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Modelling the WEF Nexus to support Sustainable Development: An African Case

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Abstract

In today's world, rising populations and growing economies have led to an ever-increasing demand for water; for domestic, industrial and agricultural purposes. This water stress is more acutely felt in the global south which is experiencing a much more rapid rate of development than the rest of the world. Africa in particular, is the fastest growing region of the globe as it undergoes a population explosion and an economic boom. In addition, the region is also one of the most vulnerable in terms of adverse impacts of climate change; sea-level rise, flooding, and drought. This perfect storm of water-related challenges is exacerbated by poor management, placing the continent in dire need of new and efficient approaches towards managing its resource. This chapter examines the WEF-Nexus from an African perspective, presenting the WEF-Nexus approach as a key driver for Sustainable Development in the region. Drawing from research carried out as part of the EU Horizon 2020-funded DAFNE project, the chapter goes on to describe a model for Economic Developments for the WEF Nexus at river basin scale and its incorporation into a Decision Analytic Framework that integrates environmental, socio-cultural, legal and policy dimensions of the WEF-Nexus.

1 Introduction

African Region is endowed by 8% of the world's natural gas, 12% and 30% of global oil and mineral reserves respectively, 40% of global gold ore and up to 90% of chromium and platinum. In addition, the continent holds 10% of the world's internal fresh water, while 65% of all arable land lies in Africa. With projections estimating a total population of 2billion by the year 2050, Africa also possesses vast human capital (UNEP, 2021). Despite this wealth of natural resources, the 'triple threat' (Walker, 2020) of unprecedented population growth, exceedingly rapid economic growth as well as climate change (coupled with poor and ineffective natural resource management) has seen water and food security issues on the rise, with Africa being the only continent on which the number of undernourished people witnessed an increase in recent decades (Plaizier, 2016). Given the fact that more than 70% of the Sub-Saharan African population depends directly on these natural resources, with natural capital accounting for 30%-50% of total wealth on the continent (UNEP, 2021), the socio-economic impact of these threats is disproportionately higher in the region. While climate change, as well as economic and population growth are major contributing factors driving global water stress, in Africa in particular, inefficient water resource and service management poses the biggest challenge (UNDP, 2006; Ngaira, 2009; Mason, Nalamalapu and Corfee-Morlot, 2019).

This trend towards increasing water-stress is particularly concerning as not only is water a fundamental life-giving resource in and of itself, it is central to other essential activities such as food and energy production. As such, the availability of water plays a central role in sustainable development. Water permeates all aspects of life, being essential for the survival and productivity of all life and all ecosystems, including agro-ecosystems – and therefore all ecosystem services for people. Human's biological, economic, social and cultural needs depend on a wide range of ecosystem services. Therefore, water is essential not only for basic ecosystem functioning, but for producing food, energy, and indeed all the material products needed for daily life. Water is also at the heart of adaptation to climate change, serving as the crucial link between the climate system, human society and the environment. At the same time, water stress affects agriculture and threatens a community's access to food. Food-insecure communities can face both acute and chronic hunger and also chronic illnesses due to poor diet, such as diabetes. For the case of Africa, the social and economic consequences of a lack of clean water penetrate into realms of education, opportunities for gainful employment, physical strength and health, agricultural and industrial development, and thus the overall productive potential of the communities and/or the region. Already, an increase in both conflict and migration in the region, driven by climate-induced water stress, is being observed, subsequently creating a ripple effect around the globe (Iceland, 2017).

On a global scale, the risks associated with the scarcity of water, energy and food are equally concerning (WEF, 2011; NIC, 2012). NIC (2012) estimates that the growth in the demand for food, water and energy by 2030 will be 35, 40 and 50 percent respectively. This is due to an increasing population and urbanization. The increased average food prices are an indication of growing natural resource scarcity (Ringler et al., 2013) and result to a large portion of the global population, being unable to afford their basic nutritional needs (Mohtar and Daher, 2012). The world demand for food will increase substantially in the next decades, due to demographic growth: world population should increase from 7.1 billion in 2013 to 9.6 billion by 2050 (United Nations Department of Economic and Social Affairs Population Division, 2013; Nellemann et al., 2009). Likewise, water consumption is increasing at a global rate of 1% annually, and an even greater strain on water resources is anticipated over the next 20 years with the development of the domestic, industrial, energy and agricultural sectors. This is expected to further drive a significant increase in water demand (United Nations, 2018; Boretti and Rosa, 2019). In addition, in many remote locations, water is under-priced and ground water is depleted (WEF, 2011).

