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PUBLIC HEALTH AND WATER ISSUES IN TUNISIA

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Chapter 1

INTRODUCTION

Contrast of Tradition and Modern in Tunisia

by Prof. Naomi Wakasugi

Tunisia is a very interesting country in which both an ancient tradition and modernity are coexisting at the same time. The Phoenicians came from the eastern Mediterranean Sea and founded Carthage (now Tunis) in 814 BC already and controlled the North African coast from western Libya to Gibraltar strait, and ruled over southern European countries such as Spain, Corsica and Sardinia all around Mediterranean Sea. They invented the alphabet and had an advanced writing. After three wars against Rome in which famous military leader Hannibal led elephant mounting team it has been attached to the Roman Empire(148BC~439), followed by long Arab-Islamic dynasty period and French colonial period (1881~1957). In 1957 independent Republic Tunisia was proclaimed.

Such long history left a strong tradition in Tunisia. Water allocation from North to South or the idea of judgment for water sharing with equity were explained to us as a traditional way they have taken since long time. We, Tunisia internship participants have heard often they say "it's our tradition".

In contrast to this, we could see many advanced modernized aspects in Tunisian society now. For example, Tunisia is the first and only country in Africa to have abolished polygamy regime in 1956 and prohibited early marriage. Its progress in family planning policy nationwide since 60's is well known. Also, it should be noted that health system is well developed and free health service is provided to every people. Even they receive and treat 500 thousand patients from Europe a year seeking inexpensive quality medicine of Tunisia.

The objective of our internship was to learn about both Water and Health issues in Tunisia by visiting and hearing experts and public officials in water/environment and public health areas and seeing things on the ground. We visited the capital Tunis and also had a long distance trip to geographically varied regions countrywide, such as CapBon, Nabeul, Kairouan, Tozeur (the nearest to Sahara Desert), Kasserine and Kef. The last day in Tunis at INAT (National Agronomical Institute of Tunis) a synthesis conference was held inviting the experts and public officials of water/ environment and public health to have their lectures and to discuss with us. The detail of what EDL students learned by this internship will be reported later, but I am sure that it was very good for us to have learnt both Water and Health issues together. Because these are closely linked on the ground in everyday life of the people but are not often learnt or investigated in an integrated manner.

Chapter 2

GENERAL SITUATION OF TUNISIA

2.1 Geography

The Republic of Tunisia lies on the Mediterranean coast of Africa, 130 km (80 miles) southwest of Sicily and 160 km (100 miles) due south of Sardinia. It is bordered by Algeria to the west and Libya to the southeast (Figure 2.1). Its total area is 163.610 km2. The landscape varies from the cliffs of the north coast to the woodlands of the interior, from deep valleys of rich arable land to desert, and from towering mountains to salt pans lower than sea level. South of Gafsa and Gabes is the Sahara desert. The 1100 km (700 miles) of coastline is dotted with small islands, notably Jerba in the south and Kerkennah in the east, and from the northwest to the southeast the coastline is backed successively by pine-clad hills, lush pasture, orchards, vineyards and olive groves.

2.2 Climate and vegetation

The climate is Mediterranean in the North and on the East coast, semiarid in the inland and Saharan in the South. Average temperatures vary between 11.4°C (December) and 29.3°C (July). Rainfalls are irregular and concentrated during the cold season (3/4 of the total yearly rainfall): North 800 mm, South 50 to 150 mm. A forest floor in the North and dominant olive trees plants in the Center and Sahel and date palm trees in the south. The main water streams are Oued Medjerda and Oued Méliane.

2.3 Water resources

2.3.1 Precipitation and surface water resources

Tunisia receives on average 230 mm/year of rainfall; that is 36 billion cubic meters (bcm) of rainfall. However, this volume varies between 11bcm during a drought year and 90 bcm during a very wet year.

Figure 2.1: Geographical location of Tunisia

The variability of the climate under the Mediterranean influence in the north and under the Saharan influence in the south makes rainfall at the same time scarce and unequally distributed in space and time. The annual precipitation is on average 594 mm in the north, 289 mm in the center and only 150 mm in the south. The ratio between the highest observed values and the lowest observed values of precipitation vary from 4.4 in the north to 15.8 in the south. Surface water resources in Tunisia are characterized by problems of quantity and quality. These resources are limited because of the dominating semi-arid to arid climate, with episodic droughts, and a natural deterioration of water quality because of the salty types of rocks outcropping within the country.

Surface water resources are estimated at 2700 million cubic meters (Mcm) distributed per year over three natural areas distinguished by their climatic and hydrological conditions as well as by rather homogeneous geomorphologic and geological aspects.

The north provides relatively regular contributions evaluated to 2190 Mcm, thus representing 82% of the total surface water potential while covering only 16% of the country. The center part, covering 22% of the area, is characterized by irregular resources. It provides 12% of the total surface water potential. The southern part of the country which accounts for approximately 62% of the total area is the poorest in surface water, providing very irregular resources evaluated at 190 Mcm which represents 6% of the country's total potential of water.

These inequalities in quantities and quality make water management more difficult and explain the need to transfer surface water from the north to the Sahel and the south in order to improve the drinking water supply and insure equity between regions.

2.3.2 Groundwater potential

The groundwater resource is estimated to 2000 Mcm. It is estimated that 650 Mcm of this resource is non renewable and mainly located in the south. Groundwater is characterized by unequal allocation and variable quality in terms of salinity. Groundwater is distributed as follows:

- The north has 55% of the shallow groundwater resources and only 18% of the deep groundwater resources
- The center provides 30% of the shallow resources and 24% of the deep resources
- The south provides 15% of the shallow resources and has 58% of the deep resources.

Groundwater with good quality is found in only 8% of shallow water and 20% of deep aquifers. Drought is one of the most determinant factors controlling the groundwater quality. In fact, during periods of drought, the salinity of the water stored in shallow aquifers can reach 3.5 g/l due to overdraft as resources are drawn down for both drinking and irrigation.

2.3.3 Total water resources potential

Total water resources in Tunisia are estimated to 4700 Mcm including 650 Mcm of non renewable resources (13.8% of the total water resources). Groundwater resources represent 42.5% of the total potential. Thus, the per capita endowment is about 450 m3 per year. This ratio will reach 315 m3 per capita per year in 2030. This ratio is higher in other Mediterranean countries such as Morocco with a ratio of about 1083 or Algeria, with a ratio of 655.

2.3.4 Use of Water Resources

Irrigation constitutes the largest consumer of water in Tunisia, using 80% of the total water potential in the country. In 2003, agricultural land accounted for about 370,000 hectares. The phreatic water levels irrigated over 150, 000 hectares, while the deep levels irrigated over 70,000 hectares, for a total of 220,000 hectares. Dams irrigates 130,000 hectares, treated wastewater serves to irrigate 7,000 hectares, and the rest is irrigated partly from pumping directly from temporary water sources and partly from natural sources.

The volume of water used for irrigation is estimated at 2,100 million m3 with average consumption per hectare of approximately 5500 m3/year. Consumption reaches 20,000 m3 /hectare / year in the oasis in the South and is on average about 4000 m3/hectare/year in the North.

In 2003, 70% of the total irrigated land was equipped with water conservation systems including drip irrigation, sprinklers, pipes and watertight channels. A group of collectives (AICs) manage the irrigated lands. These associations are responsible for the maintenance of the irrigation network and the distribution of water to their members. Drinking water in metropolitan areas is managed by a national company (SONEDE) that distributes 350 million m3 per year to meet the needs of 1.5 million subscribers. The volume is expected to increase to 450 million m3 by 2030. In rural areas, the administration of the drinking water distribution system is handled by cooperative associations (AIC).

Conflicts between various water users will become more acute in the future. There will be pressure on the agricultural irrigation sector to transfer water to the urban, industrial and tourist sectors; the agricultural sector will need to compensate by strengthening water conservation efforts and water efficiency programs. The small traditional farmer will have problems despite government subsidies which may only postpone their economic failure.

2.4 Health Care System

The health delivery system is predominantly public, with a growing private sector. At the national level, about 88 % of hospital beds belong to the public sector. The main provider of care is the Ministry of Public Health, which is organized into three levels of care.

The primary care level comprises some 2,028 primary health care (PHC) centers, Local Hospitals which are small facilities averaging about 23 beds per facility, and maternity centers, which together account for about 14 % of the bed capacity in the public sector. Primary health care accounts for 27 % of MOPH expenditures.

The secondary health care level is provided by 34 regional hospitals (RHs), which are general hospitals that account for about one-third of the total bed capacity and physician specialists in the public sector. This level absorbs about 25 percent of MOPH budget and receives additional funding through its self-generated revenues and reimbursements by the social security system.

The tertiary health care level is composed of a network of 22 university hospitals (Etablissements de Santé Publiques - EPS) ranging in size from 26 to 1,010 beds, and with an average bed size of 390. They constitute about 50 % of total public sector beds and absorb almost half of the MOPH budget.

There is a growing private sector in health care, accounting for some 12 % of total bed capacity and 70 % of the high-end technology services. In terms of human resources, it employs 50 % of the doctors, 73 % of the dentists, and 80 % of the pharmacists. Private clinics are concentrated almost equally in the large urban zones, and half in the capital city. The private providers are financed largely by direct household spending.

2.4.1 Health coverage and expenditures

More than 80 % of the Tunisian population has access to health care either through a health insurance scheme or a medical assistance program. This is a remarkably high percentage for a country at Tunisia's income level.

