Personal details

Name: Evangelos Rozos

Birthdate: 24 January 1974

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Current work: Associate Researcher in the Institute of Environmental Research and Sustainable Development of the National Observatory of Athens.

Education

1997 Civil Engineering Degree, Department of Water Resources and Environmental Engineering, National Technical University of Athens, Athens, Greece

2010 PhD. in Groundwater Hydrology, Department of Water Resources and Environmental Engineering, National Technical University of Athens, Athens, Greece

Experience in planning and executing research

Groundwater hydrology

The science of hydrology remains the main field of work since my graduation. My first steps during my diploma thesis included familiarization with Geographic Information Systems (GIS). Back then, I studied the spatio-temporal correlation of the groundwater level around Lake Yliki with the water level of Lake Yliki. The purpose of the study was to highlight the inefficiency of the practice to pump water from the energy intensive boreholes in the vicinity of the lake when there is water available in the lake since the surrounding karstic aquifer and the lake are communicating. At the same time, I was involved in GIS mapping and land development projects of various parts of Greece. In various research programs in the late 1990s, I started dealing with the processing and storage of hydrological information. I developed applications in Microsoft Access that queried the data regarding irrigation and pumped water volumes for various regions of Greece.

During my Ph.D., I began to build my first models of groundwater and surface hydrology. The original objective was to study the groundwater flow in aquifers where the flow is not laminar (e.g. karstic), Darcy's law does not apply, so standard groundwater flow models (e.g. MODFLOW) cannot be used. The model I developed was later incorporated in the hydrological model Hydrogeios of the Hydrology Laboratory of the School of Civil Engineering of the NTUA. I also studied aquifers of high incertitude (aquifers where boundaries are vaguely defined, or no water level measurements, or the groundwater flow takes places primarily inside discontinuities of the aquifer). To facilitate the modelling of such kinds of aquifers, I employed some innovative approaches: a hydraulic analogous that represents the flow with a network of tanks and pipes, assessment of the multi-cell modelling error in transient flow conditions for different types of discretization, a mixed flow equation that is applicable in both flow conditions within a karstic conduit, and a holistic approach with coarse discretization and the parsimonious parameterization.

Recently, I was involved in a project (SUBSOL) that was studying the employment of compact treatment units to treat brackish water and reinject into the aquifer to improve the groundwater conditions. In this project I developed a spatial screening tool to identify the locations suitable for subsurface water solutions.

Surface Hydrology

Hydrogeios model, in which I was one of the main developers, was designed to be a tool that will simulate all interacting hydrological processes for studying and understanding the water cycle on the hydrological basin scale. Hydrogeios includes a global optimization algorithm for two reasons: to i) calibrate the parameters of the model based on the available measurements, and ii) to assess the management strategies that achieve the optimal trade-off between cost and acceptable risk. Hydrogeios is based on GIS to define the sub-models' discretization and how they interact with each other. In particular, the discretization of the surface model is done by applying a spatial Cartesian product between thematic layers that represent different properties of the terrain (e.g. permeability, inclination, type of coverage, etc.). The result is the classification of the catchment area in a small number number of categories (the number of them equals the product of the number of categories of the thematic layers) with specific geomorphological characteristics, hence specific hydrological behaviour. These categories are called hydrological response units and are modelled in Hydrogeios with a soil moisture model (modified Thornthwaite model that calculates actual evaporation, surface runoff and salinity). On the other hand, the groundwater model is discretized employing an empirical method, which has been suggested during my Ph.D. Specifically, the suggested method is to draw the edges of the cells of the groundwater model either on flow lines or on equipotential lines. In this way, the simulation of the groundwater flow can be done with satisfactory accuracy even with a very limited number of cells. Surface runoff, calculated from the soil moisture model, plus the spring discharge, calculated from the groundwater model, is propagated to the downstream node of the hydrographic network (node is inserted in hydrographic network locations with flow measurements, junctions or any point of interest) with the Muskingum method.