Sachs (2015) suggests that the energy system, is the most complicated and urgent challenge of reconciling growth to planetary boundaries. World energy consumption is projected to grow by nearly 50% between 2018 and 2050, with most of this growth coming from countries that are not in the Organization for Economic Cooperation and Development (OECD). In fact, this growth is focused in regions where strong economic growth is driving demand, particularly in Asia and Africa (U.S. Energy Information Administration; International Energy Outlook 2019).

The WEF nexus framework consists of the study of the connections, dependencies and relationships between three important resource sectors: Water, Energy and Food, as well as the synergies, conflicts and trade-offs that arise in their management (Hellegers et. al., 2008; Bazilian, 2011; UN-Flores, 2017; Fernandes Torres et. al., 2019; Katz et. al., 2020). The historic focus of the WEF Nexus approach on resource security (WEF, 2011), has since broadened to address interdependencies and integration to achieve the sustainable management of resources (Simpson et al, 2019). Traditionally, natural resource management has adopted a sectoral focus with even stated integrated approaches such as Integrated Water Resources Management (IWRM), espousing a decidedly water-centric outlook (Benson et al., 2015; Lieu et al., 2017; Allouche et al., 2015), which has resulted in the disproportionate and inequitable allocation and prioritization of resources witnessed today (Mabhaudhi, et. a., 2019). Rather than considering the development of each sector in isolation, the WEF Nexus approach analyses cross-sectoral issues simultaneously (Rasul and Sharma, 2016; Mabhaudhi, 2016; Nhamo, 2018). Many authors argue that the WEF nexus, since it holistically integrates different sectors, it could be highly complementary and more efficient than the IWRM approach, which was included as a component of the Millennium Development Goals (MDGs) by the United Nations (Benson et al., 2015). Cai et al. (2018) also suggests that the WEF nexus can be accepted by a broader set of stakeholders than IWRM, especially in the agricultural and energy sectors; while, Garcia and You (2016) underline that framework needs to incorporate multiple spatial and temporal scales. This type of 'systems thinking' (Sterman, 2000) is integral to the delivery of sustainable development (Albrecht et. al, 2018; Liu et. al., 2018), as it acknowledges the complexities and interdependencies between the various environmental and societal challenges and developmental issues. Pandey and Shrestha (2017) highlight the link between the WEF nexus to green economy, poverty reduction and global resource scarcity. In general, climate change, the environment, land, governance, urbanization, waste and livelihoods are some of the components that are intrinsically examined under with the three sectors (FAO, 2014).

In the same vein, FABLE (The Food, Agriculture, Biodiversity, Land-Use, and Energy Consortium, 2021) mentions that current trends pathways to transition from 2010 to 2050, lead most countries towards unsustainable land-use, food and water systems, but through decisive action governments and other stakeholders can meet the related SDGs and objectives of the Paris Agreement. FABLE's projections underline the importance of implementing a Decision-Analytic Framework that will support sustainable pathways to all interconnected systems of land use, forests, water, energy and food. Each of the panels depict the sustainable versus the current trend pathways to transition from 2010 to 2050.

In this context, the challenge addressed by the WEF nexus is to provide the framework for the development of policies that will not only support the sustainability of water, energy and food resources, but also to simultaneously provide access to these resources for all levels of the society. When considered from this perspective, the WEF Nexus approach becomes more than a mere tool for efficient water resource management, but emerges as a key driver for Sustainable Development and policy implementation.