Health expenditures have dramatically increased during the past two decades, with an annual average growth rate of 11.7 percent. There are three major sources of financing for health expenditures. In 2004, the State budget from government general revenues constituted 21.8 %, social health insurance contributed about 23.3 %, and direct household spending accounted for 53.6 % (including about 9 percent, which is reimbursed by the voluntary health insurance schemes, and about 1.3 % by the corporate work health services of total health expenditures. Almost half of household expenditures are spent on drugs and about one-third on ambulatory care. Household surveys showed an increase in the share of income that is spent on health, which reached an average of 10 % t in 2000.

The increase in health spending reflects health system dynamics that are affected by economic growth, demographic and epidemiologic transitions, and technological advances. The increase in health expenditures is outpacing the country's economic growth, and most of the increase is being borne by households. Between 1990 and 2003, total MOPH expenditures increased at an average growth rate of 10 %, but its relative share in total health expenditures decreased from 80 % to 64 % over the same period. The increasing reliance on direct household spending would suggest that an increasing share of health financing is being provided through a mechanism that does not ensure adequate risk pooling and social protection for the population.

2.4.2 Epidemiologic Profile

Causes of mortality

Overall, diseases of the circulatory system (e.g., cardiovascular disease) account for the largest percentage, with women having slightly higher rates than men. The second most common cause of death is cancer, followed by violence and respiratory diseases.

The causes of death vary with age: perinatal mortality and malformations represent the largest cause of mortality among children under 5 years of age. For age groups between 5 and 35 years, violent deaths, principally accidents (approximately 40 percent) are the leading cause of death; while among the 45 and older age group, cancers and circulatory disease are the main causes of death.

Maternal and under-five mortality

The maternal mortality ratio (MMR) was 70 per 100,000 population for Tunisia in 1994 based on the last maternal mortality survey. According to MOPH officials, MMR was estimated at 50 per 100,000 population in 2003, based on reports from MOPH health facilities (not confirmed by any surveys). Compared to other MENA countries, Tunisia's MMR is relatively low, but the ratio is not as low as ones for some of gulf countries. It is twice as high in rural areas, in the western part of the country (>90), and in the coastal areas. Maternal deaths occurring during and after delivery represent 70 percent of the total.

Another outcome of the Tunisian emphasis on reproductive health has been a significant improvement in infant and under-five child mortality rates. The Tunisian infant mortality rate (19 per 1,000 live births)was well below the MENA average (43 per 1,000 live births) and other lower-middle-income countries(31 per 1,000 live births). The objective to reach the Millennium Developments Goals (UN/WHO) is an IMR of 13 per 1,000 by 2015.

In line with the decline in infant mortality, under-five child mortality has also declined dramatically from52 (per 1,000 live births) in 1990 to 24 (per 1,000 live births) in 2003; it is currently among the lowest levels in the region.19 Tunisia is, not surprisingly, on track to achieve the under-five child mortality rate MDG (under-five mortality of 16 per 1,000 by 2015). Indeed, these trends of infant mortality and analysis of its causes show that about 50 percent are associated with a respiratory or intestinal infection, which indicates that this is a realistic objective.

Morbidity analysis

In order to clearly present these data, this section has been divided in two parts: the first one gives an overview of problems mainly affecting the adult population; the second part describes the situation invulnerable groups, such as mothers and children, teenagers, and workers.

Communicable diseases

Within the context of the strategy for controlling communicable diseases, a notification, intervention, and surveillance system has been established and directed by the Directorate of Basic Health Services(Direction des Soins de Santé de Base - DSSB).

No indigenous malaria case has been reported since 1979. A few dozen cases (50 in 2002) were imported by Tunisian travelers (sportsmen, workers, businessmen), and foreigners (mainly students originally from endemic areas) are currently diagnosed and treated every year.

As for Tuberculosis, it has been targeted by a specific program, providing free treatment and prevention for the patient and the patient's family. Incidence was about 20 per 100,000 in 2003 and it has decreased regularly over time, with infantile and meningeal tuberculosis now being exceptional.

In addition, hydatid cysts (200 cases in 2003), brucellosis (250 cases), and mucocutaneous leishmaniasis (about 1,700 cases) have not been eradicated from their traditional endemic areas in the Center-West and South.

STD's an HIV/AIDS

The fight against AIDS is multidisciplinary as it involves primary care services, the school health department of the Ministry of Public Health, and national NGOs. A surveillance system has been in place since 1985, when the first cases were detected. From 1985 to 2002, there were 1,125 cumulative cases, of which 387 are deceased. In 2002, there were 188 new cases, of which 66 were Tunisians, divided into 45males (68 percent of cases), 19 females (29 percent), and 2 children (3 percent) who were infected by their mother. Heterosexual contacts and intravenous drug injections, which apply mainly to Tunisians living abroad, are the two main routes of infection. Even though the number of cases has remained stable since 1990 (around 70 cases), it is important to remain vigilant mainly because of the growth of tourism and immigration (legal or clandestine) of people from endemic countries.

Chapter 3

DAILY REPORT

3.1 DAY 1 (Tunis, 28 July 2010)

Reported by K.Kazuna, L.Meihua and Z.Otgonbayar

The international internship group from the University of Tsukuba visited the central authorities of water and public health of Tunisia. Prof. Jamila Tarhouni from National Institute of Agronomy in Tunisia had arranged the visit and accompanied the group.

3.1.1 The SONEDE Head Quarter-Water Authority for Supply and Distribution-National Society for Drinking Water Supply

Mr. Zeriaa Fethi, Central Director of SONEDE made an introduction. He explained that it is national company and according to financial aspect, is semi private company. The company, since 42 years belongs to the Ministry of Agriculture. Also, the company has some water supply and remote drinking water responsibilities in rural area. SONEDE is in charge of urban area and includes supply for half of all population of country. The total length of water supply network is 45000 kilometers. The General Direction is responsible for regional technical and financial management, which includes 58 districts working under the same processes and management methods. Mr. Zeriaa Fethi made brief presentation about water resource and introduced that the total water supply by company values water resources for 10 million citizens, 4.6 million liter water is total capacity per year. It means 450m3/ person. The current supply is 50 %. Prof. Maki Tsujimura added as a comparison that in Japan the water consumption is 250 liter/ day person. Mr. Zeriaa Fethi continued that the total water resource contained from 50 % of surface water and 50 percent groundwater. Water quality and safety are satisfied.

Some water resources show high salinity. Therefore, desalination of sea water for drinking purposes is essential. In 2003, Desalination Program 2050 was adopted. Under this program, efforts were focused on both quantity and quality of water. The Government fixed the consumption tariffs, considering the consumption reason and dividing to five weight blocks, which starts from 0.08USD/m3. The principle is for more consumption, more costs must be paid.

Figure 3.1: General Director of SONEDE giving his speech

Figure 3.2: Prof. Jamila introducing the visitors in SONEDE

Block stage	Consumption m3	Price per m3 (USD)
1	0 - 20	0.08
2	21 - 40	0.15
3	41 - 70	0.20
4	71 - 150	0.40
5	151 and more	0.60

Mrs. Sihem Trimech, Cooperation and Communication Director, presented about cooperation experience of SONEDE. As the organization established in July 1968, the mission was focused on (1) production, (2) distribution and (3) development. Concerning desalination, there are 4 plants processing 18.2 millions m3 of water. Regarding water quality, 47000 samples have been tested with 99% satisfaction of Tunisian and World Health Organization standards. Then Mrs. Sihem Trimech explained the organization of SONEDE. In fact, SONEDE has totally 6875 staff members and its flow chart is basically composed of general director and departments. She mentioned the close cooperation and links with institutions. SONEDE has cooperation with many counties and organizations from Africa and Middle East and it operates international projects in the scope of training of global experts as short and midterm technical assistance. In addition, SONEDE is an international member in African Water Association, Institute of Mediterranean Water and International Arab water council. Every year, SONEDE organizes training for the national and international personnel mainly from African countries. Future perspectives are to establish subsidiary SONEDE international in order to share the knowledge in water treatment and management. Prof. Maki Tsujimura expressed his sincere appreciations for giving lectures on basic knowledge about the general background of water in country. And, he added that the SONEDE has very well organized network in Tunisia. He added that regarding the country's natural water resources and annual rainfall, it is impressing and challenging that water supply reached even the south, where water is a rare resource. Mr. Imed Bellili, Head of GIS project in SONEDE, said that the water management is very traditional, which might started 2000 years ago. Prof. Maki Tsujimura continued that there is one more point, which impressed him, is good international training at SONEDE. Japan does not give such kind of education. And he asked two questions:

- First, in near future global warming will cause severe problem in Mediterranean region, according to modeling, a rainfall amount will decrease. More lands will become arid in coming 50-100 years. According to your long term planning and strategy to sustain water resources, how this issue can be

Figure 3.3: Medjerda canal uptake in Ghedir El Golla plant

Figure 3.4: Pumping station of Ghedir El Golla plant

considered and included in such strategy.

- Second, as there is very good international communication in North Africa and international cooperation, how do you handle international surface water and transboundary water resource issue.

