

# Climate Change and Hydro-conflicts The Storylines of Sudr Scenarios: A Platform for Adaptation

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## Abstract

*Ras Sudr, located on the Gulf of Suez, South Sinai, is a typical arid area inhabited mostly by Bedouin, a special group of Egyptians with specific ethnic characters and traditions.*

*Ras Sudr is one of the vulnerable areas of Egypt to climatic externalities, including drought and flashfloods. On occasional basis, the area experience brief but intense rainfall during winter, causing severe flashfloods. The area has also been suffering severe drought for the last few years, with some serious impacts on people and environment. In addition to natural drivers, a number of man – made drivers are affecting the quality of life, with significant bearing on Ras Sudr ability to cope with climate change extreme events. Governance, land use pattern, flashflood and drought management are major drivers that influence Ras Sudr resilience to climate change and the ability of Bedouin to adapt. Inefficient management of flashfloods and drought have always been a potential source of conflicts between Bedouin and governance, with frequent manifestation of violence, dismay and discontent. Local knowledge is playing a remarkable role within Sudr community. Bedouin have developed a remarkable repository of local knowledge accumulating through long years that they use as a think tank in all aspects of their lives and in crisis management. In the present study, four scenarios are*

*presented to depict how future may unfold in view of the impacts caused by climate change, and the man – made drivers that shape future adaptation. The scenarios presented in this study are also considered as a platform of how adaptation measures to climate changes could be formulated, and how to plan future response to Sudr vulnerability and how to boost its resilience to climate change.*

**Keywords:** Ras Sudr, climate change, flashfloods, drought, hydro – conflicts, adaptation

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## Introduction

Climate change is probably the most serious change that humankind has faced (IPCC, 2007; Stern, 2006). Climate in the Middle East and North Africa is expected to be hotter, drier, with more intense drought throughout the area (IPCC, 2007). In addition, Kostopoulou and Jones (2005) indicated the increased likelihood of extreme events, including heat waves, flashfloods and drought in Eastern Mediterranean region as a result of climate change. Similar results were also reported by Oikonomou et al., (2008), noted *a general future tendency towards longer extreme dry spells and accordingly shorter extreme wet spells for all seasons, except autumn, when the opposite behavior is predicted.* The impact of climate change is manifold, and would entail socio-economic impacts that might involve poverty, displacement of people, and other impacts. As a macro-driver of many kinds of environmental change, climate change poses risks to security and can lead to conflicts. Conflict may arise around adaptation responses (Zografos & Martínez-Alier, 2009). For example, dams or desalination plants, both adaptation options in the context of climate change and also for increasing water demand due to other factors, are often a source of social conflict between environmentalists and the authorities (Kallis, 2008). Similarly, displacement of people from floodplains and land-use controls often place property owners or those resettled in conflict with the authorities. Generally, climate change is potential cause for a wide variety of conflicts and human security issues .

## Sudr, Climate Change, Human Security and Scenarios

Scenarios can serve as useful tools in describing and evaluating future environmental problems and assessing policies to resolve them (Alcamo, 2001). The present storylines are plausible scenarios of how the future might unfold in the 2040s around Ras Sudr, a coastal town on the Gulf of Suez, South Sinai, Egypt. The local population of Sudr is predominantly Bedouin\*, for whom agriculture and grazing are their main activities. Local knowledge is one of their major assets that allowed them to survive the hard spells that they frequently faced. Sudr is also one of the popular Gulf of Suez resorts, where many tourist villages are located,

\*Bedouin is a collective term

attracting scores of holiday makers all the year round. A number of extractive companies, including petroleum and metal extracting companies are well established in Sudr. Middle East and North Africa, including Sinai Peninsula, have experienced some severe drought that many have attributed to climate change Nicholson, 2005, SEI URL and UNFCCC URL, Tawfic Ahmed et al., 2009. Sudr is also vulnerable to flashfloods that often cause severe destruction and occasional death cases. In recent years, non-Bedouin settlers, coming from various parts of Egypt have significantly