As part of the EC-H2020 DAFNE (Decision-Analytic Framework to explore the Water-Energy-Food Nexus in complex and trans-boundary water resources systems of fast-growing developing countries) project, this chapter presents research on the development of economic WEF nexus models, and their integration[1] under a Decision Analytic Framework (DAF) developed by the project to support stakeholders in effectively managing shared (transboundary) water resources. The DAF provides an integrated framework of models that examine all aspects of the WEF nexus including environmental factors (such as hydrology and climate change), societal and

[1] H2020 DAFNE (project Grant: #690268) – Deliverable 4.5: Integrated framework of models for social, economic and institutional developments.

institutional structures, economic developments, as well as policy and governance principles (Koundouri et. al., 2022). The study focuses on two African case study river basins (RB), the Zambezi River Basin (ZRB) and the Omo-Turkana River Basin (OTB), which are adopted as the system boundary for the implementation of the individual models. Due to its particularities, Africa consists of an important region for researching on the WEF nexus approaches. Located in the south-central part of the continent, the Zambezi is the fourth longest river in Africa. The ZRB spans eight countries including, Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe. With approximately 40 million inhabitants within a transboundary setting, inreasing demands on the shared water resource for domestic and industrial use, energy production, power generation and a wildlife-based tourism sector, translate into ever increasing water stress in the region (Koundouri and Papadaki, 2020). The OTB on the other hand spans southern Ethiopia and northern Kenya, where the introduction of new hydropower infrastructure has reduced the availability of water for other sectors; food production in particular (Hodbod *et al.*, 2019). Both cases reflect an increasing need for efficient water resource management within the region.

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2 Modeling Economic Developments from the WEF perspective

The Model of Economic Developments consist of an economy-wide model which will describe the economic development of the regions or countries of each case study. The shared resource that is under pressure, namely water, has a central role in this model. In order to provide a more accurate representation than usually provided by abstract models, the sectors associated with each country correspond to a production function, adequately adapted to the corresponding characteristics. More specifically, the analysis includes information on the economic characteristics of each country such as total employment, production output of the energy and food sectors, volume of water use, environmental indicators, etc. In particular, the model developed is able to capture the interdependencies between two neighboring, possibly different, economies sharing the same resource. It supports also the principle of sustainable development, in the sense that sustainable strategies for economic development will be accommodated given the effects of climate change.

The Model of Economic Developments, as outlined here and analytically defined in DAFNE[2], is formulated as a Stochastic Water resource management model (a Stochastic Dynamic Game Model) in a trans-boundary setting (Kim et. al., 1989; Bhaduri et. al., 2011, Koundouri and Christou, 2006, Koundouri et al., 2019) produced from a WEF Nexus perspective, and takes into consideration the Total Economic Value of water by properly estimating production and demand functions per sector and by country. As multiple countries share water resources, the likelihood of conflicts over the allocation of water resources increases; particularly under the effects of climate change (Homer-Dixon, 1999; Barnes, 2009; Miguel and Satyanath, 2011; Koundouri and Papadaki, 2020). Apart from the agricultural (including aquaculture), energy (including hydropower production) and water sector, the model expands the WEF nexus link to mining and quarrying, residential and tourism sectors also, as they are considered to have a substantial impact on water use within the case study areas[3]. For the purpose of the underlying Game Model, the case study countries are classified under two categories: the upstream and downstream countries, based on their physical location and their hierarchical access to Zambesi river basin (ZRB) and the Omo river basin (ORB)[4]. Furthermore, the multistage dynamic game approach uses two different scenarios subject to tradeoffs between upstream and downstream countries. The non-cooperative scenario refers to the case where game participants maximize their Net Benefit without considering any externalities and benefits from trading with the neighbors. On the other hand, the cooperative scenario permits regions to trade (hydropower and food exports are defined as the tradable goods for the case studies). The Water resources, which are stochastic, are expected to evolve through time and are defined to follow a geometric Brownian motion, which account for different climate effects among regions. Based in the first scenario, the multistage allocation of stochastic water resources between regions is defined as the “Nash Equilibrium” of the underlying game. In the latter scenario, firstly, we find the solution to the follower’s problem of maximizing a payoff function, and then, using the follower’s reaction strategy, we maximize the leader’s objective function. Since all the model coefficients are de-

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[2] The Analytical definition of the models is also presented in H2020 DAFNE (project Grant: #690268) – Deliverables D4.1 and D4.6 (Models of Economic Development in the Zambezi River Basic and the Omo-Turcana Basisn respectively).

