

# Sustainable Development in Morocco: Health, Water, Energy, and Environment

## Développement durable au Maroc : santé, eau, énergie et environnement

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### Abstract:

By using a systematic-narrative review methodology, the article systematically assesses Morocco's various and interrelated challenges of health, water, energy and environmental sustainability. The study synthesises information from 45 selected resources (2015-2023) such as academic publications, national strategies, and reports from different agencies, and evaluates Morocco's progress and challenges from the theoretical perspectives of the Water-Energy-Food-Health Nexus as well as polycentric governance. The findings show that despite the implementation of ambitious sectoral strategies by Morocco, their implementation has been constrained due to the existence of institutional fragmentation, lacking cohesion between the sectoral policies, implementation gaps, and the resulting low level of systemic resilience. The primary contribution of this article is to present an integrated governance framework that links territorial planning, cross-sectoral collaboration, and participation by the communities. Furthermore, it is suggested that Morocco's path to sustainable development will rely more heavily on its ability to construct adaptive, inclusive, and coherent governance structures that are able to optimise the management of competing interests when there are potential trade-offs between multiple sectors.

**Keywords:** Morocco, sustainable development, nexus governance, water-energy-food-health nexus, polycentric governance, territorial resilience, institutional fragmentation.

**Classification JEL:** I1; O1; Q2; Q4; Q5; R1.

**Paper type:** Theoretical Research

## 1. Introduction

Sustainable development has become a central idea for how we understand global policy and has shifted from the traditional "three pillars" (economy, society and environment) toward a new view that sees all of these areas as inter-related components of a larger system. Sustainable Development Goals (SDGs) set forth by the United Nations for 2030 are based upon this new way of thinking, and recognize that health, water, energy and environment do not exist within their own silos; they are all related as part of what researchers refer to as a "nexus" (Hoff 2011; Weitz et al. 2017). As such, resolving issues in one area often causes or depends on other issues being resolved. For many developing nations facing increased pressures related to climate change, as well as limited resources, the challenge lies primarily in governance — that is, how we design and utilize our institutions to effectively manage these complex and interrelated decisions (Bazilian et al. 2011; Ostrom 2010).

Morocco is an excellent example of how to lead the world in sustainable development. It lies at the intersection of Europe and Africa and is also vulnerable to the impacts of climate change. Morocco has made many national objectives for sustainability since 2006, including creating a comprehensive national strategy on water, creating an ambitious goal of reaching 52% renewable energy by 2030, creating a Health Plan by 2025 to provide universal access to health care and a strategy on Sustainable Development. The levels of commitment to the political development of these planning objectives are evident in the development of several high-profile projects such as Noor Solar Power Station, electrification of rural regions in Morocco and increased life expectancy in Morocco (HCP, 2023; Ministry of Energy, 2023).

While every positive development has a negative counterpart, the fact remains that the vulnerabilities of Morocco have only gotten worse over time and remain present. Presently, Morocco is experiencing an increasing level of water scarcity due to over-utilisation of aquifers and prolonged drought years resulting in less than 600 cubic metres of annual per capita water consumption. Improvements within Morocco's healthcare delivery system have occurred; however, these improvements have not been evenly distributed across the rural versus the urban populations. Rural areas in Morocco are experiencing lower levels of access to health care services (including doctors) than urban counterparts. The rate of chronic and climate-related disease is also increasing within Morocco. Morocco has made strides towards transitioning to renewable energy sources; however, the country is still heavily reliant upon the importation of fossil fuels, particularly coal, which will continue to undermine the country's ability to achieve its climate goals. In addition to all of the aforementioned issues, Morocco is experiencing a continuous loss of biodiversity, environmental degradation and pollution; this is putting the very foundation of its development at risk.

There is a stark contrast between the high-level ambition of morocco and the enduring, systemic challenges that the nation faces in managing the links among water, energy, health, and environment; thus, the main question this article will answer is: What if morocco's failure to achieve sustainability is not primarily related to the lack of good ideas or sector-based plans, but rather a failure of governance? Specifically, could it be that morocco's inability to govern these linkages among major challenges poses a barrier to long-term sustainability?

Research to date has identified many components necessary for connecting the individual pieces of the puzzle together. As evidenced by the volume of publications available on Morocco by the High Commission for Planning (HCP), the World Bank and other governmental ministries, these institutions provide a substantial number of reports outlining how Morocco's economy, natural resources, and human capital are performing in conjunction with the strategic goals of one another, albeit through many independent reports that focus on their sector separately (i.e. HCP reports provide insight into a range of different sectors).

Further, there are a number of small academic studies focusing on specific areas (e.g. the impact of renewable energy policy on job creation, Choukri and El Ghazali, 2020; The Importance of Environmental Governance (e.g. Abouab, 2023); and The Importance of Health and Health-Related Duties).

The idea of the WEF nexus (the interrelationship between the water, energy, and food systems) and application of the nexus framework to define and prioritize these interrelationships has gained momentum since its creation, and recently there has been a renewed focus on the health aspects of the nexus, but rarely has it been applied as a full analysis.

Analytic frameworks are also being created based on the concepts of polycentric governance (Ostrom, 2010) and socio-ecological resilience (Folke, 2016). However, the relationship between the two frameworks is typically used only to describe the cause of an institutional bottleneck. Thus, these two concepts have not yet been integrated into an integrated analysis of Moroccan circumstances.

The research suffers from an important gap that can only be addressed through a complete and objective study that uses these powerful theoretical frameworks and tools (nexus thinking, polycentric governance, resilience) to examine in detail the interrelationships between water, energy, health, and the environment in Morocco, and to identify specifically what governance failures are preventing a transition to a truly just and sustainable society. This article seeks to close that research gap.

Three main questions guide our exploration:

1. How do real world connections and trade-offs appear at the interface of the water-energy-health-environment nexus in Morocco, and what do they create in terms of vulnerability for communities and for the economy?
2. What is the effectiveness of Morocco's current governance system (i.e., its combination of national ministries, basin agencies, regional councils, and private players) in managing this complex array of interconnected challenges, and does it possess the degree of coordination, flexibility, and authority required to do so effectively?
3. What would a pragmatic integrated governance framework in Morocco that fully adopts the principles of nexus thinking and polycentric governance to build authentic resilience in local communities against climate and health shocks?

