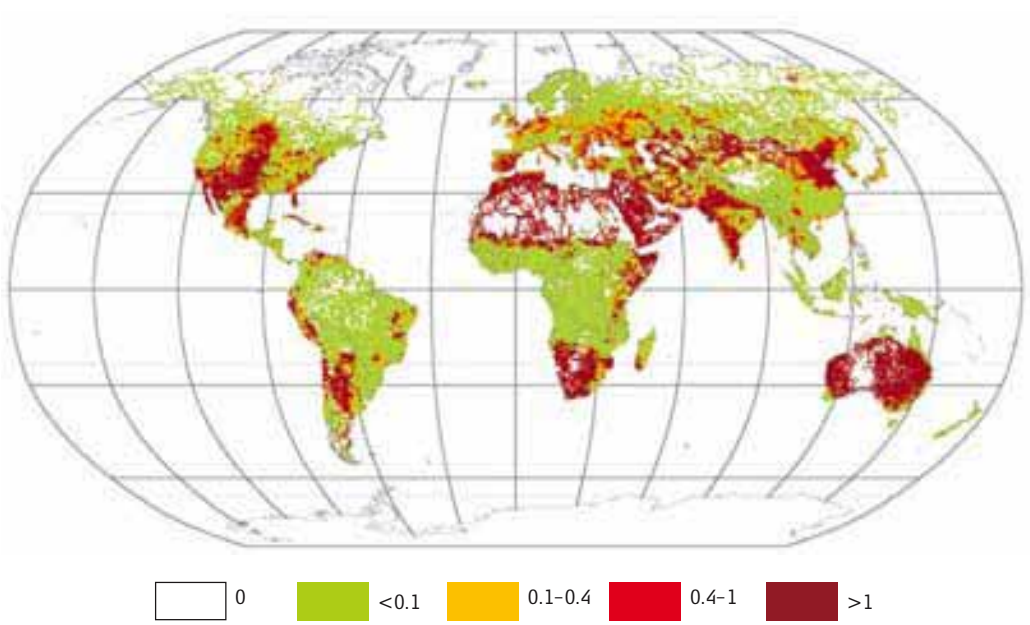
Water scarcity is fundamentally a problem of the distributions of climate and human society, which vary greatly around the world. Compared to the global proportion of 52% of total population living in arid or semi-arid regions, approximately 75% of all Africans live in such conditions (mean CMI-CV < 0; see inset). In addition, 20% of all Africans live in areas that experience high interannual climatic variability as expressed by a CMI-CV > 0.75 (Vörösmarty et al., 2005a). This explains why Africa suffers disproportionately from water scarcity and water stress compared to other continents.

Source: Water Systems Analysis Group, University of New Hampshire. Datasets available for download at http://wwdrii.sr.unh.edu/

The Water Reuse Index

Water use by humans is a recursive phenomenon, by which water is withdrawn, used and reused as it passes from upstream source areas downstream past agricultural, industrial and domestic users to the sea. The Water Reuse Index (WRI) provides a measure of pressure on river basin water resources (Vörösmarty et al., 2000, 2005a). Beginning at zero in the headwaters, the WRI can vary widely over the course of a river according to the pressures of different uses along its trajectory. If demand is high relative to the available flow (e.g. when encountering a city or major irrigation works), the WRI will move upwards (see graph below). If relatively low-use tributaries feed into the mainstream, the Index will decline. In many of the world's river systems water reuse can exceed, sometimes greatly, natural river flow. With high values for this Index, we see increasing competition between water users – both nature and society – as well as pollution and potential public health problems. The WRI can shift markedly with climate variability. For example, for the Orange River in Africa (inset graph below), the relative water-use ratio remains well below 1.0 (i.e. 100 percent use of river flow) at mean annual flow conditions. However, water use becomes 'over-subscribed' by a factor of more than 10 under 30-year low flow (drought) conditions (Vörösmarty et al., 2005a). If water is to be delivered to all users, then it must be reused, flowing through canals, pipes and pumps more than ten times to satisfy all.

Water Reuse Index



Source: Water Systems Analysis Group, University of New Hampshire. Datasets available for download at http://wwdrii.sr.unh.edu/