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ROYAUME DU MAROC

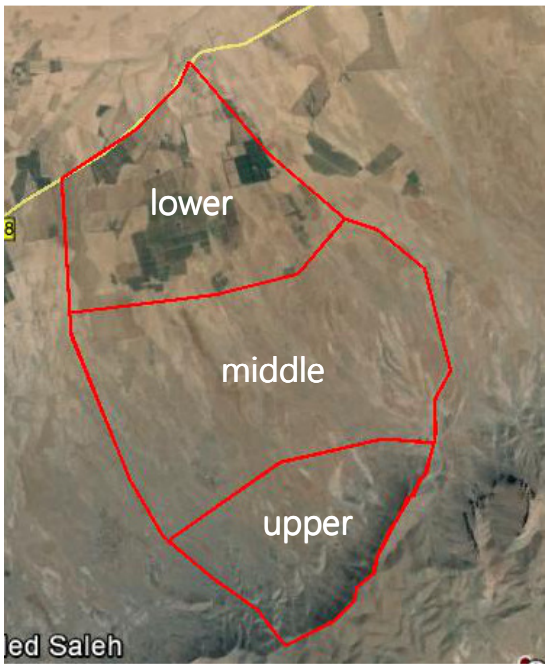
Ministère Délégué Chargé de l'Environnement
Observatoire Régional de l'Environnement Et du Développement Durable Marrakech-Safi

Interventions for the demonstration project of the Hydrologic Corridor Morocco

9 May 2016

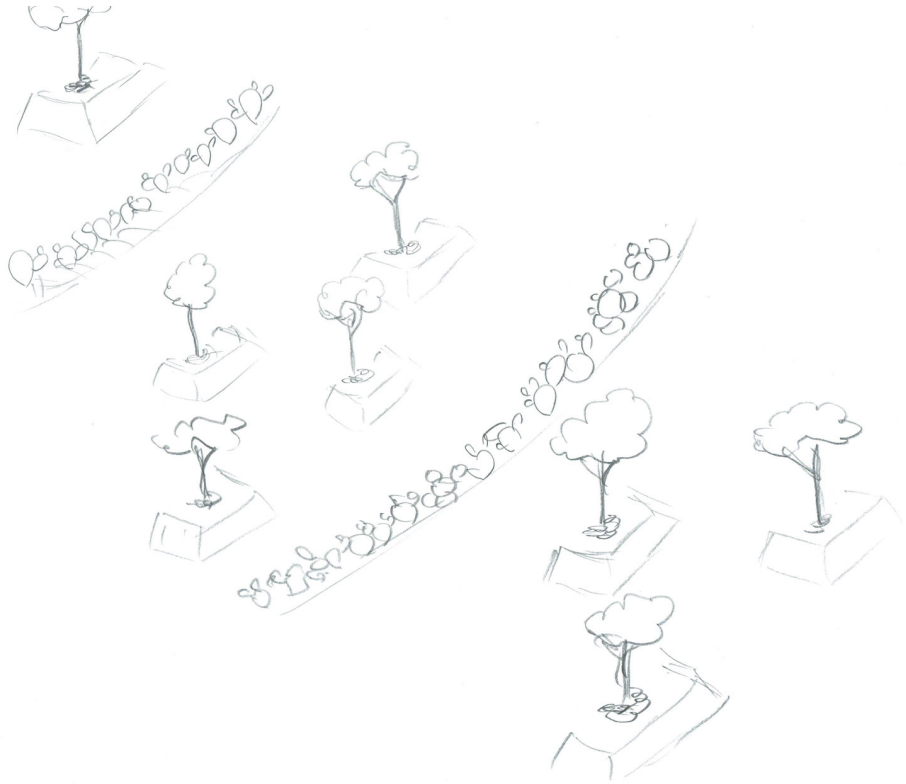
The Interventions

Naga Foundation made an initial proposition of a range of possible interventions in the three subzones of the demonstration project area. These have been extensively discussed in various meetings with regional and provincial governing bodies The consultations led to the selection of a smaller set of interventions, which are, of course, still subject to modifications as they have to be discussed with the families and household members living in the demonstration area.