Stochastics

Along with the technical hydrology, I have also used stochastic hydrology in various research projects. For example, in my Ph.D. thesis I implemented in MATLAB the symmetric average algorithm in two dimensions in order to produce synthetic fields of hydraulic conductivity. This stochastic algorithm is based on the moving average methodology over a random noise field and is capable of producing time series of any form of autocorrelation, which is required to represent the phenomenon of persistence. In another case, I used the MATLAB WeaGETS algorithm to investigate the effect of climate trends on the evolution of demand for the Athens water supply system. This algorithm uses Markov chains to simulate the transition from rainy to no-rainy (and the other three combinations) and then uses a random number generator (Pearson III distirbution) to produce rainfall depth if day is rainy. In another application, I used an AR (1) autoregressive model (the model parameters are derived from the 2×2 zero and first order correlation matrices of the minimum and maximum temperatures) to produce synthetic timeseries of minimum and maximum temperatures. During the ODYSSEUS research project, I studied the effects of climate change on the recharge of an aquifer that is discharging to a spring important to the Athens water supply system. Employing Monte Carlo simulations (model running each time with a different synthetic rainfall time series), the 95% confidence intervals for the future spring discharges were derived. Freely available stochastic models were tested during the Hydropolis research project, and they were compared to the stochastic model Castalia (a model developed in the Hydrology Laboratory of NTUA) regarding their capability to reproduce the statistical structure of the observed time series and the persistence phenomenon. Castalia uses the symmetric average method to produce annual time series, and then an autoregressive periodic model PAR (1) for the monthly and daily time step (with cut-off threshold for rainy / no-rainy day separation) in iterations to ensure consistency between of different scales (annually and daily).

Water resources management

The expansion of human activity is linked to increasing water demand, both for domestic and non-domestic uses. One of my research interests over the last ten years is to investigate methods to address this problem. Inevitable, a successful management strategy needs to expand over many sectors of the human activity and many scales. At the higher scale is the water resources management. A balance between risk and operating costs minimization needs to be achieved. UWOT (a model that I started developing since I was in Exeter University and still continue to do) employs a parametric rule to distribute the water demand (for domestic use, industrial, farming, etc.) to the water resources according to their water availability. In essence, the parameters of the parametric rule define a management strategy. With the help of the MATLAB optimization library (UWOT is a stand-alone application, but is also available in a mex format, i.e. a MATLAB executable), single or multi-objective optimization can be performed. A classic example is the Athens water supply system. Athens is supplied with water from two main reservoirs, Lake Yliki and Mornos. The first one exhibits significant leakages because of the lake's karstified bottom, so abstractions from it help reduce water losses from the system. However, because of the lake's low water level, water needs to be pumped to Athens. Mornos, on the other hand, does not have significant leakages and the water flows by gravity (some energy is produced also) towards Athens. If Mornos is used exclusively as resource, operating costs are reduced, but water losses from Lake Yliki are maximized, which in the case of a drought can result in water shortage. If Lake Yliki water is used preferentially, then the risk is minimized, but the energy consumption is maximized. The representation of the Athens water supply system in UWOT helped to develop a set of optimal management strategies each of which outweighs all the others either in terms of cost (including energy) or risk. To verify the management scenarios produced by the UWOT model for the Athens hydro-system, Hydronomeas, a water resources management program developed by the Hydrology Laboratory of NTUA, was also used.

Consultancy experience

During my work in the Special Secretariat for Water, I was involved with the Floods Directive and responsible for the IT support. In particular, the Secretariat was preparing the reports of the most vulnerable areas indicated by historical records of catastrophic flood events. I helped the Secretariat with the GIS applications required for this submission and the organization of the information into the required format.

During a cooperation with Hydroexigiantiki Consulting Engineers, I participated in the setup of a hydrological surface model for the water management of the dam of Gadouras in Rhodes. This included the estimation of the monthly hydrological water balance of Rhodes, and in particular the surface runoff at characteristic sites, as well as the infiltration, i.e. the recharge of the underlying aquifers through the unsaturated zone. This work has been done with Hydrogeios (version for MapWindow).