[3] For example, focusing of the underlying countries included in the Zambesi river basin (ZRB) and using data from AfDB, OECD, UNDP (2017a, 2017b) the share of Mining and Quarrying sector to National GDP for 2015 was 23.6%, 19.6%, 5.6%, 13.7%, 4.4%, 13.4% and 9.5% for Angola, Botswana, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe respectively.

[4] For ZRB case study Angola, Botswana, Namibia, Zambia and Zimbabwe are considered as the upstream countries, while Mozambique is considered as the downstream country. For OZB, upstream and downlstream countries are considered as Ethiopia and Kenya respectively.

terministic functions of time, we assume that the respective countries use Markovian perfect strategies. These strategies are decision rules that dictate optimal action of the respective players, conditional on the current values of the water stock, that summarize the latest available information of the dynamic system. The Markovian perfect strategies determine a subgame perfect equilibrium for every possible value of the water stock reserves, and the strategy defines an equilibrium set of decisions dependent on previous actions.

For both of the case studies, the above set up develops a model of two different set of economies that have access to the same natural resource, here a river basin, and explore whether they can perform sustainable trans-boundary water sharing per sector taking into account the uncertainty posed by climate change. This problem was modelled by an upstream country that has the right to unilaterally divert water away from a downstream country, which though has access to water stock reserves that provide additional hydropower benefits (for the ZRB case study), or additional agricultural (food) benefits (for the OTB case study), not enjoyed by the upstream country.

In order to quantify the development pathways, this chapter presents the estimates of the production and demand functions per sector for the upstream and downstream countries for the ZRB case study, which are also necessary for the implementation of the dynamic model described above (social net benefit functions), and which quantifies the economic value of water use in the areas from a WEF Nexus perspective. The model, as presented in DAFNE, is defined as a panel 2SLS random effects Instrumental Variables Regression as described from Eq. 1-2, where Y denotes the depended variable, X the k explanatory variables and Z the m instruments[5].

$$Y_{i,t} = \beta_0 + \sum_{j=1}^{k} \beta_j \widehat{X_{\iota,t,J}} + u_{i,t} \quad i = 1, .., N \ \ and \ \ t = 1, ..., T \tag{1}$$

$$X_{i,t,j} = \pi_0 + \sum_{j=1}^{m} \pi_j Z_{i,t,j} + u_{i,t} \quad i = 1, .., N \ \ and \ \ t = 1, ..., T \tag{2}$$

We illustrate the results for ZRB case study, where our panel data consists of 112 observations from 8 countries from 2001 to 2013. Heterogeneity in the intercept of the model between upstream and downstream countries is controlled with a dummy variable taking the value of one for the case of upstream countries (Angola, Zambia, Malawi and Tanzania for ZRB). Table 1 reports the estimates for all sectoral models for ZRB. Statistical

[5] A complete list of all variables we use as instruments in the regressions, can be found in H2020 DAFNE (project Grant: #690268) –D4.1 and D4.6 (Models of Economic Development in the Zambezi River Basic and the Omo-Turcana Basisn respectively).

significance is denoted for 1% (***), 5% (**) and 10% (*). The relevant Chi Square statistic is reported. The Dependent Variable for all models is the Gross Value Added of the underlying sector. Table 2 describes all the variables included in model as well as their source.

In order to obtain a production function in terms of the water use (variable wu), we need to collapse all the all variables (except wu, wu squared and the region dummy variable, d) into their means. Using the estimates (equations 1 and 2) the production function of all sectors is decribed by Eq. 3 where $\widehat{X_{\iota,J}}$ denotes the mean over t=1,…,T.

$$\widehat{Y_\iota} = \hat{\beta}_0 + \hat{\beta}_1 d + \hat{\beta}_2 wu_i + \hat{\beta}_3 wu_i^2 + \sum_{j=4}^{k} \hat{\beta}_j \widehat{X_{\iota,J}} \qquad (3)$$

Table 1 Table reports the estimates of the panel 2SLS random effects instrumental variables regression of Eq. 1-2 for the ZRB case study. Statistical significance is denoted for 1% (***), 5% (**) and 10% (*). The relevant Chi Square statistic is reported. The Dependent Variable for all models is the Gross Value Added of the underlying sector.