The three catchment areas

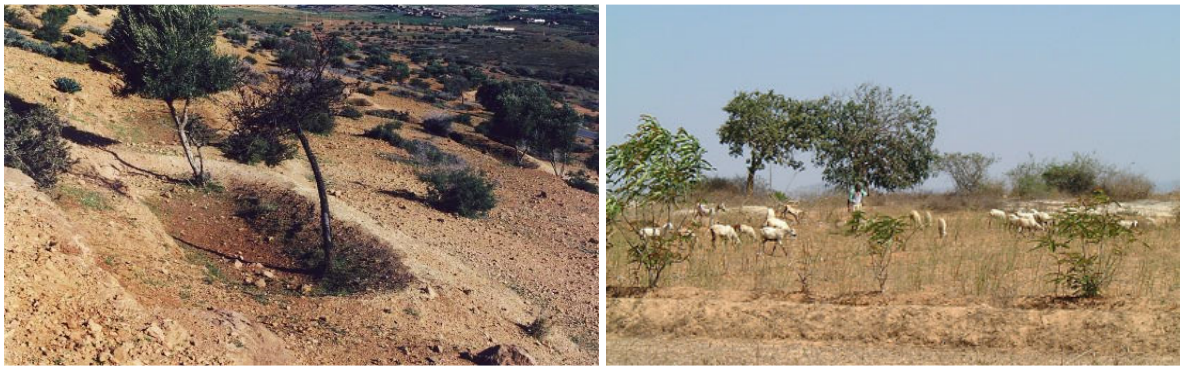
Upper catchment



Sketch impression of interventions in the upper part of the catchment (to be edited)

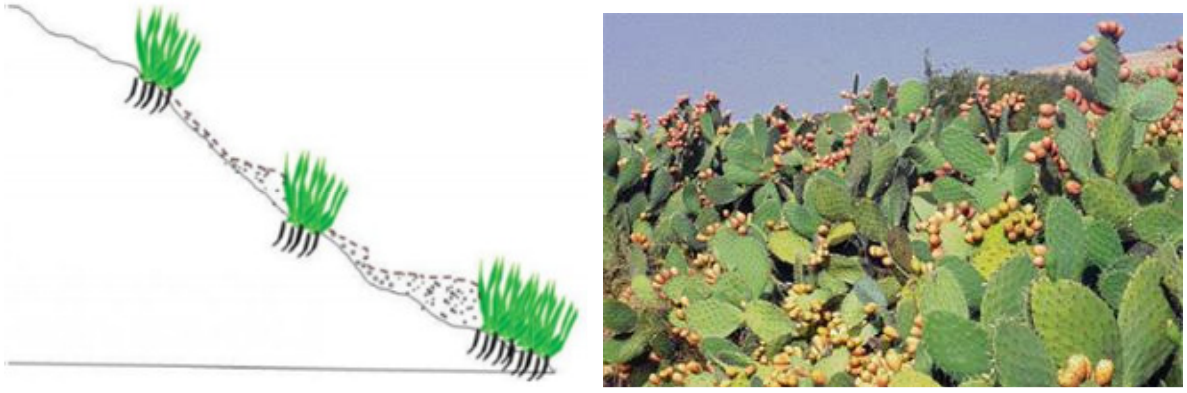
The upper catchment is characterized by sparse woody vegetation and bare slopes. There are several re/afforestation projects with plantations of cactus, promoted and subsidized by the Direction de l'Agriculture. Much of the foothills is used as grazing ground.

