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## **RESEARCH ACTIVITIES**

At the INRGREF, I am member of the Research Laboratory dealing research on irrigation systems and the use of non-conventional water resources in agriculture. My research experience in the water sector is focused on wastewater quality and reuse for agricultural purposes; I was interested in effluents reuse for artificial aquifer recharge as well. In water research, I was dealing with the following aspects: wastewater quality and monitoring reuse for agriculture and aquifer recharge, and emerging contaminants in wastewater and exposed environment. For the first aspect, I was working on the physiochemical quality of sewage effluents. I performed several sampling campaigns to monitor the water quality parameters at the inlet and the outlet of the majority of the working sewage treatment plants in Tunisia, mainly in those which effluents are reused for irrigation. Evaluation of the efficiency of the various applied treatment processes in reducing the polluting load- organic pollution and heavy metals - is controlled, together with the compliance of the effluents with the Tunisian irrigation effluents and discharge quality standards. I have been also monitoring the quality and the heavy metals load of sewage sludge produced in the corresponding sewage treatment plants (domestic, industrial, touristic).

The second aspect that I developed in my institute concerns the occurrence of emerging organic pollutants in wastewaters and sewage sludges. Concerning this topic, and for my PhD thesis I was working on the disrupting organic compounds in wastewater used for irrigation, irrigation exposed soils and eventually affected groundwater. This work was carried out in an area where effluents are reused for irrigation and artificial recharge of aquifers. The investigated organic compounds were those potentially acting act like estrogenic hormones (estrogen-like) and dioxin substance (dioxin-like and recently called PAH-like); some results were also obtained on the occurrence of contaminants with various effects, called xenobiotics. Some innovative tools based on bioassays technique were used to estimate the load of these pollutants. The identification and the quantification of the involved compounds needs sophisticated analytical techniques (like gas and liquid chromatography coupled to mass spectrometry) that are not well developed in Tunisia. Sampling campaigns were also carried out to investigate persistent pharmaceutical compound and its metabolites that are not eliminated after secondary treatment. They are used as indicators of contamination of the environment by wastewaters. Since some estrogen-like and pharmaceutical compounds were detected in groundwater, and as the peri-urban/rural populations living in irrigated area are using groundwater for garden crops and livestock watering, it is planned to perform a survey in the irrigated area to identify the uses of groundwater and determine the risks associated to these practices.

Again in the field of the emerging organic pollutants, I was interested in determining the occurrence of some Polychlorobiphenyls (PCB) (the most persistent 7 congeners) in sewage sludge, since the latter is currently being spread on agricultural soils. The objective behind this experiment was to improve the state of knowledge on sewage sludge quality, especially their content in this type of persistent substances. It was foreseen to contribute further to quality standards elaboration to facilitate their reuse in agriculture, even if these contaminants are not considered in the existing standards yet.

Currently, I'm working in collaboration with specialists in solar energies on a project proposal on wastewater treatment processes in conjunction with renewable/low-cost energies, wastewater treatment, and water reuse in the African continent.

## **FIELDS OF RESEARCH TO BE DEVELOPED**

The fields of research that I would like to develop at the Arab level in partnership with German are related to two main topics: (i) emerging contaminants in reused wastewaters and (ii) wastewater reuse in the framework of an integrated water resource management.

- The first topic deals with the occurrence of emerging organic contaminants in wastewaters, especially treated wastewater reused for irrigation purposes, their fate in soils and transfer to groundwater. This field of research needs to be enhanced since several gaps of knowledge still exist and the available data are scattered and hardly comparable. The main obstacles are related to the lack of technical skills and analytical equipments, on one side, and lack of federating projects and cooperation between the national research teams and international specialists on the other; laboratories in the Arab countries have to be upgraded too to comply with QA/QC standards. Almost Arab countries are lacking studies on the loads of these chemicals in their wastewaters despite their increasing number of sources, like the flourishing industrial and touristic sectors and the domestic consumption of detergent, pharmaceutical and personal care products, and other persistent substances. These compounds may have a negative long-term impact on health and environment as it has been shown in advanced countries during the last two decades. In order to tackle these likely harmful effects before their occurrence, it is important to address this issue in the framework of a large project where national and international experts and specialists can be involved.

- The second topic deals with wastewater reuse in the framework of an integrated water resources management policy in the Arab countries. The situation of wastewater reuse in the Arab countries is so much contrasted. Some countries are using raw wastewater with minimal or no treatment at all for market gardens products even if this practice is banned. These products will be consumed by farmers and their families or sold in local markets. At the opposite, other countries are using tertiary treated wastewaters for the irrigation of gardens and ornamentals and they are applying very stringent regulations. In both cases wastewater is not efficiently used: in the first case the population and the environment are exposed to various chemical and biological contaminants transported by wastewaters. In the second case, water resource is wasted and is not appropriately and efficiently used as these uses do not need such a high quality of water. There are also countries with situations in between where wastewater reuse is an integral part of the water resources policies, but where there many institutional, economic, legislative and social constrains hampering an effective implementation of reuse. In others, wastewater reuse is an illegal old practice but there is no political will to set up serious plans for a formal implementation. As a whole, and as noticed by several water experts, few countries in the Arab region have been able to implement substantial wastewater treatment and reuse programs. Collaboration may be enhanced on this topic to deal with case studies where IWRM can be implemented; building capacity and awareness raising will be of high significance too.

Now, given the current situation in the Arab countries characterized by a political change, with political transition for ones and continuous struggle for others, the water sector in the Arab countries may be affected in term of quantity and quality on one hand, and planning and implementation of the projects on the drawing board. The research activity may be affected too since there may be less budget than before to be allocated to buy facilities for research institutes.