Three new contributions emerge from this research: First, the fusion of “nexus” with polycentric governance can be used to understand the environmental governance challenges facing North African states; using Morocco as the example, this article expands the understanding of nexus-based environmental governance in relation to Morocco’s position as both a developing country and a member of a larger regional economic community. Second, the evidence provided here shows how various policies within Morocco work together to create an overall negative impact on the physical environment in which they exist, thereby affecting all sectors within Morocco. Finally, this article presents a way for policy-makers to implement an effective governance model for cross-sector coordination and integrated local planning within the context of a nexus-based approach.

In order to address our research questions, we employed the systematic narrative review methodology, as described by Greenhalgh et al. (2018). A systematic narrative review draws together data from a variety of sources (e.g., academic literature, governmental reports, or statistical data), resulting in a comprehensive narrative of what is known about a specific topic. The objective was to conduct comprehensive literature searches over the course of three years (2015-2023), through Scopus, Web of Science and institutional websites, to identify all documents that have been published that refer to Morocco, focusing specifically on both governance (nexus) and governance of two or more sectors identified in our study. Through these searches, we identified and selected 45 key documents that are integral parts of our overall analysis.

In the following segments of this document, we will provide an overview of our Integrated Conceptual Framework developed from a combination of Nexus Thinking and Governance Theory into a singular Analytical Model. In Sections 3, 4, and 5 we will demonstrate the use of The Integrated Conceptual Framework in addressing Morocco's Interrelated Issues of Health, Water, and Energy. In Section 6 we will provide a summary of our findings and introduce The Integrated Governance Framework for Morocco. Last, in Section 7 we will provide a summarized argument for our assertions and outline important recommendations for Policy Makers, as well as highlight limitations and future Research Opportunities related to our work.

## **2. Toward a sustainable health system in Morocco: examining equity, resilience, and the interconnection**

Morocco's ambition to develop a viable health care system will be central to its future. With the demographic, epidemiologic and environmental changes that have occurred, a sustainable healthcare system must include more than fiscal responsibility. Sustainable healthcare systems must also demonstrate the ability to meet the health care needs of current populations while providing the same opportunity for future generations within an evolving context (WHO, 2010). Therefore, Morocco's Challenge has two major components: 1) Strengthening the Health Care System's capability to withstand and prepare for system shocks such as pandemics and climate change (Kruk et al., 2017) and 2) A focus on both the concept of horizontal equity (providing equal access to Health Care for individuals with the same need) and vertical equity (providing greater access to health care services to those who have a high need) (Marmot, 2015). The COVID-19 pandemic was an adequate "stressor" for the health care system by exposing significant weaknesses and creating opportunities for short-term change; however, COVID-19-related changes were primarily only partially complete. The findings of this section incorporate the results from all prior diagnostic and explanatory analyses and will provide an integrated approach to assessing Morocco's ability to build a sustainable health care system, first by assessing past challenges, and second, by addressing potential solutions for creating a sustainable and just health care system.

### **2.1. Diagnostic: Progress Marred by Persistent Structural Divides**

In general, Moroccans are making good progress in their health status as indicated by increased life expectancy, which rose from 63 years (in 1980) to over 75 years today (HCP 2023). Progress has been made with respect to the successful containment of infectious disease and reducing child mortality. However, although this is the average for all of Morocco, these numbers mask the magnitude of serious and long-standing social and territorial inequities that threaten to erode the sustainability of Morocco's health care system.

The most important social inequity is "territorial," where many rural and remote areas in Morocco experience significant difficulties accessing health care due to limited health care infrastructure, medical equipment/resources, and in the case of rural and remote areas (even more critically) a shortage of available human resources (physician and other health care provider) to provide medical services. The doctor-to-population ratio in these areas is significantly below the guidelines established by the World Health Organisation (WHO), resulting in substantial inequity in horizontal equity for these areas (Ministry of Health 2023). As a direct result of these inequities in geography, there are high rates of maternal mortality and infant mortality, and poorer management of chronic diseases in non-urban centres (World Bank 2022).

In addition, the country is experiencing a fast-evolving epidemiological picture. Over 80 percent of deaths are from NCDs (e.g. coronary artery disease, diabetes and cancer). The "double burden" of communicable diseases and the growing incidence of chronic degenerative

conditions creates a strain on current health care systems and constraints on available funding, which were established for a previous time period.

## **2.2. Explanatory Mechanisms: Unpacking Governance, Finance, and Nexus Dynamics**

These long-standing challenges have occurred due to several interrelated issues caused by a failure in governance, financing, and inappropriate use of linkages through different sectors throughout the country.

### **1. Disconnection in Governance and Implementation of Services (The Gap):**

With respect to governance, Morocco's health care system is a "health care ember" that is divided into various government ministries (MoH), Social Security Fund (SSF) and Private Sector involvement, with six to eight new RAs implemented by Framework Law 34-09. Theoretically, the MoH and several new potential regional authorities could make the whole system more responsive and adaptive. However, the MoH system in practice is poorly coordinated and duplicated because of poor accountability, lack of clear authority for regional authorities, the limited number of established regional authorities and the failure of the Regionalization Programme to implement complete or effective health authority decentralization. One major obstacle in Morocco's health care system is the parallel relationship that exists between the public sector and private sector regarding governance, regulation, quality assurance and equity (Abouab, 2023).

### **2. The Financing Trap: Between Aspiration and Fiscal Reality:**

The trap of financial resources (the "Financing Trap") lies between ambition (aspirations) and fiscal reality. Achieving financial sustainability in a health care system (FSS) requires addressing the issue of finance. With health care expenditures at about 6.5 % of gross domestic product (GDP), there remains a substantial financial gap and funding source issues. This could be considered a form of regressive finance for the population, with a high level of out-of-pocket payments, which can create catastrophic health care financing.

