ENERGY-WATER-FOOD SECURITY CHALLENGE FOR MIDDLE-EAST AND NORTH AFRICA (*MENA*)

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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I, Bahareh Berenjforoush Azar declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Information, Systems and Modelling at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution. This research is supported by the Australian Government Research Training Program.

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List of Abbreviations

FAO	Food and Agriculture Organization
GCC	Gulf Cooperation Countries
GDP	Gross Domestic Product
GFSI	Global Food Security Index
GHI	Global Hunger Index
GTAP	Global Trade Analysis Project
HKH	Hindu Kush Himalayan
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
ILO	International Labour Organization
IO	Input-output
IOA	Input-output analysis
LCA	Life Cycle Analysis
MDG	Millennium Development Goals
MENA	Middle East and North Africa
MFA	Material flow analysis
MIRO	Multi-Regional Input-Output
OEC	Oil exporting country
OIC	Oil importer countries
SD	System Dynamics
SEI	Stockholm Environment Institute
UAE	United Arab Emirates
UNEP	United Nations Environment Programme
VWT	Virtual water trade
WHO	World Health Organization
WPI	Water Poverty Index
WRI	World Resources Institute

Abstract

In the backdrop of emerging concerns about Energy-Water-Food (EWF) security, this research analyses the impact of alternative developmental policy pathways (Scenarios) on EWF security and economic and social outcomes, for the period 2015-2050, for the Middle East and North Africa (MENA) region – a region typified by highly uneven distribution of energy endowments, acutely scarce resources, rather limited arable land, and high degree of political volatility. These impacts are assessed in terms of seventeen selected attributes, grouped into four areas of interest – energy security, water security, food security, and economic and social outcomes. Five Scenarios considered in this research, namely, Business-as-Usual (BAU), Energy-oriented (ESC), Water-oriented (WSC), Food-oriented (FSC), and EWF Nexus-oriented (NSC) – reflect alternative sets of technological, economic and social developmental trajectories – as relevant for each country included in this research. A specifically designed Input-Output framework – incorporating flexible (nested) production functions, factor substitution possibilities through price mechanism, and with high degrees of sectoral disaggregation – is employed to analyse the medium-to-long term impacts of alternative scenarios. Analysis suggests that while the BAU scenario (representing country policy trends) will lead to highly precipitous water security outcomes for most countries considered, and considerably worsened food security outcomes for some countries. Analysis also suggests that while domain-special scenarios (e.g., ESC) will have a perceptibly positive outcome for the domain (i.e., energy), but detrimental outcomes for other domains (e.g., water, food, economic and social). The research also reveals that improvements in water security will come at the expense of economic and social outcomes. Overall, the NSC scenario provides modest outcomes for most domains, although with sharp contrasts across countries – thus demonstrating the 'value' of nexus-informed policy considerations. The analyses were undertaken in this research – it is contended – provides innately useful insights into the trade-offs that policymakers in various countries can consider while develop resource, economic and social policies. Further, while this research has been undertaken for the MENA region, the analytical framework developed, and the overall 'philosophy' adopted to develop a more nuanced perspective on EWF security challenge should serve as a robust platform for other countries as they endeavour to develop policy prescriptions to redress the EWF security challenges. Therein resides yet another significant feature of this research.