



STUDY FOR THE REALIZATION OF FERTIRRIGATION PILOT PROJECTS IN TUNISIA

FAO Project: "Forest restoration in Algeria, Egypt, Morocco and Tunisia using treated wastewater to sustain smallholders' and farmers' livelihoods" GCP/RAB/013/ITA.

Prof. Masi Salvatore, ing. Rafet Ataoui

University of Basilicata, Potenza (Italy)



- The scarcity of water resources is a global problem.
- Even in the south of Italy there are large areas classified as semi-arid and desertification risk.



SANITARY RISKS

The risks associated with the handling of treated wastewater, alone or in combination, are relatively low.

If conducted in a controlled way, treated wastewater reclamation for agricultural reuse is safe from health risks.

In any case, the level of risk depends on the following aspects:

- **Types of treatment**
- **Irrigated crops**
- **Irrigation techniques**

HEALTH RISKS ASSOCIATED WITH CROPS AND IRRIGATION SYSTEMS

HEALTH RISKS ASSOCIATED WITH CROPS AND IRRIGATION SYSTEMS

RISK LEVEL	TYPE OF CROP	IRRIGATION SYSTEMS
High	<ul style="list-style-type: none">▪ Vegetables to be eaten raw▪ Fruit grown near the ground▪ Gardens and parks	SPRINKLING
Medium	<ul style="list-style-type: none">▪ Vegetables to be eaten cooked▪ Fruits harvested in the irrigation period	INFILTRATION
Low	<ul style="list-style-type: none">▪ Forage consumed after drying▪ Crop seeds (maize, soybean)	DRIP IRRIGATION
Very Low	<ul style="list-style-type: none">▪ Fiber crops (cotton, hemp)▪ Energy crops	SUB-SOIL IRRIGATION

WASTEWATER IS WIDELY USED IN AN UNCONTROLLED WAY



GENERAL ASPECTS OF WASTE WATER TREATMENT FOR REUSE

Currently for wastewater reuse trying to achieve the same quality of natural surface water.

This is true in particular for the content of pathogenic microorganisms.

In this way, however, are lost almost entirely agronomically useful substances contained in the wastewater

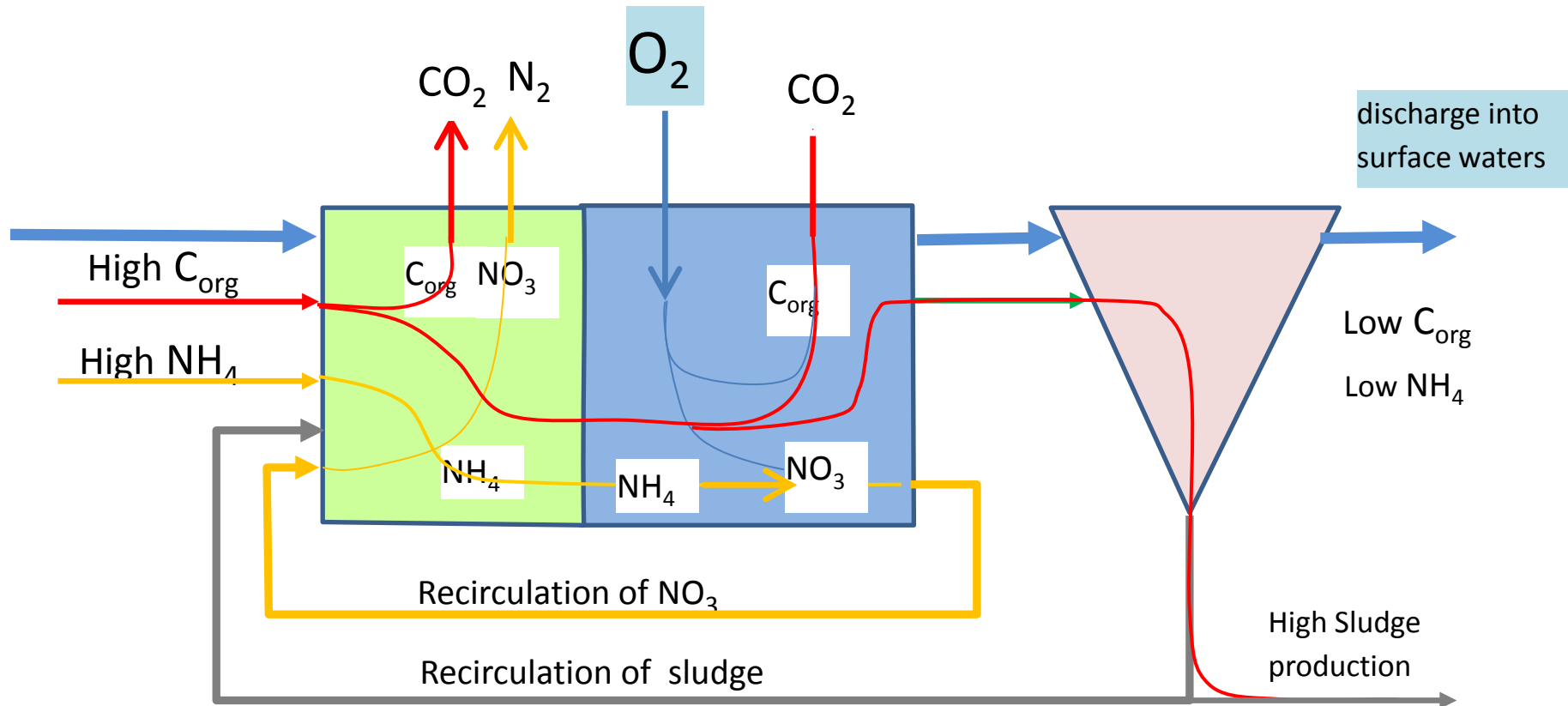
- organic carbon
- nitrogen
- Phosphorus.