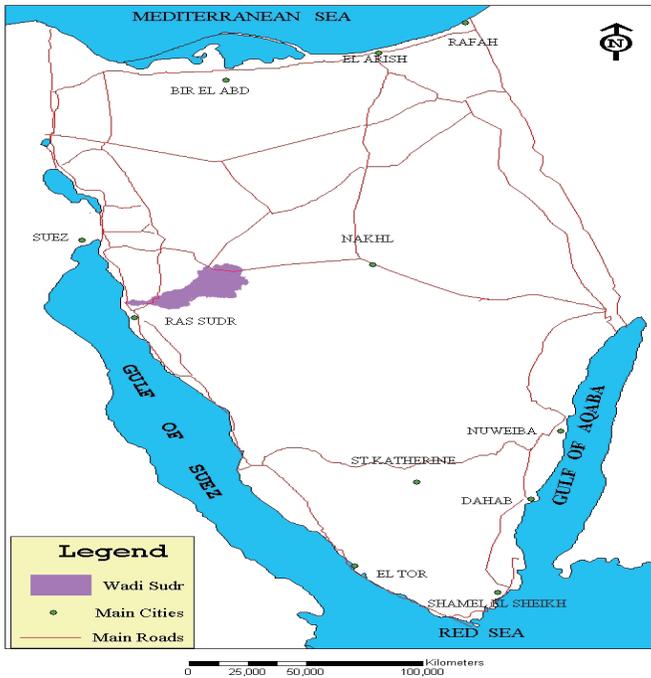


Figure 1. Map of Sudr, Southern Sinai, Egypt

increased in numbers on the expense of the Bedouin community. Bedouin are no longer feeling the sovereignty they used to have over Sudr. A feeling of discontent has been building up and occasionally erupting in disputes with government authorities, and other non - Bedouin settlers. Problems have increased in recent years, as water supply becoming scarcer and flashfloods hitting and destroying Bedouin homes, fields and infrastructures, with the blame put on the incompetent performance of governance bodies.

The present scenarios would shed some light on conflict causes at Sudr. They are also considered as platforms of how adaptation measures to climate changes could be formulated, and how to shape up future response to Sudr vulnerability and how to boost its resilience to climate change.

### Scenario Construction: Major Drivers

The method employed to develop these scenarios was a hybrid that integrated the Futures Groups Scenario method (Glenn, 2003) and the Prospective Approach

(Godet, 1994), mainly the MIC-MAC and the Mactor methods. This hybrid approach took the following steps:

- 1) *Identification and Ranking of Drivers.* The driving forces in the study area were identified based on meetings and interviews with local people, and also the observations and records made by the assessment team. The drivers were then ranked according to their influence, independence, inter-relationship. A limited subset of key drivers was then selected. Much of the drivers-ranking process was based on Bedouin views and experience.
- 2) *Identification of Stakeholder Interest, Objectives, and Influence.* Ascertaining the goals and objectives that would meet people's needs and aspirations is an important part of the scenario process. A basic step in this respect is to identify the main actors, influential groups in the study area, their stands on these objectives, along with their influence and support.
- 3) *Scenario Matrix Construction and Development.* A matrix, based on the two most important drivers was built to produce four quadrates, each of which characterized one of four scenarios for Sudr. Based on the four quadrants of the two-dimensional matrix, the four storyline scenarios were created describing the system along key characteristics (i.e. water scarcity, conflicts, and others).

### **Key drivers**

Questionnaires and interviewing Bedouin have indicated that a suite of drivers of changes are influencing the scenery of Sudr. Further discussion and visits have further indicated the weight and relative influence of each of these drivers. The following is a list of the most influential drivers identified in the area.

#### **Water scarcity**

Sinai Peninsula has experienced a significant drop in rainfall for some time, with significant impact on quality of life, and Sudr is no exception. Tankers transport freshwater from Suez, the nearest big city to the Bedouin areas on weekly basis. Bedouin also store rainwater in ditches they dig in the ground and use it to cover much of their needs. Water scarcity is the major driver affecting Bedouin life, and is the root causes of conflicts and concerns about human security in Sudr.

#### **Flashfloods**

In Egypt, flashfloods are considered the most frequent and destructive extreme events related to climate change, with severe impacts on people and properties, Figure 2, ( Arab Republic of Egypt,2008).