	Mining	**Energy**	**Residential Water Supply**	**Agriculture**	**Tourism**
constant	-0.36***	-1.78	0.02***	-0.45***	0.69***
d	0.17***	0.23***	0.009***	0.09***	0.17***
water use (wu)	4.02***	3.75***	0.33***	0.02***	5.04***
wu^2	-10.85***	-10.15***	0.90***	-0.0004***	-11.22***
employment	-0.005	-0.05**		-0.005	-0.31*
gross fixed capital	0.0001***	0.09***	0.003***	0.0001***	0.09***
energy use	-0.00006***			0.0035***	
co2	0.00008***	0.00002*		0.0005***	
renewable electricity production		-0.0003***			
biodiversity habitats		-1.13***	-0.06***	0.288**	-1.22***
no2		0.52**			
people using basic drinking water services			0.01*		
natural, cultural and mixed heritage sites			0.0036***		
agricultural area				0.0004***	
international arrivals (tourism)					0.0008**
terrestrial protected areas					-0.004*
Wald χ^2	941.70***	456.17***	457.58***	572.55***	533.33***

Table 2 provides the description, the unit and the source of all the variables included in model of Table 1.

Variable	Unit	Source
gross value added	dollars	Eora Global Supply Chain Database[6]
employment	persons	ILO International
gross fixed capital	dollars	Eora Global Supply Chain Database
water use	m^3	Eora Global Supply Chain Database
Energy Use	TJ	Eora Global Supply Chain Database
co2	Gg	Eora Global Supply Chain Database
renewable electricity production	%	United Nations Statistics Division, Energy Statistics
biodiversity habitats	%	Environment & Climate Change Data Portal
no2	Gg	Eora Global Supply Chain Database
people using basic drinking water services	% of population	World Bank
natural, cultural and mixed heritage sites	integer	UNESCO World Heritage Centre
agricultural area	$10^3 ha$	FAOSTAT
international arrivals (tourism)	persons	World Bank
terrestrial protected areas	Km^2	World Database on Protected Areas

Figure 1 presents the empirical production functions for all sectors, for both upstream and downstream countries for ZRB Case Study. The y-axis is GVA (constant 2005 $) and x-axis is the water use in billions of

[6] http://worldmrio.com

cubic meters.