These substances are subsequently added to the soil for their enrichment and for fertilization.

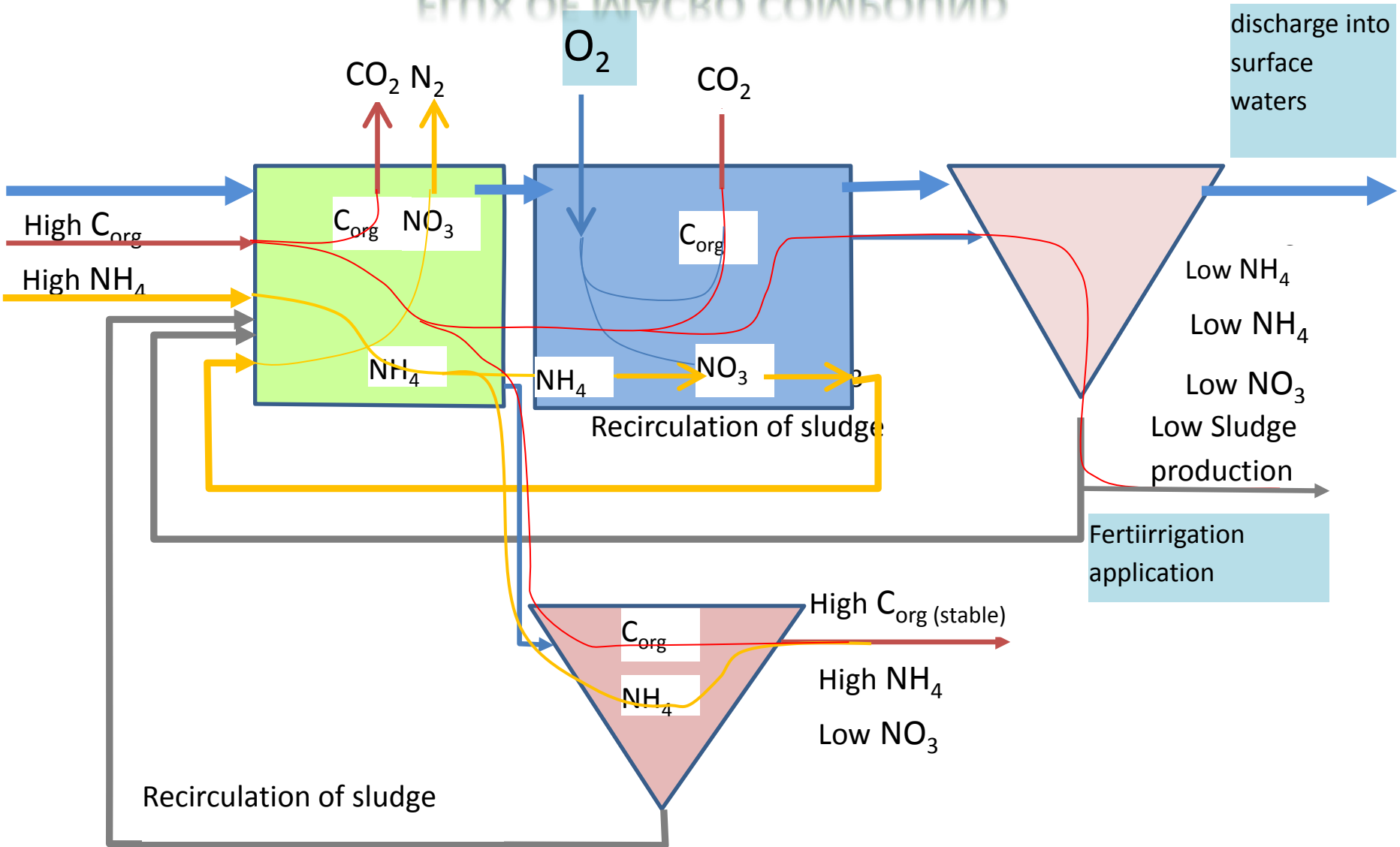
The innovative idea is to operate a controlled and selective removal of these substances.