During a cooperation with Hydrodomiki Ltd, I participated in the study of the sewerage network of Glyfa, Fthiotida, Greece.

During a collaboration with Argyropoulos & Associates, I participated in the hydrological study for the management of the water resources of Pylos, specifically of the watersheds of

Kserias and Giannougas. The study of the hydrological balance of these two basins was done with two simple models (one for each basin with identical structure, but different parameters) that simulated the unsaturated and saturated zone. These models were used to study management scenarios under the prospect (during the study period) of the development of the Costa Navarino resort.

International experience

From 2007 to 2009 I have been Associate Research Fellow at the Centre of Water Systems in the University of Exeter. The Centre of Water Systems is one of the most renowned research centres in the UK. The research project I was involved included integrated and sustainable water management for new developments by provision of tools and guidelines, study of technical aspects of the water cycle (water supply, wastewater collection, storm drainage/SUDS), management of the water cycle as delivered at the local level in new developments, and development of a Decision Support System. Apart from my participation in the research project, in these two years I was also teaching CAD lessons to 2nd year students of the school of engineers.

In 2011 a Ph.D. student visited the Hydrology Laboratory of the NTUA for a period of 6 months. During her stay, the hydrologic model Hydrogeios was setup to simulate the daily discharge along the hydrographic network of the river Liri. For the representation of surface hydrological processes I used a spatial parameterisation, taking into account the heterogeneity of the surface system, based on the concept of the hydrological response units (HRU). For groundwater, I chose a sparse network of interconnected tanks (hydraulic analogous) to simulate the groundwater cycle and the response of a karstic spring. This approach has provided a satisfactory compromise between model complexity, data availability and computational load (see http://www.itia.ntua.gr/en/docinfo/1118/).

In 2015, the School of Geography of the University of Seville, in collaboration with the Agencia de Obra Publica de la Junta de Andalucia, was studing the redevelopment of social housing in the Las Huertas district of Seville. For the redevelopment, they were proposing two alternative scenarios. The first scenario did not require large investments (mainly installation of low water consumption appliances), while the second scenario included a set of measures that have been assessed as sustainable and have positive acceptance by the social actors, but require more funding (rainwater and water recycling). To study these alternatives, the University team used UWOT. To support them in the model setup, they asked me to visit Seville for a few days. I also implemented some additional features in UWOT to better adapt to the needs of their study. The results of this study are reported in the Aqua-Riba report (available on the internet): Guía Para La Incorporación De La Gestión Sostenible del Agua En Áraas Urbanas.

In 2016, Oslo VAV (Oslo water supply company), wanted to test the implementation of smart solutions in the water distribution system at a pilot level. The smart solutions included: smart water meters to motivate reduction of water consumption and smart water distribution networks to optimize water system performance. Oslo VAV was interested in a methodology to upscale the results of the pilot applications to the city level. For this reason, modelling the entire Oslo water supply system (including water and wastewater treatment plants, water supply, and sewage systems) was required to analyze and upscale the results of the pilots under alternative scenarios. The final objective was to identify the benefit of these interventions to the water supply system reliability. To accomplish this, I represented the entire Oslo water supply and wastewater network in UWOT. Then, I prepared alternative representations corresponding to various intervention bundles (different technologies and extent of their application). This resulted in a chart that gave the robustness/resilience of the system at a time horizon of few decades for the various interventions and the alternative scenarios.

Recently, a Ph.D. candidate from the University of London started looking into the potential of installing a sewer mining system in Tehran's Apartment 2. The concept was to use a compact sewage treatment plant to pump the sewage from a nearby wastewater pipeline, process it and return sludge back to the sewerage. For this study, UWOT is used to help in the design of the compact unit, assess the wastewater quality at a downstream location of the unit, the energy consumption, the green area that can be irrigated, and finally the microclimate benefits due to the latent heat generated by the evapotranspiration.