The laws put in place for social security will help lead to the establishment of a universal health care system by 2025; thus, these laws can provide vertical equity for all groups within the population. However, without the necessary resources to expand access to health care services throughout the country and adequate capabilities to support a greater volume of patients, expansion of health care access through social security systems will ultimately result in the decline in quality of services, increased waiting time for service, as well as resulting in the public being disillusioned with the expanded access to care.

### **3. The Health-Water-Climate Nexus: A Web of Causal Pathways:**

Health is inextricably connected to environmental factors, and environmental factors create points of causation that are not managed by the current governance systems that exist in sectors such as Water Mismanagement to Disease (i.e. the 30% of childhood illnesses attributable to unclean water (WHO, 2021)). The creation of waterborne disease through contaminated source areas due to agricultural chemical runoff or poorly managed sanitary systems, coupled with Water scarcity, has forced individuals utilizing these low quality sources of water, to utilize Water from Unhygienic sources and decrease the amounts of Water available to keep themselves clean. As a result of Poor Water Management, the burden on the health system will continue to grow at a faster rate.

Climate Change as a health risk multiplier: The effects of climate change are not something that will occur in the future, but rather something that occur now in terms of clinical reality. Extreme heat events have been shown to be increasing cardiovascular and respiratory related deaths. Additionally, changing the precipitation and temperature patterns will increase the distribution of vector borne disease (i.e. malaria and leishmaniasis). On top of the above listed climate impacts, the drought will continue to create food insecurity which in turn will cause malnutrition to compound upon other health related vulnerabilities; as a result, the health system

will continue to feel the brunt of the realities of climate change and, at the same time, Sustainable Development is working to create mechanisms to better integrate the Health and Environment sectors through initiatives like the Health-Environment Plan. 2022-2023.

### **2.3. The Future of Healthcare: How to Create a Resilient and Sustainable Health System**

The creation of a sustainable, resilient healthcare system will require a paradigm shift from the current focus of curative care provided primarily by hospitals toward a greater emphasis on prevention and primary care through an integrated governance approach.

**1. Adaptive and Integrated Governance:** In order to achieve regionalised health care access and reduce health disparities within regions, it will be critical to create inter-regional governance platforms that provide oversight of health care. Additionally, in order to ensure a sustainable health care system, it is important to create inter-sectoral governance platforms across health, environment, and water so that there can be an ecosystem approach to the identification and implementation of strategies to mitigate the environmental factors that contribute to health issues.

**2. Developing Strategies to Finance Resilient and Sustainable Healthcare:** Reforming the financial aspect of the healthcare system will involve two primary strategy goals. The first goal is to establish a risk pool for patients who would otherwise incur catastrophic out-of-pocket (OOP) expenses. The second goal is to create "smart" purchasing incentives for the providers of preventive and primary care services to ensure that they continue providing high-quality services and that the need for hospitalisation is minimised. Utilizing innovative sources of funding (i.e., earmarked taxes on health-harming goods such as tobacco and sugar; and using Global Climate Adaptation Fund climate-smart infrastructure) can strengthen fiscal resiliency.

**3. Technology is Key to Equity and Nexus Management:** Digital health is a possible way to help eliminate geographic barriers in accessing healthcare; however, it will require support from multiple sectors (i.e., electricity, internet service providers) in order to be successful in providing remote services. Additionally, digital health enables the creation of accumulation of information from both clinical and environmental sources into one location for early warning systems, thus, enabling us to provide preventative services for all climate-related health threats.

To create health sustainability in Morocco, there needs to be less focus on building hospitals and more focus on establishing smarter connections within various sectors, all level of government, and clinical care systems that represent the socio-ecological context where these health issues occur. Creating these smarter connections will require the integration of best clinical practices and healthy business practices that will allow us to provide equitable access to care through all different geographical regions in Morocco.

### **3. water governance in morocco: navigating structural scarcity through nexus thinking**

Water is essential for the development of Morocco's economy, communities and ecosystems; however, as a result of Morocco's increasing population, rapid urbanisation and reliance on water-intensive agricultural practices, the nation has been affected by decreasing per capita availability of water quickly dropping to below 620m<sup>3</sup> per capita today (compared to approximately 2,560m<sup>3</sup> per capita in 1960) - Morocco is now considered to be structurally experiencing severe water scarcity using the World Bank's definition of stress-related water scarcity, which is defined at <1,000m<sup>3</sup> per capita (HCP, 2023).

In order to understand how to confront the current challenges pertaining to Morocco's water crisis, this paper will argue that the current Water Governance Crisis is not just about having

an inadequate water supply for a certain population but rather represents a Governance challenge that relates to the water governance structure that is currently in place in Morocco. The current water governance framework in Morocco has been defined by three analytical pillars: (1) by the issues associated with structural vulnerability and increasing pressures (2) through the evaluation of the water governance framework in terms of IWRM and (3) the necessity for innovative technologies and policies through the lens of the WEF nexus.

### **3.1. Structural Vulnerability and Mounting Pressures on the Resource**

Morocco's water vulnerability is becoming systematic, and its significance is escalating due to Climate Change. Climate Change will not only cause numerous droughts but will also alter precipitation, affect evaporation patterns and increase temperatures to reduce the availability of renewable surface and groundwater Recharge. The low capacity of the nation's reservoirs averaging 30% (Ministry of Equipment and Water 2024), exemplifies the precarious nature of the supply and demand relationship.

The agriculture sector is under tremendous pressure because it consumes more than 80% of the mobilized water within the country. This consumption is mostly within major active basins such as Souss-Massa, Tensift, and Oum-Er-Rbia. High-value export crops (including citrus and watermelon) create demand for irrigation within these areas, creating levels of competition between agriculture, urban and industrial water usage for water resources. Moreover, this has created an extremely limited availability of Environmental Flows for Ecosystems, as most water within the agriculture, urban, and industrial sector is consumed.

Groundwater over-pumping has created extreme overdraft within most aquifers throughout Morocco, with the Souss-Massa aquifer declining by approximately 2–3 meters annually due to excessive pumping. This situation has created a typical "tragedy of the commons" (Hardin 1968) scenario where individual rational behaviour (i.e. excessive pumping of groundwater) leads to the ultimate destruction of collective resources. Depletion of this resource not only decreases the quantity of water available; it also threatens the long-term viability of agricultural production and the rural economy in Morocco.