CONVENTIONAL SCHEME OF TREATMENT:

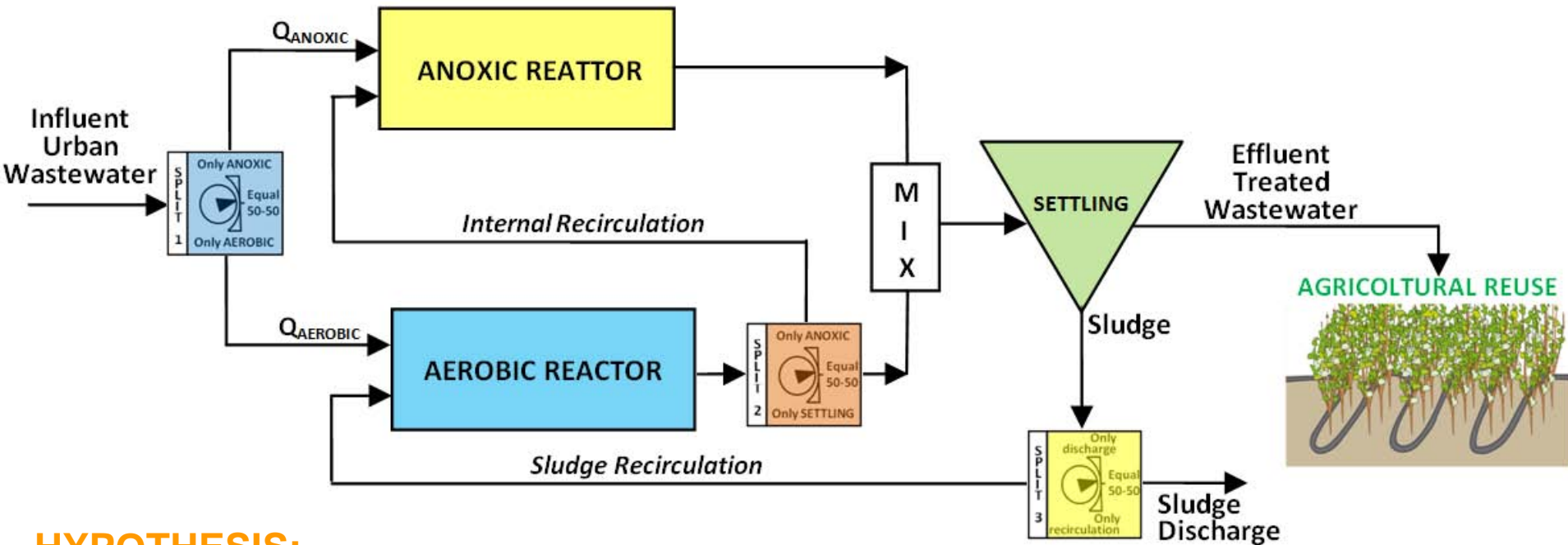
FLUX OF MACRO COMPOUND



INNOVATIVE SCHEME OF TREATMENT: FLUX OF MACRO COMPOUND



LOW REMOTION SCHEMES FOR WASTEWATER AGRICULTURAL REUSE



HYPOTHESIS:

partial, selective and modular removal of the agronomically useful substances

Main compounds	Wastewater Influent	Treated Wastewater Effluent
<i>Ammonia</i>	<i>High</i>	<i>Low</i>
<i>Nitrate</i>	<i>Low</i>	<i>High</i>
<i>Readily Biodegradable Organic Matter</i>	<i>High</i>	<i>Low</i>
<i>Slowly Biodegradable Organic Matter</i>	<i>High</i>	<i>High</i>

EXPERIMENTAL FIELD

Trees	Mature plants— cv Maiatica (dual purpose)
Distances	8 m x 8 m (156 trees ha ⁻¹)
Soil	Lime – Sandy
Sustainable Management	Spontaneous grassing + pruning mulching material + fertigation controlled



Production (average 2001- 2008)

	Sustainable	Conventional	Sustainable	Conventional
	<i>Kg trees⁻¹</i>		<i>t ha⁻¹</i>	
average	62.4	27.0	9.7	4.2

Sustainable practice

Conventional practice



Short description of the project areas: Kairouan center and Haffouz (TUNISIA)

Experimental Site:



Two experimental sites were selected during the field mission:

- WWTP of Kairouan city;
- WWTP of Haffouz.

Climatic characteristics:

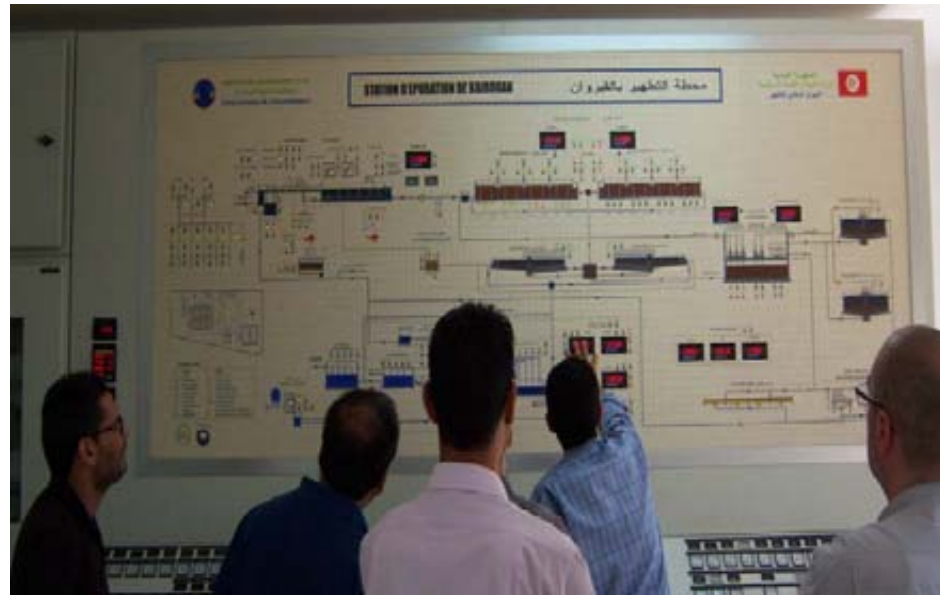
- **Generally, the center of Tunisia is characterized by a semi-arid, continental shade climate with high temperature and modest rainfall, among 200 and 400 mm/yr, in particular Kairouan center and Haffouz city areas are so close and more or less show the same climatic characteristics:**

		J	F	M	A	M	J	J	A	S	O	N	D
Rain (mm)	Monthly Average	38	19	26	36	28	11	0	14	36	36	17	32
	Annual Average	293											
Temp. (C°)	Monthly Average	11.1	12.0	15.3	17.9	22.8	27.2	30.7	30.1	25.3	22.3	16.2	12.4
	Annual Average	20.3											

KAIROUAN TREATMENT PLANT



primary and secondary clarifiers of the WWTP of Kairouan



A descriptive scheme of the WWTP of Kairouan

Technical aspect of Kairouan treatment plant

The treatment plant of Kairouan can treat wastewater coming from the city with a capacity of 14,000 m³/d through a secondary and tertiary treatment.