In this subzone, the objective is to reduce soil erosion, prevent downstream flooding when intense rains occur, retain runoff water and sediments to both stimulate the regeneration of natural vegetation and assist saplings of newly planted trees. Environmental objectives have to go hand in hand with social and economic concerns directed at improving local livelihoods and providing rural families with additional sources of income. To achieve these multiple objectives, in these upper lands we propose the integration of reforestation with soil and water conservation based on ***elements de banquettes***. Elements de banquettes are a type of terraces made of earth bunds of variable height (50 cm on average) and length (5 m in our case) that are built along contours in staggered rows, which allows trees to capture runoff more effectively. Additionally, both farmers and shepherds can circulate more easily, which increases the likelihood of adoption compared to continuous benches. The width of the earth bunds is generally 1-2 m and the spacing along the same line around 5 m. Elements de banquettes are suitable to harvest runoff water in arid and semi-arid regions and on steep slopes (20-40%).



Elements de banquettes (left) and a controlled grazing around trees (right)

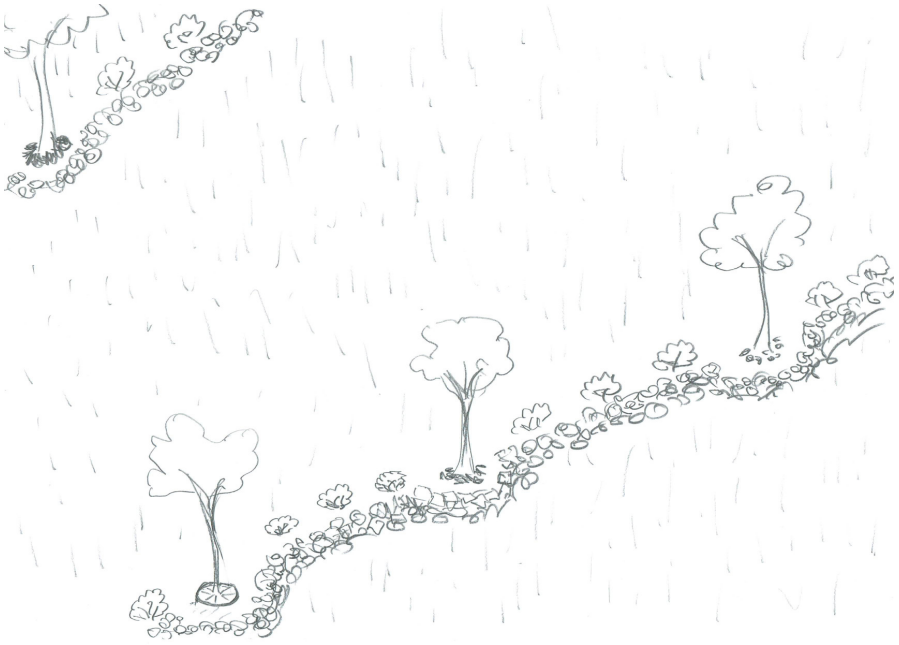
The tree species considered for this project are multipurpose (food/fodder/soil and water harvesting/timber/medicinal) and with high tolerance to water stress. Possible trees could be carob tree, olive, almond, acacia gummifera, tamarix casuarina. The idea is to plant a number of different species to improve biodiversity and related ecosystem services such as stimulating below and above ground microbial diversity and activity, attract beneficial insects (pollinators, bees), enhance the effect of different rooting systems on soil structure and health and so on. The ultimate decision on tree species will be done in consultation with members of the local community and authorities. Planting pits will be enriched with compost to improve soil structure and microbial activity, to supply nutrients to the saplings and to increase soil's water holding capacity. If possible, compost will be inoculated with mycorrhizae, symbiotic fungi that colonize tree roots and substantially increase nutrient and water uptake by plants. Tree plantations on elements de banquettes will be interposed with **living barriers** of cactus and Atriplex to further slow and retain runoff.



The concept of living barriers (left) with cactus (right)

Because pastoralism is a main livelihood and production system in the area, a sufficiently large area will be left as **grazing land**. This area will be defined matching the carrying capacity of the land to the number of livestock, but also considering social and cultural perspectives.

