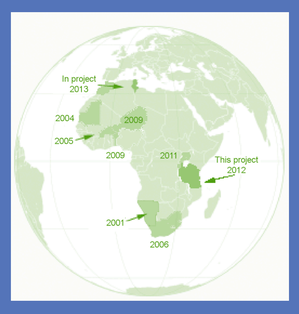

SNMR PROJECT IN AFRICA

Direct groundwater detection

Knowledge transfer

Fundació Privada Marcel Chevalier

UNESCO's Participation Programme 2012-2013

Participation Programme is a mechanism to support the regional, subregional or national activities of Member States that are in line with the global priorities of the Organization, and that benefit National Commissions for UNESCO principally. Particular attention is given to the global priorities fixed by the Organization (Africa and gender equality), and to our priority target groups (least developed countries, developing countries, countries in post-conflict or post-disaster situation, small island developing states and countries in transition).

Surface Nuclear Magnetic Resonance technique and experience

Surface nuclear magnetic resonance is a non-invasive groundwater-exploration method that allows a direct determination of the water content and eventually the estimation of discharge. While the efficiency of the MRS applied to groundwater related studies is already proved in developed counties, only few experiences were carried out in Africa: Namibia (2001), Mauritania, Marocco and Western Sahara (2004), Burkina Faso (2005), South Africa (2006), Niger and Benin (2009), Ruwanda & Uganda (2012).

SNMR technology use the natural Earth's magnetic field to energize the free hydrogen atoms in the nature, and in nature, only water and hydrocarbons molecules have such free hydrogen atoms, so in theory if any NMR signal is detected, that would be originated mostly from water (river, lake, reservoir, groundwater). The Magnetic Resonance Sounding (MRS) technique is specially designed to detect groundwater, in which the possible water molecules are energized by pulses of alternating current at the proper frequency (Larmor frequency) transmitted into a loop laid on the ground. The information obtained allows to detect the water content at different depth and the mean pore size, both parameters useful to determine the prospects of a groundwater reservoir BEFORE DRILLING

The pilot study will integrate all the scatered experiences on SNMR done untill now in Africa by different research groups. That previous experience showed us the technical and metodological problems, the device choice and hardware configuration. That is specialy important in the case of Tanzania because the low strength of the Earth's magnetic field hapens, while in Tunisia is rather moderate and the study will be valid for mostly al the Arab Maghreb region.

Tunisia

Tunisia is the Northernmost country in Africa surronded by the Mediterranean Sea to North and East. Its area is almost 165,000 square kilometres with an estimated population of just over 10.4 million. Tunisia is the smallest of the nations situated along the Atlas mountain range. The South of the country is composed of the Sahara desert with much of the remainder consisting of particularly fertile soil and 1,300 kilometres of coastline. The agricultural sector stands for 11.6% of the Gross Domestic Product, industry 25.7%, and services 62.8%. Climate is temperate in the North, with mild rainy winters and hot, dry summers. The terrain is mountainous (Figure 1), which, moving South, gives way to a hot, dry central plain. In the Khroumerie, the northwestern corner of the Tunisian Tell, elevations reach 1,050 metres and snow occurs in winter. The south is semiarid and merges into the desert. Surface water resources (56%) are the most used (90%), while groundwater (44%) can be subdivide in shallow aquifers (< 50 m depth) and are mostly overexploited, deep ones are 80% used.