Mr. Zeriaa Fethi answered that it should be seen the climate change history over 100 years and more long periods, the climate change is not very important to include as an issue in the future elaborated strategy of 2050. We hope that there will not happen so serious global changes as models predictions and less severe problem will occur. On transboundary water issue, we have one resource of very deep groundwater sharing with Libya and Algeria with enough quantity but with a relatively high salinity. The Government committee works to examine and ensure recommendations and the regional office is in charge for cross-boundary water. We have problem of high cost of desalination. Concerning a question asked by Prof. Wakasugi about international cooperation of SONEDE, Mrs. Sihem Trimech answered that close cooperation with other partners is undergoing. Our neighbor countries tend to follow the experience of Tunisia using same ideas and expectances. Our organization is looking for financial support from international organization such as World Bank and JICA. Dr. Irie Mitsuteru clarified about the water distribution network efficiency; Mr. Zeriaa Fethi said that it is 83% efficiency. Previously efficiency rate was 85%, now it is 83%. Following the reason of such decrease, it was discovered that it is related to the old counting devices which they are actually planning to change them.

3.1.2 Drinking Water Treatment Plant of Ghedir El Golla

Mr. Moncef Amara, Head of Dam and Pumping Stations Department, Mr. Chaouachi, Head of Treatment Department and Mrs. Zyedi, Head of Water Quality Control Department invited us to visit the sites of plant and introduced drinking water treatment processes. Firstly, we visited the pump-in plant, which receive water from north-west dams through 30 km long canal. Water is purchased from the responsible company. It treats water for drinking purpose. Pumped water is filtered by two filters and capacity of pumping station is 3.5 m3/ sec. The plant works under supervision of Ministry of Agriculture, Hydraulic Resources and Fishery. From this station canal continues for 1.5 km till next plant for treatment.

Second our station was two reservoirs with capacity of 3.5 million m3 water, which is 3rd big by its capacity. The reservoirs are fed by rainwater and water from dam, which is located 100 km far. Transportation of water through canal causes deterioration to water quality, salinity level is more than 1.5 g/l because of higher evaporation. Control of distribution is carried out from the control tower

and water level, concentration of chlorine, turbidity and salinity are measured continuously in situ. Production is approximately 6.0 liter/sec.

Figure 3.5: In the control tower of the plant

Figure 3.6: Water quality laboratory of Ghedir El Golla plant

Then, third site was water treatment station, which has 2m3/sec capacity. Here, the water treatment is conducted by three different stages of coagulation (adding Al2(SO4)3 and mixing), flocculation (adding polyacrylamide, sludging and de-sludging) and decantation (static decontation, then French type decantation and laminar one). Last stage is sand filtration and chlorination with high speed water. At last quality specification of pH, turbidity NTU, EC and Cl are controlled.

Finally we visited the SONEDE Central laboratory. It carries out physical, chemical and microbiological tests for controlling water quality of 50000 samples per year. It is accredited laboratory according ISO 17025 standard. Heavy metal contamination in water does not occur in Tunisia.

3.1.3 Department of Public Health and Basic Cares, Ministry of Public Health

Dr. Mondher Bejaoui, Director of the Department welcomed us and made introduction and talking about infectious decease situation in country: for controlling of water transferring deceases, the social program and social intervention were adopted. Malaria was totally eradicated since 1963. parasite deceases are now in sleeping state in water. Last case of belarzosis was in 1982. Now only 52 imported cases and few cases of parasitic deceases are registered. The last case of cholera was in 1996. It is benefit of good vaccination program throughout country. Concerning tuberculosis, case number is decreasing, stabilized and now under control.

Figure 3.7: The director of Public Health Department giving his speech

Diarrhea is mainly caused by food or water related reasons and one of the government programs is focused on controlling children cases. Diarrhea cases have decreased year by year from 1960s and now only 5 cases are registered. Concerning avian influenza, no cases happened, even in birds. For prevention, a committee was established in 1997 and finished its job in 2005. The H1N1 commission worked for prevention and the spent money and vaccination started very early same as in France, beginning in November 2008. Prof. Wakasugi Naomi expressed her impression that it is clear that an improvement and health expenditure is increasing. Dr. Mondher Bejaoui agreed and continued that in Tunisia, for example, who have not enough money does not need to pay some insurance, but receive medical service free of charge. On health insurance, there is one public system and two private systems, which can cover till 80% of expenditure and can receive it. Tunisia has good service of primary health care and currently more than 2000 medical doctors are working primary health centers. Infectious deceases are controlled by health doctors and by laboratories. Epidemiology chart and health map are essential and implemented in WHO documents.

3.2 DAY 2 (Nabeul, 29 July 2010)

Reported by Yudi Setiawan, Aijun and Wanjun

3.2.1 Water Resources Direction in Nabeul Prefecture (Commissariat of Regional Development Agriculture)

Prof Tarhouni introduced Dr Rekayya Moncef, the Director of water resources in Cap Bon area, to the internship participants. Prof Tarhouni said that the director has spent his time almost for thirty years in Cap Bon area.

Dr. Rekayya Moncef welcomed the participants of internship in Cap Bon area, the north-eastern area of Tunisia. The area is about 280.000 ha which it consists of irrigated area and non-irrigated area as an agriculture use area, and non-agriculture area, such as forest and others.

This agriculture area is 5% of agriculture area in Tunisia, however, the production contributes 60% of national production. The "dates" (fruit) or palm tree can be found commonly in agriculture area. However, this area actually was famous for citrus production, more than 80% of national production of citrus, and the area is about 40.000 ha. The crops like potatoes, tomatoes, peanuts were produced in this area about 60% of national production. The grain and strawberry are produced about 55% and 100% of national production, respectively.

Figure 3.8: Discussion about water irrigation issues in Cap Bon

Figure 3.9: Agriculture land in Cap Bon area

The important research in Cap Bon area was focused in water resources, especially ground water resources. As mention by Dr Rekayya that there are 30.000 depths well in Nabeul area, from the 150.000 depth well in all of country, and there are a five aquifer in this area.

Then, Dr. Rekayya introduced Mr. Abdallah Rebhi, the General Director of Agriculture Department in Nabeul. Mr. Abdallah welcomed the participants of internship in the agriculture area of Nabeul. The Nabeul area is the important area for national production of Tunisia because of its contribution to the production. There are 3 important actions in economic aspect, as follows: touristic, agriculture and industry. Recently, agriculture production in this area was decreasing in year by year because of several problems, and the most problem is related a water resources. Therefore, collaboration with other department (multi-department) is needed in order to protect and save the agriculture production.

Prof Tarhouni tried to introduce the participants of internship program. She emphasized the objectives and also some expertise of 3 professors from University of Tsukuba as a coordinator/ supervisor of

this internship, they are: Prof. Maki Tsujimura (Hidrology), Prof. Naomi Wakasugi (Public Health) and Prof. Mitsuteru Irie (Hidro-biology), and also Dr. Akawachi.

Dr. Rekayya explained again that there was opportunity to establish the relationship between Tunisia and other countries in Cap Bon area, study about water resources, and include the relationship between surface water and ground water. In Cap Bon, the treated waste water also used for agriculture area, and also there are some artificial recharge areas, however, this area has faced some water problem, as follows: over exploitation of water, salinity of ground water and sea water intrusion. Several water problems can be studied by specific technique, such as the uses of isotope and also water database, include several parameter.

Prof Tsujimura explained briefly based on the cooperation between Japanese scientists and Tunisia (Prof. Tarhouni) that there is a good database of water and water related issues, such as: artificial ground water issues, sea water intrusion and salt of ground water contain due to agriculture activities. Prof Tsujimura believed that the good data will useful if the various data can be interpreted as well one by one, since they might be interrelated among parameters. He mentioned the fields data observation collaborated with database existing will give some understanding to the participants (students) about water resources issues in the field.

Dr Rekayya said that a water resource in aquifer is 180 million m3 per year, meanwhile the abstraction more than 220 million m3 per year. As mentioned before that there are water problems such as over exploitation and sea water intrusion, then some solution was started to observe since 1941. One of the solutions at the moment is the coastal area between Nabeul and Hamen was prohibited for ground water exploitation, because the shallow aquifer is important to be saved from drought. In 1940's, the precipitation is $500 - 650$ mm per year in this area, but in this decade, it was not more than 200 mm per year, consequently, the area was becoming dry. Prof Tsujimura repeated the explanation that there are 30.000 dig wells in the area. A dig well is a very shallow well, which explore water from the shallow aquifer. It was used for irrigation in agricultural land by the farmers.

Historically, learned from the experiences, the farmer known how to abstract more water by dig well, because of there are big problem of the construction related to the natural condition, such as very fine sand and water availability. The farmer has developed special technique about dig well construction in this area.

The dig well in this area about 2-3 meter for diameter and depth about $10 - 30$ meters generally. But, since 1990's there is more special technique, which is in the bottom of the dig well there is a pipe in order to abstract deeper ground water. So, the water can be abstracted from both of shallow aquifer and deep aquifer. Figure 3.10 explains the schema of this technique.

Prof Tsujimura briefly explained that since the dig well was drought, then the farmer try to abstract more water from deeper aquifer by using pipe (boring technique). The depth of the deep aquifer is about $20 - 50$ meters. Consequently, the farmer can take water not only from shallow aquifer, but also from the deeper aquifer (different aquifer). Such kinds of activities cause another problem, that is: decreasing of the ground water storage in deep aquifer. Then, there are some programs related to the interrelation between shallow aquifer and deep aquifer, however such kind of relationships is not enough information, even in developed countries. In that case, the information of interrelation among surface water, shallow aquifer and deep aquifer is necessary.

There are also many programs related to the desalinization, because of when the exploitation of ground water is too much, the ground water level will decrease, and consequently the sea water will intrude to the ground water.