➤ *Pre-treatment and primary treatment:*

It consists of removing materials that can be easily collected from the raw wastewater before they damage or clog the pumps and skimmers of primary treatment clarifiers;

➤ *Secondary treatment:*

The treatment plant includes 2 surface aerated basins with a total volume of 15600 m³ and a total of 6 aerators providing 2.2 kg O₂/KW, they transfer air into the basins required by the biological oxidation reactions, and they provide the mixing required for dispersing the air and for contacting the reactants;

➤ *Tertiary treatment: Includes;*

- UV treatment which is composed of 3 channels and 12 UV lamps disinfecting 860 m³ of secondary effluent every 1 hour;
- Six sand filters having everyone 1.2 m as sand thickness and 0.4 m of a gravel layer.

The WTP is suitable:

For a higher level of wastewater treatment (tertiary treatment)

To undergone some modifications in order to have a simplified treatment

Cultures with high sensitivity to risk

Irrigation

Cultures with minor sensitivity to risk

Due to the poor resources of the region, this option is considered not economically profitable

More favorable

This site shows all the necessary skills needed to implement the pilot project of Ferti-irrigation



NOTE: IT SHOULD BE NOTED THAT MOST OF THE VOLUME OF TREATED WASTEWATER IS DISCHARGED INTO THE EFFLUENTS, WHICH IN TURN LOSE THEIR PURPOSES WITHOUT BENEFITING FROM THE POTENTIAL CONTRIBUTION THAT MIGHT BRING.

In fact, through the use of the treated wastewater of Kairouan treatment plant, two hypothesis could arise:

First hypothesis



First hypothesis

Problem: the lands surrounding the WWTP of Kairouan are characterized by high soil salinity that make it unexploitable.



Solution:

- discharge a part of the treated wastewater into these areas as a management option (leaching) to reduce the soil salinity;