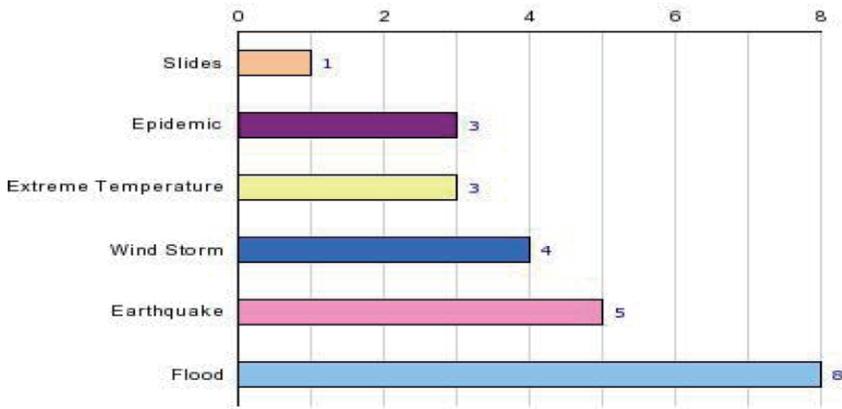


Figure 2. Natural Disasters Occurring in Egypt, 1926 - 2006

The management of the flashfloods in Egypt lacks an integrated approach, in which Bedouin could contribute. Sudr is one of the vulnerable places to flashfloods in Egypt. In Sudr, recent flashflood in 2010 had caused severe destruction of properties and infrastructure, specially roads and public utilities, and has also caused some death.

### Governance

The local council is the governing body of Sudr. It consists of a number of members, coming from the various villages that make up the district of Sudr. The local council has a number of mandates that include requesting the district budget and setting priorities for public works, as well as directing and supervising the implementation of various development projects. Council members are elected through eligible citizens voting. Incompetent governance is a strong determinant that reverberated on social and economic landscape of the area, affecting people’s welfare.

### Land use change

In Egypt, policies of land use are not very well enforced and Sinai is no exception. Much of what drives these violations is speculative development, which is how most wealthier Egyptians invest, not with banks or other ventures commonly used but through investing in land and properties. Violations of basic land use are apparent in the study area. Changes in land use pattern, including building in flashfloods routes are a major reason for the huge damage caused by flashfloods. Land use change is also one of the major reasons for the losses of flashfloods water since illegal building would affect water harvesting and exploiting water stream.

### Unemployment

Agriculture and grazing, the main activities of most Bedouins, have been badly hit by the significant drop in rainfall. As a result many Bedouin involved in these activities have lost their jobs. Unemployment is a key factor behind poverty,

migration, illiteracy, and is one of the causes for the cultivation of illicit crops in the highlands.

### **Illiteracy**

The area has a high rate of illiteracy compared to other parts of Egypt. Girls are allowed to attend school for only part of their primary education, if any, after which societal norms require them to stay home. Despite a current strong drive to change these norms in the Bedouin community, most of the Bedouin families are adamantly opposing any changes in this practice. In mountainous area, there is no enough schools in the vicinity and pupils would walk some long distance to reach their schools. In these areas, Bedouin parent would not allow their girls to go to schools because of the possible risk involved. On the other hand, parents living in towns where many schools are available, Bedouin would send their girls to schools up to certain stages where they can read and write, then most parents would ask their girls to stay home where they would be helping in household issues including grazing, fetching water, and collection of medicinal plants for family use. Poverty also plays a key role in the high rate of illiteracy recorded in the area.

### **Environmental degradation**

Environmental degradation is very apparent in Sudr, manifested in soil degradation, land use change, water pollution, loss of biodiversity and landscape fragmentation. Environmental degradation has affected much of the floral diversity of Sudr, with many of the characteristic plants nearly disappearing.

### **Poverty**

Poverty is one major denominator of many of Sudr flaws and dilemmas. In Sudr, poverty is not restricted to financial deprivation but also includes lack of clean water, sound education and many others. On the other hand, environmental degradation has a potential impact, limiting many of the natural resources that Bedouin use to support their daily living, hence exacerbating poverty and widening its dimension in Sudr.

### **Scenario Conduction: Collection of Information**

Sudr scenarios are a blend of two major sources: influential drivers and the narrative information collected from various stakeholders. Storyline information was collected at different levels, from Bedouin chiefs, key decision makers at governance level, researchers working in the area, down to ordinary Bedouin and others. Meeting elder Bedouin provided leads about awareness, vulnerable sectors, local knowledge and the role it plays. Decision makers at government level and researchers represented another tier, mostly dominated by people coming from outside Sudr, but who have been living in the area for years. This tier provided an insight to the official position of government towards climate change and other communal issues, including preparedness, awareness, vulnerability and ability to cope. They also provided valuable information about the socio-economic construct of the area and the nature of the relationship between various tribes.