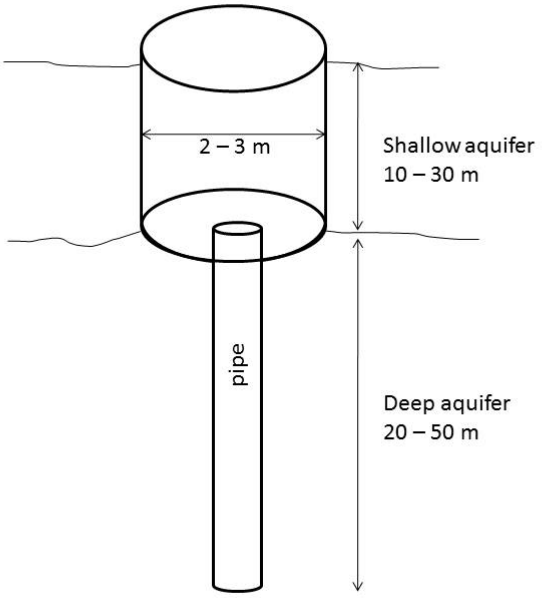

Figure 3.10: The dig well and the pipe to abstract more water from both of shallow and deep water aquifer

Another program not only the prohibited zone (save zone) of Nabeul in 1940's but also there is a real program to transfer surface water from north to the Cap Bon and Sahel area, and then distribute to the agriculture area. The project is cooperation between Tunisia and China. The distance of this canal (Majerda Nabeul canal) is about 150 km, and the water come from Sidi Saad Dam. The volume of water transferred by this canal is about 85 million m3, however this volume was decrease to 55 million m3. The water is only used in summer, when water availability in this area is limited. Meanwhile, in winter season, we also have applied the 10 selected of artificial recharge, which located in upper area of Nabeul.

There is an issue of contaminated ground water by nitrate from agriculture (from fertilizer), however, this case is special case occurred in this area. The farmer has look for another solution related to efficient cost and time, then they developed drip irrigation for the land.

Regarding the analysis the water of agriculture uses is rich with nitrate (nitrogen), therefore, the program is to propose to the farmer that the fertilizer is not essential in this area.

- Some questions were asked by internship participants related to the explanation about water resources. Prof. Irie asked about how the sludge was treated in the waste water treatment plant, such as: composting or others. Mr. Thuan asked about the number of water treatment plants exist in Nabeul area. From 10 water treatment plants, there are 2 plants in Nabeul area, with capacity 10.000 m3/day and 14.000 m3/day (only extension). Mr. Binbin asked about water price for agriculture in this area. If the water used shallow aquifer or dig well ($<$ 50 m), that is free of charge, but if the water used is more than $>$ 50 m or deep well, the consumer should pay for that (2 millims per m3 for agriculture, 5 milliims per m3 for industry and more for touristic). Mr. Yudi asked about land owner of agriculture land. In average the farmer has less than 1 ha; however there are also the farmers has more than it. The irrigated land, the average is about 2-3 ha. In citrus area, the farmer has about 5 ha. Recently, those areas become small and small. Mrs. Otgor asked about private area and

Figure 3.11: Environmental Health discussion in Nabeul Perfecture

also pastures such as sheep. There is diversification of agriculture with pasture, but it is household scale (small). Mr. Shuozhi clarified about the high evaporation in the irrigation area and also family agriculture (agriculture worker). Mr. Tra asked about the source of drinking water, the primary and secondary sources.

3.2.2 Direction of Health and Basic Care in Nabeul

Prof. Tarhouni introduces to the General Director of Public Health Office in Nabeul area, the countries of participants of this internship program. Dr. Nejib Chouche (Director) welcomed the participants to the Nabeul area. Prof. Wakasugi briefly introduced about objective and background of the internship participants. She mentioned that the student want to learn about general line of public heatlh in Tunisia, especially in Nabeul.

Dr. Chouche explained about demography of the area. The characteristics of this area are: touristic, agriculture and industrial area. The area is the most of national production area, such as: potato, peanut and citrus. There are 3 main industrial area, which were covered by electricity 100%, drinking water supply 98%. Concerning the water supply, it was supplied by SONEDE. Water supply for urban are and rural area (rural water supply) also explained, include rural engineering authority and associations. Ms Malika emphasized about the association of rural water that there are 50 networks and 42 reservoirs (local area). The important points are: a. pumping water after chlorification treatment, b. the quantity of chlor is measured every week (control), c. until last June, there were 6.500 samples analyzed and 200 samples for bacteriology analysis.

The SONEDE has control system for chloride before to supply water for rural area. Moreover, the health authority also has to analyze also the chloride in the selected locations in daily (3x, morning, noon and afternoon). The bacterial analysis also was performed to the 1.500 citizen/month (for control). The analyzed water is irrigation water, waste water treatment and sea water for swimming pool, and also water from industrial mineral water.

The recorded of disease in this area also is good, since malaria (1940), cholera and others were disappear; only tuberculosis still be a problem. Generally, communal diseases were decreasing but the non-communal diseases were increasing. Therefore, some prevention is still continuous.

The future plan is the collaboration between Tunisia and Japan, also with Asian countries to discuss the public health (primary level). Actually, JICA was concern to the primary level of health care. Prof. Wakasugi explained birth of rate in Tunisia is safe, and all of vaccination being done in Tunisia as national vaccination program. Also she explained that there are 120 health center with less than 100 km of inhabitant (4.000 people). Such kind of situation is very good.

Figure 3.12: Pilot station of artificial groundwater recharge

Prof. Wakasugi asked about sufficiently of the parameter of water quality controls used such as chloride, nitrat, in order to explain the water quality for public health. She asked also about the impact climate change to the disease. The data should be collected onsite, because the data is still not enough, and required international collaboration between many countries.

3.2.3 Pilot Station of Artificial Groundwater Recharge

Mr. M.N. Khelil explained about the responsibility of the experimental station. The experimental is applied to the treated water used for agriculture. The area was developed since 1983, it covers 26 ha and citrus crop mainly.

There are 2 types of irrigation water, they are: treated water and groundwater, which irrigation system used is the drip/drop irrigation and line irrigation.

Climatology systems in this area consist of: annual rainfall from 1982-2006 about 173 (min)–960(max) mm/year and regarding FAO Penman-Monteitl (formula for potential evapo-transpiration), and from the comparison ETo and monthly rainfall (Ombro-Termic diagram), it showed that deficit period is between March – October with the maximum time is July (summer). Therefore, in period April – September, crops should be irrigated.

Figure 3.13: Tunisia Internship members took a photo of citrus plantation in artificial groundwater recharge

Figure 3.14: Artificial groundwater recharge

Mr.Naserl (Researcher from this experimental station) explained about the center. He pointed out important problems, related to: fertilizer value and contaminated of groundwater. He explained also

about the parameters analysis. Moreover, there is artificial re-charge which consider the treated water used. The first of artificial re-charge from agriculture is applied in 1982. Such kind of water waste used should be re-considered, because of it will increase the nitrat consentration in groundwater. The consentrate of nitrat in treated water is about 200-300 mg/litre. Therefore, water waste treated is used for agriculture, and not for re-charge groundwater.

3.3 DAY 3 (Kairouan, 30 July 2010)

Reported by Anis Chekirbane, Ni Bingbin and Wang Shuozhi

3.3.1 Regional Department of Environment and Sustainable Development of the Steppe Zone

We were received by all the staff of the central administration. Eng. Nabil Hamdi, head of the department welcomed us and gave a brief introduction of the department activities. The regional department of environment and sustainable development of the steppe zone in Kairouan is under the tutorship of the Ministry of Environment and Sustainable Development. It is responsible for monitoring and evolution of the environment in Central - East of Tunisia (Kairouan, Kasserine and Sidi Bouzid).

The main interests of the department are:

- Evaluation of the natural resources state
- Assessment of all pollution kinds and sources
- Ensuring a good environmental aesthetics and contributing in citizen welfare
- To contribute in environmental education and awareness.

Eng. Mansouri Youssef gave a speech in which he explained the importance of water resources in Kairouan and their vulnerability to pollution factors. He also gave an overview about the action plan to reduce the risk of water pollution. In fact, several mechanisms have been set up such as sanitation, mandatory conducting of environmental impact studies, creation of the De-pollution Fund (FODEP), stepping up an environmental control and drawing up a national program for environmental upgrading of industrial and tourist companies.

Major remediation projects in Kairouan city started since 1987. The National Sanitation Utility, known as ONAS in Tunisia, has invested in Kairouan city 68 million dinars (about 62% of investment in Kairouan prefecture). The city is considered as a pole with 125,000 inhabitants, which represent about 70% of the total prefecture population of in 2008. Five new wastewater treatment plants were established in Kairouan prefecture. Purified water discharged into the environment or reused in irrigated area is periodically controlled to ensure that its quality fits the standards of hygiene in Tunisia.

3.3.2 Wastewater Treatment Plant of Kairouan II

Eng. Sahbi Hrizi, head of the wastewater treatment plant of Kairouan II, welcomed us and explained in situ the technical functioning of the station.

