

Article

# Assessing Water Security in Water-Scarce Cities: Applying the Integrated Urban Water Security Index (IUWSI) in Madaba, Jordan

Hassan Tolba Aboelnga <sup>1,2,\*</sup> , Hazim El-Naser <sup>3</sup>, Lars Ribbe <sup>2</sup> and Franz-Bernd Frechen <sup>1</sup>

<sup>1</sup> Faculty of Civil and Environmental Engineering, University of Kassel, Kurt-Wolters-Str. 3, 34125 Kassel, Germany; frechen@uni-kassel.de

<sup>2</sup> Institute for Technology and Resources Management in the Tropics and Subtropics (ITT), TH Köln-University of Applied Sciences, Betzdorfer Straße 2, 50679 Köln, Germany; lars.ribbe@th-koeln.de

<sup>3</sup> Chairman of the Middle East Water Forum (MEWF), Arar Street 20, Al Fuheis 19152, Jordan; hazim.elnaser@mewf.de

\* Correspondence: haboelng@th-koeln.de

Received: 1 April 2020; Accepted: 29 April 2020; Published: 5 May 2020



**Abstract:** Water security is a major concern for water-scarce cities that face dynamic water challenges due to limited water supply, climate change and increasing water demand. Framing urban water security is challenging due to the complexity and uncertainties of the definitions and assessment frameworks concerning urban water security. Several studies have assessed water security by granting priority indicators equal weight without considering or adapting to the local conditions. This study develops a new urban water security assessment framework with application to the water-scarce city of Madaba, Jordan. The study applies the new assessment framework on the study area and measures urban water security using the integrated urban water security index (IUWSI) and the analytic hierarchy process (AHP) as a decision management tool to prioritise and distinguish indicators that affect the four dimensions of urban water security: drinking water, ecosystems, climate change and water-related hazards, and socioeconomic aspects (DECS). The integrated urban water security index (IUWSI) highlights the state of water security and intervention strategies in Madaba. The study reveals that urban water security in Madaba is satisfactory to meet basic needs, with shortcomings in some aspects of the DECS. However, Madaba faces poor security in terms of managing climate- and water-related risks. The IUWSI framework assists with a rational and evidence-based decision-making process, which is important for enhancing water resources management in water-scarce cities.

**Keywords:** urban water security; water-scarce cities; efficient water management; analytic hierarchy process

## 1. Introduction

Water security is widely recognised by policy makers and academics as a global risk and policy challenge that transcends national security, endangers the health and livelihoods of vulnerable communities, and matters to global security [1–4]. Since water security is a multifaceted challenge, the concept of water security is viewed from diverse perspectives that cannot be easily reconciled [5,6]. It can generally be seen as the umbrella goal of water resources management toward sustainable development thinking with the focus on meeting water demand for societal and ecological needs [7–9]. The concept has emerged from the need to balance people’s needs with conserving water resources, and is reflected explicitly in the United Nations’ Sustainable Development Goal related to water and sanitation (SDG6) [10].