

3.5 Description of the Kiti - pervolia aquifer case study, Cyprus

Title of Case Study	Tritium (and (CFCs) concentration analysis of groundwater samples
Location (region, Country)	Kiti – pervolia aquifer, Cyprus
Other information	—

Description of Case Study (background information on the region)

The kiti – pervolia aquifer is situated in the southern part of Cyprus and covers an area of 40Km². It's a small phreatic aquifer and it extends from the Kiti dam to the north to the Larnaka Salt Lake(s) to east and up to the chinks and marls outcrops of the Lefkara formation to the west (near Tersefanou village). The southern boundary of the aquifer is in hydraulic contact with the sea. Tremithos River runs from north to south and discharges to the sea, along the western half of the aquifer. In 1964, however, the Kiti recharge dam was constructed on Tremithos River, at the northwestern part of the aquifer. The two dominant land use types are agriculture and urbanization. The area's surficial geology is dominated by Pleistocene marine terraces and Holocene alluvial sediments. Underlying the abovementioned sediments are the chinks and marls of the Lefkara (Paleocene-Oligocene) and Pachna (Miocene). The aquifer is phreatic and it develops in alluvial sediments and marine terraces with the Paleogene chinks and marls acting as the impervious base of the aquifer. Groundwater is recharged through the dam, Tremithos river bed infiltration, from precipitation and return irrigation.

The whole area is characterized by semi-arid conditions, with a mean annual precipitation of 330,6 mm and a mean annual temperature of 19.9°C. Precipitation is not distributed evenly throughout the year, though. The months of December followed by January are the wettest with an average annual rainfall of 84mm and 76mm, respectively. Winter and spring seasons are usually followed by dry summers with little or no precipitation.

Description of problem (why is this location chosen for a Cases Study)

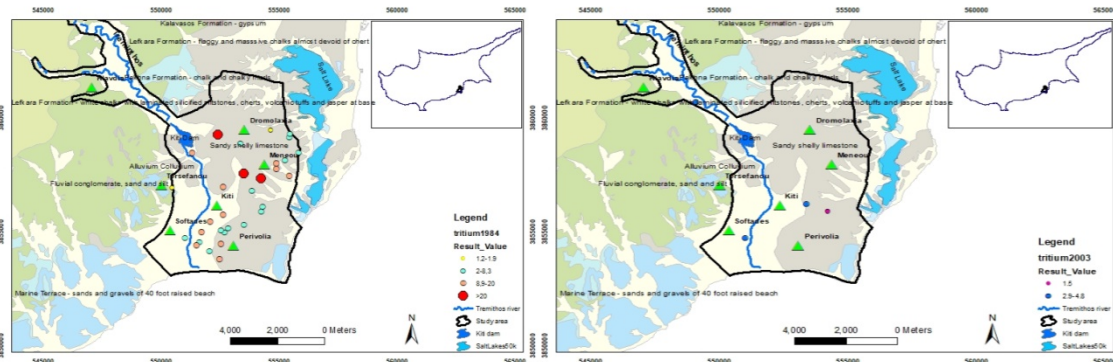
Kiti – pervolia aquifer is a small, coastal aquifer of vital importance to local economy, agriculture and environment. Intense agriculture is practice along these typical coastal aquifers where major irrigation projects have been implemented. Decreasing precipitation during the last decades has caused a dramatic decrease of water inflow to the recharge dam and artificial recharge activities have been put on hold due to the general water deficit in the country. Overpumping and decreased recharge have led to negative water balance of the aquifers. The area is affected by both point and diffuse pollution sources thus deteriorating groundwater quality. Sea water intrusion and nitrate pollution are the main pressures on kiti-pervollia groundwater quality status.

Methods to be used in the Case Study (analytical and isotope techniques, modelling)

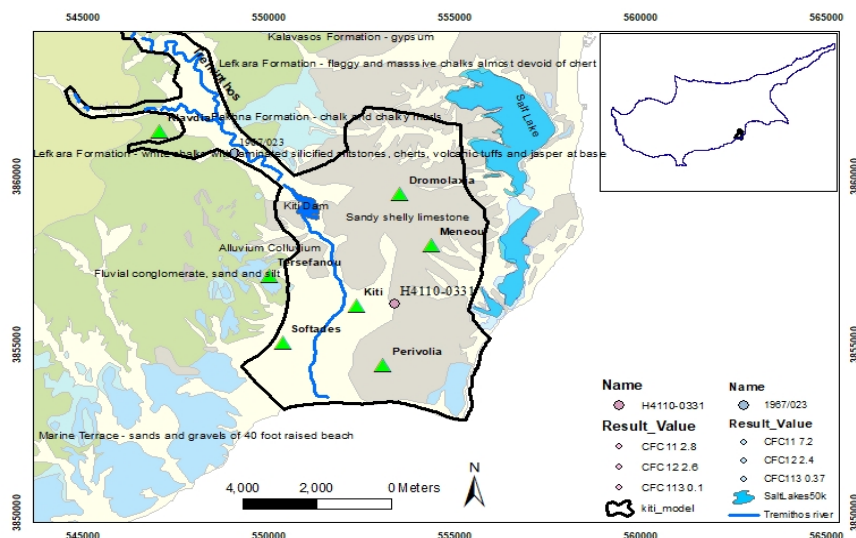
Two tritium sampling campaigns were carried out in 1984 and in 2003. In 1984, 31 groundwater samples were collected and in 2003 four (4). Furthermore groundwater samples from two boreholes were collected for CFCs (CFC-11 and CFC-12, and CFC-113) analysis, in 2003. Concentrations of CFCs and tritium in 2003 were determined at the Hydroisotop GmbH, in Munich. All samples were collected from the alluvial part of the aquifer.