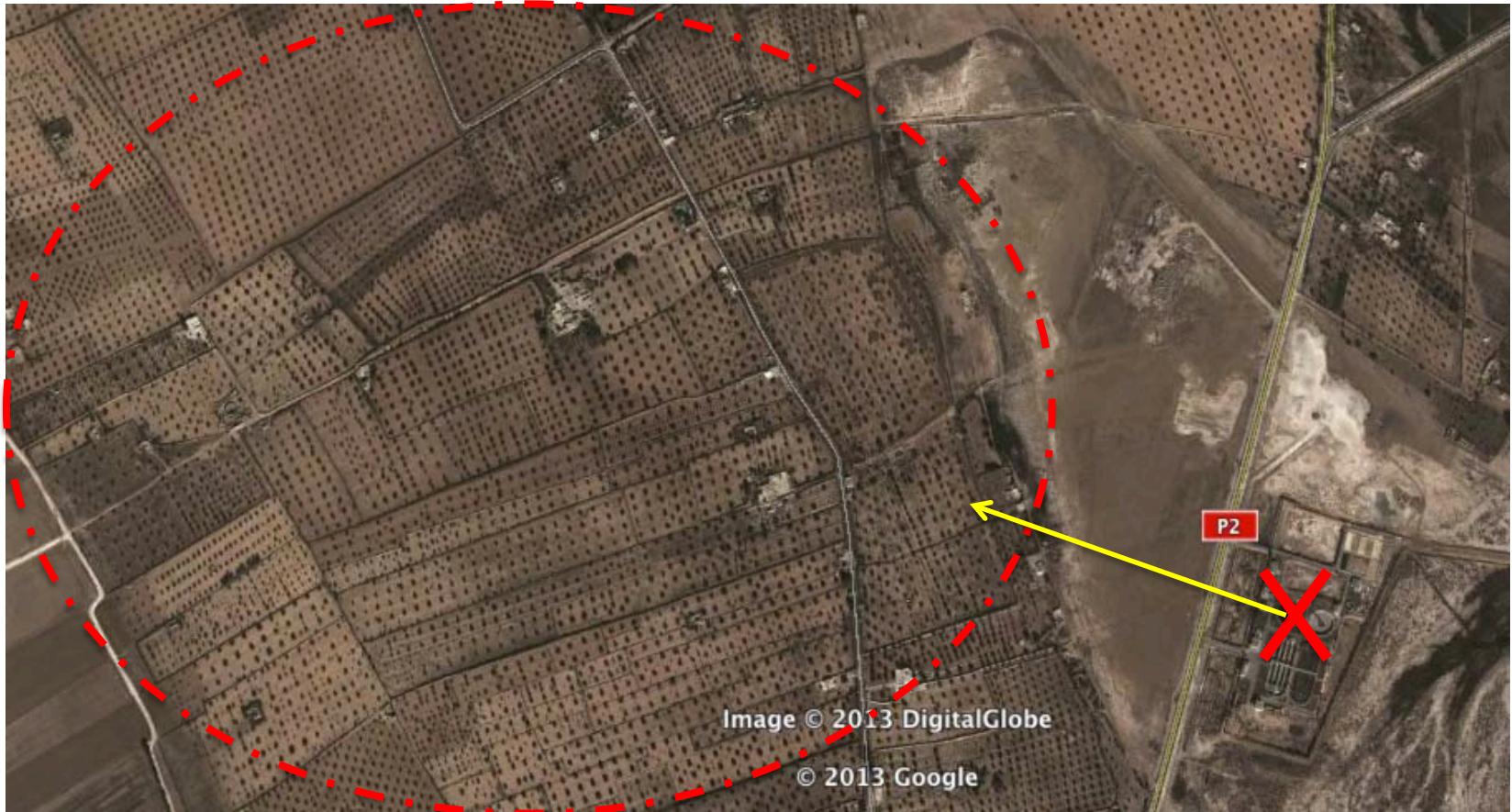


make the land more useful and implant crops for energy purposes (bio-energy).



Second hypothesis

Problem: on the west side of the station, there are large agricultural lands, most of these lands are cultivated by olive trees and are ***not irrigated***



➔ ***The WWTP of Kairouan produce 5Mm³/year of treated wastewater, and considering the average annual rainfall of the region we could irrigate of about 1600 hectares (4*4 km)***