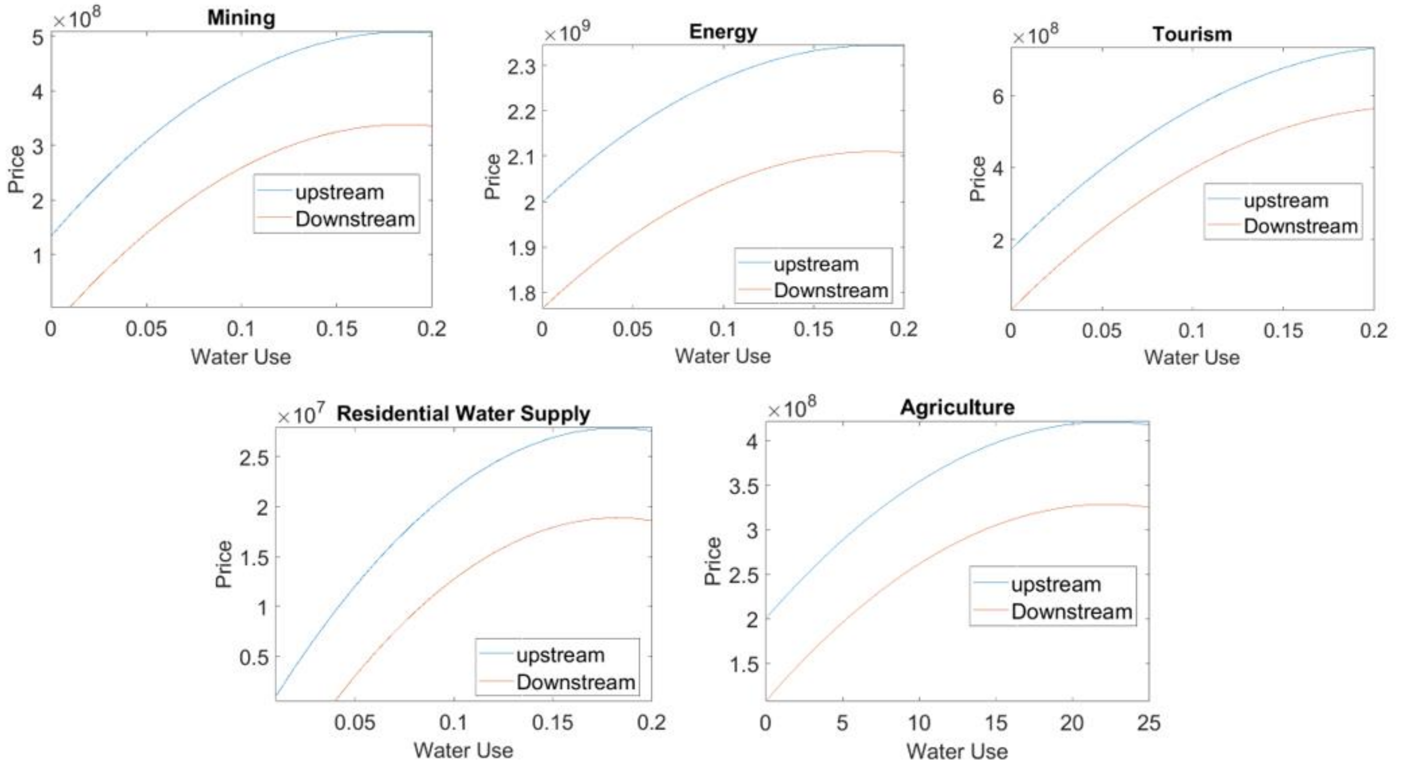

Figure 1 Production Functions – ZRB Case Study

Empirical Demand Functions can be calculated by differentiating Eq. 3 with respect to water use variable (wu):

$$\frac{\theta\widehat{Y_i}}{\theta wu_i} = \hat{\beta}_2 + 2\hat{\beta}_3 wu_i \qquad (4)$$

Figure 2 presents the empirical Demand Functions for all sectors for ZRB, where the y-axis is the price of the water in $ and the x-axis is the water use in billions of cubic meters.