### **3.2. Governance Frameworks And Discontent: Practical Aspects Of Integrated Water Resource Management (IWRM)**

Morocco has helped establish the region as a leader in developing progressive policy for the development of water resources, as shown by its National Water Plan and the creation of River Basin Agencies (RBAs), which is an early demonstration of Morocco's commitment to implementing the principles of Integrated Water Resources Management (IWRM). The principles of IWRM focus on coordinating the management of water and land resources; managing water resources for the greatest social and economic benefits; and using ecosystems sustainably (Global Water Partnership 2000).

The implementation of Integrated Water Resource Management (IWRM) in Marrakesh has provides a number of significant differences between the outlook of the IWRM philosophy, and the realisation of its principle in Marrakesh. The reasons for these differences includes the Different Authorities, Levels Of Jurisdictions and Levels of Authority de facto responsible for Water Resource Management, the Difficulty of being able to Achieve Integrated Water Resource Management from an Integrated Water Resource Management Framework.

Water management policy development is hampered by the fragmentation of the various Authorities responsible for managing the water sector, including: The Ministry of Equipment and Water; the Ministry of Agriculture; River Basin Agencies; Local Communities; and a variety of levels of user associations. The River Basin Agencies have been established to provide a mechanism to plan and manage the River Basin and river basin management activities, however, due to the competing political and economic agendas of the various ministries and larger Sectoral entities, the Agencies frequently have limited authority to regulate

the activities of Water Users. As a result, a fragmented approach to the development of the Water Management Policy, combined with the fragmentation of the Water Management Authorities, has led to an inability to effectively enforce the existing Rules and Regulations, such as prohibiting the establishment of illegal wells, and has resulted in a lack of communication between the Ministries and Regions. As such, the concept of Integrated Water Resource Management (IWRM) has effectively lost its meaning, and the promises of IWRM will continue to go unfulfilled.

An analysis of the past and present trends suggests there is a conflict between government policy and the agricultural subsidy system regarding the perceived versus real incentives provided to farmers so far as water availability is concerned. While government initiatives to modernize agriculture (such as the Green Generation initiative for the years 2020-2030) have a focus on developing and promoting a diversified agricultural sector with an emphasis on high-value crops created for export (which use large amounts of water), this does not align with the overall goal of conserving water resources. This is exemplified by current subsidy programs for new and more efficient technologies (drip irrigation systems) that provide farmers with financial support to adopt new irrigation technologies. The subsidies that lower the per unit cost of water provide incentives to farmers to increase their use of irrigation water; this most commonly produces either a Jevons Paradox or a rebound effect with regard to water conservation in terms of expanded use of irrigated land or increased production of crops that require more water than was previously employed. Thus, agricultural policy tools such as crop consulting (advice to farmers concerning crop selection and production techniques) and subsidies are currently not supportive (and in many cases, directly contradict) the objective of sustainable water resource management.

Historically dominant, centralized-based planning methods related to management of water resources have been associated with many benefits but will not enable sustainable development due in part to their limitations. Centralized, infrastructure-based projects (e.g., large dam and interbasin conveyance) have failed to adequately incorporate local social and cultural contexts, to provide smallholder farmers with adequate input into the decision-making processes associated with the development and management of their resources, and to effectively adapt to the changing needs of the clients. Integrated Water Resource Management (IWRM) has focused on addressing these three areas by promoting greater stakeholder involvement in IWRM processes, as well as, allowing for more flexibility in the planning and development of IWRM initiatives as opposed to the inflexible nature of centralized planning.

### **3.3. Innovation and the Nexus Pathway: Towards a Coherent Future**

The systemic innovation to solve the current water availability crisis in Morocco must not be based solely on isolated solutions; instead, there needs to be a collaborative approach that builds strong, innovative partnerships that span all related water, energy, and food sectors. It is essential that the development of both technological and public policy innovations be done using a WET nexus lens (Hoff, 2011).

Large amounts of investments in supply chain innovation to support the water-energy-food Nexus, including large-scale desalination plants located in Agadir and Casablanca, are essential for increasing coastal region's security with respect to water resources. Addressing the widespread use of energy associated with such plants must be achieved to sustain them; therefore, use of renewable energy sources such as solar energy represents an ideal way to produce freshwater in a smoother, more environmentally friendly manner. In a similar way expanding wastewater treatment and recycling systems, as an alternative to pollution and scarcity of water resources, must be adopted on a more widespread scale but face considerable technical, regulatory and social acceptance obstacles.

Smart incentives to manage consumption demand for the water supply will enable water systems to support sustainable use of water resources. When considering sustainable ecological use of water resources, the goal is to significantly reduce the amount of water used. The primary strategies that can be employed include: changing agricultural subsidy incentives to provide financial incentives based on sustainable practices (e.g., water efficiency or drought tolerant methods), as enacted in Austria; implementing tariff structures to price water at its corresponding scarcity value for large-scale users and providing affordable access for economically disadvantaged households as a basic need; and providing the capacity of local communities—municipalities and Water User Associations—to be empowered and sufficiently resourced to manage decentralized systems (i.e., solar-powered boreholes) through enhanced accountability and adaptive management at the local level.

The necessary transition from Integrated Water Resources Management (IWRM) to Governance Frameworks that clearly address the interdependency of Water, Energy and Food (WEF) in the WEF Nexus is the best way forward. One example of the importance of using Nexus Impact Assessments as part of decision-making around major projects and policy changes is the assessment of a proposal in a water-stressed basin to expand irrigated agriculture. Assessing the impact of the expansion should not only look at the amount of water used, but also the amount of energy needed to pump it, how it will impact local groundwater levels and whether or not this will lead to sustainable food production in the long term. Another consideration is the impact of pumping on the quality of the water in that same aquifer, as well as the downstream impacts to other users of that same water body, including the environment. Therefore, it is necessary to comprehensively evaluate all impacts of an action or project within the context of the WEF Nexus, since the cumulative impact of that action will affect all components of the nexus.

