Basin: Rmel

Author(s):SihemJebari, Doha Zamel, Dalel Ousaifi

Date/version: 6.5.2015 (final)

# Narrative

* 1. Description of the basin

The coastal watershed of Oued Rmel is a National pilot study area located on the Eastern coast of Tunisia. Bounded on the west by the Jebel Zaghouan mountain and on the east by the Mediterranean Sea, it covers an area of 87,000 ha and has a population of 135,438 inhabitants.

The Oued Rmel watershed is subject to a double influence climate, Mediterranean and continental, with an average temperature of 18.5°C. Precipitation is very irregular, with average rainfall ranging from 350 mm to 600 mm.

The basin is covered by forest formations ranging from degraded scrub land to dense forest. Deposit slopes, forming the catchment, are occupied by bushes or scrub land areas as well as forest relics of Aleppopine. In the hills connecting the mountain, low lands lopes and agro cereal

The Oued Rmel watershed is a rich region in wild game, as reflected in the variety of wild species such as boar, jackal, fox, wild cat, and partridge. It is important to stress some species of birds such as hawks that are sedentary, while others are migratory as the booted eagle or dove. The wealth of wildlife has declined but remains important and deserves to be developed as it may be the basis of a great contribution to launch the green tourism in the area: nearTunis, Hammamet, Sousse, in an attractive environment where the forest and hill dams are attractive landscapes.

As far as economic activities are concerned, they are primarily based on traditional self- subsistence agricultura mainly (anual crops of cereals and vegetables) and a diversified extensive livestock dominated by goats and sheeps. The herds are mainly supplied from range land and scrub forests, fallows and stubbles... Forage resources are insufficient and do not cover the needs of the herds (cattle).

An important part of the rural population is constantly looking for a casual off-farm employment opportunities or emigration to the neighboring governorates. However, the study conducted by the Department of farmland conservation and management at Sbaihia sub-basin (a representative hilllake in the watershed Rmel), shows that 40% of agricultural land in the basin belong to large farmers or non-residentowners, who practice cereal agriculture. And only 30% of land belongs to the families who belong to the areathatis heavy inhabited by the majority of the population living on low-yielding cereal crops, extensive production and especially off-farmincome (migration, constructionsites...). The plains and piedmonts are under a heavy human pressure. They are systematically cultivated; mainly cereals, within appropriate farming techniques, which speed up the process of land degradation and consequently the phenomenon of erosion.

* 1. Current status

A cognitive map of the basin is presented in Figure 1 and it gathers all declarations provided by the participants during the workshop, the awareness campaign, individual interviews and some reports in current issues and challenges in the basin. It also gathers the statements of where the key impact indicators can be derived.Then, participants were invited to analyze the map and indicate if any factors should be included, relations needed to be changed or new ones integrated. Moreover, they were invited to give a weight to these relations, referring to a range from 3- to 3+.



Figure 1: a cognitive map of the Rmel basin

This map contains in total 18 factors. The main factors are water availability, soil degradation, water quality, Agriculture (irrigated cropland and rainfed cropland) and job creation.

The water availibily is influenced by the surface water and ground water (2+) that has a direct relationship with precipitation (+3) which is a driver. So when precipitations occur two major challenges increase which are water availability and soil and water reserve. These two factors increase by their turn the agriculture (irrigated cropland (2+) and rainfed cropland (2+)), cattle raising(2+)and forest resources(1+).

The preservation of water availability consists especially on setting water and soil conservation techniques (2+) to collect runoff water in order to promote green water and to increase family yields, incomes and creation of jobs (1+).

Yet, dry periods that is considred as a driver has a negative influence on water availibilty(1-) and soil water reserve and consequently affects negatively the other factors influenced already by both water availability and water reserve which are surface water and ground water(2-), cattle raising (1-) and forest resources (2-).

The water quality is one of the relevant challenges, that’ s why it’s significant to identify causes that have a negative influence on it. As the map shows several factors such as soil degradation (2-), population livelihood (2-), industry and tourism(1-) have a negative influence on water quality. According to the map, this factor is only influenced positively by forest resources (1+). However, the latter forest resources are badly affected by forest fire (1-) and population livelihood(2-). In this context, a major effort is being prosecuted for forest preservation, special measures of prevention and control should be adopted such as the establishment of the adequate techniques to protect and safeguard forest resources from fire, the introduction of new agro foresty species and a better gouvernance of these resources.