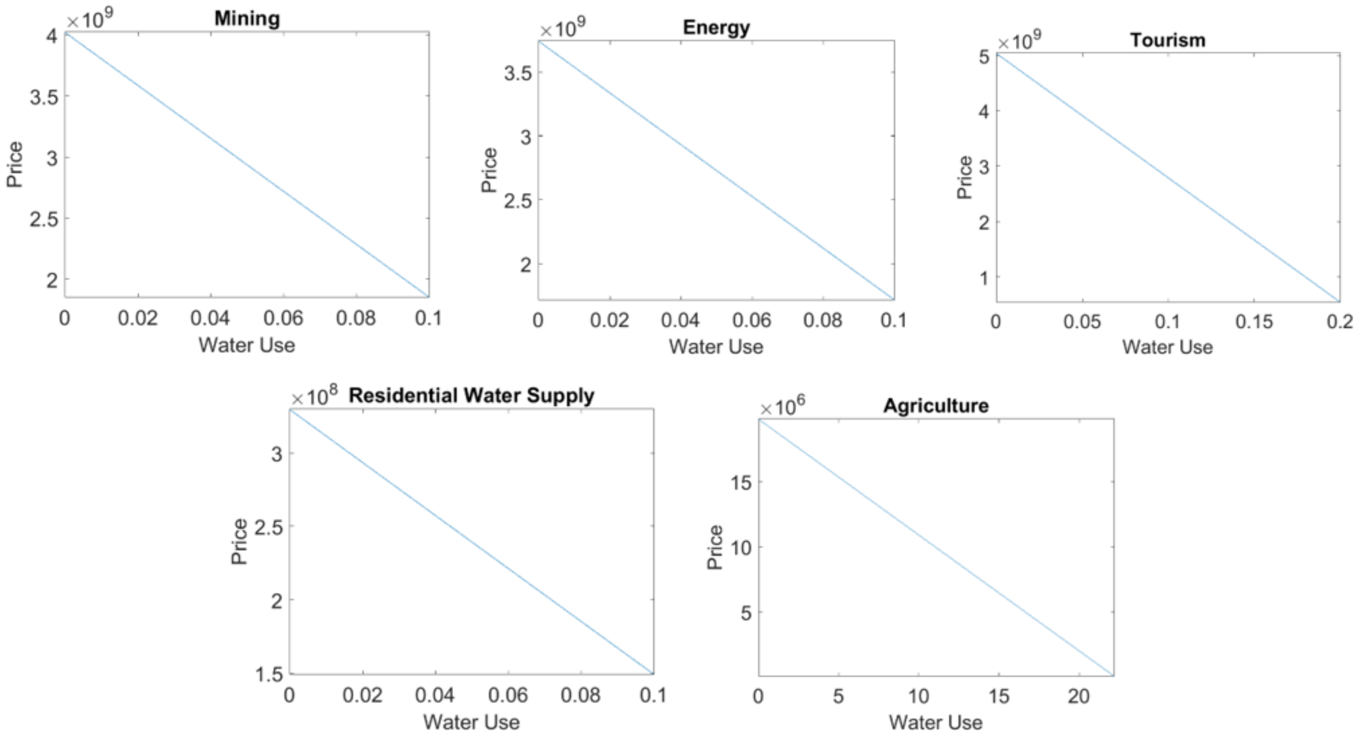

Figure 2 Demand Functions – ZRB Case Study

The derived demand curves represent the relationship between the price of the intermediate good, water, and the quantity demanded for a given period of time, revealing exactly how many units of water will be purchased at various prices. Therefore, as the price of the water increases over time due to decreasing water availability, water demand for each of these economic sectors reaches zero sequentially, ending up with an ordering via their demand function for the two riparian countries.

Employing the stochastic dynamic game via the appropriate estimated production functions above (social benefit functions in the model), we established an inter sector cooperative water allocation trade-off between the two set countries, where the downstream country offers to the upstream one hydroelectric power (ZRB) or one agricultural-food exports (OTB) at a discount price in exchange for greater transboundary water flow, and made the comparison with the non-cooperative case. Main results, as presented in DAFNE, indicate that for the case of ZRB case study, under cooperation, the downstream country has the opportunity to increase water withdrawal for consumption without reducing hydropower or agriculture benefits from the water stock reserves it has access to. If the upstream country increases its water diversion, then the downstream one will initially reduce its water abstraction due to cooperation. However, after a certain point, the latter will increase its water abstraction, since its benefit from water consumption becomes higher than the benefit from hydropower/ agriculture, preventing accordingly the upstream country from manipulating the agreement. Furthermore, the resulting equilibrium water allocation policies in the long run are sustainable even under the uncertainty captured by climate change (i.e., as the variance of water flow increases). The results demonstrate that cooperation generally provides a framework to increase benefits from shared water resources. There is a number of reasons why an open economy is more preferable than a closed one. Focusing on our results for the OTB case study; Firstly, both riparian countries become better off due to comparative advantages of each country concentrating on a specific area of production, i.e. Ethiopia in Hydropower (Energy) and Kenya in Agriculture. Secondly, they make a more valuable use of the river basin with Ethiopia accepting the upcoming benefits of trading with Kenya and so, allowing the former one have access to augmented quantity of water deriving from the river. Lastly, this collaboration has a positive footprint on the ecosystem surrounding those countries, which is based on the Turkana lake, limiting so, the negative economic and social impacts of the marine habitat destruction. Last but not least, even in extreme Climate change circumstances, where the net benefits fluctuate, trade remains the most profitable option for both countries.