To summarize the current situation of Morocco's current approach to achieving water security is at a critical juncture, where there will be requirements for more than just "more facilities or stricter laws" if they are to successfully manage water, food, etc. Overall, in order for Morocco to broadly and holistically manage these interdependencies between their systems, it will require that they significantly change their governance approach (e.g., creating true partnerships with other agencies and departments) to promote collaborative development of the best available economic tools to encourage conservation and create the necessary investments in innovative processes/technologies that will facilitate synergies, not just added trade-offs. Ultimately, it will be their ability to manage these highly interrelated issues that will enable Morocco to sustainably manage and develop their water resources.

#### **4. Morocco's energy transition: a multi-level perspective on lock-ins, nexus trade-offs, and a just pathway**

Morocco has relied on fossil fuels imported for a significant amount of time in its history, with over 90% of Morocco's main energy supply coming from those sources. As a result of such dependency, Morocco's economy is subject to global fluctuations in pricing, ultimately creating a trade deficit of more than \$ 4 billion (35,940 million dirhams) according to the Office des Changes (2023). In an effort to address its reliance on fossil fuels, Morocco has created one of the most progressive renewable energy plans of any developing nation by having a minimum of 52 percent of its currently installed capacity originate from alternative energy sources by 2030. This transition represents a transformation of Morocco socially and technically; it is about more than just replacing technologies. This chapter will analyze Morocco's shift to renewable energy technologies in a way other than just purely technological. It will examine how Morocco has adapted its entire system in many areas, including economics, society, and the environment, as a result of the many benefits of renewable energy. To analyze this transition, we will use the

Multi-Level Perspective (MLP) to analyze how emerging innovations interact with established energy regimes and larger landscape pressures (Geels, 2014). Moreover, we will evaluate evidence for lock-in mechanisms supporting fossil fuel use, examine interactions between climate and energy policy, and analyze relationships between Morocco's energy transition and other sectors, such as water and health, within a nexus framework.

#### **4.1. A Multi-Level Configuration of the Transition: Niche Innovations, Regime Stability, and Landscape Pressures**

The MLP Framework is helpful for examining the interactions and dynamics surrounding Morocco's energy landscape.

Niche innovations are an avenue for emerging radical technologies and ideas that were previously protected. The Noor solar energy projects (Noor I, II and III) in addition to commercial wind farms in Tarfaya and Taza, new green hydrogen projects in Pilot Taza, and small scale distributed renewable energy systems are examples of the many key development areas/trajectories that emerge from the niche innovation space for renewable energy development in Morocco. The emergence of these developments is driven by a combination of government policies promoting sustainable energy, e.g., through the enactment of renewable energy laws - Law No. 13-09 and Law No. 58-15 (e.g. Laws 13-09 and 58-15), as well as organisations like the Moroccan Agency for Solar Energy (MASEN) who provide appropriate support to the sector, together with international funding from The Green Climate Fund and the European Bank for Reconstruction and Development.

The socio-technical regime is comprised of the dominant and commonly accepted practices (including technology), governmental institutions and policies that influence daily activity in Morocco. The Moroccan electrical system has been centralized and structured and relies heavily on large thermal generation facilities (Jorf Lasfar, Safi) owned by state and utility companies (ONEE). Also, the industrial sector has developed based on the predictably inexpensive use of electricity. All of these factors create a significant level of CO<sub>2</sub> "lock-in." CO<sub>2</sub> "lock-in" encompasses the physical forms of fossil fuel resources and their associated infrastructure (e.g., generation plants, pipelines) as well as the institutional mechanisms that support their operation and the economic organizations that have developed around them. All of these means create a tremendous amount of inertia associated with large-scale changes in the electrical generation systems.

Broader external market forces that will drive the transformation of any given industry represent the landscape pressures that will take effect in Morocco's energy sector; the key landscape pressures are; the rise of export markets for green hydrogen as a product of European decarbonisation policies, international climate commitments such as the "Paris Accord", severe fluctuations in the global fossil fuel pricing structures, and increased labour-force pressures along the lines of job creation and energy independence within Morocco.

The speed at which the transition is taking place is a result of the interplay between these many pressures. While there has been an increase in the number of niche innovations, they have not yet achieved a level of stability sufficient for the disruption and replacement of fossil fuel-powered systems due to substantial lock-in benefits associated with fossil fuels.

#### **4.2. Confronting the Lock-In: The Political Economy of Coal and Policy Incoherence**

Morocco's transition to renewable energy comes with a unique paradox in that it achieves an ambitious renewable energy strategy while at the same time continues its high dependence upon coal to generate about 40 per cent of its electricity supply in 2022 (Ministry of Energy Transition (2023)). The fact that Moroccan policymakers have allowed themselves to be completely dependent upon coal as an energy source does not represent a lack of knowledge or

lack of a viable alternative, but rather an entrenched political and socio-economic system that has created dependence upon coal.

Two factors lead to the ongoing support of burning fossil fuels with coal-fired generating facilities. These are primarily the economic issues associated with large initial investments in coal infrastructure (sunk capital) and a historical view of providing grid operators with baseload (core/base-load) generation using coal-fired generation as being reliable and stable. Supporters maintain that the minimal operating and maintenance costs of each unit of electricity produced when it is generated from burning coal give them the greatest opportunity to support grids in maintaining their stability. They do not, however, acknowledge that burning coal creates large porosity-related coal mine air pollution into the atmosphere and creates large amounts of energy when using them.

A Just Transition is important when approaching the social lock-in dilemma due to the extent to which coal-fired power generation, along with its many associated industries, is integrated into Jerada's community, job, and economy. Should the power plants shut down quickly, it would lead to stranded workers and could cause social unrest. Consequently, managing the transition toward alternative fuels will require intentional efforts to retrain the workforce, diversify the economy, and include all stakeholders in the process to create an equitable and socially viable transition plan.

