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TRIPLE HELIX MODEL TO DEVELOP WATER AND ENERGY NEXUS FOR LIFE IN LIBYA

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ABSTRACT

The global demand for technological materials is continuously increasing as the world's population is increasing in cycle with increasing standard of living, especially in emerging and developing countries.

The challenge we face in the 21st century is sustainable development of our resource supply. To secure a reliable and sustainable supply of critical resources, innovative solutions need to be developed along the entire value chain. In this paper, we apply the Triple Helix (TH) concept which can be defined as a set of components (university, industry and government) to model the integration between water and energy for life in Libya.

Water situations as well as current energy situations in Libya were analysed, with tracing challenges that face TH model implementation.

KEYWORDS: Triple Helix, Energy, Water, Integrated Water Management

INTRODUCTION

Libya with its population counted 5,323,000 (census 2006) living in an area of 1.67 million km^2 face several challenges in life regarding water and energy sectors. Since the governmental organization, General Water Authority (GWA) is responsible for research in the field of organizing water resources and energy and their relations, this work concentrates on the policies and challenges face (GWA) during its planning. GWA mandate includes water policy and regulations, study and research and supervising water development projects, dam construction, irrigation, drainage and soil.

There is a demand of water and it is needed in the north mostly for Agriculture, while in the south it is needed mostly for producing oil. Therefore, nowadays a sound of the relation between water and energy must be realized in order to sustain natural resources in Libya.

This relation of interdependency between water and energy is referred as nexus. The issue of water-energy nexus represents a complex challenge for synergy between water and energy in many forms such as resources management, strategic planning, policy making, technological development and environmental conservation in a given country. Therefore, in order to efficiently utilize water-energy resources and ensure their sustainability along with environmental protection in the region, a nexus approach has to be investigated, integrated and implemented. Adopting water-energy nexus within the Triple Helix model of university-industry-government is thought to be a wise tool for GWA to follow in planning and managing, its water policies and strategies.

BACKGROUND

Triple Helix of university-industry-government relations has been proposed by Etzkowitz and Leydesdorff (1995 and 2000) for explaining structural developments in knowledge-based economies. Knowledge-based economy suggested against political economy, due to the structure of society is constantly disturbing the transformations which originate from techno-sciences. The related framework of society can thus be expected to have changed. Using the Triple Helix (TH) model, analysis can be more specific than by claiming a generalized transition from "mode 1" to "mode 2" in "the new production of knowledge" (Gibbons *et al*., 1994). While in a political economy, only two types of communication are prevailing—(*i*) the equilibrium-seeking dynamics of markets and (*ii*) normative control mechanisms along the public-private interface—a third sub dynamic, namely (*iii*) the equilibrium-upsetting dynamics of socially organized knowledge production, have also been considered in the analysis of knowledge-based economies.

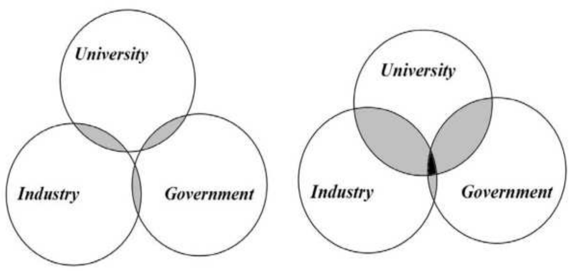
The sustainable triple helix, the community, as the **subject**, pushes the formation of the helix and its progress. In each Triple Helix, a third sphere is usually the creative element in a Tertius Gaudens effective (the third party benefits from conflict between the other two).

The model consists of Triple Helix twins interacting (Figure. 1), working together as a pair in a yin/yang dynamic that advances sustainable economic and social development (Etzkowitz and Zhou, 2006).

METHODOLOGY

Leydesdorff *et al*., (2006), cited in Leydesdorff, L., (2012) mentioned in a series of case studies of national systems, for example, Netherlands considered as a *national* system of innovations (given a specific operationalization of the three subdynamics in terms of indicators. Similarly, one can examine whether innovation systems are technology-specific or sector-based (Pavitt, 1984; Carlsson, 2006).