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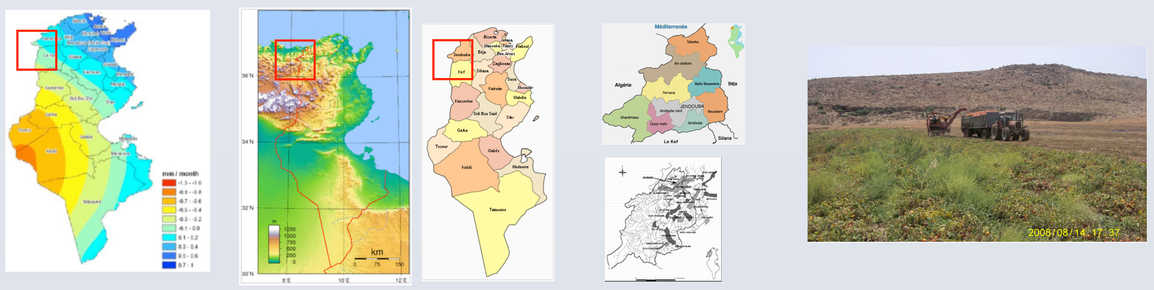
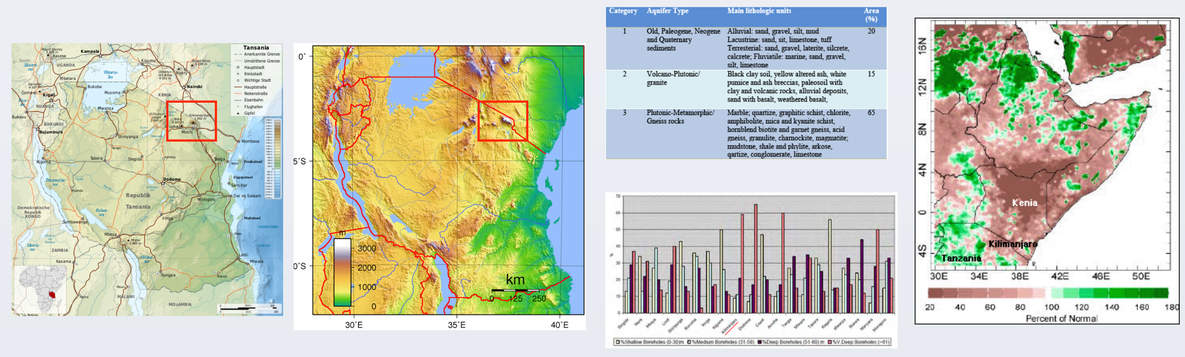


Figura 1: *Trend in terrestrial water storage from the 2003-2008 based on GRACE satellite data, where blue areas indicate increases in terrestrial water. Physical and administrative regions of Tunisia and localisation of the surveying area Jendouba region had 3,102 Km2 and a population of 420,500 persons. The water supply on urban areas is 100% while on rural areas 74%. The 25% of the agriculture surface (170,000 Ha) is irrigated with dammed water and groundwater exploitation. Shallow acquifers in the Northwest zone of Tunisia. According to the whole Tunisia 2000 inventory, the renewable potential of phreatic aquifers is estimated at 736.7 million m3/year. Their net rate of development is 106% from 123 000 phreatic wells. Phreatic water reserves are overexploited at the rate of 104 %. The rural Jendouba have the lowest access to water in all of Tunisia, so the SNMR survey point out in the needest region of Tunisia.*

The impact of crop water deficit on yield is accounted for through the linear crop-water production function developed by the FAO (Food and Agriculture Organization of the United Nations). In the future scenario, temperature systematically increases, whereas precipitation increases or decreases depending on the location and the period of the year. Mean annual precipitation declines in Jendouba and raises in Kairouan (central Tunisia). Under climate change, the water conditions needed for sowing occur earlier and cycle lengths are reduced in both locations. Crop water deficit and the corresponding deficit in crop yield happen to be slightly lower in Kairouan; conversely, they become higher in Jendouba.The global assessment of water resources gives a real evaluation of the possibility of the agricultural production. When applied to the Tunisian water balance, this analysis indicates that, the improvement of food security will depend, in the future, on the capacity to manage all the available water in particular by improving the potential of the rain fed agricultureThe aim of the SNMR pilot survey (this project) is to improve the groundwater exploration overall any geological complexity in Jenouba (and furthermore in Tunis) and change the conclusions of report like the previous one (Raport No. 17208) in the future.

Tanzania

Tanzania covers an area of approximately 945,000 Km^2, of which the Zanzibar Islands cover 2,400 Km^2, is also among the least urbanized countries in Sub-Saharan Africa with a population of 36 million people. Except for the coastal belt and islands, most of the country is part of the Central African Plateau (1,000-1,500 m.a.s.l) characterized by gently sloping plains, broken by scattered hills and low-lying wetlands. Agriculture remains the largest sector in the economy accounting for about half of GDP (Gross Domestic Product) and exports, and 70% of rural incomes. The area of the SNMR pilot study is close to the border with Kenya, in the Kilimanjaro area of Tanzania and close to Moshi town (890 m.a.s.l.), a small market town with an urban population of 150,000 and rural population of 402,400 and It is the regional capital of the Kilimanjaro region. Ideal Coffee crops constitute the most rewarding local export. The upper parts in the slopes of Mt. Kilimanjaro receive 1200-2000 mm rainfall per year, and the rest of the area receive only about 500 mm per year. There are two distinct rainy seasons, the short one from mid October to December and the long one from mid March to June. It includes the Pangani Basin. The main supplies are from surface water (about 95 percent), and the remaining water is taken from groundwater sources. There is a significant amount of groundwater potential compared to the other basins in the country. Irrigation is the main ground water use, which accounts for 80 percent of the total use. The areas most prospective for Groundwater irrigation include Mtware, Coast, Morogoro, uvuma, Shinyanga, Kilimanjaro, Kagera, Lindi, Mwanza and Mbeya due to the dominance of unconsolidated sand and gravels water bearing formations that permit yields and the existence of suitable soil for agricultural crop cultivation.