Soil degradation is mainly increased by heavy precipitation (3+), forest fire (2+), flooding (1+), cattle raising(2+) and dry periods(1+). According to the map this factor is decreased by both soil and water conservation techniques (2-) and forest resources(reforestration) (2-). In this way it’s imperative to improve the function of existing water and soil conservation techniques and consolidate them by plantation.

In terms of job creation, this factor increases population livelihood and settlements (2+) as more jobs may attract more people. However, industry and tourism (1+) as well as agriculture (2+) create jobs as it can be seen in the map through the relationships between these factors.

 In the future, more projects on agricultural developement and environmental sectors may promote the above mentioned factor (employments) and this can be achieved by facilitating financing in different sectors for encouraging people to invest and by organizing training sessions to facilitate their integration into professional life.

All these factors and relationships were ran in a script for ananalysis sensitivity. The sensitivity indicates which relationships have a large effect on the dynamics in the basin, it does not indicaterightorwrongrelationships.

It allows interpreting the management options to change the balances represented by the FCM. These changes can be one or more changes of intensity as regard interactions between two factors.

* 1. Climate change

Tunisia has initiated a prospective thinking on the impacts of climate change on the agriculture and natural resources and has managed to limit its effects with a strong and sustainable way.

For this reason, a national strategy for the adaptation oftunisian agriculture and ecosystems to the climate change (MARH, 2006) and ,also, a study on protecting ecosystems and climate change adaptation (MEDD, 2007) have been developed.

For climate projections over Tunisia, HadCM3 model (general circulation model coupled atmosphere-ocean) was used to quantify and evaluate the increase in temperature degrees and the likely decrease of rainfall in addition to the study of the variability of precipitation and the extremes horizons of 2030-2050. The variations in temperature and rainfall have been given over the reference period (1961-1990).

The impacts of climate changes are:

* Increased frequency and intensity of extreme dry years.
* Drier and wetter periods should vary greatly from one season to another.
* Decrease drainfall
* Temperature increases by 2050

The main resources affected by these climate changes are wáter resources, ecosystems and agrosystems.

*Impacts on Water Resources*

* Groundwater, primarily in groundwater of high salinity, coastal aquifers and not-renewable aquifers, decrease by 28% in 2030.
* The decrease in surface water will be about 5% in the same horizon. The exploitable water will decrease slightly.
* The decrease in summer precipitation will increase the lack of soil moisture. The increase of salinity of groundwater close to the coast leads to the rise of the sea level.

Thetrend of mobilization of surfacewater and ground water in the country, shows that ground wáter ispractically mobilized as well as the surface water in the horizon of 2025. From 2020, it is practically necessary to rely more on non-conventional wáter resources to meet the demand for water quantities and required quality.

*Impacts on Ecosystems*

* Because of the rising temperatures, the risk of large fires in the North will increase.
* Rising temperatures and rebounding of sea levels (50 cm by 2100), will increase the marine erosion of coastal regionsand will cause the advance of the sea to the mainland coastal areas such as:
* Delta Wadi of Medjerda (loss of fertility of 2600 ha).
* All sebkhas with an area of 730 ha will turn into lagoons.
* Gulf of Hammamet with an area of about 1400 ha will turn into lagoon.
* Archipelago of Kerkennah and Djerba Island, about 30% of the total area would be exposed to marine erosion.
* Salinization of ground water aquifers

*Impacts on Agrosystems*

Under the assumption, the impacts on agricultural systems are:

* In the occurrence of a succession of dry years, it will be a lower production of olive surfaces and cereal area in the center and south and a reduced cattle in the north but especially in the center and south.
* In case of favorable rainfall years, the security performance of the dry oil production andyields of rainfed arboriculturewill increase by 20%.
* In case of flooding, irrigated cereal production will be affected.
* In the South, climate change may render the situation of oasis (microclimate) more critical.
	1. Challenge
		1. Water quantity

In the study area, the rainfall regime is characterized by an irregular and high intensity that cause soil degradation. Also, unconventional human activities (overgrazing, bad agricultural practices…), accelerate erosion. The limited water and soil conservation techniques all over the catchment and their conditions are causing reduction of the dams to rage capacity. Certain are as remain disserving drinking water. Losses in the drinking water supply network and low flows affect the quality of water especially during peak hours.Responding to the needs of the local polpulation and good water management is apriority in our basin.

This challenge is related to water and soil conservation techniques, soil degradation, flooding, surface water and ground water, irrigated cropland, soil water reserve, water demand, water availibility in reservoirs in the FCM.

