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EDITORIAL

Groundwater under threat from diffuse contaminants: improving on-site sanitation, agriculture and water supply practices

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Between a third and half of the world's population depend on groundwater for drinking water supply. However, groundwater of high quality is not ubiquitous and groundwater contamination is becoming a critical issue. Particularly, diffuse pollution by nitrate is a cause of groundwater quality degradation in many countries. Such pollution is especially due to agricultural and livestock practices. Moreover, rural and peri-urban settings are increasingly marked by investments in decentralised water services, mainly on-site sanitation systems and reuse of wastewater. Consequently, problems connecting bacteria and viruses are of increasing concern and can cause health problems of differing severity.

From the point of view of governments and other agencies responsible for drinking water supply, methodologies to evaluate a degraded resource and how to regain quality are crucial. In rural and peri-urban settings, there is a need to promote changes in agricultural practices to protect aquifers. This may require farmers to adopt new methods and accept different policies. Their willingness may depend on the awareness of the impact of their practices on water quality. Farmer unions often blame poor on-site sanitation or inadequate wastewater treatment for pollution. Clearly, there is need to discriminate between contamination sources.

The main aim of this special issue of Environmental Science and Pollution Research (ESPR) is to focus on diffuse contaminants and related impacts from an interdisciplinary point of view, that spans the technical and social sciences. This issue was made only of invited papers after selection by the guest editors. Year 2016 was a major milestone for the International Association of Hydrogeologists (IAH) and its 43rd Congress, celebrating the 60 years of IAH, was hosted in Montpellier, France, in September. Following the successful session on diffuse groundwater contamination at different scales, especially due to on-site sanitation and agriculture, the Special Issue in ESPR represents an original contribution of the IAH by collecting complementary approaches to this increasingly important subject. Particularly, it analysed field-based studies of diffuse pollution in groundwater and surface water, mainly nitrate and pathogens, and suggested different methodologies (modelling, interviews…) to tackle groundwater resources degradation and to increase awareness also for stakeholders and population.

Five papers analysed nitrate pollution in groundwater and surface water. Ouedraogo et al. (2017) assessed the validity of an African-scale groundwater pollution model for nitrate and found it difficult to apply at this scale. Mas Pla and Menció (2018) studied effects of global changes such as climate and groundwater nitrate pollution from a water balance-based analysis of several aquifers at regional scale in Spain. Górski et al. (2017) investigated long-term (1958–2016) water nitrate data from Warta River in Poland, analysing the role of improvement in water and sewage management and a more

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rational use of fertiliser. Ducci et al. (2017) worked on the evaluation of effectiveness of the groundwater monitoring network, the distribution of nitrate in groundwater and the evolution of nitrate trends, using spatial and time series statistical approaches, in a large coastal plain of southern Italy. Lasagna and De Luca (2017) evaluated the nitrate sources and the ongoing geochemical processes in a shallow and deep plain aquifer in northern Italy, using isotopic composition of nitrate and boron.

Four papers concerned the impact of on-site sanitation systems on groundwater and how multiple point sources of contaminants may turn into diffuse pollution. Jangam and Pujari (2017) focused on groundwater analysis for physicochemical and bacteriological parameters with the aim of assessing the contamination due to on-site sanitation systems in India. Geary and Lucas (2018) monitored the subsurface movement of nutrients and faecal contaminants from failing septic tank systems and analysed the contamination of a coastal estuary in Australia used by oyster farming. They highlight difficulties in scaling up from monitored individual systems to identifying their contribution to the cumulative impact at the catchment scale. In the same viewpoint, Nasri and Fouché (2018) monitored the intermittent flux from a sand filter for household wastewater to the vadose zone and integrated solute transfer to the water table, especially nitrate and organic micropollutants such as parabens. Alternatively, Nasri et al. (2017) characterised the compost and leachate composition (phosphorus, nitrogen, pathogenic parameters) and flux from familial waterless litter composting toilets in dispersed rural areas in France and evaluated its threat to the environment.

At last, three papers deal with the topic from a health, social or management point of view.

Taneja et al. (2017) estimated health risk from nitrate present in the drinking water and vegetables in India and conclude that irrigation of locally grown vegetables should be monitored periodically for nitrogen accumulation by the crop above the acceptable daily intake (ADI) limit. Thoradeniya et al. (2017) investigated the community perspectives on impacts of water quality on agriculture, livelihood and community well-being within rural farming communities in Sri Lanka. The study adopted 'key informant interviews' as the methodology to investigate community and other stakeholder perspectives. Finally, Du et al. (2018) highlighted the role of integrated hydrodynamic modelling for water supply planning and management of a Mediterranean hydrosystem in southern France, especially with regard to undocumented water abstraction for agriculture use and to hazard of point-source pollution of groundwater resources.