These policy models can be developed further into a program for industrial stimulus which takes the knowledge factor into account (Etzkowitz, 2005, cited in Leydesdorff, L., 2012; Mirowski & Sent, 2007). However, Leydesdorff (2012) differentiates between this neo-institutional approach and the research related program. He emphasized that networks of relations between universities, industries, and governments, must be considered. While institutions and inter-institutional arrangements can be stimulated by local or national governments, markets and sciences operate at the global level. From this neo-evolutionary viewpoint, the role of institutional agency bores distributed instances. The distributions of noticeable occurrences can be experienced statistically for their significance against the expectations.



Negative Model **Positive Model**

Figure. 1: A Triple Helix Configuration With Negative and Positive Overlap Among the Three Subsystems

Triple Helix has attempted to carry these two intellect perspectives together (Leydesdorff and Zawdie,2010). Leydesdorff organized a workshop at Amsterdam in1993 (with Peter van den Besselaar), about "Evolutionary Economics: New Directions in Technology Studies", he summarized the results using the picture of a hypercycle as reproduced in figure (2). He argued that only two—instead of three—dynamics were postulated in Schumpeter's (1939) model of innovation: factor swap in terms of changes along the production function versus technological developments as changes of the production function towards the origin (Sahal, 1981).

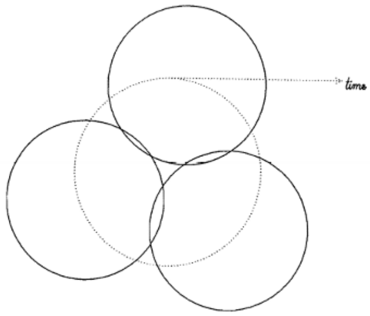


Figure. 2: The Hypercycle Model as Postulated by Leydesdorff

Our study was carried out using the literature on the hypothetical framework of the Triple Helix model, eco-entrepreneurship and entrepreneurial universities, based on documentary research. The case study took place at GWA of Libya. The gathering of data was performed through interviews with department managers and representatives, using a questionnaire based on earlier information. In addition, use was made of the information obtained from documents produced by Libyas' energy organizations like; National Oil Cooperation, general Electric Company and Renewable Energy Agency.

ANALYSIS

Water Situation in Libya

Arid and semiarid regions face a dilemma in water resources as the demand increases due to population growth and increasing economic activity. "Arid" means extend dryness and is used with respect to the climate and the land below it. Most of the world surface is arid, characterized as too dry for conventional rain feeding agriculture. In such regions millions of people live, increasing their population imply challenges on limited natural resources. Usually on arid lands the evaporation potential of water from the land exceeds the rainfall. Water that falls has modest use of crop plants because the quantity is too small to penetrate the soil sufficiently, or it may infiltrate a porous soil too quickly, or it may run-off very fast. WELL Project (Water and Energy for Life in Libya, 2014) indicated that several degrees of dryness must be predictable. The first is where the dry climate is customized by regular rainy seasons. In such region it might be possible to produce a wide range of annual crop during the short rainy season, enough to keep going animals and feed mankind. The second condition is a year round aridity, sometimes adapted by light or irregular rains, which might make production of crop impossible. The third situation is where water is got from wells, canals, or other means so that ordinary agriculture can survive, in spite of the aridity of the climate as shown in Figure (3).