* + 1. Water Quality

The basin contains an industrial zone about of forty four ha. This region consists of thirty three enterprises that throw their wastes (waste of olive presses, lime) at Oued Rmel. These wastes influence water quality in the basin.Implying recycling waste water and water discharge control is necessary to preserve the water quality in the basin.

This challenge is related to water quality, industry and tourism, surface water and ground water, water demand in the FCM.

* + 1. Agriculture

The current situation of the irrigated sector is characterized by several levels of exploitation and an over all modest increase resulting from various constraints, mainly social and land.The majority of farmers are very aged and are trapped in ancient techniques and old agricultural customs, moreover they are struggling with land conflicts.

Good management of irrigated perimeters, support of farmers and improving operational and management requirements constitute a challenge to improve agriculture that represents the main occupation of the basin.

This challenge is related to population livelihood and settlements, irrigated cropland, rainfed cropland, job creation, water quality in the FCM.

* + 1. Forest and biodiversity management

The forest is both a valuable protective mantle of soil and incomparable set of sites and landscapes but it isparticularly threatened. The over-exploitation of the forest and the intensive agro-pastoral practices have led to severe degradation of forest formations, it is an opportunity for us to highlight the key roles played by the forest in the economic, social, ecological and land scaped areas and to affirm the need to developing and ensuring the protection of this precious and fragile heritage.

This challenge is related to forest fire, forest resources, soil degradation, pasture and cattle raising, population and settlements in the FCM.

* + 1. Awareness of civil society

The lack of awareness of civil society about the importance of natural resources is due to the lack of coordination between the authorities and civil society and the keeping out of role of local people in decision making not only in basin, but in all region.

Therefore, awareness, training and integration of civil society in studies and the coordination between society and science are necessary for success of the project.

This challenge is related to population and settlement, forest resources, surface water and ground water, soil degradation, pasture and cattle raising, irrigated cropland, industry and tourism in the FCM.

* + 1. Human resource and employment

The analysis of socio-economic issues has identified constraints that concern the future beneficiaries, the main constraints mentioned by young people are, namely, guidance difficulty to wards vocational training, lack of generating in come projects, unemployment, migration, lack of specialized manpower.

The better exploitation of existing human resources in the basin and the creation of job in agricultural sector is a relevant challenge for the development of the area.

This challenge is related to job creation, industry and tourism, population and settlements, irrigated cropland, rainfed cropland in the FCM.

# Annex I

**Table I.1: documentation of the factors in the cognitive map**

|  |  |  |
| --- | --- | --- |
| Number | Name of factor | Definition |
| f1 | Precipitation | Irregular and high intensity regime of precipitation  |
| f2 | Surface water and ground water | Volumes of water in rivers and the level of aquifers. |
| f3 | Soil water reserve | Volume of water that is stored in the soil |
| f4 | Flooding | Natural extreme event. |
| f5 | Soil degradation | Causedby heavy precipitationonbaresoils and slopyareas. |
| f6 | Water availability in reservoirs | Volume of wáter mobilized in dams,hilllakes, etc. |
| f7 | Irrigated cropland | Irrigated perimeters that are created downstream after the construction of the dam. |
| f8 | Water quality | Refers to pollution of rivers and aquifers by industrial zone that is recently created. |
| f9 | Forest resources | Various species of forest (productive and protectress species). |
|  |  |  |
| f10 | Water demand | Waterdemand of different sectors (Agriculture, potable, industry and tourism). |
| f11 | Soil and water conservation techniques | Limited within thecatchment, they are located on slopy upstream farmlands to collect runoff water. |
| f12 | Job creation | Creation of jobs in agricultural and environmental sectors to promote developement in the region. |
| f13 | Forest fire | Disaster that can be natural or anthropogenic. |
| f14 | Industry and tourism | Includes different enterprises, factories ,olive presses and thermalstations, etc. |
| f15 | Population livelihood and settlements | Includes all population categories and settlements in different sectors based on promoting new agricultural and environmental projects |
| f16 | Pasture and cattle raising | Developed mainly in Rural communities. |
| f17 | Rainfedcropland | Land contains crops that rely on rainfall. |
| f18 | Dry periods | Succession of dry years. |

