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The water poverty index as an assistant tool for drawing strategies of the Egyptian water sector

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Abstract Developing strategies for the water sector in integrated manner is essential. The present study details the development and uses of the Water Poverty Index (WPI) to be applied as a holistic tool for the conceptualization of water strategies in Egypt. The WPI herein considers the following: (i) water availability; (ii) access to water taking into account energy as a factor to water system operation; (iii) capacity to manage the water system considering the gender perspective; (iv) allocation of water uses considering the economic value of water; and (v) quality of the environment. The developed WPI was applied at the Egyptian governorates level and priorities to be achieved in their water sector were determined. The study concluded that, WPI as a summarized index combines into a single number a cluster of data is considered a robust tool to assist decision makers in determining priority to conduct prospect development plans in the water sector.

1. Introduction

Assessing progress, determining the priority work activities, and developing strategies for the water sector require an interdisciplinary approach and need a wide range of issues to be addressed [1]. These issues should relate to water management for sustainable development, in keeping with the principles of integrated water resources management. With the various uses of water and the assortment of factors that impact development in the water sector, it is important for decision makers to have an informed and holistic view when making decisions regarding the water resource. Indices and indicators effort has gone into the development of policy instruments which support decision-making in planning, targeting and prioritization. Indices and indicators are increasingly recognized as powerful tools for such purposes [2]. Among these indices and indicators is the Water Poverty Index (WPI).

WPI is holistic water management tool designed to contribute to more effective water management and water resource evaluation, in keeping with the sustainable livelihoods approach to evaluate development progress [3]. The Water Poverty Index (WPI) can be estimated at local, district or national level [3,4]. The index has found significance in policy making as an effective water management tool, particularly in resources allocation and prioritization processes [2].

The WPI integrates a number of aspects that refract major preoccupations in developing countries related to physical availability of water resources, extent of access to water and

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sanitation, people's ability and capacity to manage water for sustaining access, use of water for different purposes, and the environmental factors which impact on the water supply.

In Egypt, the challenges facing the water sector are enormous and require the mobilization of all resources and the management of these resources in an integrated manner [5]. In Egypt several ministries are involved in achieving progress in the water sector. The most significant are Ministry of Water Resources and Irrigation, Ministry of Agriculture and Land Reclamation, and Ministry of Housing, Utilities and New Communities. The previous ministries are all directly and actively participating in the management of Egypt's water sector. Several other ministries have a more indirect role with respect to law development and enforcement and monitoring and inspection.

Egypt has endorsed several policies and strategies to achieve progress in the water sector. General objectives of the national policy of Egypt related to progress in the water sector include the following[6–8]: increase of the economic value of water, increase of the per capita GDP, protection of the Nile and other freshwater resources from pollution, extension of sewage networks, extension of domestic supply networks, promotion of water conservation in domestic, agriculture and industry use, and the support of the development in various economic sectors.

When developing strategies in an integrated manner, determining prioritization in the water management decision is a vital issue. To assist the water managers and policy makers in Egypt in this area, the current research was carried out, where, through this research, the WPIs of 22 Egyptian governorates were developed, calculated, and analyzed. The governorates most in need to improve their water sector were determined. The weaknesses in the water sector and the priorities in the water management decision at each governorate were verified.

2. Water poverty index

A set of comparative performance indices were applied to evaluate water sustainability and progress and priorities for water policies intervention. Among them, as shown in Table 1, are the water availability index, the water scarcity index, the Water Resources Vulnerability Index, Social Water Stress Index, Water Stress Indicator (WSI), and the Water Poverty Index (WPI) [4,9–11].

The WPI is helpful and holistic tool to identify areas of greatest need, thereby enabling prioritization of action in the water sector [12]. It is a mechanism for determining the prioritization in developing the water sector [13]. WPI is an evaluation tool to be applied at a variety of scales enabling more informed decisions to be made [2,3].

The WPI integrates a number of aspects that refract major concerns in the water sectors, where, five components of **WPI** composite are [2,14,4,13,15] (i) **Resources (R):** measure the water availability, (ii) **Access (A):** indicates the accessibility of water for human use taking into account the distance to a safe source and the time needed to collect the water for household and other needs such as irrigation and industrial use, (iii) **Capacity (c):** represents human and financial capacity to manage the system, (iv) **Use (U):** captures the actual amount of water being used and extracted from the system. The water use includes domestic, agricultural and industrial use. The efficiency of how water resources are used is also assessed in this component, and (v) **Environment (E):** evaluates the factors which impact on the water supply.

Table 1 The most applied water sustainability and management indices.

Index	Definition
Available Water Resources per capita (AWR)	AWR measures the ratio of the renewable water in the hydrological cycle to the number of people
Water Scarcity Index (WSI)	WSI measures the ratio of the Available Water to water requirements for basic human needs (drinking water for survival, water for human hygiene, water for sanitation services, and modest household needs for preparing food
Water Resources Vulnerability Index (WRVI)	WRVI separates the water needs into industrial, agricultural, and domestic sectors, as well as incorporated water lost from reservoir evaporation
Social Water Stress Index (SWSI)	SWSI integrates the capacity of a society to consider how economic, technological, or other means affect the overall freshwater availability status of a region
Water Stress Indicator (WSI)	WSI recognizes environmental water requirements as an important parameter of available freshwater
Water Poverty Index (WPI)	WPI is holistic water management tool designed to contribute to more effective water management and water resource evaluation. WPI combines data on the local water resources, access, use, social and economic capacity and water related environmental quality to be used by local people and water development agencies to monitor progress in the provision of the water at the community, national, basin, and region level

Each of the five components is made up of a number of sub-components (indicators) that can be directly measured, collected, or calculated [2,3]. The selection of sub-components of the index differs as the countries may have different ways of assessing their progress in water sector. Thus, countries identify their own sub-components in keeping with the WPI structure, maximizing the use of existing data, and minimizing the need for more data collection [2].

Two aggregation processes are used in WPI. The first aggregation was used to combine the sub-components into the five WPI components. Once these values for the five WPI components are obtained they are aggregated to obtain the final index value. The most common aggregation methods that are used for calculating the WPI and its components are the weighted arithmetic mean (Eqs. (1) and (1.a)) and the weighted geometric mean methods (Eqs. (2) and (2.a)). The previous equations are applied by Sullivan et al. [3], Sullivan et al. [12], Xin [13], Sullivan et al. [14], Manandhar et al. [15], Foguet and Garriga [16], Sullivan et al. [17], Yahaya et al. [18], Fenwick [19], and Jemmali and Matoussi [20].

The weighted arithmetic mean method, the widely used one is as follows:

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