## Questionnaires

Questionnaires provided a clear and ample configuration of how Bedouin would reflect on pertinent issues with full transparency. The study team formulated a number of questionnaires to help collecting information from a variety of Sudr inhabitants representing a wide spectrum of social classes, interests, educational levels and backgrounds. Senior decision makers and elder Bedouin were also consulted by the study team and the questionnaires were thoroughly honed, based on their recommendations.

## Storylines Quadrate

In the scenarios developed here the two drivers with the most potential impacts and dominance were used for the two axes of the scenario building blocks shown in figure 3 below. The vertical axis shows flashfloods and varies between current intensity and possible future high intensity caused by climate change, as indicated by IPCC latest report (IPCC, 2007). The other axis shows flashflood management competence that varies between the current inefficient management of flashfloods, and possible future, integrated and competent management.

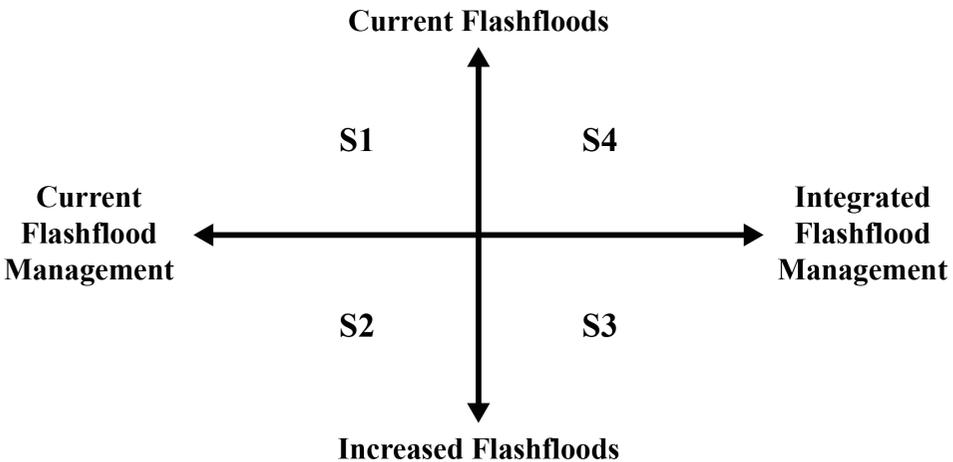


Figure 3. Scenario Quadrate

Table 1. *Scenarios Summary*

S 1 Current flashflood intensity and current flashflood management	In this scenario, no changes would occur in flashflood intensity and management attitude. Conflicts would increase between Bedouin and governance and also between Bedouin and non-Bedouin. With no early warning system, flashfloods would cause serious damage to properties and lives, beside massive loss of flood water. The area would also suffer environmental damage. A number of Bedouin have resorted to grow illicit crops in remote mountainous areas as a result of prevailing poverty and unemployment, and also as an adaptation to harsh drought hitting the area for years.
S 2 Increased flashflood intensity and current flashflood management	The local council has managed to install an early warning system though operating staff were not adequately trained, rendering the system inefficient in many cases. The abundance of water has attracted many non - Bedouin coming to settle in the area, resulting in a bout of ethnic problems. Conflicts between Bedouin and non Bedouin, were one of the human security concern in this scenario, meanwhile, some other conflicts were also reported involving investors, Bedouin and governance.
S 3 Increased flashflood intensity and integrated flashflood management	An enlightened city council is taking good advantage of water abundance to meet people various demands. Women played a major role in Counsel decisions and public works. The council has also managed to install an efficient early warning and education system that provides information about flashfloods, helping public preparedness. A special campaign was also made to minimize environmental impacts caused by flashfloods, growing suites of plants and shrubs. Bedouin themselves as indigenous people have acquired an acute sensitivity to recognizing weather conditions that precede flash floods. These education and warning systems thus benefit non-Bedouin residents.
S 4 Current flashfloods and sound flashflood management	With good management, the council has managed to establish an early warning system through its good public relation with industries and others. Some water storage facilities were established to harvest flashfloods. Bedouin were encouraged to form Well Users Associations to look after wells of common use, to improve water and well quality and to prevent over abstraction and water salinity. The council has introduced a new approach to diversify Bedouin livelihood to improve their resilience to climate change impacts.