Category	Aquifer Type	Main lithologic units	Area (%)
1	Old, Paleogene, Neogene and Quaternary sediments	Alluvial: sand, gravel, silt, mud Lacustrine: sand, silt, limestone, tuff Terrestrial: sand, gravel, laterite, silcrete, calcrete; Fluvialsile: marine, sand, gravel, silt, limestone	20
2	Volcano-Plutonic/ granite	Black clay soil, yellow altered ash, white pumice and ash breccias, paleosoil with clay and volcanic rocks, alluvial deposits, sand with basalt, weathered basalt,	15
3	Plutonic-Metamorphic/ Gneiss rocks	Marble; quartize, graphatic schist, chlorite, amphibolite, mica and kyanite schist, hornbleud biotite and garnet gneiss, acid gneiss, granulite, charnockite, magnasine, mudstone, shale and phylite, arkose, qartize, conglomerate, limestone	65

Figure 2: *Localisation of the planed SNMR surveying area in Tanzania. The area is close to the Kenia border and on the southern foothill of the Kilimanjaro volcano. Tables and graph with the type of groundwater in Tanzania.* On the east of the Moshi town the Njoro forest in an area of high groundwater fed by run-off from Mt. Kilimanjaro (5,895 m.a.s.l), the 15% of the aquifers from Tanzania are located in volcanic or igneus rocks *drilling depth of wells. The census in 2010 was that a total of 16,124 only 200 catchments are located in the region of Kilimanjaro, most of the aquifers in the area of Kilimanjaro wells are operated by more than 80 m deep (60%) and 20% between 50-80 m deep. The Kilimanjaro region had in 2011 more rain than years before but in general the Eastern Africa a lack of rain water happen in 2011 by the Monsons.*

The Eastern Africa region suffered a severe drought affecting millions of people in the period 2010-2011. Drought is a consequence of the lack of precipitation in the period of "short rains", which typically occur from October to December, and the period of "long rains" that usually occur from March to May related with the monsoon (http://ca.wikipedia.org/wiki/Monso). The lack of rain was expected given short a well established relationship with La Niña (http://ca.wikipedia.org/wiki/La_Niña_clima), but decreased precipitation in the rainy season was not long to predict. Lyon & DeWitt in a recent study (http://www.agu.org/pubs/crossref/2012/2011GL050337.shtml) show that the lack of "long rains" is associated with an abrupt change at large scale pattern recurrence of rainfall around 1999. The authors used observations and climate model simulations show that the abrupt decrease in precipitation in the period of "long rains" in East Africa is associated with marked changes in the temperature of the sea surface, mainly in the tropical Pacific . In Figure 2 you can see how the region between Kenya and Tanzania was below average precipitation in the period March-May 2011.

Conclusions from the 2010 International Water Management Institute study to assess groundwater availability across sub-Saharan countries are, in the case of Tanzania, that there are limited information existing on the present state of quantity and quality of groundwater, and before it can be used for large-scale irrigation or other uses, extensive research is needed. Also the majority of people have inadequate understanding of groundwater resources and this has led to inappropriate development of groundwater. In that sense the SNMR survey in Kilimanjaro area will contribute to a better groundwater knowledge and a new method to improve that situation..

Estimated budget

The project monitoring will be done by the Marcel Chevalier P. Foundation, given to the local Unesco commission all the results and reports once made following the previous exposed schendules. The last year of the biennial the guideline on groundwater exploration on Africa using SNMR technology and techniques will be writen. Is important to note that we shoud start early on the 2013 year because is not possible to work in the raining season between March to May in Tanzania. So is for that we plan to go to Tanzania before the raining season. Survey in Tunisia should be done when Universities open to make the knowledge transference to students.

OUTGOINGS		INCOMINGS	
Equipment	$33704,43	UNESCO	$33704,43
Field work and final report	$47378,76	Fundació Marcel Chevalier	$47378,76
TOTAL	$81083,19		$81083,19