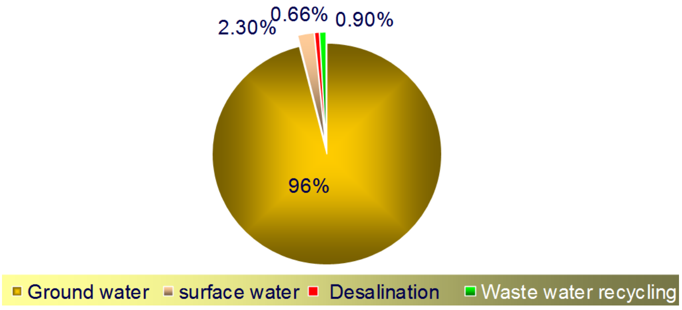


Figure 3: Water Resources in LIBYA, (GWA, 2000)

Accordingly, Libya is considered to stand within the third situation, where water in agriculture is entirely necessary for all plant and animal life. Plants have to grow, that are able for living and reproducing in semi-arid, arid, and even desert regions. However, the problem in this case is as aridity increases, fewer and less species are modified, and the prospective biomass are reduced. Water from wells and lakes in Libya as in arid regions face problems of quality, especially the presence of excess minerals. The depth of the well necessary to obtain water may vary a few to hundreds of meters. Water from wells is either fossil (stored in aquifers for thousands of years), or from soil stored water from rain, in any case it is stored rainwater. Both sources are limited and can be exhausted.

The irrigation water might direct to the accumulation of salts in the soil, resultant an increase in alkalinity or salinity, which then might limit crop production. In the arid regions a major challenge is to manage water appropriately. The purpose of such management is to obtain water, to conserve it, to use it efficiently, and to avoid damage to the soil and the mentioned echo-system. Many of the agricultural practices in arid lands are not very different from those in other climatic zones. The distinctive problems of arid lands are almost completely related to water or its effects over long or short periods (WELL Project, 2014).

Pollution of water and soil arise an environmental problems cover influences on the ability of self restoration of vegetative communities. Anthropogenic forms of a relief are formed and such processes as salinization, water logging, and impoundment have been strongly developed. Industrial water containing dissolved organic and mineral substances, forms another source of pollution problems. The poisonous substances arriving in water reservoirs, change physical and chemical properties of water, and soil. Level of pollution depends on the peculiarity of applied technological processes. When constructing ecologic and geomorphologic mapping, first of all it is necessary to notice the micro shape of relief. Therefore, an ecological monitoring program can be established in Libya.

In order to overcome the problem of water resources shortage in arid zone, maximizing the development of renewable water resources are in great need. It is necessary to develop modeling techniques which can stand for the prevailing hydrological processes and their temporal variability, so that management options can be explored and long time sustainability investigated. The hydrology of arid and semiarid areas is significantly different from that of humid regions and, traditionally, data from arid regions have been strictly limited. It has been generally stated that the major limitation of the development of arid zone hydrology is the lack of high quality observations. As a result, the characteristics of the hydrological response of arid areas have not been fully understood and hence the procedures usually used in hydrological design and water resources management has generally been rented from the humid zone with little restrictions.

Current Energy Situation in Libya

Libya as one of the North Africa countries with rich oil and gas resources, Figure (4). It also has some of the highest solar resources in the world. The Libya solar potential was calculated by the IEA (WEO 2010, cited in WELL Project, 2014) is 2.173 TWh in zones with more than 5 $kWh/m^2/day$, Figure (5).

To date the solar resources are almost totally unexploited, being the solar energy production in Libya of 29 TWh in 2008. While solar is the most abundant resource in Libya, also wind resources are available. In 2008, less than 3% of the region's electricity came from renewable, but the share of electricity from renewable in Libya was less than 1%. Support for renewable has grown in recent years in Libya and policies to promote renewable energy in the region are spreading. Libya has set the following targets, programmes, measures and incentives involved

Renewable Energy Targets For 2020

- The 10% of the primary energy share
- 1 500 MW wind;
- 800 MW CSP;
- 150 MW solar PV;
- 300 MW solar water heaters

Libyan Programmes Measures and Incentives

- Medium-term plan 2008-2012: 610 MW wind;
- 5-10 MW grid-connected PV;
- 2 MW off-grid PV;
- 500 roof-top PV systems;
- 100 MW CSP;
- PV and solar water heater manufacturing

