



Editorial

Wetland pollutant dynamics and control



1. Introduction

Human activity in rural areas is considered to be very negative regarding water quality. On the one hand, resources have been overexploited, thus leading notably to the reduction of natural wetland surfaces, and the discharge of an increasing number of pollutants has led to ecosystems degradation. In this context, researchers, stakeholders and industries have jointly worked to develop new management strategies and remediation processes to reduce pollutants' transfer to the natural environment.

In 2008 almost half of the world population was living in rural areas. Despite this percentage being expected to slightly decrease in coming years, the contribution of partially treated or untreated effluent from small collective and non-collective domestic sources has been widely recognized as a major contributor of pollutants release into the surrounding environment. This often leads to pathogen transmission, the eutrophication of surface water and the development of cyanobacteria/green algae, which affect ecosystems and hamper recreational use and/or fishing in many lakes (e.g., Lake Tai in China, [Pan et al., 2011](#), Lake Champlain and Lake Erie in Canada, [Smeltzer et al., 2012](#); [Michalak et al., 2013](#) or coastal and seaside resorts (e.g., the coast of Brittany in France, [Charlier et al., 2007](#), and the Gulf of Mexico, [Turner et al., 2008](#)). The need to both develop new and adapt existing wastewater treatment technologies for small communities with less than 2000 inhabitants and to develop treatment and management strategies to reduce the discard of fertilizers, pesticides and micro-pollutants from diffuse sources is particularly true for EU member states. This is connected with the evolution of the European water policy (Water Framework Directive [2000/60/EEC]).

The capacity of wetlands to retain, accumulate and degrade a variety of pollutants in both urban and rural environments has been recognized for decades. This aspect is more and more frequently studied, either to implement constructed wetlands (CWs) sites, to reduce pollutant emissions in the surrounding environment, or to analyze natural wetland treatment capacities and answers to the effects of pollutants.

During the last two decades the multiple functions and values of wetlands have been recognized not only by the scientists and managers working with wetlands, but also by the public. The ability of wetlands to transform and store organic matter has been exploited in CWs. In CWs, pollutants are treated by a combination of physical, chemical and biological processes. The removal of each

category of pollutant is typically associated with a specific microbial functional group. Therefore there have been several studies that aimed to test and employ specific design and operational methodologies to enhance the activity of that group and enable performance to be optimized. This can be achieved by combining different combinations of processes (saturated/unsaturated) or by using process intensification. Over the last 10 years (since the last WETPOL conference in Tartu, Estonia in 2007), the number of scientific papers published has increased rapidly, going from about 400 papers published per year in 2004–2006 with the combinations of keywords “treatment wetland(s)” and “wetland pollution control” to more than 1000 papers per year in 2012–2014 ([Fig. 1](#)), with always about 10% of the papers being published in *Ecological Engineering*.

Although in the 2000s the focus of most of the research conducted was on describing, revealing and understanding circumstantial evidence of wetlands' ability to treat and retain pollutants, the latest developments have followed three very clear trends over recent years:

- a the development of a new generation of intensified treatment wetlands for advanced wastewater treatment with either physical intensification (use of effluent recycling, use of forced aeration), chemical intensification (use of reactive media such as apatite, steel slag or struvite or of coagulants to remove nutrients) or biological intensifications (use of porous media, use of plant and flow combinations; see [Wu et al., 2014](#));
- b pharmaceuticals and personal care products (PPCPs, see [Matamoros et al., 2009](#); [Ávila et al., 2010](#)) and nanoparticles ([Zhang et al., 2014](#)) have been the focus of recent research, and concerns about their occurrence in wetlands and the efficiency of treatment wetlands in removing them;
- c analysis of the structure of microbial communities and functional gene abundance and diversity studies using next generation sequencing and quantitative PCR techniques are already widely used, and the first results from free water surface (FWS) CWs ([García-Lledo et al., 2011](#)), vertical subsurface flow (VSSF) and horizontal subsurface flow (HSSF) CWs ([Ji et al., 2012](#)), and artificial riverine wetlands ([Ligi et al., 2014a,b, 2015](#)) have been published.