## **1- Current management and current flashfloods intensity scenario**

### **Business as Usual Scenario**

#### *Early warning system*

In this scenario, the city council could not afford to have an early warning system to serve the area. Lack of funds and outreach to potential donors has made it impossible to find funds to acquire the system. Lack of an early warning system, coupled with a lack of preparedness, are behind the significant losses caused by flashfloods. These losses were also the main causes of a state of deep discontent that prevailed between the Bedouin, triggering a chain of resentment between government and Bedouin.

#### *Local council*

In this scenario, the representation of Bedouin in the council is not proportional to their population. Investors and government employees, who originated from outside Sudr, dominate it. This imbalance often manifests in conflicting views regarding how to prioritize activities and where to lay special emphasis. Lack of sound land use plans and lack of enforcing civic building codes have been major reasons for the destruction caused by flashfloods. Public participation in flood management is inadequate. This is primarily due to lack of community spirit among people. The area has no recognized leadership that can evoke a sense of community spirit and commitment.

#### *Conflicts*

A spiral of conflicts flared up with the Bedouin on one side and both government and industry on the other. Conflicts over water resources were most vigorous for a variety of reasons. Water scarcity caused by the poor management of floods, spurred strong protests and confrontation between Bedouin and local authorities. Water shortage has already turned many of the orchards non-productive, causing financial losses and unemployment. Severe water scarcity in drought-stricken areas and lack of sanitation, have contributed to serious hygienic impacts. Some cases of death have been reported, especially among newborn children have aggravated the already sour relationship between Bedouin and governance. Water scarcity has badly affected the grazing industry in the area with many Bedouin selling their frail herds before they perish, increasing the burden of unemployment among Bedouin.

In an attempt to deal with water scarcity, local council imposed a number of new laws/regulations to manage the situation. However, none of these measures were accepted. The legislation package included restricting drilling of new wells unless a permit was granted by the local authority. Attempts were made to meter groundwater withdrawal to prevent groundwater depletion and seawater intrusion. The new measures were met with strong refusals from the Bedouin, who demonstrated outside the local council protesting the new measures and asking for their abolishment. Resentment over water issues has spread between Bedouin, who also vented their discontent about other civic equity issues that they have always felt discriminated against.

The impact of flashfloods on people and the area has promoted a strong

sympathetic feeling, with considerable donations and funding from numerous charitable organizations. Trucks loaded with various commodities and materials, including blankets, beds and food were rushed to the local council for distribution to flood-affected families. Serious problems arose over the distribution of donated items with each and every Bedouin claiming this right to them. A state of chaos spread when a financial compensation scheme was announced to help Bedouin who lost their homes and businesses, with almost every Bedouin claiming his legitimate right for financial compensation. Disputes, including fist fights between Bedouin and local council representatives and within the Bedouin community, were reported. Bringing elderly Bedouin in to mediate these disputes, a customary process has also failed. In some cases elder Bedouin were attacked and insulted by young Bedouin, an unusual behavioral attitude that Bedouin communities hardly know.

### *Illicit crops and drug trafficking*

The syndrome of poverty has entailed not only a lack of financial ability but was extended to include inaccessibility of good quality water, lack of reasonable health care services and prices increases. Driven by despair and long suffering, a number of young Bedouin have taken advantage of the remoteness and isolation of the highlands to grow narcotic plants to earn their living. Vast areas were planted with illegal plants, establishing a drug racketeering activity. Involvement in narcotics has added a new dimension to new conflict species, with government and police forces alike. Frequent raids on the area searching for narcotic farms have sparked a sense of apprehension and suspicion in the area. The cultivation of illicit crops could be looked at as one of the adaptation measures that some Bedouin have taken to combat the harsh impact of drought and water scarcity dominated the areas for years.

### *Environment*

Poverty, coupled with discontent building up within the Bedouin community, was strongly reflected in the way the environment was looked at in the area. Bedouin have always considered their environment a sacred subject. In return, the environment has always provided many of their basic needs. Food, animal feed, medicines and building materials are among the goods and services provided by Sudr environment. Drought, and the harsh poverty that followed, has shaken Bedouin belief in environmental integrity and has ushered a new state of mind that shifted many of these beliefs. Wells in drought affected areas were over-pumped beyond replenishment, causing water salinity. Water scarcity, along with elevated temperatures and overgrazing, has affected the vegetative cover in the area, with a number of well known medicinal plants disappearing.