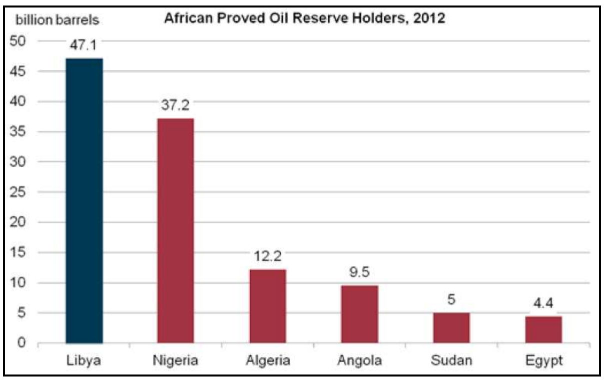


Figure 4: Libya Oil Reserve Comparative of Africa Proved Oil Reserved (Oil & Gas Journal, 2013)

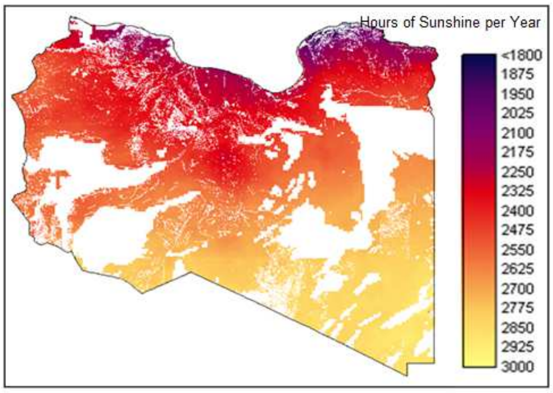


Figure 5: Libyan Solar Intensity Map (WELL Project, 2014)

Integration of Water and Energy

Although the total supply of water on the planet remains constant, the fresh water furnish is becoming more and more scarce. Hence, boosting this supply by desalting seawater on a large scale has become usual. On the other hand, desalination predominantly using thermal methods needs a great amount of energy. However, desalination, which is in permanent increasing significance, is already a mean of augmenting fresh water resources in many parts of the world, including the European Union. In 2002 just over 26 million cubic meters of fresh water were being formed per day all over the world, being 18 million cubic meters sea water freed from salt. That represents a 30-fold increase in global capacity over three decades. However, desalinated seawater takes place to be until now less than 0.2% of the fresh water used worldwide. Taking into account that more or less 60% of desalinated water is formed from thermal processes and the 40% from mechanical processes, in this case the required primary energy is in average 150 kJ per kg of desalted water - something like 3.5 liters of oil producing one cubic meter of fresh water. Likewise, producing the total amount of desalted water of all facilities in the world requires an enormous amount of energy, which is approximately equivalent to 0.3% of primary energy in terms of fossil fuels consumed all over the world. Thus, the present condition anxiety intensified attention to be attentive on the combined research, design and development of efficient water and energy systems.

Furthermore, power generation and fresh water production systems represent complex networks of mass and energy flows. For the blending and the design of such systems, it is highly attractive for the planners to have a holistic model approach for the conception of integrated water and energy systems.

Role of Research on Triple Helix Governance Model and Socio-Political Stability in Libya

Libya is now experiencing weakness of the national government's authority over resource management and the increased individual control of personal water supply and the cycles of internal violent civil crisis prevent the development of the central government's authority over natural resource management. The critical long-term natural resource management of scarce supplies may impact on weakening state building efforts on exploring best practices in natural resource disagreement mediation in pre-disagreement period. Thereby, is fundamental maintaining and strengthening GWA'S position of national water management and reinforce its water resources, research and its access to water management technologies even during and post-disagreement in the foreseen context of the Libyan political stability. The dynamics that influence the underlying relationship of the state to its citizens through a study of water resource management institutions and processes is identified below.

Libya, by mean of **GWA**, needs to develop water resources in order to address current water deficits and to support future development in multiple sectors. This requires that transboundary water issues must be addressed to the neighbors and particularly to the international financing necessary for the infrastructure development. GWA, by mean of WELL research project (2014) focuses the water topic exactly in the research context leading its results to the socio-political situation impact. This will allow GWA to a better management of its capacity building in order to improve the country situation.