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 (trash, tree limbs, leaves, etc.). In WWTP of Kairouan II it is principally composed by:

- Two bar screens with a total capacity of 670 l/s
- Grit removal chamber composed of 2 channels with a total volume of 350 m3, a maximum flow rate of 670 l/s and retention time of 9 minutes
- Fat and grease removal mechanism composed by a clarifier with a surface charge of 25 m/h and an air flow rate of 350 m3/h

Secondary treatment

Secondary treatment is designed to substantially degrade the biological content of the sewage which is derived from human waste, food waste, soaps and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. To be effective, the biota requires both oxygen and food to live. The bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into floc. The system of Kairouan II station 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 (that is, oxygen, wastewater and microbes). Residence time is estimated to 1.5 day.

The final step in the secondary treatment stage is to settle out the biological floc or filter material through a secondary clarifier and to produce sewage water containing low levels of organic material and suspended matter.

Tertiary treatment

It is necessary to mention that tertiary treatment in Kairouan II plant is performed in demand of 15 farmers belonging to the irrigated area of Draa Tammar created since 1989 with a total area of 240 ha. The process includes principally:

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

The contribution of tertiary effluent in the irrigation of Draa Tammar field is estimated to 35 %.

The treatment efficiency

The analyses of the produced water by kairouan WWTP reveals that OBD5 (Oxygen Biological Demand), OCD (Oxygen Chemical Demand) and SM (Suspended Materials) are in conformity with the tunisian standard as shown by the table below.

Parameter	Suspected value of WWTP	Tunisian norm NTI06-02
OBD5	< 20	30
OCD	< 60	90
SM	< 10	30
Fecal coliform	< 2000 / 100 ml	< 2000 / 100 ml

3.3.3 Regional Department of Health and Basic Cares in Kairouan

We were welcomed by Dr. Mohamed Habib Hadhri, head of the division of Basic Health Cares, and Mr. Naceur Mejri, supervisor of the division of Community Hygiene and Environment Protection.

Dr. Hadhri expressed his pleasure to receive us in Kairouan and he gave a speech about the global situation of public health in Kairouan. In July 2009, the number of inhabitant in Kairouan prefecture is 553800; however the estimation of 2010 is around 555400 inhabitants. Then he expressed a special interest to explain the maternal and children health in the prefecture. In fact, the life birth number is 11200 in 2009, reproductive age women (age between 15 and 49 years) are estimated in 2004 to 27.5% and the married women in reproductive age are 12.6% of the total population. Health infrastructure in Kairouan prefecture is well developed; it is composed of 130 basic health centers practically accessible by all the population with an accessibility indicator less than 5 km, 10 health centers (health circumscriptions) and 1 regional hospital. The health centers contain at least a division of medical practitioners, maternity service and an emergency service in addition to a qualified staff and sufficient medical equipment. The private health sector is more and more developed in Kairouan prefecture especially after the set up of the new insurance system of the country (CNAM, directly translated from French as National Fund for Diseases Insurance). Dr Hadhri explained then the evaluation system throught the national program of prenatal (recently called reproductive health program) focusing on maternal and children health to enhance the cares and consultations before, during and after delivery.

In the second part of his speech, Dr. Hadhri was asked to give an overview of some directly linked infectious diseases to water in Kairouan prefecture. He mentioned that cholera is totally eradicated since more than 3 decades; however some cases of sporadic typhoid fever, viral meningitis and hepatitis A and E sometimes appear. Most of the traditional infectious diseases are already disappeared or disappearing thanks to the evolution of Tunisian lifestyle, the high effectiveness of the monitoring system and national strategy of public health especially based on an integrated approach involving all the stakeholders in health sector.

3.3.4 Water Resources Department in CRDA of Kairouan

Eng. Slah Darmoul, head of water resources department in CRDA of Kairouan expressed his pleasure to welcome us and he gave a presentation about water resources in Kairouan prefecture. He mentioned that water is precious in Kairouan since old times; in fact, an old hydraulic basing serving for harvesting

water runoff existed since the year 860. Kairouan area is characterized by a semi arid climate with an irregular annual precipitation in time and space, usually ranging between 230 and 400 mm, an annual temperature mean of 20.5 ° C and an evapo-transpiration potential of 1267 mm/year. Water resources of 2009 are summarized in the following table:

Resource (Mm3)	Surface water	Shallow groundwater	Deep groundwater	Total
Mobilizable	179	63.5	82.5	325
Mobilized	172.5	63.5	80	316
Exploited	146	92.1	80	318.1
Total	497.5	219.1	242.5	959.1

Concerning the hydraulic infrastructure, Kairouan contains 3 big dams (Sidi Saad, El Houareb and Nebhana), 22 hillside dams, 69 small lakes, 520 deep wells and 12000 shallow wells. Agriculture is the main water user with 89% (283.6 Mm3/yr); however both industry and drinking water are just exploiting 11% of the total water resources. In 2007, exploitation of deep groundwater is estimated to 97%; however the shallow groundwater is overexploited with 145%. The monitoring network of groundwater is ensured with 145 piezometers. Groundwater table drawdown is more and more severe and reaches sometimes 2m/yr in an observation period between 10 and 40 years. Natural recharge by rain water and dam water is no longer sufficient to avoid such alarming situation. In order to face theses difficulties, water authorities are proposing an action plan aiming:

- Rational use of water resources
- Aaquifers recharge during the rainy season
- Increase the number of exploration drillings
- Assess the potential of brackish water for desalination
- Revise the water code
- Involve all the stakeholders in water management

Dr. Tsujimura thanked Eng. Darmoul for his presentation and asked about the possibility to use treated wastewater as a resource to support irrigation with conventional water. Eng. Darmoul replied that they are effectively doing such kind of practice in the irrigated area of Draa Tammar basing on the tertiary treated water coming from the wastewater treatment plant of Kairouan II.

Dr. Tsujimura commented also the alarming groundwater situation in Kairouan and mentioned that charging system seems to be the most effective solution to allow the recovery of water table as it was applied in Japan, Thailand and some other asian countries. Prof. Tarhouni replied that government may actually think about charging system but the main difficulty is the low income of the farmers.

3.3.5 Visit to Sidi Saad and Houareb Dams

Eng. Ben Salem, responsible of both Houareb and Sidi Saad dams, was waiting for us near Sidi Saad dam where he summarized some technical characteristics of the two dams.

El Houareb Dam

It is located 140 km far from the capital Tunis and 35 km in southwestern Kairouan city. It is controlling a watershed of 1120 km2. It was constructed in 1989. The main objectives of its construction were the protection of Kairouan city against flooding by Marguellil wadi (1/10000 years), creation of 2400 ha of irrigated area, groundwater recharge in downstream and drinking water supply. Its technical characteristics are summarized in the following table.

Principal dike	
Height	33 m
Length	2070 m
Width	8.5 m
Top level	228.5 m
Volume of embankments	6 millions m3
Reservoir	
Normal water level	217 m
Normal storage capacity	95.3 millions m3
Maximum water level	226 m
Maximum capacity	236 millions m3
Spillway	
Location	Right side
Channel length	250 m
Slope	0.12%
Maximum flow rate	2450 m3/s
Contributed volume (1989 – 2009)	410.4 millions m3
Water quality (Total Dissolved Salts)	1.5 g/l
Total construction cost	50 000 000 TD

Sidi Saad Dam

Sidi Saad dam is located in Nasrallah delegation in Kairouan prefecture. It is far 170 km far from Tunis and 50 km in the northwestern of Kairouan city. It was constructed on Zeroud wadi in 1981. Its objectives are: protection of Kairouan plain against the flooding caused by Zeroud wadi, creation of 5000 ha of irrigated area, groundwater recharge and fish farming. The following table summarizes characteristics of Sidi Saad dam.

Principal dike	
Height	70 m
Length	560 m
Width	8 m
Top level	302.5 m
Volume of embankments	4.6 millions m3
Reservoir	
Normal water level	270 m
Normal storage capacity	209 millions m3
Maximum water level	302.5 m
Maximum capacity	1994 millions m3
Spillway	
Location	Right side
Channel length	63 m
Maximum flow rate	6900 m3/s
Contributed volume (1989 – 2009)	1496 millions m3
Water quality (Total Dissolved Salts)	2.2 to 3.8 g/l
Total construction cost	60 000 000 TD

3.4 DAY 4 (Tozeur, 31 July 2010)

Reported by Nguyen VanTra, Thuan, and K. Kazuna

3.4.1 Visit to Water Management of Oasis Area

We visited Chott area in Tozeur, where it is adjacent with Sahara desert. This area covered dominantly by ordinary bush-desert alternated with sand dunes.

Figure 3.15: Landscape and view of Sahara and Oasis in Tozeur

During observing desert region, Prof. Tsujimura explained about oasis as a specific ecosystem located in the arid region. The oasis performs specific ecosystem since water concentrated there much more than its surrounding area. Oasis is formed by topographical slope and groundwater. Oasis location depends on groundwater level, lower the groundwater level further of the area oasis located. Obviously, oasis is a discharging point and it can be maintained by artificial measure. Also, oasis causes micro climate changed (air temperature and air flow) due to the evapo-transpiration in the location. Then, Prof. Tarhouni added that there are three levels of plantation in oasis ecosystem, as follows: palm tree, fruit tree and yearly crops.

After leave the Chott area, we visited a discharging point in Tozeur where there was some water discharges from the ground and being collected into a pit likes a small valley, then these water is flowed through small canal. The arrangement of trees, canal and stepped land in the pit creates a beautiful structure.

3.4.2 The Department of Water Resources in Tozeur

The next destination is Department of water resources in Tozeur. We were welcomed by Mrs. Aida Jeridi, head of the water resources department. At the meeting, Mrs. Aida presented characteristics of the area.