## **2- Current management and increased flashfloods scenario**

### *Early warning system and preparedness*

In this scenario, the city council has managed to obtain an early warning system to help managing flashfloods well in advance. Lack of proper training and maintenance work has limited the successful deployment of the station. Many of the technical staff appointed to operate the station were not efficient enough. With such lack of proper training the station was often out of order, not able to operate

to reliably alert Bedouin. Bedouin recognizing the inefficiency of the station had to depend on their local knowledge and on information coming from other Bedouin tribes in the highlands, but very often local knowledge has failed to provide them with in time warning to get prepared to flashfloods bouts.

*Local council, socio economic impacts and conflicts*

The local council has good representation of the various groups of inhabitants, however the council does not include experienced members who can plan and implement sound integrated flashflood management. One major reason behind this is that many of the members are not yet convinced about expected climate changes. Local authorities could not adopt a successful flashflood water management policy that takes advantage of the copious volume of water that might come. Efforts to slow down flashflood streams with baffles and diversion ponds in order to recharge groundwater were unsuccessful. Flashflood intercepting and diversion structures were not set in the right places, leading to a massive loss of water capture for use when the area would suffer severe drought. Local authorities have made some efforts in building water storage facilities. Decisions on the locations of many of these facilities were taken with no consultation with the Bedouin who know the ideal places for these structures, hence many of these facilities failed to capture and hold enough water. In this scenario, the city council, along with relevant departments, are not enforcing land use regulations.

Oil companies operating in the area have established a network of pipelines to transport oil from exploration sites to other places where raw oil is processed or transported overseas. The pipeline network has been passing over vulnerable territory and is often hit by flashfloods, with massive oil spills, causing widespread environmental damage, groundwater and soil pollution. Bedouin have filed court cases against oil companies for the harm inflicted on them and their croplands.

A number of facilities owned by investors coming from outside the area were badly affected by flashfloods. Investors established these facilities in parts of the city after purchasing land from local inhabitants without being aware of the vulnerability of these areas to flashfloods. The city council does not offer good advice regarding land use for new investors when establishing their facilities. In response, affected businessmen have turned to the Bedouin and officials asking for compensation. Some serious clashes were reported when investors and Bedouin could not settle their disputes about fraudulent practices in land acquisition deals.

On a different scale, Bedouin whose houses were affected by the floods and moved to temporary residence on the outskirts of the city have been relentlessly complaining about the quality of such residences. They have been accusing the local council of being inefficient in managing their crisis.

Availability of water has attracted scores of non-Bedouin from outside the area to settle in Sudr. There was a growing demand for cropland, especially from new settlers, who also introduced new crops that the area had never known in the past. With their experience in farming, new settlers managed to create a type of monopoly on some markets. Demand for land has increased even further, and tensions between Bedouin and newcomers became more tangible, and tense. Frequent confrontations between the two groups have sometimes turned violent. Customary approaches headed by the chiefs of each sect were not always successful.

As a result of incompetent water management, some parts of Sudr have had a

bigger share of the flood impacts, while others are still very arid and suffering water scarcity. Bedouin in areas suffering water shortages have demonstrated violently on several occasions to express their discontent.

On several occasions grazers had to graze outside their tribal territories, provoking tribal conflict. The impact of water scarcity in these areas is also manifested in hikes in food prices.

#### *Impact on environment*

Poor management of flashfloods, coupled with poor land use planning has resulted in some areas swamped with stagnant water, attracting mosquitoes. Such an adverse aesthetic impact alienated many of the holiday makers causing additional loss of employment opportunities. Flashfloods have also swept wells in the area, with floating debris covering the wells restricting their use. Bedouin have been deprived of a major source of water that they use in agriculture and other issues. Strong flashfloods caused considerable land erosion, adding to the desertification problems of the area.

### **3- Sound management and increased flashfloods scenario**

#### *Early warning system and preparedness*

The council has managed to install an early warning system to serve the area. Donations are made by industries working in the area, beside revenues obtained from advertising agencies placing their commercials in the tourist villages of Sudr. On the other hand, running and maintaining the station is performed by the Ministry of Water Resources and Irrigation. Parallel to this, the city council has implemented a thorough preparedness and disaster reduction plan that helps managing sudden strong floods.

#### *City council*

The city council is made up of a good mix of Bedouin and others, with wide experience of technical issues especially flashflood management, socio-economic, risk and disaster management issues. The counsel has also included some Bedouin women highly trained in community services and voluntarily works. The frequent campaigns to support the education of women and encourage them to participate in public activities proved successful with the number of educated women increasing and their involvement in societal issues growing. The city council has established the Water Security Contingency Group (WSCG) that has the task of maximizing the possible benefits of the flashfloods while minimizing all possible threats, conflicts and damage it may cause to people and their hydrological security. The group is made up of experienced employees from the Ministry of Water Resources and Irrigation, social service specialists and volunteers.