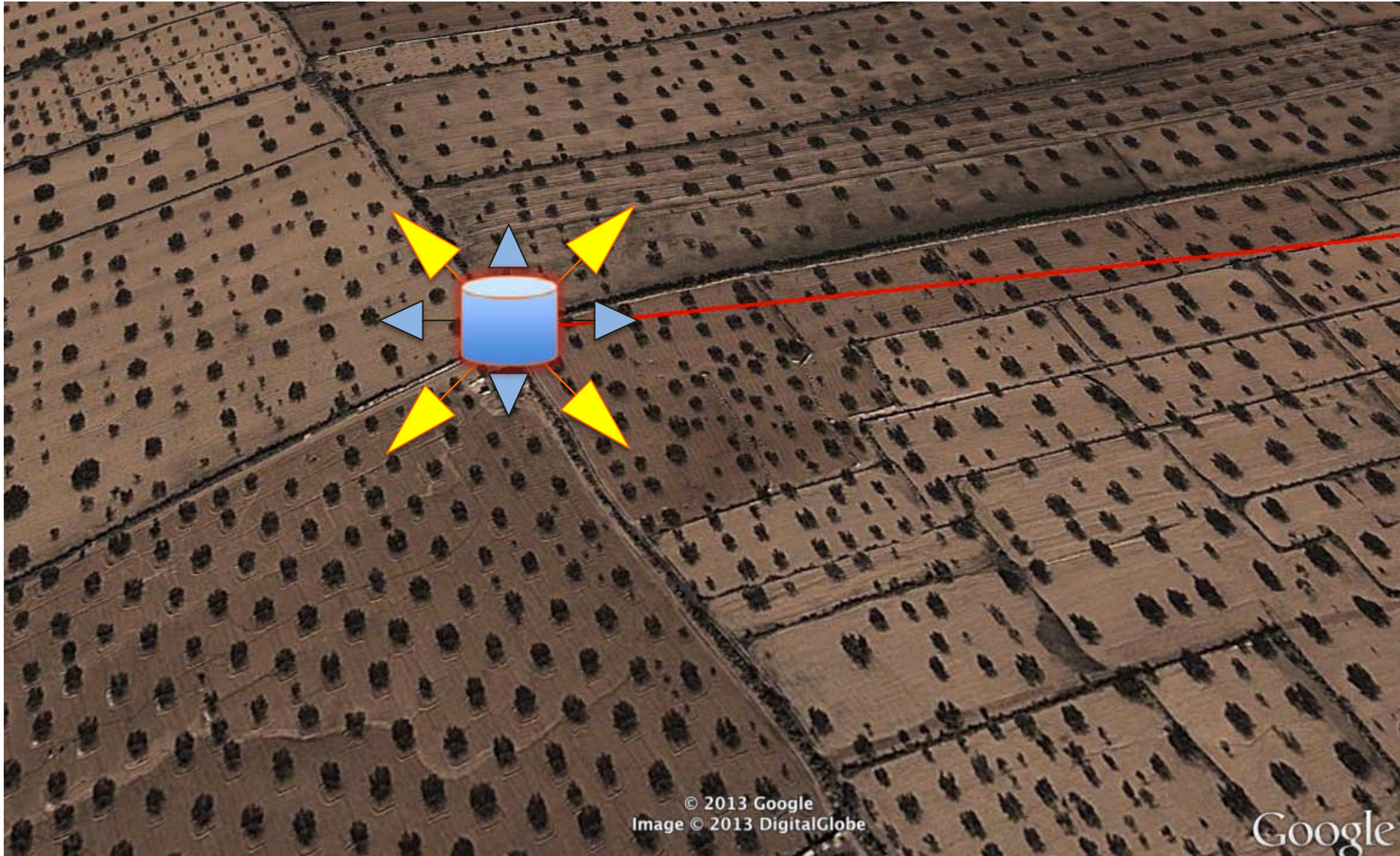
Solution:

- build a storage tank on the uphill side, then pump the treated wastewater produced by the WWTP to the storage tank through a supply pipe (2km). (see path"video")



Solution:

- Use the stored treated wastewater to irrigate the surrounded fields of olive trees.



HAFFOUZ TREATMENT PLANT

HAFFOUZ TREATMENT PLANT



primary and secondary clarifiers of Haffouz WWTP



Second settlement tank



Drying beds

Technical aspect of Haffouz treatment plant

- The WWTP of Haffouz is located at 41 km west of Kairouan center;
- The wastewater is coming from Haffouz town (60000 inhabitants) with no risk of pollution from heavy metals;
- the treatment plant treats wastewater between 500-700 m³/h with a tertiary treatment;
- The treatment plant is surrounded by public and private lands, most of them; are dedicated to agriculture and cultivated by olive trees, also, the forest domain is very close (2Km);
- *The WWTP of Haffouz produce 4Mm³/year of treated wastewater, and considering the average annual rainfall of the region we could irrigate of about 1400 hectares (3.5*4 km).*

This site shows all the skills to carry out the pilot project of fertigation.

First hypothesis



- build a storage tank on the uphill side, then pump the treated wastewater produced by the WWTP to the storage tank through a supply pipe. (click on the image above to see the path)

~~SECRET~~



- Use a part of the treated wastewater to Irrigate olive trees which are located in the down side of the WTP (no need to pump water). *More favorable than the first hypothesis.* (click on the image above to see the path)

Second hypothesis



THE AGRICULTURAL AREA OF ZAOUIET SOUSSE

- Olive trees and other crops are irrigated by the treated wastewater supplied by the WWTP of Sousse



➔ The figures show that the use of wastewater in this zone was very beneficial for agricultural production in terms of quantity and quality.

THANKS FOR YOUR ATTENTION