Reviewer in scientific journals

Urban Water Journal	20
Hydrological Sciences Journal	14
Water Open Access	9
Journal of Hydrology	3
Water Resources Management	2
Journal of Environmental Modelling and Software	2
Resources	1
Resources, Conservation & Recycling	1
Journal of Hydrologic Engineering	1
Environmental Science and Pollution Research	1

I am also serving as Associate Editor in Hydrological Sciences Journal. Since 2012 I have handled 91 submissions.

Scientific publications

Google: H-Index 12, citations 527

Scopus: H-Index 9, citations 273

Journal publications:

1. E. Rozos, An Assessment of the Operational Freeware Management Tools for Multi-Reservoir Systems, WST: Water Supply, doi: 10.2166/ws.2018.169, (in press).
2. C. Makropoulos, I. Koutiva, P. Kossieris, E. Rozos, Water management in the military: The SmartBlue Camp Profiling Tool, Science of The Total Environment, Volume 651, Part 1, Pages 493-505, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2018.09.056, 2019.
3. C. Makropoulos, D. Nikolopoulos, L. Palmen, S. Kools, A. Segrave, D. Vries, S. Koop, H. J. van, Alphen, E. Vonk, P. van Thienen, E. Rozos and G. Medema.A Resilience Assessment Method for Urban Water Systems, Urban Water Journal, 15:4, 316-328, doi:10.1080/1573062X.2018.1457166, 2018.

4. S. Baki, E. Rozos, and C. Makropoulos, Designing water demand management schemes using a socio-technical modelling approach, Science of the Total Environment, doi:10.1016/j.scitotenv.2017.10.041, Volumes 622–623, pp. 1590-1602, 2018.

5. E. Rozos, I. Tsoukalas, K. Ripis, E. Smeti, and C. Makropoulos, Turning black into green: Ecosystem services from treated wastewater, Desalination and Water Treatment, 91 (2017), 2017.

6. Makropoulos, C., Rozos, E., Tsoukalas, I., Plevri, A., Karakatsanis, G., A., Karagiannidis, L., Makri, E., Lioumis, C., Noutsopoulos, C., Mamais, D., and Rippis, C. Sewer-Mining: A water reuse option supporting circular economy, public service provision and entrepreneurship, Journal of Environmental Management, Special Issue, 13th IWA, doi: 10.1016/j.jenvman.2017.07.026, Volume 216, 285-298, 2018.

7. E. Rozos, D. Butler, and C. Makropoulos, An integrated system dynamics – cellular automata model for distributed water-infrastructure planning, *Water Science and Technology: Water Supply*, doi:10.2166/ws.2016.080, 2016, 16(6), pp. 1519 – 1527.

8. D. Bouziotas, E. Rozos, and C. Makropoulos, Water and the City: Exploring links between urban growth and water demand management., *Journal of Hydroinformatics*, 17 (2), doi:10.2166/hydro.2014.053, 2015.

9. E. Rozos, E. Akylas, and A. D. Koussis, An automated inverse method for slug tests – over-damped case – in confined aquifers, *Hydrological Sciences Journal*, doi:10.1080/02626667.2014.892207, 2015.

10. K. Behzadian, Z. Kapelan, G. Venkatesh, H. Brattebø, S. Sægrov, E. Rozos, C. Makropoulos, R. Ugarelli, J. Milina, L. Hem, Urban Water System Metabolism Assessment Using WaterMet2 Model, Procedia Engineering, Volume 70, 2014, 113-122, doi:10.1016/j.proeng.2014.02.014, 2014.

11. P. Kossieris, Panayiotakis, K. Tzouka, E. Rozos, and C. Makropoulos, An e-Learning approach for improving household water efficiency, *Procedia Engineering*, *WDSA 2014*, Bari, Italy, Water Distribution Systems Analysis, 2014.

12. E. Rozos, C. Makropoulos, and C. Maksimovic, Rethinking urban areas: an example of an integrated blue-green approach, *Water Science and Technology: Water Supply*, 13 (6), 1534–1542, doi:10.2166/ws.2013.140, 2013.

13. E. Rozos, and C. Makropoulos, Source to tap urban water cycle modelling, *Environmental Modelling and Software*, 41, 139–150, doi:10.1016/j.envsoft.2012.11.015, Elsevier, 1 March 2013.

