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Development of a pocket technology Groundwater Risk Application for Local Evaluation (GRAppLE) in highly groundwater reliant populations

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Up to 500 million Europeans currently use a groundwater source for daily household consumption, of which 10-20% are private (unregulated) wells. Private groundwater sources in the Republic of Ireland (RoI) currently provide drinking water to an estimated 750,000 people, with recent studies reporting that groundwater users have an increased risk of enteric infection from waterborne pathogens. Due to the socioeconomic, cultural, linguistic and demographic diversity characteristic of Europe, successful "Top Down" approaches to groundwater protection have remained elusive. Similarly, the dispersed, decentralised and ubiquitous nature of private groundwater sources add to the inherent complexity of legislative processes. Accordingly, "Bottom Up" approaches, whereby individual custodianship is facilitated via "pocket technologies", may aide in safeguarding public health at the household level. The current study employs existing Irish data and predictive models pertaining to microbial groundwater contamination coupled with mobile device technology for development of a prototype Groundwater Risk Application for Local Evaluation (GRAppLE) for non-expert risk assessment and management.

GRAppLE comprises three parallel multidisciplinary work-packages, as follows:

1. Calibration and validation of a simplified probabilistic (regression-based) risk model capable of extrapolation to provide hydrogeological and climatic representivity at the national (RoI) scale. The simplified model has been developed using a homogenised, integrated dataset from several previous groundwater contamination studies (2012-2016), and minimises necessary levels of user-defined input, thus increasing overall usability, functionality and accuracy.

2. Development of a novel mobile device application which combines scientific data, live geo-referencing (variable auto-population), and (minimised) user inputs permitting private well owners to probabilistically assess the contamination risk associated with their source. The application is being developed using NODE, a JavaScript runtime built on Chrome's V8 JavaScript engine, which uses an event-driven non-blocking I/O model. Upon opening the application, in-built GPS implementation will automatically employ coordinates to retrieve locally-specific model inputs (e.g. groundwater vulnerability, subsoil type, bedrock geology, antecedent precipitation) and populate the risk model via "live call" fetch and entry functionality (device-server-device connection). Source-specific model criteria (user-derived inputs) will be collated via well user/owner engagement directly with their mobile device. Once the risk estimation equation has been populated, the application will present the user with a "contamination risk" (%) estimate and associated mitigative recommendations.

3. Assessment of prototype functionality and accuracy through a concurrent process of focus group studies and coordinated private water supply sampling and analysis. Focus group studies will be demographically focused and used to maximise overall ease of use, while groundwater sampling across a diverse range of source types and hydrogeological settings will ensure accuracy. Results will be used to assess the overall feasibility of the application for widespread national and international 'roll out'.

Using user-derived data, validated national-scale shapefile datasets, and "live" source-specific risk assessment, GRAppLE will narrow the gap between laboratory science, hydrogeology, social engagement, and "pocket technology", thus representing the 'state of the art' in both geoscience research and citizen science, providing scope for future integrations of science and technology to protect natural resources and public health in Europe.