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IAH Italian Chapter

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FOREWORD

FLOWPATH 2014, the National Meeting on Hydrogeology, Viterbo 2014, follows up on previously organized and successful meeting FLOWPATH 2012 held in 2012 in Bologna. According to the aim of the 1st Edition, the conference will be an opportunity for Italian hydrogeologists to exchange ideas and knowledge on diversified groundwater issues. The IAH Chapter organized the 2nd Edition to ensure the continuation of this stimulating debate within the scientific and professional community, giving priority to proposals and ideas of young hydrogeologists.
This Abstract Volume contains abstracts of technical oral and poster contribution accepted to the FLOWPATH 2014, and of the invited keynotes presentations. The abstracts were evaluated by the members of the Scientific and Organizing Committees. More than 80 abstracts have been submitted for oral or poster presentations, mainly but not only by Italian hydrogeologists. Significant and interesting contributions were also received from many counties such as Algeria, Austria, Belgium, Canada, Egypt, France, Germany, United Kingdom, Guatemala, Portugal, Russia, Serbia, Slovenia, Spain, Switzerland, Tunisia, USA.

FLOWPATH 2014 focuses on four themes of great importance:

1. Contaminant Hydrogeology,
2. Groundwater Quality Protection,
3. Hydrogeology of Mineral and Thermal Waters,
4. Climate Change and Groundwater Sustainability.

The Table of Contents of the Abstract Volume is organized according to the four topics of the conference. Within each topic, the abstract of the keynote lecture opens the Session and is followed by the technical contributions in alphabetical order of the first Author's name. In order to facilitate the use of the volume, the Index of Authors is placed at the end of the volume.
The printing of this volume was made possible thanks to the contribution of the Executive Committee and of the Department of Ecological and Biological Sciences, Università degli Studi della Tuscia.

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[69] DESIGN OF ARTIFICIAL AQUIFER RECHARGE SYSTEMS IN DRY REGIONS OF MAGHREB (NORTH AFRICA)

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Introduction

North Africa arid land of Maghreb suffers scarce water conditions. Erratic behaviour of rainfall events over brief intervals often produce short and intense floods events which converge into ephemeral wadi beds. Since often this intermittent surface water is not optimally managed, most part of it is lost, providing scarce benefits for households living in villages of such semi-desert areas.

The present research is developed in the frame of WADIS-MAR (www.wadismar.eu). This is one of the five Demonstration Projects implemented within the Regional Programme "Sustainable Water Integrated Management (SWIM)" (www.swim-sm.eu), funded by the European Commission and which aims to contribute to the effective implementation and extensive dissemination of sustainable water management policies and practices in the Southern Mediterranean Region. WADIS-MAR Project concerns the realization of an integrated water harvesting and artificial aquifer recharge techniques in two watersheds in Maghreb Region: Oued Biskra in Algeria and wadi Oum Zessar in Tunisia. These areas are characterized by water scarcity, increasing water demand, overexploitation of groundwater resources, and are highly exposed to climate change risk and desertification processes. The situation is quite critical since groundwater withdrawal is bigger than the rate of recharge, with consequent groundwater deterioration and/or an imbalance in the groundwater budget.

Integrated (Sustainable) Water Resources Management (IWRM) promotes a coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of the environment. IWRM strategies are based on the four Dublin Principles presented at the World Summit in Rio de Janeiro in 1992. In arid and semi-arid areas, the optimum course of action for sustainable water resources management is, in most case, a combination of surface and groundwater use, with a range of storage options. Water harvesting techniques might catch water during rainfall events in order to recharge an aquifer, thus impeding the quick runoff out of a catchment area. An alternative or supplementary activity to it is the artificial aquifer recharge, consisting in a process of induced groundwater replenishment (Murray and Harris 2010; De Vries and Simmers 2002). The successful operation of an artificial recharge (AR) facility depends largely on an effective management. Among several technical aspects, before developing an AR facility, the viability and feasibility of the project should be assessed to verify that: (i) artificially recharged water does not cause geochemical reactions to occur in the subsurface that adversely impact aquifer water quality; (ii) water quality analyses of the possible sources of water for AR and water currently present in the aquifer to be recharged must be obtained; (iii) adequate permeability, thickness, and lateral extent occur to achieve the desired performance standards for the AR facility.