Morocco's commitment to addressing climate change through the Paris Treaty is not aligned with their energy policy. As of now, Morocco's electricity system relies heavily on energy efficiency gains to meet their climate commitments and goals. Morocco has dramatically increased its renewable energy production capacity, but this growth in renewable energy has not resulted in any net reduction of total CO<sub>2</sub> emissions attributed to the electricity generated within Morocco. Therefore, it places Morocco's Paris Agreement national determined contributions at greatest risk of failing to be achieved or maintained over time. In order for Morocco's climate commitment to be achievable and viable, it is important for the country to develop a transparent and publicly accountable strategy to eliminate coal fire generation, through the required upgrades to grid infrastructure, energy storage systems, etc.

#### **4.3. Trouble With Energy Transition Nexus Management**

The effectiveness and sustainability of the energy transition will affect not only other sectors but also create synergies and significant trade-offs across sectors, necessitating careful management to achieve positive results.

The interconnection between energy and water, also known as the Energy-Water Nexus, indicates the importance of understanding the interdependencies between these two resources at both a national and local level. Renewable energy sources including solar photovoltaic (PV) and wind provide significant benefits to water-stressed areas because they require much less water for their cooling systems than do thermal generators. On the other hand, there are some types of renewable technology (e.g. Green Hydrogen produced through electrolysis and Concentrated Solar Power (CSP) generated with wet cooling), that use more water than traditional fossil-fuel-based generators. As a result, these types of renewable resources need to be located in areas with sufficient water supplies. When renewable energy is supplied to water-scarce locations to power large-scale desalination plants (which use a large amount of energy to produce freshwater), it is vital that the energy used comes from renewable sources. This ensures that we are solving the water crisis rather than exacerbating the global carbon crisis through new fossil-fuel generation plants.

The Energy-Health Nexus serves as a unique yet under-appreciated link between Energy and Health. By switching from traditional fossil fuels, such as coal and diesel, to clean sources of energy, harmful air pollution (including, but not limited to: Sulfur Dioxide, Nitrogen Oxides, and Fine Particulate Matter) is greatly reduced, thereby also decreasing the incidence of

respiratory and cardiovascular illnesses caused directly by those pollutants. It is imperative that we not only consider moving toward clean energy as an environmental and economic imperative, but as an important public health goal. By emphasizing the connection between clean energy and the direct health benefits that come from that transition, the chances of acceptance by society, and therefore the opportunity to move more quickly toward transitioning to a clean energy future, will be increased.

Energy equity is a more comprehensive issue than just the achievement of nearly universal access to electricity, as there is also concern about perpetuating regional disparities with a "big project" transition, as seen in many cases where large-scale projects fail to address existing inequalities. Energy equity means providing affordable, dependable and modern energy access to all individuals living in remote areas (e.g., Atlas Mountains, southern regions), including both urban and rural communities. Energy equity requires a dual approach that includes the use of decentralized renewable energy technologies (i.e., micro-grids, solar home systems) as well as establishing a fair and equitable rate structure that protects lower-income households from aggravated energy burdens.

#### **4.4. Advancing Towards an Integrated Approach, Industrial Policy and Governance**

In order to move into the next phase, we must proceed with developing an integration strategy through the creation of a comprehensive, transparent climate and energy integration plan that will synchronize our goals relating to energy and climate; it will include a detailed timeline for the phase-out of coal and specific carbon budgets as part of the overall plan. The success of this strategy relies heavily upon making significant investments in improving grid flexibility and the various means that will help facilitate a stable and reliable transition, including increased battery storage capacity. To create a sustainable economy, green industrialization is essential when creating new products that produce green technologies (i.e., renewable energy) that support building domestic value chains. The creation of this domestic green manufacturing industry creates new forms of job creation, increases technical skills, and has the potential to grow the economy by providing support for ongoing operations and maintenance of these products. The implementation of a Nexus Governance Mechanism will require the establishment of formal processes or tools to evaluate the repercussions of significant energy policies and initiatives on water resources, public health, as well as equity on a regional basis. By adopting this structured methodology, we will be able to identify, quantify and assess the multiple, interdependent co-benefits that are produced as we shift toward a more sustainable economy. To effectively plan for a Just Transition, three separate strategies are necessary: An Economic Diversification Strategy, a Skills Development Strategy and a Social Development Strategy. Collectively, these strategies will be designed to provide support to both workers and communities who rely heavily upon fossil fuel industries during the transition to clean energy, ensuring that all individuals have opportunities to participate in and benefit from the transition. Morocco's energy transition is poised to be both a challenge to technological development and a result of inertia from state institutions, as well as multiple socioeconomic factors that shape energy usage across the country. Successful outcomes of this transition should be measured based on reduction of carbon lock-in, equitable sharing of economic benefits among sectors of the population, and successful integration of flashpoints of current national circumstances, including health and water access issues. Morocco should therefore develop a multi-level nexus thoughtful and just approach in order to effectively navigate this critical juncture and create a sustainable and resilient energy system.

## **5. Governance for Sustainability and Territorial Resilience: An Integrated Framework for Morocco**

The previous exploration of Morocco's challenges in health, water and energy demonstrates a common thread between the ambitious goals of sector-based strategies (such as Energy Policy) are diminished by a fragmented, silo-like and incoherent governance approach. This section will move from a sectoral diagnosis to a synthetic prescription. The goal is to create a theoretical framework for governance that focuses on sustainability and territorial resilience. This framework is intended to define and integrate the core concepts of the governance for sustainability and territorial resilience, as well as to situate the experience of Morocco within the broader theoretical literature on these two concepts. This theoretical framework is intended to serve as the basis for both an analytical tool to assist in understanding systemic failures and a practical implementation guide for reforms.

### **5.1 Conceptual Foundations: Sustainable Governance and Territorial Resilience**

To solve the interrelated problems of water, energy, health, and the environment, Sustainable Governance is one of three concepts that form the foundation for an effective Governance System that has been designed to address Complexity. As described in the definition of this concept by Lafferty & Meadowcroft (1996), the key characteristics of this Governance Model include the following: Integrated Approaches to Governance across the Environment and Development sectors, Involvement of Multiple Stakeholders, Transparency & Accountability, and the Ability to Adapt to Ongoing Changes. A sustainable governance framework will provide assistance to the Moroccan government as they manage their tradeoffs and discover their synergies across these four important interrelated sectors.