**Table I.2: documentation of the relationships in the cognitive maps**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | Precipitation | Surface water and ground water  | Soil water reserve | Flooding | Soildegradation | Water availability in reservoirs | Irrigatedcropland | Water quality | Forest resources | Water demand | Soil and water conservation techniques | Job creation | Forest fire | Industry and tourism | Population livelihood and settlements | Pasture and cattleraising | Rainfedcropland | Dry periods |
| Precipitation | 0 | 0,9 | 0,9 | 0,6 | 0,3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Surface water and ground water  | 0 | 0 | 0 | 0 | 0 | 0,6 | 0 | 0,6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Soil water reserve | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,3 | 0 | 0 | 0 | 0 | 0 | 0 | 0,6 | 0,6 | 0 |
| Flooding | 0 | 0 | 0 | 0 | 0,3 | -0,3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Soildegradation | 0 | 0 | -0,6 | 0 | 0 | 0 | 0 | -0,6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Water availability in reservoirs | 0 | 0 | 0 | 0 | 0 | 0 | 0,6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigatedcropland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0,3 | 0 | 0,9 | 0 | 0,6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Water quality | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Forest resources | 0 | -0,3 | 0 | 0 | -0,6 | 0 | 0 | 0,3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Water demand | 0 | 0 | 0 | 0 | 0 | -0,6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Soil and water conservation techniques | 0 | 0 | 0,6 | -0,6 | -0,6 | 0,6 | 0 | 0 | 0 | 0 | 0 | 0,3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Job creation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,6 | 0 | 0 | 0 |
| Forest fire | 0 | 0 | 0 | 0 | 0,6 | 0 | 0 | 0 | -0,6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industry and tourism | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0,3 | 0 | 0,3 | 0 | 0,3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Population livelihood and settlements | 0 | 0 | 0 | 0 | 0 | 0 | 0,3 | -0,6 | -0,6 | 0,6 | 0 | 0 | 0,6 | 0 | 0 | 0,6 | 0,3 | 0 |
| Pasture and cattleraising | 0 | -0,3 | 0 | 0 | 0,6 | 0 | 0 | 0 | -0,3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rainfedcropland | 0 | -0,3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dry periods | 0 | -0,6 | 0 | 0 | 0,3 | -0,3 | 0 | 0 | -0,3 | 0 | 0 | 0 | 0,6 | 0 | 0 | -0,3 | -0,3 | 0 |