The triple helix model establishes a shared relationship between university, industry and government in which each one attempts to enhance the performance of the other. Actual Libya is the case of region where specific contexts of industrial clusters, academic development and lack or governing authority may influence the development of the triple helix.

The fundamental element of having a triple helix is usually collaboration, taking place through their traditional roles, among the institutional spheres most involved with innovation. GWA, by mean of WELL project, intends to play the role of the coordinator between universities, industrial firms and governments in order to participate in discussions on enhancing the local economy, developing regional growth agreement or establish new technology from research, especially water sector research. As a result, municipalities may agree to speed up building permitting processes for new plan actions on the water issue, universities may undertake to train more students in the water research area which impact is really relevant to the Libyan economy; firms may negotiate new supplier relationships with each other as an incipient cluster. At this initial level of the triple helix, the three strands typically begin to interact in order to improve the Libyan economy by enhancing the performance of existing industry and water research.

The triple helix changes as production of new knowledge and technology becomes more important. At this level of the triple helix, enhancement of the performance of the university research and other knowledge producing institutions often becomes the key issue as part of a strategy to renew an older economy or create new economic activity on the basis of intellectual capital in one form or another, ranging from formal Research and Development (R&D) in government, university and industrial laboratories to tacit knowledge emanating from existing industries. As a new overlay (Figure 6) of knowledge infuses the existing industry and as various combinations of new and old knowledge become the basis for firm formation, the university and other knowledge producing institutions replace industry as the core spiral. Government and industry may then become involved in supporting academic development. The development of the GWA research center, speeding up academic research, production, will be strategic. The university gains additional resources from industry and government to enhance the performance of research, one of its traditional functions.

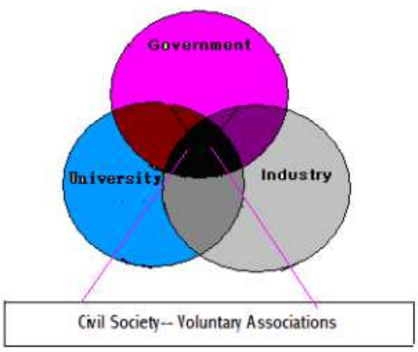


Figure 6: Triple Helix of Social Structure Model (WELL Project 2014, FP7)

Support from industry associations and state governments will extend the concept from high technology firms to raising the level of technology in existing centers, like GWA. The GWA initiative, then will extend this project to universities across the country. As the number of sources and levels of initiative increase among the triple helix actors, a growth of the meta-innovation system will be verified. **WEB networking** is the basis for a triple helix including bottom up as well as top down initiatives. A triple helix set in a civil society in crisis, as Libyan one, encourages the emergence of various sources of innovation. Creating a network, representing different benefits, to build a sustain for a regional focus is a key element in such strategy. Individuals, from the triple helix spheres, come together with bright ideas, formulate initiatives and seek out resources to sponsor regional strategies to work out emergency and develop initiatives.

GWA, by mean of WELL project, will become responsible for providing the rules of competition, but also will make available venture capital for water research, development and innovation, the reconfiguration of elements into a more productive combination, takes on a broader meaning in increasingly knowledge based societies. Thus, the appropriate configuration of the relationship among high knowledge and technology and economic growth, will thereby enhance society independence and it will take a more central role in Libya through its knowledge to reflect on giving its contribution to innovation and problem solving. Libya will have highly skilled persons and a knowledge-based economy. Knowledge based society operates according to a different set of dynamics than industrial society, focused on manufacturing tangible goods. Knowledge-based economies are more tightly linked to sources of new knowledge; they are also subject to continual transformation and innovation instead of being rooted in stable arrangements.