Middle catchment



Sketch impression of interventions in the middle catchment

This area is characterised by sparse trees and shrubs and is used mostly for grazing and rain fed cultivation of wheat and barley during the rainy season. The objective here is to increase the complexity and biodiversity of the system by facilitating the establishment of an **agro-forestry system** based on alley cropping of fruit and multipurpose trees combined with the cultivation of cereals and **fodder/cover crops between the rows**. Because water is the main limiting factor, the rows of trees will be widely spaced at 20-25 m with a distance of 5 m between trees on the line to avoid competition. In between the trees (or between the lines) **herbs** will be planted for increased water retention, biodiversity and income generation.

Tree species considered are olive, drought tolerant cultivars of almond, carob (*ceratonia silique)*, pistache (*Pistacia vera)*, and other. Again, the final choice of species will be done together with the local community and shall reflect their preferences and needs. The soil is scattered with rocks and stones, which can be used to construct stone bunds just downward of the tree lines, along the contour lines. **Stone bunds** in combination with trees will slow down runoff and retain it in the soil increasing soil moisture available for the intercrop.

Stone bunds with trees and fodder/food crops in between the rows

The planting pits will be prepared with **compost** (available from local manufacturers) to both nourish the soil and the saplings, biochar, mulching or waterboxxes.

Biochar is a product obtained from the pyrolysis (anaerobic combustion) of organic material, it is a very stable source of carbon and has multiple benefits such as stimulating soil microbial activity, buffering soil pH, improving soil structure, improving nutrient availability to plants and, very importantly, increasing soil water holding capacity.

Mulching is the process of covering the soil surface around the plants to create congenial conditions for the crop growth. Organic material (e.g. wood chips) can be used to cover the soil for the purpose of improving soil conditions, inhibiting weed growth and retaining moisture.

Additionally we would like to test **waterboxxes**[1]. These are buckets made of recycled paper that function as a plant incubator, sheltering both a newly planted sapling and the ground around it from the heat of the sun, while providing water for the plant. The lid collects water from rain and night time condensation, which is then stored in the bucket. The box acts as a shield for the water in the upper ground, and this water then spreads down and out instead of being drawn to the surface and evaporated.

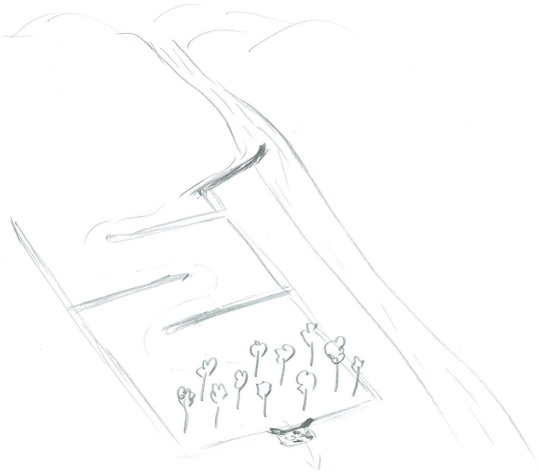
[1] A waterbox has a vertical tunnel in the middle for two trees. A wick allows water from inside the box to trickle into the ground via capillary action. The box's lid is covered by tiny papillae, which create a super hydrophobic surface due to the lotus effect. The lid serves to funnel even the smallest amount of water down siphons into the box's central reservoir. The reservoir releases small amounts (around 50 ml per day) of water into the ground by a wick to water the tree and to encourage the tree to develop a root structure.