The group has marked the well-established routes of flashfloods, based on experience, local knowledge, history, and satellite images. The group members were also in charge of clearing the pathways of the floods, making sure they would not be obstructed in any way that might waste parts of the flood. Some dams and water storage facilities have been built in places where Bedouin recommended based on their long experience and local knowledge. The group has also supervised

a campaign working on the diversion and spreading of floods streams in order to let water cover the maximum possible area. Local plants, palm trees trunks, and other local materials were placed in special areas recommended by expert Bedouin to slow down the flood, allowing water to infiltrate and replenishing aquifers. Oil companies and other extractive industries were granted particular sites for their pipelines and other works that would not interfere with flashflood routes.

### *Flashflood users association*

One of the special measures taken by the city council to manage flashfloods was the establishment of the Flashfloods Users Association (FUA). The Association is made up of a number of Bedouin and civil servants with wide experience in flashflood management. Members of the FUA were assigned to mark the routes and *drainage areas* of flashfloods, removing any possible obstacle that might affect water flow, ensuring a clear passage of the water to a catchement area. The FUA, in collaboration with the city council, has a plan to reinforce sound land use practices in and around Ras Sudr, supervising agriculture activities in these areas, offering land and other facilities to young Bedouin of various tribes on equal terms. A number of small agriculture-based industries have been established including olive oil mills and medicinal plant processing facilities. Locations for marketing these products in the tourist villages around Sudr, and on the main Sudr-Cairo road offered extra job opportunities for Bedouin. One of the most successful project put forward by the Association was the construction of a canal in the pathway of the flood. The canal would collect much of the flood water and would transport it to a newly reclaimed agriculture land. The canal has helped increasing the agriculture production of Sudr, beside increasing its crop diversity.

### *Conflicts*

On several occasions vast areas of cropland were inundated from strong flashfloods. Bedouin incurring losses of crops and croplands have been protesting against the city council, putting the blame on inadequate preparedness and flashflood management. Similarly, heavy rainfalls have destroyed some main roads that connect the area with other governorates, beside local roads within the area of Sudr. Floods have also destroyed many of the telecommunications posts that transmit telephone services. The interruption of road and other communication services was heavily reflected in the lowered supply of consumer goods to people in various parts of Sudr, with some shortages of food and other basic materials driving up prices. The destruction of roads has interrupted the provision of freshwater to Bedouin living in the countryside. Soaring prices and discontinuation of foods and other commodities were enough reasons for Bedouin to intercept the main road to Cairo and other neighboring governorates to force local council to pay compensation and help alleviating the harm inflicted on Bedouin.

## **4 - Sound management and current flashfloods scneraio**

### *Early warning system and preparedness*

In this scenario, the city council along with relevant departments, especially the Ministry of Water Resources and Irrigation, have jointly established an early warning

system to provide information about flooding. The city council has persuaded investors and industries working in the area to cover the expenses. A well structured preparedness plan was put forward by a group of experts to address possible future crises and disasters. Drills on how to deal with disasters was practiced twice a year to keep people prepared. Gender issues were high on the agenda of preparedness and awareness, with special sessions meant to educate women and to introduce climate change and its impacts.

### *City council*

Dams and water storage facilities were built in places where they can be most useful and effective. Some new wells were established behind the new dams to help replenish groundwater. Special measures were also taken to manage strong flashfloods. Some new diversion routes were made to direct floods to areas where agricultural activities could be established. The city council is committed to a policy of raising the role of public participation in flood management.

The city council has made special efforts to highlight the role played by local knowledge in adapting to flashfloods and managing drought. Over time the Bedouin have developed experience of how to identify and interpret environmental signs and signals associated with climate change such as changes in cloud colour, water flow, intensity and frequency of rainfall, as well as unusual sounds and unusual presence and movements of local animals. Special contingency plans to resolve health problems caused by heat waves or stagnant water were made, including regular health examinations and monitoring of people at risks. The council has also introduced new measures to protect infrastructures against flashfloods. The plan includes reinforcing areas prone to floods through planting indigenous species, establishing culverts to divert floodwaters away from bridges and access-ways to prevent erosion and slow the rate at which water rises.

