

Impacts of Climate Change and Population Growth in a Multiethnic Oasis Environment: the Case of the Ziz Valley, Southeast Morocco

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Introduction

Indigenous and other traditional peoples are only rarely considered in academic, policy and public discourses on climate change, despite the fact that they will be greatly impacted by impending changes. Their livelihoods depend on natural resources that are directly affected by climate change, and they often inhabit economically and politically marginal areas in diverse, but fragile ecosystems. Indigenous and other local peoples are vital and active parts of many ecosystems and may help to enhance the resilience of these ecosystems. In addition, they interpret and react to climate change impacts in creative ways, drawing on traditional knowledge as well as new technologies to find solutions, which may help society at large to cope with the impending changes.

In order to predict society's vulnerability to future climate change and identify possible needs and options for adaptive action we need to understand more about how people cope with and adapt to the impacts of current-day climate variability. The impacts of climate variability can be particularly severe in societies where people are highly dependent on natural resources for their livelihoods and also experience the impacts of extreme climate events such as floods and droughts as well as other sources of stress to their livelihoods such as disease, conflict and increased population pressure. But resilient societies learn to cope with and adapt to these stresses

This study attempts to address this need by examining the combined influences of climate change, population growth, housing demand and demand side management relative to residential water demand in the Ziz Basin. This study therefore does not seek to provide forecasts of future residential water demand, but instead to illustrate a range of possible outcomes in the form of scenarios.

The following research questions were defined for this paper

- The Environment of the Ziz Valley

The Ziz valley is located in southeast Morocco along the southern slopes of the Atlas Mountains and is part of the pre-Saharan region. The climate is continental and arid. Precipitation ranges from 70 mm in the extreme south, at Erfoud, to 290 mm in the extreme north, at Imichil. These climatic conditions preclude the practice of rainfed agriculture and necessitate the use of irrigation.

The potential productivity of the region is restricted by climatic conditions affecting the resilience of the valley's irrigated farming. Water scarcity and its erratic variability over time and space, recurrent droughts, and frequent locust invasions have contributed to the impoverishment of the valley's environment. The *lbayoud* disease ravaging the date palm trees and the annual alternating olive production combine to reduce household welfare. All these factors have, in one way or another, impeded the optimization of the agricultural resources.

- The Ziz Valley: a society of rank

For more than 12 centuries of recorded history the valley has been a theater of ethnic struggles, urbanization, and social change. Its medieval trade entrepot, Sijilmassa, which flourished from the caravan trade, slavery, and the trading of African gold, shaped the valley's environment and its historical relations of production.

The Ziz community is composed of three ethnic groups: Berbers, Arabs, and Haratine. Shurfa Arabs are believed to be descendants of the Prophet Mohammed through the line of either Idriss al-Awal of Fez or Mulay Ali Sharif of Tafilalet. The former was the founder of the first Arab dynasty in Morocco in the eighth century; he founded the city of Fez in 892AD. The latter was the founder of the Alawite Dynasty in the seventeenth century and still rules Morocco. They are entitled to a number of communal privileges and personal immunities.

Berber status derives from their social organization, historical military dominance, and persistent political power, factors prompting Berber self-perception as a dominant social class. Berber social organization is based on what structural-functionalist anthropologists call the segmentary lineage model.

The Haratine are allocated inferior status and are typically responsible for menial labor. Because traditionally they did not own land, they worked as sharecroppers for Arabs and Berbers. As for the Haratine's history, there are many versions. Local ethnohistory differentiates between slaves and the Haratine. Slaves were integrated into Berber and Arab households, whereas the Haratine never assumed that position. They have always been characterized as "the workers of the soil."

Methods

Analyzing the living conditions of the population in relation to the use of water and land in the catchment area of the Ziz river the population dynamics is an important indicator for social change. In order to meet the complexity of demographic processes, quantitative-statistical data and qualitative social-scientific data were collected and evaluated on different spatial levels from regional to local. Anthropological data have been collected through fieldwork, including participant observation in a local community, survey techniques and a multitude of open and semi-structured interviews conducted with state agents, local notables, experts, and household heads. For scenario analysis and the projected inclusion into information or decision support systems, the findings are integrated and analysed with the aid of expert models.

Development of scenarios

In this paper, defined indicators are used to propose a metric network perspective for social-hydroecological systems that enables us to better focus on the structure of interactions between climate change and identifiable components of the system. We identify three types of social-hydroecological networks (SHEN): (1) hydrosystems that are connected by people through flows of information or materials, (2) hydrosystems networks that are disconnected and fragmented by the actions of people (e.g. lowering GW level), and (3) artificial ecological networks created by people, such as irrigation systems. Each of these three archetypal SHENs faces different problems that influence its resilience as it responds to the addition or removal of connections that affect its coordination or the diffusion of system attributes.

Combine qualitative and quantitative analysis scenarios were designed and detailed for specific problems. The design of scenarios took into account the following aspects: climate change, socio-cultural change, institutional change, population dynamics, economic development, and technological innovation. Afterwards, the main characteristics and scales of the scenarios were defined. The selection of indicators and main driving forces occurred in a next step. This was followed by a broad qualitative analysis: on the one hand the indicators and driving forces were qualitatively described. Results were compiled in form of a qualitative trend-matrix. On the other hand, the storylines for different scenarios were developed. The quantification of driving forces and indicators with the help of different models took place within problem clusters that have been defined.

The storylines describe the following main thematic issues: main economic development, development in the agricultural sector, development of political framework conditions, demographic development / life quality and environment / natural resources.