The knowledge-based society in a critical Libyan situation during and post crisis will make possible the birth of together a self-directed and cooperative society with the result of a society based on horizontal relationships among inter-related institutional spheres will be developed in a stable sociopolitical system (Table 1).

DISCUSSIONS AND CONCLUSIONS

The concept of the triple helix characterises the way the three research flows have been developed as an autonomous research project, within a framework of a group effort, cross consultation and sustain. In particular, it highlights the way in which the critical impact of each flow, its potential to effect positive change in the industry, is dependent on the outcomes of the other two. In this way the three disciplines are knotted in a *singular operational paradigm* regarding the dynamics of the industry and its accessibility to strategic intervention that crosses conventional disciplinary and faculty restrictions.

This kind of structure reflects a fundamental request of sustainability research; to move away from a traditional university outstanding; to move in networks that reflect the interface between the field of study and the system in which it activates; to move against logical reductionism. The emerging unites paradigm, if there is one, then it is rising and increasing proficient discourse of ecological sustainability itself.

Table 1: Triple Helix Interactions

Sphere / Organisation	University	Industry	Government
GWA	Support from industry associations and state governments will extend the concept from high technology firms to raising the level of technology in existing centers, like GWA. The GWA initiative then, will extend this project to universities across the country.	Knowledge-based economies are subject to continual transformation and innovation instead of being fixed in stable arrangements. Under these conditions, cheering an enhanced relationship of research, government and industry encourage a continuous process of development based on advanced technologies, GWA will become the core of innovation strategy water research.	R&D with Legislation Departments for supportive economic development and support innovative research in small enterprises.

As the project is still in its first years, and the details of the research strategies are still being developed, there has not until now been a considerable opportunity to share primary research data and test the reactions of each flow to development in the other. In this common sense the expression of each research flow in this paper, within the context of curious research program, is the first to speak of the helix.

The first highlight towards resources of life in Libya is the deep permeation of all communal challenges and sustainability concepts throughout the components of the helix. In this phase, it is crucial to GWA to respect the inevitable connection between these challenges, as material insufficiency closely interlinks with e.g. climate change, energy and water scarcity. This commences at university level by giving communal challenges and sustainability concepts a fundamental role throughout all curricula, vary from engineer trainings over community sciences to business schools. Moreover, a broader public can be reached by organizing enormous open online courses. Although this is relatively uncomplicated for universities and governmental organizations, building industrial processes around these concepts is less manageable.

The second highlight has GWA to face its determining clear programs within communal challenges, i.e. the functions of the Triple Helix. In case of sustainable resource supply, the focus should be on sustainable water and energy nexus.

The third highlight is the construction of an entrepreneurial and innovative attitude in all components of the helix. The entrepreneurial university, which takes a pro-active position in putting active knowledge to use and to create new knowledge, is a vital concept in obtaining this. Additionally, the relationships between the components is of crucial importance as the challenges come up to a high degree of complexity and multidisciplinary which individual helix components cannot resolve, looking at the tasks they can work on. The value of these interactions in executing the tasks is acknowledged by the implementation of varying platforms worldwide such as a “Knowledge and Innovation Community” (KIC) on raw materials in Europe and Energy Innovation Hubs (EIH) and Engineering Research Centers (ERCs) in the United States.

Implementation - Policy Implications and Directions for Further Research

A key feature of this research was to initiate the study of eco-entrepreneurship in Libya, an area as yet untapped, from the point of view of research into entrepreneurship. Another aspect was to begin a mapping and analysis of organizations that, by their characteristics, can be classified as eco-entrepreneurs, so that one can understand in the future, whether this particular segment has faced greater difficulties than other organizations setting up in Libya. Consequently, analysis from the point of view of the Triple Helix Twins is shown to be appropriate, since the interaction between the University-Industry-Government helix and the University-Public-Government helix makes it possible to specify the disputes and difficulties encountered by these organizations in the innovation process.

Under these conditions, encouraging an enhanced relationship of research, government and industry, fostering a continuous process of development based on advanced technologies, GWA will become the core of innovation strategy water research.

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