Managing Urban Shallow geothermal Energy

Project number GeoE.171.006

D 1.5

Cumulative research article

Authors and affiliation:
Staša Borović[1]
Cornelia Steiner[2]
Gregor Goetzl[2]

[1]Croatian Geological Survey, HGI-CGS
[2]Geological Survey of Austria, GBA
sborovic@hgi-cgs.hr

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The involved MUSE team

Hrvatski geološki institut (P04 HGI-CGS)	Staša BOROVIĆ (preparation of deliverable and editing)
Geologische Bundesanstalt (P01 GBA)	Cornelia STEINER (preparation of deliverable)

General description of the deliverable in the application

Cumulative research article published in a special journal issue on “shallow geothermal application in European urban areas” (1 cumulative research paper issue). The cumulative paper hosts several short articles contributed by the project partners on different research topics within MUSE and will be submitted within the project life-span.

Version

Version	Description
29-10-2021	Initial version
29-10-2021	Final version

List of abbreviations

Abbreviation	Full name
C-D-E	Communication, dissemination and exploitation
SGE	Shallow Geothermal Energy

LIST OF CONTENTS

1 DESCRIPTION

GeoERA project MUSE addressed the energy use of the shallow subsurface in urban environments. Since the preparatory phase and writing of the proposal, the MUSE project team was aware that that the project will yield results which should be communicated to the scientific community in the form of published peer-reviewed paper. Such a publication was therefore also included in the MUSE C-D-E plan, described in more detail in the **D 1.4** report.

The original plan was to organise a special issue in a scientific journal with aims and scope appropriate for the subject of the project. The issue would host a series of articles about the topics and pilot areas investigated in the scope of MUSE. However, by the time there were actually some project results available, the circumstances were very different than in the time of project preparation: due to the COVID-19 pandemic the contacts were limited to online collaboration and it slowed down the project progress. The MUSE team have therefore decided to submit a cumulative research paper instead of initialising the special issue.

The topic of **WP 3**, Management strategies and action plans for a sustainable and efficient use of shallow geothermal energy, seemed very appropriate for a cumulative paper. PP10, Spanish IGME, under the lead of Alejandro García-Gil, devised an elaborate questionnaire about different aspects of governance of SGE resources. All the PP institutions filled in the questionnaire and the data was analysed and presented at a project workshop in Cardiff. It was concluded that the analysis is very interesting for publication and the manuscript was drafted by A. García-Gil, and edited and revised by other PPs. The submission was successful and it was accepted for publication in the ***Energy Policy*** journal (**IF** for 2020 **6.142**, ranking in **Q1** for topics Energy & Fuels, Environmental Science and Environmental Studies, according to Web of Science).

The paper presents SGE management framework structure and a governance model agreed among 13 European Geological Surveys, providing a roadmap for the different levels of management development, adaptable to any urban scale, and independent of the hydrogeological conditions and the grade of development of SGE technology implementation. The management approach reported is based on the adaptive management concept, thus offering a workflow for the non-linear relationship between planning, implementation and control that establishes a cyclical and iterative management process. The generalized structure of the SGE management framework provided allows the effective analysis of policy to identify and plan for management problems and to select the best management objectives, strategies and measures according to the proposed policy principles. The paper is added to this report as **Annex 1**.

Two MUSE project partners, IGME from Spain (PP10) and NERC-BGS from the United Kingdom (PP2), have collaborated on the topic of exploitation patterns of groundwater heat pump systems. This collaboration also resulted in a paper published in the **Science of the Total Environment** journal (**IF** for 2020 **7.963**, ranking in **Q1** for topic Environmental Science, according to Web of Science).

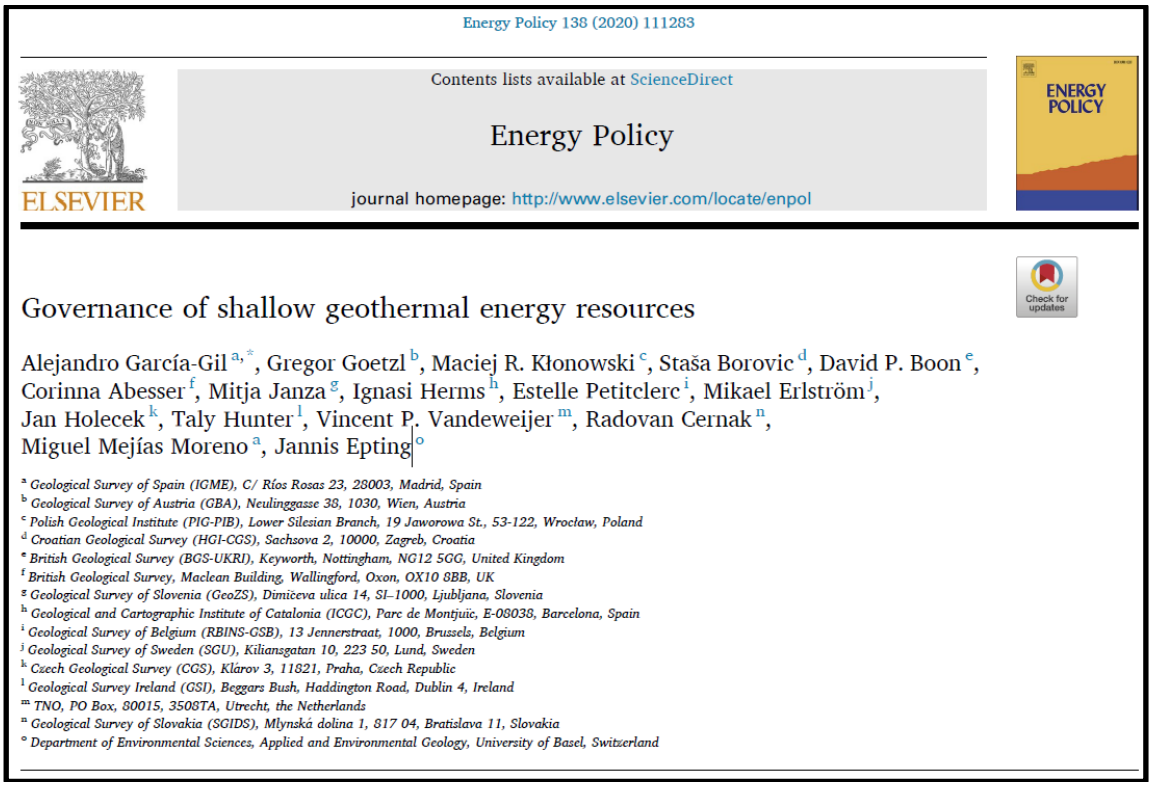
The paper discusses how unmanaged intensive use of groundwater for thermal purposes as a SGE resource in urban environments threatens the resources' renewability and the systems' performance, due to the thermal interferences created by a biased energy demand throughout the year. The exploitation regimes of 27 groundwater heat pump systems from an alluvial aquifer in Zaragoza (Spain) were firstly examined using descriptive statistics. The examined exploitation regimes presented a clear cooling bias and a similar cyclicality. The researchers have demonstrated that such biases in exploitation regimes of groundwater heat pump systems in Mediterranean areas require correction measures to ensure a more balanced exploitation of the SGE resources. The proposed definition of the characteristic exploitation pattern can be applied to guide resource managers by identifying unbalanced systems, understanding existent exploitation strategies and proposing corrective alternative plans. The paper is added to this report as **Annex 2**.