Basically three different scenarios (Z1-Z3) are developed that follow different basic logics.

Climate is not an explicit thematic issue described in the above mentioned storylines. Instead we used 3 climate reference scenarios, defined for the south Atlas area (IMPETUS, 2006) which serve as external drivers of the more general scenarios.

In Scenario Z1 “*Marginalisation – non-support of the Ziz-Region*” governmental and international institutions withdraw their support. As a result, the marginalisation of the region and the impoverishment of the local population accelerate.

Scenario Z2 “*Rural development in the Ziz-Region through regional funds*” is a constant economic growth scenario. Against the background of overall political stability and supported by governmental aid programs, under-developed regions like the Ziz-Region experience an improvement of overall living conditions and economic development, too. As a result, migration declines and the population increases.

Scenario Z3 “*Business as usual*” extrapolates the dominant trends of past decades. The status as a marginalised region remains unchanged and only incremental improvements in the overall living conditions and economic development occur.

Scales of scenarios

We divided the regions of the catchments into homogenous sub-regions that differ regarding the main driving forces. The construction of sub-regions considers: i) administrative boundaries, ii) demographic framework conditions, iii) economic framework conditions, and iv) natural framework conditions

In the research area in Morocco, the Ziz valley till sandy desert south of Merzouga, we distinguish the following three scenario regions:

- i) High Atlas: This sub-region can be characterised as a marginalised mountain region with a poorly developed infrastructure. Water availability is, however, relatively good and is thus only a weak limiting factor for agricultural production.
- ii) Basin of Errachidia: The good water availability is a specific feature of this sub-region that is also characterised by a well-developed infrastructure and strong urban centres
- iii) Oases southern of Mansour Eddahbi Dam: Low water availability is a main impediment for economic development in this sub-region. Agriculture is dependent on the management of the Hassan Dakhil dam.

Results and discussions

In the geographically, politically and economically peripheral region of the Ziz catchment, water allocation functions according to a complex system of inherited water rights using communally built, managed and defended irrigation channels. Although the exact characteristic of the local irrigation methods and the relationship between water users varies, similar systems exist in the High Atlas Mountains as well as in the Errachidia basin, and in the Tafilalt valley south of the Hassan Dakhil dam. In the wetter mountainous areas the water availability is generally better but shows a higher regional variability than in the ziz valley. Here the lack of water from the dam caused an almost complete abandonment of the old system. Local farmers increasingly reacted to periods of water scarcity through the building of wells operated by motor pumps, thus individually exploiting scarce subterranean aquifers. Research also showed that, even if water from the river Ziz is less easily available and materially important, its “ownership” as laid down in the “traditional” irrigation system, remains an important category of symbolic prestige throughout the villages.

The irrigation system is not only governed by social relationships, but rather subject to intracommunity relationships designed to disguise the extortion of collective labor, especially when the level of technology and resource management techniques are simple, yet demand communal participation.

Following increased water scarcity, the region witnessed massive out-migration of large parts of its population during the past decades, resulting in monetarisation processes and a decrease in importance of agricultural production. Parallel to the observed rural out-migration were processes of urbanization.

Beneficiaries were not only the large coastal cities, but also local centres like the provincial capitals of Errachidia and Erfoud and medium-sized towns like Erich.

The valley's growth is placing too many latrine systems too close to too many wells. The septic waste are seeping into drinking-water wells on the nearly every Kasbah, high levels of nitrates are showing up in water wells and most of sampled wells had bacteria contamination from septic wastes.

Although tourism is an expanding industry in southern Morocco, the influence on the local labour market is rather small. Major beneficiaries are international tourist enterprises who run hotels and travel agencies in the urban centres. Moroccan entrepreneurs only benefit in some tourist hot spots. As water is a highly fragile resource, tourism, especially the big luxurious hotels recently constructed in the south, can increase the ecological problems.

Conclusions and Recommendations

The Moroccan case studies presented in this paper have shown that social capital exists in both bonding and networking forms and is possessed both by individuals and society through the existence of institutions that can be considered as embodied by groups of various kinds

Some conclusions pertaining to population growth, housing patterns, climate change and demand side management are presented below along with recommendations for further research. These are followed by a brief discussion of some of the data quality and availability issues that proved challenging when carrying out this research.

- **Population Growth**

Clearly, population growth is important factor influencing domestic water demand in the Ziz valley. It is also the most difficult to predict and control. Migration to the region is influenced by a host of factors including economic conditions, housing prices, transportation corridors, quality of life, etc., some of which can be controlled by governments and some of which cannot. This implies that sufficient flexibility must be built in to the water management system in order to accommodate unexpected changes in service populations.

- **Housing Patterns**

While population growth may be difficult to control, housing patterns are not. From the perspective of water management, housing patterns are intriguing because of their ability to be influenced by local zoning bylaws

- **Climate Change**

As with population growth, climate change had a relatively important influence on scenarios of future residential water demand. The significance of climate change in the water management planning horizon. Depending on the population growth scenario, annual water demands predicted without climate change may occur in excess of a decade earlier when climate change scenarios are factored in.

The challenges to be faced in meeting these emerging needs include the typical constraints of arid regions where natural resources do not support unlimited intensification and development of agricultural production. Hence the imperative of diversifying income sources, particularly for poor families, so that they may overcome the obstacles of depleted soil and drought, a structural reality in the project area. New prospects are opening up for economic and social development in Tafilalet and Dades, through promotion of the tourism and film industries and developing ecohydrological studies.