In addition to being an ecological framework, Territorial Resilience addresses the sociocultural and political aspects of a region through its socio-ecological system (Bristow & Healy, 2020). Like the ecological framework, Geographic Resilience encourages regions to develop their ability to withstand shocks (e.g., droughts, health crises, natural disasters), adapt to changing circumstances, and ultimately grow. These attributes require developing and maintaining adaptive communities, supporting diverse economic opportunities, and creating adaptive governance systems, all tailored to the unique characteristics of a region. Examples of regions include Morocco's Souss-Massa and the Rif Region.

Polycentric governance, according to Elinor Ostrom's theory, states that when managing. It is possible to manage complex common pool resource systems more effectively with a cooperative combination of different local, regional and national organizations as opposed to a central government organisation (Ostrom, 2010). When properly coordinated, a polycentric governance system can promote innovations, assist adaptation to local conditions, and provide for the effective monitoring of the stakeholders. Morocco's regulatory framework has a number of elements that provide the basis for a polycentric system of governance, such as the ministry, basin agencies, regions, and municipalities (Ostrom, 2010). However, currently, the Moroccan system lacks the coherence necessary to function as an effective and fully integrated polycentric governance framework.

### **5.2. An Integrated Governance Framework for Nexus Management**

In addition to the high-level concepts described in this report, we present an integrated framework for governance that has been adapted specifically for Morocco through understanding that the integration of various components will produce resilient outcomes and sustainable development within a specified geographical area. For example, when looking at Nexus Pressures (or Spectra) which are defined as the external (exogenous) and internal (endogenous) drivers of change that must be managed by the system, we will see that there are multiple Nexus Pressures such as Climate Change (droughts, floods), Economic Volatility,

Demographic Change, etc., which cause different regional manifestations of these forces. For example, while Water Stress is one of the most critical Nexus Pressures affecting the Souss-Massa Region, rural populations living in the Atlas Mountains are significantly impacted by a lack of access to healthcare. Governance Subsystems are the second component, serving as the administrative support organizations for an entire system through multiple sectors throughout a region; most Governance Subsystems exist independently from each other (e.g. Independent Sector). Examples of Governance Subsystems include many ministries: Ministry of Health, Ministry of Energy, and Ministry of Agriculture, as well as important national public entities such as ONEE (National Office of Electricity and Water) and MASEN (Moroccan Agency for Solar Energy), in addition to regional and local governments. While they work within the same national governance framework, Governance Subsystems exist with conflicting missions (i.e. there is competition among them for the same resources) and thus limit opportunities for collaboration, preventing coordinated action from occurring. Component 3 is known as Coordination & Integration Mechanisms (also known as Governance Glue). It consists of several new concepts to the framework. The purpose of these mechanisms is to serve as a connecting medium between different types of Governance Subsystems by assisting in coordinating their individual activities and capabilities into a unified effort in building and strengthening Resilience throughout the entire system. Sustainable Governance as a process that works through many different iterations of evaluation of outcomes from both traditional sector-based sources, like Megawatts of energy generated, and from integrated nexus metrics, like Health-Adjusted Water Security or Carbon Intensity per unit of Agricultural GDP, is established in Component 4 of the Framework. The results obtained through assessing these dual sets of outcomes will then feed back into continual Policy Adaptation and strengthen the Governance Coordination Mechanisms. The feedback loop created through continuous cycles of evaluation of these two sources of results will further enhance the systemic management of the entire system.

### **5.3. Morocco: Locations, Evidence of Confirmation, Nuances, and Collisions in Theory**

The Moroccan case study offers concrete support and nuance to the literature on governance, particularly concerning the evidence of polycentric dysfunction via evidence of uncoordinated polycentricity, and reflects what Ostrom referred to as a 'fragmented polycentric' system. The country has several overlapping institutions that exercise power and authority in decision-making but lacks the institutional mechanisms to foster trust, communication and a formal means of conflict resolution that allows these institutions to work together effectively. The dysfunctional arrangements have produced a well-documented contradiction between policy and implementation (i.e., agricultural water subsidy policies that are counter to the National goal of resolving water scarcity).

The insights on Morocco's experience with the NEXUS approach indicate that this method is more than just a tool for technical planning; it represents a challenging political governance situation. Identifying connections among water, energy, food and health is relatively uncomplicated; however, the more complex challenge is determining how to successfully implement changes in the political and institutional frameworks necessary to manage these connections effectively. Morocco has developed appropriate technical strategies (such as IWM) for addressing the challenges posed by the water, energy, food and health nexus; however, the country has not been able to effectively implement them. This discrepancy serves as an example of the disconnect that exists between political and institutional systems in the utopian technology-driven movements that many of the NEXUS literature supports.

The narrative about Morocco's ongoing transformation to renewable energy frequently presents the country's energy transformation using "green growth" models that assume the capacity to expand both environmental sustainability and economic growth separately and/or in addition to

the other. Morocco's current reliance on coal and agricultural products requiring significant amounts of water (and therefore energy) represents a clear contradiction to how the energy transition will proceed smoothly. This example illustrates the range of factors associated with the current socio-technical and political systems that inhibit Morocco's ability to adopt a true green growth strategy. Thus, in order for Morocco to successfully complete these transitions, there must be explicit efforts to dismantle existing systems through targeted governance, and create a pathway for a just transition to renewable energy. Future studies on socio-technical transitions and political ecology will be essential for understanding how best to approach this complicated trajectory.

Morocco has not been inhibited by the lack of either policies or technological means but instead suffers from the fact that its governance system does not fit well with the integrated nature of the sustainability issues that it faces. Currently, Morocco has a very complex and polycentric governance system; therefore, the governance systems that need to support sustainability must better reflect that reality. The proposed framework will allow Morocco to realign its governance with that reality. In particular, by establishing the required “glue” for effective governance coordination, Morocco will be able to change the fragmentation of governance and management of their critical resources into a stable foundation for supporting adaptive, resilient, and sustainable management. This next section will synthesize the findings of this framework and offer actionable recommendations that can be implemented through the use of this integrated framework.