Another scientific publication is in preparation in collaboration of three MUSE project partners, GBA from Austria (PP1), IGME from Spain (PP10) and PGI-NRI from Poland (PP13), on the topic of the nexus of groundwater management and shallow geothermal energy use.

The MUSE team concludes that the published papers, and the manuscript in preparation, have contributed significantly to the scientific collaboration of scientists from geological survey organisation involved in the project, and that it has ensured project recognition and visibility in the scientific community. Also, the scientific collaboration already continues among various partners through COST action Geothermal-DHC, and will continue through new project applications (Horizon Europe CSA already in preparation for the call due in January 2022, and others to come).

2 ANNEXES

2.1 Annex 1



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Governance of shallow geothermal energy resources

Alejandro García-Gil [a,*], Gregor Goetzl [b], Maciej R. Kłonowski [c], Staša Borovic [d], David P. Boon [e], Corinna Abesser [f], Mitja Janza [g], Ignasi Herms [h], Estelle Petitclerc [i], Mikael Erlström [j], Jan Holecek [k], Taly Hunter [l], Vincent P. Vandeweijer [m], Radovan Cernak [n], Miguel Mejías Moreno [a], Jannis Epting [o]

[a] Geological Survey of Spain (IGME), C/ Ríos Rosas 23, 28003, Madrid, Spain
[b] Geological Survey of Austria (GBA), Neulinggasse 38, 1030, Wien, Austria
[c] Polish Geological Institute (PIG-PIB), Lower Silesian Branch, 19 Jaworowa St., 53-122, Wrocław, Poland
[d] Croatian Geological Survey (HGI-CGS), Sachsova 2, 10000, Zagreb, Croatia
[e] British Geological Survey (BGS-UKRI), Keyworth, Nottingham, NG12 5GG, United Kingdom
[f] British Geological Survey, Maclean Building, Wallingford, Oxon, OX10 8BB, UK
[g] Geological Survey of Slovenia (GeoZS), Dimičeva ulica 14, SI–1000, Ljubljana, Slovenia
[h] Geological and Cartographic Institute of Catalonia (ICGC), Parc de Montjuïc, E-08038, Barcelona, Spain
[i] Geological Survey of Belgium (RBINS-GSB), 13 Jennerstraat, 1000, Brussels, Belgium
[j] Geological Survey of Sweden (SGU), Kilianzgatan 10, 223 50, Lund, Sweden
[k] Czech Geological Survey (CGS), Klárov 3, 11821, Praha, Czech Republic
[l] Geological Survey Ireland (GSI), Beggars Bush, Haddington Road, Dublin 4, Ireland
[m] TNO, PO Box, 80015, 3508TA, Utrecht, the Netherlands
[n] Geological Survey of Slovakia (SGIDS), Mlynská dolina 1, 817 04, Bratislava 11, Slovakia
[o] Department of Environmental Sciences, Applied and Environmental Geology, University of Basel, Switzerland

2.2 Annex 2

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Defining the exploitation patterns of groundwater heat pump systems

Alejandro García-Gil [a,b,*], Corinna Abesser [b], Samanta Gasco Cavero [c], Miguel Ángel Marazuela [d], Jesús Mateo Lázaro [e], Enric Vázquez-Suñé [d], Andrew G. Hughes [b], Miguel Mejías Moreno [a]

[a] Geological Survey of Spain (IGME), C/Ríos Rosas 23, 28003 Madrid, Spain
[b] British Geological Survey, Maclean Building, Wallingford, Oxon OX10 8BB, UK
[c] MRC Harwell Institute, Mammalian Genetics Unit, Harwell Campus, Oxfordshire OX11 0RD, UK
[d] GHS, Institute of Environmental Assessment & Water Research (IDAEA), CSIC, Jordi Girona 18-26, 08034 Barcelona, Spain
[e] Department of Earth Sciences, University of Zaragoza, c/Pedro Cerbuna 12, 50009 Zaragoza, Spain