14. E. Rozos, and C. Makropoulos, Assessing the combined benefits of water recycling technologies by modelling the total urban water cycle, *Urban Water Journal*, 9 (1), doi:10.1080/1573062X.2011.630096, February 2012.

15. I. Nalbantis, A. Efstratiadis, E. Rozos, M. Kopsiafti, and D. Koutsoyiannis, Holistic versus monomeric strategies for hydrological modelling of human-modified hydrosystems, *Hydrology and Earth System Sciences*, 15, 743–758, doi:10.5194/hess-15-743-2011, 2011.

16. E. Rozos, C. Makropoulos, and D. Butler, Design robustness of local water-recycling schemes, *Journal of Water Resources Planning and Management - ASCE*, 136 (5), 531–538, doi:10.1061/(ASCE)WR.1943-5452.0000067, 2010.

17. E. Rozos, and D. Koutsoyiannis, Error analysis of a multi-cell groundwater model, *Journal of Hydrology*, 392 (1-2), 22–30, 2010.

18. A. Efstratiadis, I. Nalbantis, A. Koukouvinos, E. Rozos, and D. Koutsoyiannis, HYDROGEIOS: A semi-distributed GIS-based hydrological model for modified river basins, *Hydrology and Earth System Sciences*, 12, 989–1006, 2008.

19. E. Rozos, and D. Koutsoyiannis, A multicell karstic aquifer model with alternative flow equations, *Journal of Hydrology*, 325 (1-4), 340–355, 2006.

20. E. Rozos, A. Efstratiadis, I. Nalbantis, and D. Koutsoyiannis, Calibration of a semi-distributed model for conjunctive simulation of surface and groundwater flows, *Hydrological Sciences Journal*, 49 (5), 819–842, 2004.

I have also 8 publications in fully evaluated conference publications and 30 presentations in scientific conferences. For a complete list please check Reasrchgate profile.

Leadership in industrial design

Coordinating human resources. When I was working in the Special Secretariat for Water, Greece was obliged to submit reports for the EU Floods Directive. At the initial stage, the impact of significant historic flood events had to be submitted. This job required first the collection of the available information from various sources, and then the population of a database, which (after processing it with various tools) was submitted to the European Environment Agency. Since the European Environment Agency had not provided a tool to populate the database, the collected information had to be inserted by a single person manually into the database tables. To overcome this problem, I designed and implemented a tailored data entry procedure. First, I prepared spreadsheets that were reproducing the database structure. Then, the data entry was carried out in parallel in separate spreadsheets. Finally, the spreadsheets were massively inserted into the database. This coordination of the available resources allowed the timely submission of the report, despite the very strict deadline.

Automating procedures. While working in Hydrodomiki Ltd, to facilitate the study of the sewerage network of a town, I formulated a spreadsheet to perform the hydraulic calculations and the checks of compliance with the regulations (minimum / maximum flow velocity, minimum / maximum gradient). Furthermore, to automate the drawing of the longitudinal profiles, I prepared VBA macros that create a DXF file directly from the calculated values of the spreadsheet. Further CAD processing on the automatically created DXF gave the final shape of the profiles. These macros have been uploaded to http://www.michanikos.gr/files/file/1168-builddxf/. According to the statistics of this site, the users have given 5 stars to these macros.

Designing measurement networks. During the DESSIN research project, I had been responsible for the installation of two temperature sensors and a multi-sensor for measuring meteorological parameters at the EYDAP research and development centre. For this reason, I performed the market survey, prepared the document with the required specifications, supported the procurement process, and supervised the installation. I still manage the station and take care of any hardware failures. The station data are uploaded periodically in openmeteo.org (see http://openmeteo.org/stations/d/1423/).

Services to society. Providing information (e.g. meteorological data) and services to the community is one of my major motivations. For this reason, during the project Hydropolis I developed an online platform that performs queries on a non-relational database containing details regarding water-saving appliances and technologies. The user selects from a drop-down menu the category of appliance he is interested in, and provides key terms related to the specifications he wishes to examine.