### *Conflicts*

Occasional shortages of water caused severe drought in some parts of the area, affecting the quality of life. People living in drought prone areas have had crops failures and grazing animals badly affected because of the shrinking vegetative cover. Many of the grazing animals have perished or have been sold at very cheap prices before they perish. Water scarcity, along with soil salinity have affected crop production leading to an increase in staple food prices, aggravating the situation even further. In order to alleviate the tense situation, the council has contacted the Ministry of Agriculture seeking drought-resistant seeds for the major crops grown in the area, especially olives, the main staple food. Loans from the agriculture bank were offered to Bedouin to enable them to purchase drought-resistant seeds.

The city council has introduced water metering in an attempt to save groundwater supply and to stop seawater intrusion. Many Bedouin have not accepted the idea and started a long debate with the council. The council explained that the system meant to overcome the water shortages in some parts of the region and also explained the relationship between over-pumping of groundwater, soil salinity and seawater intrusion.

In order to ease growing tension, the group has proposed a scheme that would maintain metering mechanisms while addressing most of the issues that arose.

Bedouin would be granted a large quota of free water proportional to their family size and cropping requirements. Moreover, they would be provided with an extra allotment at a very competitive cost, provided they use it in agricultural production. The group would help supply the Bedouin with drought tolerant seeds for their crops and they would be compensated if their crops failed. The local counsel has also introduced the concept of Well User Association, an NGO that combine well users in each area in a sort of a union that look after the well, ensure optimal use that prevent over abstraction and sea water intrusion. The idea of WUA has proved successful in maintaining well and water quality, and also in combating drought impact, with some contribution in minimizing social conflicts caused by water scarcity.

### *Environment quality and diversifying livelihood,*

The impact of water scarcity was apparent in the highlands normally rich with natural flora. Lack of rain, overgrazing, extensive use of groundwater have contributed greatly to a serious condition of desertification and loss of plant coverage. Current environmental degradation poses a potential threat to biodiversity, with many of the well known medicinal plants disappearing. It also exacerbates flashflooding by diminishing the root systems that help to hold back water.

One of the most appealing mechanisms introduced was focused on the introduction of tissue culture propagation of some of the most threatened medicinal plants. On the one hand this would help maintain the floral diversity of the area, while on the other hand this it could be considered as an adaptive measure for the Bedouin to cope with climate change. Many Bedouin accepted the idea and were supplied with tissue culture seeds for large scale propagation. A flourishing trade in these plants has started with a growing demand. The city council has also organized regular trips for holiday makers in the nearby tourist villages to visit the highlands, spend some time in the intriguing desert environment and buy fresh medicinal and aromatic plants at a range of prices.

## **Conclusion**

Dry land ecosystems are among the most vulnerable to climate change, and the area of Sudr is no exception. Sudr has been suffering a long spell of drought, beside frequent destructive flashfloods that hitting the area, causing substantial damage to people and properties alike. A number of determinants, including lack of preparedness, inefficient governance and lack of awareness are behind the poor resilience of Sudr. Scenario projections of how the future might unfold in view of externalities posed by Sudr vulnerability to climate change, and possible adaptation measures offers a point of departure towards a preferred future for the area. Special emphases on conflicts and human security issues as influenced by climate change impacts on hydrological profile were featured here. Four scenarios were narrated, based on changes in flashfloods intensity and frequency, against prevailing efficient or inefficient flashflood management systems. The impact of flashfloods, coupled with the relative efficiency of their management systems on major societal issues were viewed as key determinants in each of the four scenarios. Issues such as conflicts, environment, socio-economics and others were looked at in detail as consequences to the quality of water and flashflood management. The scenarios emphasize the need to improve governance, introduce technologies for early warning

and mobilize local efforts as vital components for a sound adaptive capacity, a cornerstone in adaptation policy. The scenarios also stress the need to mainstream local knowledge in Sudr preparedness policies as an efficient guidance mechanism. The scenarios revealed the urgent need for new water resource management plans to cope with the growing demand of water, and to forestall possible conflicts in Sudr. Equally important is to draw up and enforce a sound land use plan that would maintain landscape integrity, while harnessing flashfloods and improving water harvesting.

Scenario	Early warning and preparedness	Local council	Conflict	Water Availability	Environment
S 1					
S 2					
S 3					
S 4					

Figure 4. Scenarios Summary

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