In this area, the average precipitation is about 150mm/year and it is very hot in summer, the main problem, of course, is water resources. The agricultural production in this area was based on deep wells managed by the Department. In the area there were about 160 deep wells which are well managed by farmers in term of association (CRDA-Regional Offices for Agricultural Development). The association has responsible to manage payment of electricity cost in pumping stations, water distribution and infrastructures maintenance. Meanwhile, the water resources department has role to

Figure 3.16: Corbeille of Nafta: Water supply system to the Oasis

assist and control the functions of the association and carry out maintenance of operations in which maintenance cost is paid by the association.

In drilled wells (depth from 600m to 2,000m) and artesian wells there are 6-9 wells can supply hot water for household consumption at night as air temperature becomes low. Then, the water is recycled for irrigation. The area has two types of oasis:

Traditional oasis. It was created in Roma period. Limited by the Chott area in the South and urban area in the North, the oasis has no change during long time period. In the traditional oasis, it has old system for irrigation. In economic view point, this type of oasis did not have high income.

Modern oasis. Located in the North and included mountain oasis. In mountain oasis near Algeria border where irrigation is done by spring's water.

As mentioned above, the interesting in this area is the presence of the traditional water distribution system. This system was designed and constructed about 2-3 centuries ago by Ibn Shabbat (1221-1285). The system covered 900ha irrigation area and proved high effective in the past with equal distribution of water among farmers and clever diversion of water. Water from springs at the upstream area was flowed in canals by gravity principle. On the way from upstream to downstream, water was easily diverted by using spillways. Width of canals and size of spillways would determine the water volume supplied to each consumer. In this system, Shabbat considered about affect of soil condition, irrigated area and slope as the major factors to water distribution in order to provide the most suitable water needed for different irrigated area. And different crops would receive different water amount to ensure the effectiveness of water using. Distribution was done by time for each consumer to ensure equal water receiving for all consumers from upstream to downstream. Recently, the system was stopped due to the lack of water in springs.

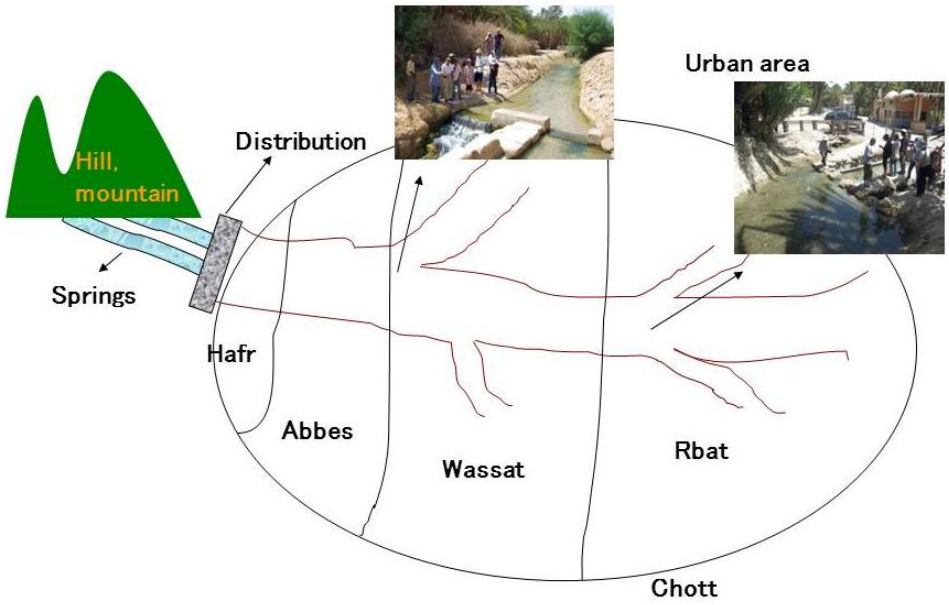

Figure 3.17: The water distribution system designed by Ibn Shabbat

Prof. Tarhouni, Prof. Irie and Prof. Tsujimura added some explanation considering the Shabbat integrated soil condition and canal's size into his system. Concerning public health sector, Prof. Wakasugi mentioned about integration of health into water management because of the importance of water to health.

After meeting at the Water resources Department, we visit to field where the Shabbat water diversion system was applied. The system is very simple and easily operated; however, it showed the brilliant think and effective system in water distribution. We also visited a farm in the oasis. The farm had three typical plantation levels of the oasis: palm tree, fruit tree and annual crop tree. The landscape liked tropical area.

Figure 3.18: The three stages cultivation in Oasis of Tozeur

Figure 3.19: Underground dam of "Oum Lagsab"

3.4.3 Visit to the Underground Dam in Kasserin

In the afternoon, on the way departed to Kasserine, we had chance to visit underground dam. The underground dam was constructed under a wadi to supply water for irrigation. Under flow aquifer has

been stopped by the dam, so that underground water at that dam fence could increase high enough to supply irrigation demand. The fence was put at the depth of 12m in the clay layer. We only saw the top layer with some stone mark point of the dam. The area had two wells to provide water to other area. During this visiting, we got a complaining by local people about groundwater dam affected to their wells. They thought that the dam decreased the groundwater level in their area so that their wells had decreased water. However, actually, as Prof. Tsujimura analyzed that the dam would not have direct relationship to the decreasing of groundwater. The reduction of water level in the wells may be due to the decreasing groundwater in general. Although the local people should be considered as a part of water management strategy and it should be suitably solved.

In this area, we felt a very friendly welcome of local people. We had chance to visit a farmer's house with his farm. Watching plants bred in the arid land and tasting their special fruits. We learn more about not only general water management but adaptation ability of Tunisian.

3.5 DAY 5 (Kasserin-Sbiba, 1 August 2010)

Reported by L. Meihua, Z. Otgonbayar and Z. Aijun

3.5.1 Visit to Al Brek and Sfisifa Dam

When the group reached El Brek Dam, Prof. Maki Tsujimura explained about Sbiba watershed and its dams. He mentioned that three dams in Sbiba watershed are important for recharge of groundwater. In this watershed, there are different geological boundaries of limestone in upstream region. Then we reached to the Dam office and Mr. Mohamed Elltedi, Head of Dam Office introduced about dam at its components. El Brek Dam construction project has tasks to recharge groundwater, water supply for irrigation, and protection from flood. The construction was finished in 2001 and current recharge rate is 0.9 Mm3 / yr actually. Then we reached at El-Brek dam and observed surrounding environment. Prof. Maki Tsujimura mentioned that the water level was lower and water was clearer than it is in the photo below, because of storm raining the water level increased and it is seen muddy. Water level is most important factor of dam.

Figure 3.20: El Brek Dam in Kasserine

Next stop was Sfisifa Dam, which is located outside of previous watershed. There are 16 deep wells, which are connected to this dam.

Figure 3.21: Sfisifa Dam in Kasserine

3.5.2 Visit to Farmer's Association of Water Management Associations in Sbiba Irrigated Area

For the purpose of being familiar with hydraulic infrastructure of irrigated area, the group visited the Sbiba irrigated area and the president and heads of farmer's water management associations welcomed us and introduced their facility, activity and development on site and in their office. The president of associations made general introduction about Sbiba Irrigated Area, as the area include totally 51000 ha land, which 5000 ha of this land is for public use. The area has historical agricultural tradition, has 2 million trees, which half is apple trees and total production of apple from area is 30000 ton per year, it supplies 60% of total apple need of Tunisia, by this number it is 1st placed area in country and apple has specific taste and quality. The association has 40 deep wells, 3 dams for water exploitation, 32 storehouses with cooling system with total capacity of 17000 ton. 9 associations are responsible for water management of the area. Then Prof. Maki Tsujimura expressed sincere appreciation on behalf of Tsukuba University that he is happy that president and heads of all 9 associations came and giving possibility for students to explore environmental issues on all sites, such a study is important for students.

Figure 3.22: Meeting with nine farmer associations in Kasserine

Then, the heads of every local agricultural association invited us their offices and introduced their activity and if briefing special things introduced by them are: irrigation provided once in twenty days, therefore reducing the time of water cycle is one problem; protection against hail is important for farmers; changing from open canal irrigation to drop-by-drop-irrigation system; all the system and techniques were constructed by the Government cost and provides from government technical staff for storehouse.

Finally, we visited the irrigated agricultural field.

3.6 DAY 6 (Kef, 2 August 2010)

Reported by Wanjun, Yudi Setiawan and Shuozhi

3.6.1 Laboratory of Public Health, Regional Direction of Health and Basic Care in Kef

This laboratory is established for three purposes:

1. Food security examination;
2. Water quality control (including drinkable water and used water);
3. Internship education

Prof. Wakasugi introduced all of internship participants from Japan and asked about short description of regional situation of public health, including disease, financial management and national data.

This is one of the 24 center that distributed all over the country. The center has 3 services which include the financial management, primary health care (especially for women and children), food and water control for contamination. This hospital is one of the top hospitals for surgery in the Kef city. The population of this region is 250,000, however, it is decreasing year by year because young people is migrating to large city like the Tunis. There is a transmission stagy coming through this country. As the epidemic situation in this region, the infectious diseases cases are decreasing in the recent years. And the life expectancy for men is up to 75. The government has set up many strategies for improving the health level in this region. For example, the national policy for cancer treatment, the policy for children and women care, the construction of health education system for young people.