Leadership in industrial innovation

Hydrogeios modelling framework represents the main processes of the hydrological cycle in heavily modified catchments with decision-depended abstractions and interactions between surface and groundwater flows. This model was developed by the Hydrology Laboratory of the NTUA. **Contribution.** I implemented the connection of Hydrogeios with QGIS by developing a plug-in (developed in Python 2.7) that serves as pre-processor to prepare the data-files required for the Hydrogeios simulation (see http://www.itia.ntua.gr/el/softinfo/25/).

UWOT is an urban water cycle model that acknowledges every urban water flow as a result of a demand. **Contribution.** I am the principal developer if this tool. The engine is developed in C, whereas the user interface is developed in Python 2.7 and PyQt 4.8. (available from http://users.itia.ntua.gr/rozos/UWOT/).

SWS Screening Tool performs coastal areas scanning to identify locations suitable for applying a subsurface water solution (e.g. aquifer storage and recovery or aquifer remediation, see http://www.subsol.org/results). **Contribution.** I am the sole developer of this tool. The program is based on the GDAL library and Python NumPy to perform spatial operations to indicate the areas that meet several criteria (e.g., sufficient elevation to allow build-up of adequate hydraulic head to intercept seawater intrusion, exclusion of forbidden areas, security concerns, etc.).

Hydrochton is a stand-alone tool that estimates the hydraulic parameters of confined aquifers (hydraulic conductivity and special storage) using the Quasi-Steady, Hvorslev's and Hvorslev-Butler methods. **Contribution.** I am the sole developer of this tool. The program has been developed in MATLAB code and uses the Octave 3.6.2 engine to run without the need for additional software (available from http://www.itia.ntua.gr/en/softinfo/30/).

Multi-cell groundwater simulation tool. This is the model I developed during my Ph.D. thesis. The novelty of this model is that the discretization mesh can be defined by cells of irregular geometry and that the implementation is based on the concept of a hydraulic analogue. According to this, the flow into an aquifer is represented by the flow in a network of tanks and conduits. Tanks simulate processes related to water storage and conduits simulate processes related to water movement. The fluctuation of the tank level corresponds to the variation of the aquifer level in the corresponding cells of the discretization. In addition, a mixed flow equation that is applicable to both flow types within a karstic conduit, i.e. free surface and under pressure, was devised. The idea comes from the hydraulic behaviour of the tunnels that drain water from a reservoir (e.g. discharge from bottom outlet). When the reservoir level is above the top of the tunnel inlet, then the water flow resembles that of a pressurized pipe. When the level falls below the top of the tunnel then water flows as in an open-channel aqueduct. The tunnel corresponds to the karst conduits, and the two flow types (pressurized and free surface) correspond to the aquifer conditions during the wet and dry period of the hydrological year. This tool was implemented initially in C, then transferred to Pascal to be incorporated into Hydrogeios modelling framework (available online from http://www.itia.ntua.gr/en/softinfo/25/).

Developing Android applications. My motivation is to explore the potentials of this modern technology in terms of studying various natural phenomena. A variety of interesting applications can be found in the literature including measuring physical quantities like temperature, acceleration of vibrations, radioactivity, etc. The most appealing advantage of this technology is that such measuring capabilities are available even to the cheapest Android devices (starting from 50 euros), which indicates a promising field of research with many opportunities regarding the study of hydrological phenomena. The first results of this effort are available at http://rozolutions.com.

Major contributions to the early careers of excellent researchers

I have provided support to 3 international Ph.D. students (Spain, Italy and UK) and currently I am mentoring a Ph.D. student.

Invited presentations to international advanced schools

I was invited to teach at a session in Sustainable Cities Conference that took place in Rotterdam, the Netherlands on 12 of July 2016. In this season I gave a hands-on experience with urban water cycle modelling.

Organisation of international conferences

In November 2015 I organized a conference for PEERE COST aciton (http://www.peere.org/2015/05/14/workshop-on-new-models-of-peer-review-athens-16-18-november-2015/)