We believe that this collection of papers will deepen knowledge about diffuse contamination at different scales due to agriculture, wastewater centralised management and on-site sanitation, highlighting possible approaches to this challenge from a technical and social point of view.

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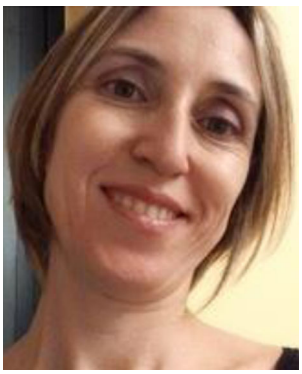
Olivier Fouché-Grobla is associate professor at Conservatoire national des Arts et Métiers (Le Cnam, Paris, France). After 8 years as a research associate at laboratory Water, Environment, Urban systems (Leesu–Ecole des Ponts–ParisTech), he is now researcher in the laboratory "Geomatics and land management" at the Ecole supérieure des Géomètres et Topographes (GeF–ESGT-Le Cnam).

During and after his PhD in Engineering Geology (2000) at the Ecole des Mines–ParisTech, he has developed an expertise in the field of hydraulics within fractured rock masses. Beyond, he is adapting his skills to other heterogeneous media—alluvial deposits, man-shaped soils—for engineering applications known as alternative decentralised solutions mainly in soil and water management. His activities are conducted in collaboration with stakeholders and researchers specialised in socio-economic strategies and public policy evaluation so that engineering problems can be coupled with questions of sustainable development. Dr. Fouché-Grobla has coordinated from 2011 to 2015 the national project ANCRES (retention and depuration by soil) on the ecosystemic services provided by soil in on-site sanitation, first of all the evacuation and natural attenuation of household treated wastewater through the soil, focusing on the pedotransfer functions in soils with high rock fragment contents. Before, for 2007 to 2010, he carried out a project on hard rock hydrogeology in Ivory Coast. The subject was mainly hydrochemistry of groundwater in the granite and schist aquifers and related weathered and fissured horizons. The problematic of heterogeneity in quality and productivity of wells has been addressed by mapping of both lineaments from satellite images and geomorphic features.

Since 2016, he is involved in an ongoing restoration study of the ecological continuity within the upstream reaches from a river, following a scenario of dam deletion of a water-mill that complies with the European Water Framework Directive, while rising potential impact on related wetlands and soil conservation.



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Manuela Lasagna is Research Technician and Lab Assistant at HYDROGEOLAB (laboratory of hydrogeological characterisation and modelling) at Earth Sciences Department of the University of Turin (Italy).

Master's Degree in Earth Sciences at the University of Turin in 2001, with a thesis on Risk Assessment: Theory, Methods and Applications. She received her PhD degree in Hydrogeology in 2006 at the University of Turin, with a thesis entitled Nitrate in Piedmont plain groundwater (Italy): distribution, origin, attenuation and hydrogeological conditioning.

Her research activities are mainly focused on the following: (1) groundwater resources quantification and management at a local and a regional scale, particularly in the porous media; (2) groundwater vulnerability; (3) qualitative and quantitative groundwater monitoring; (4) relationships between water resources and agricultural activities, with particular reference to nitrate pollution; (5) nitrate origin and attenuation processes using isotope techniques; (6) ground water-surface water interaction.

Dr. Lasagna is a member of IAH—International Association of Hydrogeology and IAEG—International Association for Engineering Geology and the Environment. She is the author of more than 60 scientific publications. She is currently guest editor of the journal Sustainable Water Resources Management (Springer) for a special issue on "Groundwater vulnerability and circulation".

Kerstin Danert (Rural Water Supply Network, Skat Foundation, Switzerland, kerstin.danert@skat.ch)

Kerstin Danert has 19 years of experience as a rural water supply specialist focusing on developing capacity with respect to sector performance monitoring, operation and maintenance, cost-effective borehole drilling and technology adoption.

Over the years, Dr. Danert has managed and undertaken thematic work and country studies and published guidelines for rural water supplies.

She is skilled in integrating the institutional, socio-economic, cultural and technical aspects of rural water supply service provision in developing countries. She has provided face to face advisory and capacity development services to national and local Governments, NGOs and the private sector in over 10 countries in sub-Saharan Africa and remote support for many more.

Since 2009, Dr. Danert has led the secretariat of the Rural Water Supply Network (RWSN). She is a skilled leader, motivator and facilitator with respect to knowledge sharing and networking. In 2011, she was director for the 6th RWSN Forum in Kampala, an event that brought together 480 professionals from 54 countries. She renewed the feat in 2016 for the 7th RWSN Forum in Abidjan, Ivory Coast.

She pro-actively connects different organisations and individuals to encourage collaboration and mutual learning. Linked to this, she has extensive experience in documentation of experiences of improving domestic and agricultural water supplies in rural areas.