Main results and discussion

A multidisciplinary research effort, including geological, hydrogeological, hydro-chemical, multi-isotopical, geophysical and hydrological investigations, was aimed at selecting suitable zones for the artificial aquifer recharge in both target areas. For each study area, a schematic

3D hydrogeological model was built based on previous maps (both geological and hydrogeological), subsurface data (well-logs), photo-interpretation and remote sensing.

Algeria: the study area is located in a flat region between the chains Saharan Atlas mountains and the Aures hills, it is crossed by the Oued Biskra according to a NS direction. The area is characterized by the superposition of several folding events occurred from Middle Eocene to Pleistocene that strongly influence the geometry of the main aquifers (Buttau et al. 2013; MdH 1980). The main hydrogeological complex are: "Nappe des sables" (deposits of Miocene and Quaternary); "Nappe de Tolga" (limestone, lower-middle Eocene); "Nappe du Maestrictien et du Campanien" (limestones); "Nappe du Turonien" (limestones); "Nappe du Continental Intercalaire" (sandstones and limestones, Albian-Barremian). The mean annual rainfall of the area as a whole is about 200 mm.

We decide to recharge the infero-flux aquifer hosted in the alluvial deposits of the Oued Biskra. The depth to the water table ranges from 20 to 30 m and the thickness of the saturated zone from 40 to over 75 m. Extraction for drinking and agriculture occurs at 15 boreholes, whose depths range from 35 to over 50 m. Total well yields average is 4.5 M m^3/year. Groundwater flow originates dominantly from the NE and moves toward south. The average trasmissivity of this aquifer is 10^{-2} m^2/s. Preliminary results from NO_3 and SO_4 isotopes coupled to chemical data evidenced the existence of a source of contamination near the town of Biskra, probably related with wastewater or fertilizers, which needs to be better characterized previous to the definitive design of the recharge system. Based on the collected data, three types of AR methods i.e. recharge basins, vadose-zone wells, also called dry wells, and recharge tranches, are suggested to catch and infiltrate flash flood waters from the ephemeral streams. We estimate an average of 1.5 M m^3/year.

Tunisia. The study site Oum Zessar belongs to the region of SE Tunisia (province of Médenine). It stretches from the mountains of Matmata (Béni Khédache) in the SW, crosses the Jeffara plain (via Koutine) and the saline depression (*Sebkha*) of Oum Zessar before ending in the Mediterranean (Gulf of Gabès). The study watershed receives between 150 and 240 mm of annual rainfall. The groundwater system of the region can be subdivided into shallow and deep aquifers, and two hydro-litho-stratigraphic provinces may be differentiated: a) the northern Jeffarah, limited to the south by the monoclinal of Djebel Tebaga de Medenine of Permian age. That province is characterized by a large coastal aquifer made essentially of Senonian limestone and Mio-Pliocene sand; b) the southern Jeffarah with the occurrence of Triassic sandstone upstream of the Medenine fault, and with Lower Miocene sand downstream of the fault (Yahyaoui 2007). Increasing values of ^{15}N and ^{18}O from nitrate in some wells in the sourthern Jeffara, indicates that denitrification processes are occurring pointing out that natural attenuation decreases the nitrate pollution. We decided to concentrate our effort on the aquifer of the Triassic sandstone. The renewable resources are estimated to 150 L/s and the salinity varies between 1 g/L and 3 g/L. The analysis of $\delta^{34}S_{SO4}$ and $\delta^{18}O_{SO4}$ indicates that the origin of this salinity is natural, mainly related to the water-rock interaction with the triassic evaporites. The water from this aquifer is used mainly for drinking water and irrigation. In 2010, the rate of overuse reached 160%, which resulted in some tendency of piezometric level decline (Yahyaoui 2007). Based on the collected data and the hydogeological feasibility, dry wells with a recharge chambers are designed to catch and infiltrate flash flood waters from the ephemeral streams in 4 intervention sites. We estimate overall an average of 2.0 M m^3/year. Artificial aquifer recharge is a long-term phenomenon; indeed, its effects in term of efficiency, have to be examined on a large time and spatial scale. This issue will be the topic for the continuation of the research.

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