## **6. Conclusion**

The primary thesis of this paper is that the ongoing difficulties faced by Morocco in terms of Enterprise Sustainability in the following sectors – Water, Energy and Health; represent a major issue associated with a lack of governance in these areas. While Morocco has created a number of ambitious sector strategies, and has many great advances in technology, their fragmented and poorly integrated Institutional Architecture prevents the successful management and collaboration required to successfully realise the interdependencies of the Water- Energy - Food-Health (WEFH) nexus. We have taken a more comprehensive approach than purely that of examining it from a sectoral basis, utilising and adapting existing theoretical frameworks relating to nexus Governance, Polycentric Governance, and Socio Technical Transitions; in order to facilitate the identification of the gaps. By utilising the gap analysis method, we have developed an Integrated Governance Framework to provide insight into what is required in terms of enhanced governance support to provide robust coordination mechanisms (the glue) between siloed institutions, so they can work collaboratively towards achieving the goal of Territorial Resilience.

The information contained in this paper provides policymakers in Morocco with specific actions they can take including understanding the importance of institutional reforms that will support all technical solutions. Above all else, policymakers must ensure that all ministries coordinate their activities through the creation of a Nexus Coordination Body. The creation of Nexus Impact Assessment legislation that mandates that a ministerial group assess all new agricultural, water, energy and urban development projects for their overall impacts, including public health, resource depletion and GHG emissions will support the above-mentioned implementation of Nexus Coordination Bodies across all Government ministries. By doing this, we can evolve away from individual sectoral decision-making processes and integrate all relevant agencies in the same decision-making system and take a more comprehensive view of our overall economy and environment.

The Integrated Governance Framework needs to be implemented in a standard manner at the territorial level by establishing legally mandated, resourced and supported Multi-Stakeholder Territorial Resilience Platforms in high priority areas, such as the Souss-Massa River Basin and

the Tangier-Tetouan-Al Hoceima Region. These platforms will bring together local government, river basin agencies, farmer associations, industrial associations and civil society organizations to jointly develop and implement Integrated Adaptation Plans. The success of these platforms will be dependent on the existence of a common Integrated Territorial Information System (ITIS) which will serve as a Digital Platform for the aggregation of real-time water and climate data, energy and health data that will provide a shared evidence base for the work of all the stakeholders.

The Third Principle requires the alignment of economic and policy incentives to support the goals of the systemic approach rather than create disincentives. Agricultural subsidies have a significant influence on the agricultural economy, and as such, they should explicitly link water efficiency and climate resilience to the provision of subsidies. Timely shifts away from providing subsidies that support the production of water-intensive export crops to sustainable agricultural practices will yield both economic and environmental benefits. Energy prices and public sector investment decisions should reflect the full price of the externalities created by energy generation to society and therefore should reflect the public health benefit of reduced air pollution and the water conservation benefit of using renewable energy. Such a calculation represents the transition from a narrow financial calculation to a greater level of socio-ecological accounting.

Therefore, Transitioning should be done with vision, fairness, and transparency. To get through the political and social lock-ins that prevent people from moving past coal, and farming in the traditional way, we need to be proactive about it and create Formal Just Transitions Protocols in regions such as Jerada or Specific Agricultural Zones. These Things should be created with input from a broad range of stakeholders and should have Retraining Programmes, Economic Diversification Plans, and Social Safety Nets designed to protect vulnerable employees and communities from being left behind and to maintain social support for impactful but disruptive change.

Although this paper presents a comprehensive and systematic analysis, it does have limitations, and those limitations point to future opportunities for further research. A primary limitation of this study is that the governance framework presented in this paper is entirely theoretical. Although it was created through policy analysis and empirical findings, its success will ultimately depend on its ability to be tested rigorously in practice. Future research should thus focus on using in-depth qualitative case studies of the specific talented areas of Morocco, such as the Souss-Massa Basin. By "following the dots" and learning in real-time how trade-offs in the nexus are traded off against existing actors, researchers can create a baseline from which they will be able to follow up with evaluations of the effectiveness of the proposed coordination solutions when implemented.

Moreover, to separate the challenges faced in Morocco from those faced by many developing countries, comparative institutional analysis is necessary. In particular, comparing Morocco's nexus governance with middle-income, water-stressed nations, such as Tunisia, Jordan, and Peru, will reveal those institutional innovations that are most likely to be transferable and those obstacles that are persistent and deeply entrenched. Through a comparative lens, we can also provide an additional global perspective on successful sustainability governance.

Quantitative modeling is advantageous for our qualitative analytical assessments; Therefore, utilizing system dynamics and agent-based modeling tools to test the long-term effects of various packages of policies (for example, putting together a bundle of policies inclusive of both water pricing adjustment policies, as well as the provision of subsidy funding for solar powered irrigation) can give a strong indication of the degree to which policies work together towards coherent goals.

For example, the simulation of integrated outcomes such as water security, GHG emissions limits and public health outcomes could provide an excellent basis for the development of a

decision-making framework or process for public policymakers to use as dynamic scenario-planning tools.

The article presents a case for, and cites research supporting, the need for deeper analysis of the procedural and institutional aspects of "nexus" governance. Research in ethnography and political science is needed to explore who will be represented in future governance platforms, such as the presently proposed "Territorial Resilience Councils", and how stakeholders will engage in the negotiation of complex trade-offs (e.g., between urban water security and rural agricultural livelihoods). Understanding how power dynamics operate, as well as how decision-making occurs with regard to stakeholder engagement and participatory processes, is fundamental to ensuring that integrated governance is both inclusive and equitable.

As such, the path to sustainability in Morocco will be tied to governance challenges. The disconnect between interconnected crises and disconnected institutions has been identified as a significant issue. A framework for creating a more coherent governance system has been proposed. We can expect that the route to this will be challenging and political, and will require a willingness to challenge long-standing power structures in order to attain it. On the other hand, should we continue to address the systemic threats we face with a series of disparate and competing tools, we will experience a continued increase in vulnerability to those threats. The need for integrated, resilient and equitable governance has never been more pressing.

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