Compost (left) and biochar (right)


Mulching (left) and Waterboxx (right)

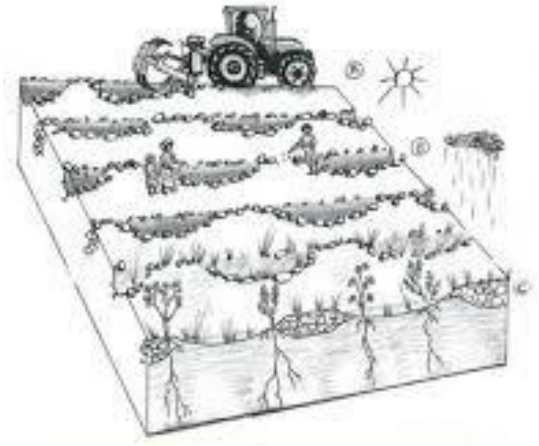
The land between the tree lines is be sown with a blend of different fodder/food crops from the grass and leguminous families. Possible leguminous crops are species from the genus lupin (*Lupinus*), vetch (*Vicia),* lentil (*Lens culinaris*); crops from the grass family are crops from the genus triticum (e.g. rye x durum wheat), oat (*avena sativa)*, barley (*hordeum vulgare)*.
The benefits of intercropping a variety of grass and leguminous crops are i) improved soil structure and soil microbial complexity and activity due to the effect of different root systems and root depths ii) leguminous crops improve nutrient availability (especially N) for the cereal crop by both improving nutrient cycling from deep soil layers and by fixating atmospheric nitrogen iii) improving animal health by providing a more nutritious and complete diet.
A variation of this system is the addition of a strip of cumin and fenugreek in between the tree lines. Besides being extremely tolerant to water stress, these crops are valued spices used in the local cuisine and an important source of income.

At a number of locations we want to apply spate irrigation systems. Spate irrigation is an irrigation technique consisting of diverting seasonal stormwater from valleys, rivers, riverbeds and gullies by gravity onto farmland situated at a lower elevation than the flood water. The flood water is then diverted to the fields.



The concept of spate irrigation (left) and spate irrigation applied in practice (right)

Part of the land will be treated using **Vallerani or Yeomans ploughs** to increase water retention, infiltration and crops yields.



The concept of the Vallerani plough (left) creating micro basins (right)

Because pastoralism is a main livelihood and production system in the area, a sufficiently large area will be left as **grazing land**. This area will be defined matching the carrying capacity of the land to the number of livestock, but also considering social and cultural perspectives.

Lower catchment

In the lower catchment, the interventions proposed focus mainly on **training and capacity building of farmers i**n agro-ecological practices such as intercropping of fruit trees and vegetables and aromatic/medicinal plants, soil regeneration methods (composting, bois rameaux fragmenté, liquid biofertilizers, etc), agro-silvo-pastoral systems integrating free grazing of sheep and free-ranging of chicken between and under the fruit trees. Chicken fertilise the soil below the trees as their manure is rich in phosphorous which is an

indispensable nutrient to stimulate tree flowering. Moreover, chicken reduce potential insect pests as they eat their larvae that hide in the soil and vegetation underneath the trees.

A second line of focus in the lower catchment is the testing of **water saving technologies** in irrigated fruit tree plantations. The system we would like to test is called SWAR, System of Water for Agriculture Rejuvenation[2]. This system allows water savings of 50% compared to drip irrigation with no negative effect on tree growth and fruit production.

SWAR irrigation

[2] Water is pumped to an overhead tank from which it flows through a PVC pipe and gets collected in five-litre moulded and ultra-violet resistant plastic jars placed next to each tree. These jars are kept embedded in two-and-a-half litre clay pots that remain buried in the soil (about 30 cm below soil surface). The cap of the plastic bottle is fitted with a filter to strain impurities and a T-knob to regulate water flow. It remains above the ground so that the farmer can monitor it. Water drips into the clay pot through a hole at the bottom of plastic jar. From each pot two micro tubes half way up the pot, fitted with a sandbag, let water slowly ooze into the soil. After some time the pot begins to sweat and this is based on the suction capacity of the soil and the plant roots. Water supply to the pots is regulated through control levers so that all plants can be reached with gravity flow.