H.F.R.I.
Hellenic Foundation for Research & Innovation

Description of the funded research project

2nd Call for H.F.R.I. Research Projects to Support Post-Doctoral Researchers

Title of the research project: Groundwater depletion. Are Eco-friendly Energy Recharge Dams a solution?

Principal Investigator: Kazakis Nerantzis

Reader-friendly title: GRecoDAM

Scientific Area: Physical Sciences

Institution and Country: Aristotle University of Thessaloniki, Greece

Host Institution: Aristotle University of Thessaloniki

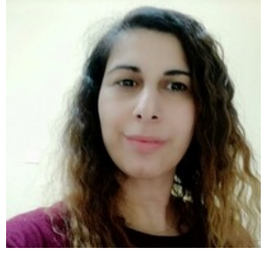
Collaborating Institution(s): a) European Commission, Joint Research Centre (Italy), b) University of Campania Luigi Vanvitelli (Italy), c) Liechtenstein Institute for Strategic Development (Liechtenstein), d) Democritus University of Thrace (Greece), e) National and Technical University of Athens (Greece)

Project webpage: https://groundwater-ecodams.web.auth.gr/

Budget: 164.000 €

Duration: 30 Months

Dr. Kazakis Nerantzis



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Research Project Synopsis

Groundwater is a primary source of drinking water for almost two billion people, worldwide. It is also crusial for irrigation, food security, human health and ecosystems. Yet, depletion of groundwater reserves is a common phenomenon worldwide in both humid and semi-arid regions. The phenomenon of groundwater depletion occurs when extraction from an aquifer exceeds the recharge, with the extent of the depletion effects being also determined by the aquifer type. The present research proposal aims to multi-model groundwater depletion in representative aquifers of Greece and Italy. Vertical distribution and seasonality of snow coverage, drought events, rainfall intensity and variation, flood events, groundwater recharge, flow and pollution transport and dam operation processes will be simulated in an integrated manner aiming to mitigate groundwater depletion. Field measurements in four pilot-sites will be used to validate the model parameters. The core of these scenarios will be the use of small recharge dams for water storage and aquifer recharge. Parallel to that, the model will assess the potential dams' transformation to mini-scale hydropower facilities for clean energy production. The aim is to design an integrated, economically feasible and eco-friendly strategy against groundwater depletion. Accordingly, integrated software will be developed to optimize dam operation for managed aquifer recharge, energy production and flood risk mitigation. In periods of high precipitation dam strategies will optimize aquifer water storage and energy production with obvious environmental and socioeconomic benefits. The proposed research will create interdisciplinary approaches based on a team that cross-cuts different scientific fields. Eventually, research findings will be translated to policy recommendations triggering discussions of relevant legislation. The coherent work plan includes a balanced and realistic targets with the project's results becoming publicly available.

Project originality

The innovative points of this project can be summarized as:

- ***Vertical distribution and seasonality of snow coverage will be estimated in the studied sites using radiance data acquired from the Moderate Resolution Imaging Spectroradiometer (MODIS) on board the Terra satellite.***
- ***Groundwater recharge rates will be estimated for the case studies using simulation models, stable isotopes and chloride mass balance in vadose zone in areas without such data.***
- ***Groundwater depletion and its impacts on groundwater quality will be multi-modeled in the studied sites; the factors that lead to this phenomenon (climatic vs. non-climatic) will be quantified.***
- ***The cost increment for pumping groundwater due to groundwater depletion will be estimated and a cost-benefit analysis of dams' transformation to hydroelectric facilities will be performed.***
- ***A website in both English, Italian and Greek language will be developed for the dissemination of the project's results on groundwater depletion and the contribution of small dams to energy production and groundwater artificial recharge.***
- ***Novel integrated software will be developed to simulate the operation of the small dams regarding energy production, flood mitigation and supply water for groundwater artificial recharge.***

Expected results & Research Project Impact

Groundwater depletion is a serious problem with environmental and socio-economic implications. For instance, as the cost for pumping groundwater increases it simultaneously increases the production cost of agricultural products. Additionally, salinization of coastal aquifers renders groundwater unsuitable for irrigation. Some areas may even be led to water scarcity with a substantial socio-economic cost. The environmental cost of groundwater depletion should also not be neglected. More specifically, the reduction of groundwater discharge to streams, springs and wetlands might lead to an irreversible reduction of surface water flow or even flow transformation from permanent to seasonal. Assessing and mapping groundwater depletion is the first step to develop strategies to mitigate this problem. In the framework of this project a further step to mitigate the depletion phenomenon will be studied, that of taking advantage of the available water stored in existing non-powered dams. The transformation of the latter to hydropower facilities can also contribute to energy security by supplying local networks and supporting national commitments for clean energy production. The scientific benefits expected from this project include the development of new methods and software. Additionally, the research will fill voids in knowledge regarding groundwater depletion, snow coverage and variability in Greece and Italy. The methodological approaches used, and the novel software produced will be able to be replicated and applied in other regions of the world that also experience similar groundwater depletion problems.

The importance of this funding

The interdisciplinary subject of the proposal will provide the opportunity for all researchers to exchange knowledge, both practical and theoretical, on the complex field of groundwater depletion. Additionally, younger researchers will benefit from interactions with experienced researchers. Additionally, the involvement of Universities and Institutes from different countries will give the opportunity for all participants to diversify and expand their research networks.

All members of the research team will have access to databases with vast amounts of data that could be used in their future research prospects. Additionally, the developed research network will provide the opportunity for all members to cooperate in future research projects and/or to participate in other research groups due to their experiences gained from this project.

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