**Table I.3: documentation of the reasoning behind the relationships in the cognitive maps**

|  |  |  |
| --- | --- | --- |
| From | To | Justification |
| F1 Precipitation | F2 Surface and groundwater | Strong positive relation because a fraction of precipitation reaches rivers directly as runoff or, indirectly, through deep drainage to groundwater and stream base flow. |
| F1 Precipitation | F3 Soilwater reserve | Strong positive relation becausea fraction of rainfall infiltrates into the soil and is available for plants.  |
| F1 Precipitation | F4 Flooding | Medium positive relation as flooding occurs occasionally |
| F1 Precipitation | F5Soildegradation | Strong positive relation because precipitation is the main reason of the soil degradation in the Rmel watershed |
| F2 Surface water and ground water | F5 water availability in reservoirs | Medium positive relation because the water in reservoirs does not come only from surface water and groundwater ,it comes from precipitations also |
| F2 Surface water and ground water | F8 water quality | Medium positive relation displays that surface water can affect the quality of water |
| F3Soil water reserve | F9 Forest resources | Low positive relation because the soil water reserve could maintain the growth of forests |
| F3Soil water reserve | F16 Pasture and cattle raising | Medium positive relation because the more we have water the more grass we have for the cattle |
| F3Soil water reserve | F17 Rainfedcropland | Medium positive relation because rainfed croplands depend on water |
| F4 Flooding | F6 Water availability in reservoirs | Low negative relation due to the damage that could be done by flooding  |
| F4 Flooding | F5 Soil degradation | Low positive relation because flooding may cause runoff that leads to the soil degradation |
| F5 Soil degradation | F3Soil water reserve | Medium negative relation because when soil is degraded its retention capacity decreases |
| F5 Soil degradation | F8 water quality | Medium negative relation because when soil is degraded the salinity increases and affects water quality |
| F6 Water availability in reservoirs | F7 Irrigated cropland | Medium positive relationbecausewhenwehavewater in reservoirstheirrigatedcroplandwill not depend only on rainy seasons |
| F7 Irrigated cropland | F8 water quality | Low negative relation because of the use of fertilizers and pestisides |
| F7 Irrigated cropland | F1 Water demand | Strong positive relation because of the water-consumingcrops (watermelon, tomatos…) |
| F7 Irrigated cropland | F12 Job creation | Medium positive relation because developed agriculture attract in somehow employers |
| F9 Forest resources | F2 surface water and ground water | Low negative relation because in somewise with more forest we have more trees consuming water from aquifers |
| F9 Forest resources | F5 Soil degradation | Medium negative relation because forest resources contribute in protecting the soil |
| F9 Forest resources | F8 water quality | Low positive relation because forest protect soil from degradation and eventually the wáter quality,moreover the growth of forest does not require fertilizers so the water quality is intact |
| F10 Water demand | F5 water availability in reservoirs | Medium negative relation because when the water demand goes up the water availability decreases especially in summer |
| F11 soil and water conservation techniques | F3 soil water reserve | Medium positive relation because these techniques would decrease the runoff so the soil water reserve is preserved |
| F11 soil and water conservation techniques | F4 Flooding | Medium negative relation because these techniques can lessen the impact of flooding |
| F11 soil and water conservation techniques | F5 Soil degradation | Medium negative relation because these techniques can in somewise lessen the impact of therainfall and runoffthat causethesoildegradation |
| F11 soil and water conservation techniques | F5 water availability in reservoirs | Medium positive relation because these techniques provide the protections of reservoirs and do not allow sediments to reach reservoirs. They keep the storage capacity of the reservoirs |
| F11 soil and water conservation techniques | F12 Job creation | Low positive relation because these thechniques in somhow require workers and fundings!  |
| F12 Job creation | F15 population livelihood and settlements | Medium positive relation because more jobs may attract more people |
| F13 Forest fire | F5 Soil degradation | Medium positive relation because fire will damage plants and trees so it will accelerate the soil degradation |
| F13 Forest fire | F9 Forest resources | Medium negative relation for the fact that more fires destroy forest resources |
| F14 Industry and tourism | F8 water quality | Low negative relation because of the waste water of factories, olive presses… |
| F14 Industry and tourism | F10 Water demand | Low positive relation because growing industry and tourism need somehow more water |
| F14 Industry and tourism | F12 Job creation | Low positive relation because when the industrial and touristic sectors grow, they create jobs |
| F15 population livelihood and settlements | F7 Irrigated cropland | Low positive realtion. For the fact that more population would require more needs for food production |
| F15 population livelihood and settlements | F8 water quality | Medium negative relation because the growth of population livelihood affect the water quality |
| F15 population livelihood and settlements | F9 Forest resources | Medium negative relation because of the growth of urbanization. |
| F15 population livelihood and settlements | F10 Water demand | Medium positive relation becausewhenpopulationgrows,itneeds more water |
| F15 population livelihood and settlements | F13 Forest fire | Medium positive relation and this is due to the lack of awareness to the importance of forest resources |
| F15 population livelihood and settlements | F16 Pasture and cattle raising | Low positive realtion.Thisrelationdueto the fact that when jobs are created they will target the population livelihood so pasture and cattleraisingincreases |
| F15 population livelihood and settlements | F17 Rainfedcropland | Low positive realtion. For the fact that more population would require more needs for food production |
| F16 Pasture and cattle raising | F2 surface water and ground water | Low negative relation because more cattle means more needs in water |
| F16 Pasture and cattle raising | F5 Soil degradation | Medium positive relation because of the overgrazing and overexploitation of thevegetation and thesoilcover |
| F16 Pasture and cattle raising | F9 Forest resources | Low negative relation because of the overgrazing |
| F17 Rainfed cropland | F2 surface water and ground water | Low negative relation because rainfed croplands depend on surface and ground water coming from precipitations |
| F18 Dry periods | F2 surface water and ground water | Medium negative relation because in dry periods surface water and groundwater are the most important water supply |
| F18 Dry periods | F5 Soil degradation | Low positive relation because in dry periods vegetation cover will decrease and during autumn period precipitations on bare soils will probably lead to soil loss. The evaporation process is active during dry periods and leads generally to the salinisation of the soil surface (bring the salt on surface) |
| F18 Dry periods | F5 water availability in reservoirs | Low negative relation because in dry periods there is a frequent use of water from the reservoirs |
| F18 Dry periods | F9 Forest resources | Low negative relation because in dry periods forest resources became more fragile |
| F18 Dry periods | F13 Forest fire | Medium positive relation because high temperature can ignite fire |
| F18 Dry periods | F16 Pasture and cattle raising | Low negative relation because in dry periods pasture and cattle raising are affected due to the vegetation shortage |
| F18 Dry periods | F17 Rainfedcropland | Low negative relation because in dryperiodsrainfedcroplands are affected because of lack of precipitation |