3 Integration of the models under a WEF nexus perspective and implications for Sustainable Development

While as a stand-alone tool, the model of economic developments, as described in the previous section, provides key insights into the effective allocation of water resources, it is in its incorporation within the context of an integrated framework which examines the WEF nexus from a variety of vantage points that its maximum value is realized. The Integrated WEF Nexus Framework (Koundouri et. al., 2022), considers both the bio-physical and socio-anthropologic models of the WEF nexus in order to provide a holistic overview of the dynamics within the WEF nexus in the region of study. The bio-physical models (such as hydrological, climate change and land-use models) are viewed as complimentary to the socio-anthropologic models (models of governance, environmental policy, social and economic development), and work hand in hand to model potential societal developments and the equivalent environmental responses (Burlando et.al., 2018). As such, supporting the decision-making process by aiding stakeholders and decision-makers in identifying, screening and prioritizing potential WEF nexus management actions (Bertoni et. al., 2017). The integration of these models is facilitated by the fact that each model incorporates the sustainable development goal indicators (SDGIs[7]) within the variables that they consider. As such, not only do the SDGIs provide a common structure around which to frame the integration

[7] SDG Indicators, https://unstats.un.org/sdgs/indicators/indicators-list/

of the separate models, but both the individual models and the wider DAF inherently embed sustainable development considerations in their operation.

For example, when the Economic model produces potential actions (e.g. prioritizing agriculture, or energy production), while the bio-physical models present the environmental responses, the Socio-Cultural model produces the potential implications of these actions (e.g. more food production leads to less poverty, or a higher demand for energy causes deforestation). The policy and governance models are then able to present policy tools and governance frameworks that can either support development in line with the proposed actions, or mitigate against potential environmental impacts that could result from a certain course of action. Thus, the Integrated WEF Nexus DAF is an effective WEF nexus analytical decision model which assess all interconnected domains simultaneously and providing unified evidence on quantitative and qualitative relationships. DAFNE provides an application of the DAF to the underlying case studies.[8]

The WEF nexus approach advocates a fundamental shift from sectoral governance approach, to a cross-sectoral, coherent and integrated approach to WEF management. Thus, WEF nexus can formulate and implement a multiscale, holistic and integrated plan for achieving the SDGs.

The integrated WEF nexus DAF is highly relevant for Africa and is expected to address issues related to water, energy, and food security in an environmentally and socially sustainable way to improve livelihoods, build resilience and enhance regional integration. However, long term barrier to these targets are the habitual sector-based approaches in resource management, which inadvertently create an imbalance in resource allocation, enhancing scarcity and inequality. Climate variability and change also increases the resource depletion, further compounding regional vulnerabilities. The situation is worsened by the dependence on climate-sensitive sectors of agriculture and hydroelectric energy, which require abundant and consistent water supply. Thus, operationalizing the WEF nexus in African Basins is envisaged to integrate decisions and sustainable adaptation pathways to the challenges of steep population growth, rapid urbanization and increased consumer demands.

4 Conclusions

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[8] H2020 DAFNE (project Grant: #690268) – D4.5 Integrated framework of models for social, economic and institutional developments

This chapter examines the WEF-Nexus from an African perspective, presenting the WEF-Nexus approach as a key driver for Sustainable Development in the region. Focusing on two African case study river basins (the Zambezi River Basin and the Omo-Turkana River Basin), this study outlines a model for Economic Developments (a Stochastic Water resource management model) in a trans-boundary setting, elaborating on the models used to quantify the economic value of water use in the areas from a WEF Nexus perspective. Results demonstrate that cooperation generally provides a framework to increase benefits from shared water resources. Moreover, the resulting equilibrium water allocation policies in the long run are sustainable even under the uncertainty captured by climate change.

In order to provide a holistic overview of the dynamics within the WEF nexus in the region of study, the economic model is further incorporated into an Integrated WEF Nexus Framework which examines the WEF nexus from a variety of vantage points.

The adoption of such an Integrated WEF Nexus DAF, within the African context has the potential for a transformational impact – targeting the most vulnerable populations to provide access to clean water, improving sanitation, reducing health issues and associated mortality, improving energy access, supporting job creation, alleviating poverty and essentially acting as a foundation for sustainable development in the region.

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