Prof. Wakasugi followed with the next question about educational system for doctors in Tunisia. The director explained that they were spent big efforts to rise up the health care situation. It refers to the improving of training system for doctors, medical equipment and medicine research. We have four outstanding medical schools in the country, and also built up the special medical care system for foreigners. The system is famous in the country that we use seawater for hygienically care system.

The directors continued the explanations about the salary of doctors, which all of them get the highest salary in our country. However, if they go to outside for diagnose, they can get more. There are some strategies for encouraging medical students go to Europe for study and research. But sometimes they won't come back because there are also shortages of doctors in Europe as explained by the director.

Prof. Wakasugi asked about any strategies for attracting the student abroad to come back to Tunis. The director explained that about 7% of the students studied in Europe have chance to stay there. But the government also has some rules and limitation for calling them back. Prof. Wakasugi asked about an introduction about the epidemic situation. Although the temperature in summer and spring is very high, we have acquired a good control of the epidemic transmission. An interesting example is that we use the Grmberia (a kind of small fish) to eat eggs of mosquito. And we have no case of malaria now. In fact, 70% of our people possess the antibody for virus of hepatitis A.

Prof. Wakasugi asked about the effect of climate change on health care. The director said that the problem have been noticed by the government, but they don't think it have brought out of any

negative effect now. Ms.Zhu asked about health care system for old people. The director said that over 15% of population is above the age 65 the region. So the government has built up a special care policy for aged people. We have health centre for lonely old person, and there is also an association for health care. The government gives annuities to every old people, but we are still prone to family care. Mr. Tra asked about the vaccinating system especially for hepatitis. They responded that they have acquired a vaccinating rate of 95%. Every year we carry out vaccinating action for students for free. As some special epidemic diseases such as the Echinococcosis,we have special treatment like surgery. Mr. Thuan asked about an introduction of health insurance system in this area. For the low-level income population, the government executes allowance strategy. As the normal salaried population, 93% of them are covered by at least one of insurance system. And we also have the plan to make it come up to 97% by the year 2014. Of course, it's still difficult for us because the health cost is increasing year by year while as far as I know, even developed countries have this kind of problems. We have free inoculation medical care especially for women who are pregnant. As the HIV we do not have many case reported and it's also treated for free.

The government have additional bonus for person who work in rural area. We also encouraged young doctors to go to rural area. In fact, some graduated students must work at least 1 year in rural area before they get a real job. Mrs.Otgonbayar asked about some communications with other countries related to the medical care system. The director explained that the medical and medicine level was high priority in Tunisia. So the government has set up some cooperation with other African countries. Also the WHO is supporting our activities of communication. Ms.Li followed the question about the health education for the students. The director said that since children entering elementary school, they can get medical consultation from professionals periodically until they graduated from university.

3.6.2 Visit to Mellegue Dam

On the way to Mellegue dam (Restaurant in de Kasbah, de Basilique)

On going to the Mellegue dam, we have some discussion with the persons of charge of Agriculture Department. Topic discussion is about groundwater dam conflict.

The conflict related to the drought in the area after the groundwater dam constructed. The local people (farmers) justified that such kind of drought phenomenon caused by groundwater dam. The government explained that have already spent much effort in order to involve local community in the project. In the first time of dam construction, the government tried to involve the local community, however, the community seems don't want to cooperate with government. Even if the government was scheduled program to give some explanation to the farmer (3, 5, 10 years), but the farmer don't want to accept the explanation of government. The government said that the farmer seems have strong power and can done anything without compromise with government.

Prof. Tsujimura emphasized that the Money Charge System is critical, even if now the farmer has strong power to exploit water. Finally, Even if the government has spent much effort and the SONEDE said no problem, but still there are many problems in the field.

Melleague Dam

Eng. Labidi welcomed the participants in the Melleague dam. He explained that the dam was constructed in 1949-1953. There are 5 curve shape in the dam, and spill way per gate about 300m3/s.

Detail technical characteristics of Mellegue Dam

Hydrology	
Mean of annual precipitation	400 mm
Annual input	180.000.000 m3
Wet area	2.728 ha
Dam:	
Dike volume	230.000 m3
Dike length	470 m
Bottom width	7 m
Top Width	2 m
Use of dam water	
a. Run off regulation of Mellegue river	
b. Irrigation in downstream valley of Madjerdah	
c. Production of electricity	
Annual production	15.000.000 Kwh
Average salinity	2 g/l

The main function of this dam are: a. water resources, and b. flooding protection. However, this dam also used for another purposes (multi-purposes), such as: electricity power generator and touristic. Electricity power about 20 MW per hour. The watershed area is 10.300 km2, volume in flow is about 180.000 m3. The dam will be extended consider both of problems, the capacity production and to protect flooding of some areas

This dam has two main problems, they are:

- Sedimentation
- Salinization

3.7 DAY 7 (Tunis, 3 August 2010)

Reported by Ni Bingbin, Thuan, Nguyen VanTra and Anis Chekirbane

3.7.1 Closing and Synthesis Conference of International Internship in Tunisia on Public Health and Water Issue under Cooperation between Institute of National Agronomy in Tunisia (INAT) and University of Tsukuba, Japan

The closing and synthesis conference was held in INAT (National Agronomical Institute of Tunisia) and it was about public health and water issue in Tunisia. The conference aimed to give to the international internship participants the occasion to deepen their knowledge about the mentioned topics and to allow a direct interaction with water and public health experts attending the conference and presenting some overviews. The most of presentations were given in French language, however, simultaneous translation to English was provided.

09:05. The welcome address was delivered by Prof. Jamila Tarhouni the co-organizer of the internship from INAT. She thanks the attended experts and audience, and hoped us to enjoy and learn something from this conference. Then, Dr. Maki Tsujimura and Prof. Wakasugi Naomi introduced themselves. Prof. Fethi Lebdi, ex General Director of INAT and actual Head of Water Sciences and Techniques Laboratory in INAT and Leader of the Water Sector in Ministry of Agriculture and Hydraulic Resources, welcomed the international internship participants and briefly introduced water resources management in Tunisia. He reminded the physiographic and climatic variety of Tunisia going from a humid North to an arid and Saharan South. Thus, he believe that Tunisia can be considered as a school of natural resources management since it is dealing with forest, surface water, groundwater, sahara, coasts,... in all their landscape forms. According to Prof. Lebdi, water management in Tunisia should be based on the equilibrium of 3 facts: efficiency, sustainability and equity. He added that Tunisia is well prepared to face global warming thanks to its experience in extreme event management since the antiquity. He mentioned as well that Tunisia can learn a lot from the Japanese experience of financing and privatization of water sector through innovative environmental techniques. Then Prof. Maki Tsujimura Associate Professor in University of Tsukuba and also the leader of this international internship introduced the Environmental Diplomatic Leader (EDL) Education Program. It is a new and innovative educational/training programme at the University of Tsukuba with the aim of producing leaders in environmental diplomacy.

9:30. Mr. Habib Chaieb, Director of Non Conventional Water Resources and Artificial Recharge in General Direction of Water Resources, gaves a presentation about "Water Resource in Tunisia". He introduced current water resources situation in Tunisia. Then he showed the main watersheds in Tunisia and spatial-temporal distribution of water. In conclusion, he believes that Tunisia may not suffer from serious water shortage under the global climate change thanks to the water strategies and policy previously undertaken.

10:10. Mr. Mounir Bouslimi from SONEDE presented about drinking water in Tunisia. SONEDE is responsible for water production, distribution and development in Tunisia. In total water consumption amount, domestic was the largest consumption (about 84.4%), however,

water used for industries was only 8.2%. Currently, SONEDE has 8,480 km water supply network with 12 treatment plants and 04 desalination stations. According to Mr. Mounir Bouslimi, the long transmission of water does not cause environmental problem.

10:30. Mr. Abdallah Ben Daly, Director of Water Saving in SONEDE, presented about water saving in Tunisia. The SONEDE has conducted some programs aiming at saving or optimizing water use. Some of these programs are: pipes rehabilitation program, improvement of the current means of counting, water system regulation, monitoring the distributed volume and leakages detection. The SONEDE has 5 different prices depending on consumption to optimize water using. Regarding the price, in September 2010 SONEDE will have tariff for pumping, electricity and maintenance related to water issue.

11:05. Mr. Med Ali Bouhlila from the SONEDE presented about drinking water production. In 2009, drinking water production demand was 490.8 million m3, in which 57% from surface water, 39% from groundwater and about 4% from desalinization. Estimated, the production demand in 2030 will be 700 million m3. Currently, SONEDE has severed 2 million customers (about 80% Tunisian population).

11:10. Mr. Nefzi Mohamed, Head of Laboratories of the SONEDE presented about treatment and control the quality of water supplied by SONEDE. Playing an important role in water management, the SONEDE has experiences in some activities such as protection of water points, optimization of water resource, rehabilitation of treatment plants, water treatment, etc. Water supplied by the SONEDE follows the WHO and EEC requirements. Also, the country has National Program for improvement of water quality. Besides, improving water quality to satisfy customers regarding health issues is very important.

12:00 Mr. Naassaoui Essaied, Director in the National Sanitation Utility (ONAS) presented treatment and reuse wastewater in Tunisia. ONAS missions are protecting pollution of surface water and groundwater, conducting sanitation works, developing and implementing treatment plans and storm water drainage and promoting sub-products of sewage. Major methods used in water treatment are: activated sludge, aerated lagoons, natural lagoons and sand filtration. Treated water is mainly reused in arboriculture, cereals, and forage plantation.