Results from this Case Study

Tritium activity concentration in groundwater wells in both sampling campaigns varied from 1.2 TU to 23 TU. All groundwater samples were found to be younger than 50 years old (the limit of tritium dating). Tritium results indicate a mixture of very young water and water 20-30-year old. However, mixing with older water (0.8–2 TU) is also observed. This can be attributed to i) lateral flow of old groundwater from the chalks, in its western part aquifer (Tersefanou area) and ii) groundwater upwelling from well that have intersected the confined lower chalk aquifer.



The highest concentration in CFCs was recorded in the groundwater sample from borehole 1967/023, which is located in the alluvium of Tremithos River. Substantial surface flow occurred during the wet period of 2002–2004 in the Tremithos River, which has contributed to the recharge of the aquifer with young and CFCs rich water.



Impact - how this Case Study contributes to the overall project aims

Kiti – pervolia aquifer is a small, coastal aquifer of vital importance to local economy, agriculture and environment of Cyprus and can serve as a case study for other similar aquifers on the Island. Tritium and CFC dating on such typical aquifer can contribute to establish a harmonized database on groundwater age tracers, thus contributing in improving groundwater management and protection.

Name of pilot area / aquifers / type: Kiti-pervolia-aquifer / Multi-layer aquifer		Country: Cyprus Region: Kiti - pervolia	
Study level	Transboundary: ☐	Regional: ☐	Local: ☒
Type of observations <i>(choose one of the options, create separate template if needed for each type if each type need specific information)</i>		Single well(s): ☐ ☐ Short screened observation wells (not pumped) ☐ Long screened observation wells (not pumped) ☒ Pumped wells, long screens in one aquifer ☐ Pumped wells, long screens over multiple aquifers ☐ Springs ☐ Other (eg. research wells; indicate type and information on pumping):	
Approximate location of pilot:			
Geological cross section / conceptual model of the pilot area:			

Name of Shape- / Geopackage file defining the area:		Projection to be used: WGS84 (Epsg4326)		
Hydrological parameters:	Mean annual precipitation (mm or range in mm)	Mean annual groundwater recharge (mm or range in mm)	Mean annual groundwater recharge temperature (°C)	Thickness of unsaturated zone (range in m)
	330	40-50		10
Pumped wells only		Typical pump discharge of sampled individual well (m³/day): 50	Typical pump discharge of complete well field (m³/day): <i>If relevant</i>	
List of aquifers and aquitards in pilot area		No. of confined or semiconfined aquifers in pilot area: /	No. of unconfined aquifers in pilot area: 1	
Aquifer no. (aqf): 1 Aquitard no. (aqt): 1 Aquiclude no. (aqc):	Aquifer/aquitard type and/or name	Lithology (Resource WP6 terminology)	Depth range (m)	GW age range (yr)
Aqf-1:	Mainly unconfined	sand to gravel	20-45	Less than 20 year

Porosity type	Porous: X	Fissured: ☐	Karst: ☐	Fissured and porous / dual porosity: ☐
Aqt-1:		marl		
Applied tracer age indicators (^3H , $^3\text{H}/^3\text{He}$, ^{85}Kr , ^{39}Ar , ^{14}C , ^{36}Cl , ^{81}Kr , ^4He , CFCs, SF_6 , etc.) Applied recharge temperature indicators (^{18}O , D, noble gases)	Aquifer-1 ^3H , CFCs			
Number of sites (wells/springs) with age indicators	Aquifer-1 1-5: ☐ 5-10: ☐ 10-25: ☐ >25: X			
GW age range (GAR) GAR-1: Modern (< 60 yr) GAR-2: Old (> 60 yr and 10 kyr) GAR-3: Paleowaters (> 10 kyr)	Aquifer-1 GAR-1: 1-10%: ☐ 10-25%: ☐ 25-50%: ☐ >50%: X GAR-2: 1-10%: ☐ 10-25%: ☐ 25-50%: ☐ >50%: ☐ GAR-3: 1-10%: ☐ 10-25%: ☐ 25-50%: ☐ >50%: ☐			
Groundwater age ranges (GAR) estimated by:	Tracer based estimates: X Flow and age model simulations ☐ Combination of model and tracer estimates ☐ Expert judgement: X			
Objective of age dating studies:				
Basic research or General groundwater management	Assessment of pollutant history		Assessment of the efficiency of remediation and mitigation measures	
X				
Water Usage <i>(not relevant for observation wells)</i>	Water supply		Irrigation	Industry
	X		X	
Geoenery related activities <i>(not relevant for observation wells)</i>	Shallow Geo-T	Deep Geo-T	Hydrocarbons	
Mining activities <i>(not relevant for observation wells)</i>	Construction materials		Minerals / metals	Coal
Other				
REFERENCES				



OPEN Access reports and papers (PDF versions made available in EGD repository making them downloadable via maps and keyword / free text searches):	Reports and papers with restricted access: Groundwater Quality Investigations in Cyprus. Main Results of a Project of Technical Cooperation in Applied Sciences, by S.L. Zomenis, W. Wagner and D. Ploethner, 1988 (Project report hydrochemistry 7 and 14) Udluft, P., Külls, C., 2003. Re-evaluation of Groundwater Resources of Cyprus for the Republic of Cyprus. Task4: New Investigations. Ministry of Agriculture, Natural Resources and Environment Geological Survey Department Nicosia.
Remarks / other relevant information:	