12:25. Tea Break. Enjoying some drinks and snacks, and short communication between presenters and students.

12:40. Mr. Mohamed Rabhi, General Engineer in Ministry of Public Health, presented about controlling health issue related to water. Water can be a vector of transmission of serious infectious diseases. The epidemics of waterborne infection reflect the vulnerability of the water control system. In regional level, each region has a department of regional environmental health & sanitation and regional laboratory of hygiene. In Tunisia there are 24 regions and 21 regional laboratories of hygiene. In Tunisia, The Directorate of Environmental Health and the Environment Protection (DHMPE) collaborates with the regional hygiene and sanitation units in National program for prevention of waterborne diseases and in providing health control related to drinking, bottled, waste and bathing. In order to ensure water quality in term of sanitation, relevant agencies have regularly conducted following major activities: 1. Monitoring the treatment of drinking water, 2. Controlling the bacteriological quality of water distributed via networks and reservoirs, 3. Disinfecting and controlling the bacteriological quality of public water points constructed,

4. Controlling the physical and chemical properties of drinking water, 5. Health control of water points in the border areas, 6. Education activities, 7. Ensuring quality of bottled water 8. Control of wastewater

13:20. Dr. Mitsuteru Irie, representative of BUTUJ in Tunisia, exposed information about "Japanese Cooperation in Tunisia". He introduced the activities on International Higher Education by North African and Mediterranean Centre for Research and Education (CAN-MRE).

13:45. Ms. Ritsuko Yamagata, representative from JICA office in Tunis, presented cooperation between Japan and Tunisia in water and health issues. In health issue, Japan and Tunisia have cooperated in Mother and Child Health, Reproductive Health and Infectious diseases. In water sector, Japan and Tunisia have 16 out of 33 loan projects and 8 out of 17 on-going projects which are water-related projects. In which, the projects focus on irrigation, water supply and sewage and flood countermeasures.

After that, students of the internship course expressed their ideas about the course and relevant issues. In general, almost students were very interested in the course. Thanks to this course, we had chance to learn water management and public health in Tunisia. We can say that Tunisian government invested a lot in water management as well as health sector. Health indicators of Tunisia are much higher than those of other African countries. Tunisian people have long term management of water and such ancient knowledge still integrated in modern water management. Thanks to Professor Jamila Tarhouni and Mr. Anis Chekirbene, we had a successful trip in Tunisia. We were always warmly welcomed by every agency or department we visited. Also, by this course, we had chance to know more about Tunisian culture and climate diversity. Each region in Tunisia is unique and interesting. However, the friendly character of Tunisian people always impressed us!

14:45. Prof. Naomi Wakasugi closed the conference. She emphasized on the integration of health and environment and preventative measures to ensure health condition and environmental sustainability.

3.7.2 Radio broadcasting in the Radio Channel Tunisia International (RCTI)

- As a Tunisian National Radio Station, the Radio Channel Tunisia International (RCTI) broadcasts some programs by international languages; English, Arabic, French, Spain, and Italian.
- With the assistance of L'Institut National Agronomique de Tunisie (as an EDL international partner), the 3 professors and 1 student were invited to talk about an objective and activities of Tunisia internship.
- Prof. Jamila, as a Tunisia counterpart of Tunisia internship, introduced the internship members and gave short overview about the internship activities. Prof. Tsujimura explained briefly about objectives of the EDL program and purpose of the Tunisia internship. At that moment, Prof. Tsujimura also highlighted a selection procedure of EDL student. Meanwhile, Mr. Yudi, EDL-student, mentioned the meaning of EDL-Tunisia internship program, that the intership has

extended prespective of student about the global environmental problems, especially in Tunisia. Then, Prof. Wakasugi gave an impression about public health issue in Tunisia. She pointed out the integration of health and environment and preventative measures to ensure health condition and environmental sustainability.

APPENDIXES

1. Route

The route of Tunisia internship

2. Schedule

Date	Time	Location	Activities
26 – 27 JULY	17.35 - 21.40 (Mon) – 12.55 (Tue)	Tsukuba - Narita Narita – Dubai – Tunis	
		Tunis	One night stayed in Tunis (Hotel Balvedere). Take a rest and preparation for next day
28 JULY (WED)	8.00 – 17.00	Tunis	1. Visit to the SONEDE, National Society for Drinking Water Supply (Mr. Khouaja Mohamed/President, Mr. Zeriaa Fethi/Central Director) - Société Nationale d'Alimentation en Eau Potable. 2. Visit to and field observation on water treatment, which managed by SONEDE in Ghedir Golla. Water Treatment Plant in Ghedir Golla (Ms. Yazidi, Mr. Takkari Habib and Mr. Nefzi Mohamed) - Complexe de Ghédir El Golla- SONEDE 3. Visit to the Direction of Health and Basic Care in Ministry of Public Health (Mr. Mondeher El. Bejaoui, Eng. Rabhi Mohamed) - Direction de la Santé et des Soins de Base-Ministère de la santé Publique 4. Visit to the Direction de l'hygiène – Ministère de la santé Publique Stayed in Tunis (In Hotel Balvedere)
29 JULY (TUE)	07.00 – 08.30	Tunis - Nabeul	Trip to Nabeul
	08.30 – 13.00	Nabeul	1.Visit to the Water Resources Direction in Nabeul Prefecture (Eng. Jelassi Faieal) – Arrondissement des RE 2. Visit to the Direction of Health and Basic Care in Nabeul - Direction de la Santé et des Soins de Base To visit and field observation in Pilot station of artificial groundwater recharge
		Cap Bon	Visit to the tourist object of Mediterranean Sea in Cap Bon
	14.00 – 17.00	Cap Bon (Nabeul) - Kairouan	Trip to Kairouan Stayed in Kairouan (In Hotel Continental)
30 JULY (FRI)	07.30 – 16.00	Kairouan	1. Visit to the Regional Direction of Environment (Dr. Hardi Nadeem) - Direction Régionale de l'Environnement 2. Field observation on the waste water purification station in Kairouan 3. Visit to the Direction of Health and Basic Care in Kairouan (Mr. Naser Marji) Hygene and Protection of the Environment - Direction de la Santé et des Soins de Base 4. Visit to the Water Resources Direction, and Sidi SAAD Barrage and El Houred DAM in Kairouan (Mr. Kallali and Mr. Ben Salem)
	16.00 – 21.00	Kairouan - Tozeur	Trip to Tozeur Stayed in Tozeur (In Hotel Iberostar Palmyre)

Schedule (*Continue*)

Date	Time	Location	Activities
31 JULY (SAT)	08.00 – 16.00	Tozeur	1. To observe the water management system in Tozeur (Oasis), tour guided by Ms. Jeridi Aida. There is a traditional irrigation system in Oasis using gravimetric system, which it has been introduced by Ibn Sabat (Judge) for a hundred years ago. 2. To observe the underground Dam in Tozeur
	16.00 – 18.00	Tozeur - Kasserine	Trip to Kasserine Stayed in Kasserine (In Hotel Sufetula)
01 AUG (SUN)	08.00 – 16.00	Kasserine	1. Visit to the El Brek Dam 2. Visit and observe the irrigated area of Sbiba, especially apple and also the farmer associations in Kasserine - Visite du Barrage El Brek et le périmètre irrigué à Sbiba
	16.00 – 18.00	Kasserine - Kef	Trip to Kef Stayed in Kef (In Hotel Leklil)
02 AUG (MON)	08.00 – 15.00	Kef	1. Visit to the Direction of Health and Basic Care (Direction de la Santé et des Soins de Base) 2. Visit to and observe the Sarrat Dam and Mellegue River (Arrondissement des RE- visite des barrages Sarrat et Mellègue)
	15.00 – 18.00	Kef - Tunis	Trip to Tunis Stayed in Tunis (In Hotel Belvedere)
03 AUG (THU)	07.30 – 15.00	Tunis	Closing and Synthesis Conference. In this section, some invited experts of water resources and public health and also JICA cooperation for North Africa gave a presentation and hold some discussion about the topic.
	19.30 - 20.00		On-Air Interview in Radio Tunisia of Channel International about International Internship of Tunisia. Representative persons regarding the internship program were interviewed by Mrs. Helda as presenter for English program in RTCI. Stayed in Tunis
04 AUG (WED)	08.30 – 11.00	Tunis – Sidi Bou Said	Visit to the touristic area of Sidi Bou Said - Visite de Carthage – Sidi Bou Said
	11.00 – 12.00	To Airport	
	14.40	Tunis–Dubai–Narita	Transit in Dubai
05 AUG (THU)	18.00	Tokyo, Narita	Arrival to Japan, Tsukuba

3. Documentation

Direction of Health and Basic Care in Ministry of Public Health, Tunis

Visit to the tourist object of Mediterranean Sea in Cap Bon (Hammamet)

Sidi Saad Barrage in Kairouan

El Houred Dam in Kairouan

Sahara Desert in Nefta (there is a oasis in backside)

Sahara Desert in Nefta (Chott area)

Restaurant in de Kasbah, de Basilique in Kef

Restaurant in de Kasbah, de Basilique in Kef

Barrage Mellegue in Kef

Sidi Saad Barrage in Kairouan

Closing and Synthesis Conference of International Internship in L'Institute National Agronomique de Tunisie (INAT)

Direction of Health and Basic Care in Ministry of Public Health in Tunis