It is in this context that the 5th WETPOL conference was held in Nantes in October 2013.

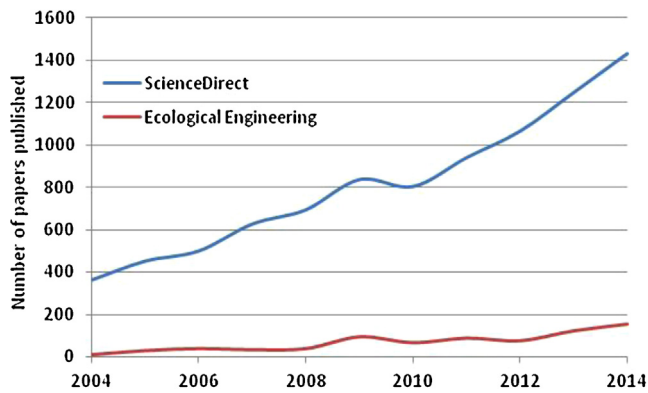


Fig. 1. Number of papers published in the fields of “treatment wetland(s)” and “wetland pollution control”. Data from Science Direct, February 2015.

2. The 5th international WETPOL 2013 symposium in Nantes, France

The WETPOL symposium, established in 2005, has become a reference forum for fundamental knowledge on pollutant dynamics and control inside wetland systems. Every two years, leading experts meet and present their research activities and experiences and discuss new concepts and new technologies. The 5th International Symposium on Wetland Pollutant Dynamics and Control was held in Nantes, France in October 2013 under the leadership of the Ecole des Mines de Nantes and the GEPEA laboratory, and was a follow-up to the following prior meetings: 2005 in Gent (Belgium), 2007 in Tartu (Estonia), 2009 in Barcelona (Spain) and 2011 in Prague (Czech Republic). The Ecole des Mines de Nantes and the GEPEA laboratory (Process Engineering for Environment and Food) lead research into environmental engineering for air and water treatment. The conference took place in the heart of Nantes at “La Cité Nantes Events Center”, where plenary, parallel and poster sessions were held. At this symposium, 5 keynote speakers were invited:

- * Bill Mitsch, USA, “Protecting the Florida Everglades Wetlands with Wetlands – Can stormwater phosphorus be reduced to oligotrophic conditions?”
- * Jacques Brisson, Canada, “Ecosystem services of wetlands: does plant diversity really matter?”

- * Lars Duyster, Germany, “Wastewater, examples on new organic contaminants, upcoming metal(loid)s, nanomaterials and the transfer/transformation in wetlands”
- * Joan Garcia, Spain, “The Cartridge Theory: a Conceptual Approach to Horizontal-Flow Wetlands’ Functioning”
- * Kela Weber, Canada, “The role and characterization of microbial communities in wetlands for water pollution control”.

Two new formats have successfully been implemented: the invited speaker sessions such as:

- 3 invited speakers held a brief presentation followed by a group discussion on selected topics such as:

* Dirk Esser, France, “30 years of CWs research in France”

* Sylvie De Blois, Canada, “Global change and Wetlands”

* Chris Tanner, New Zealand, “Wetlands to control diffuse pollution at catchment scale”

and

- a short platform presentations session was organized before the poster session, enabling most of the posters to be briefly presented in four parallel sessions using several slides. The best young professional poster was also selected and received an award.

Altogether more than 130 oral presentations and 40 posters have been presented by about 250 participants (Fig. 2) representing 47 countries. Two conference tours have been organized, the first one bringing WETPOLs’s delegates in the northern region of Nantes to the famous salt marshes of Guérande. Over the centuries in Southern Brittany, man and the ocean have shaped the Guérande peninsula into the most northerly salt marshes in Europe. Guérande is an artificial wetland used to produce salt. Since 1995, the salt marshes have been listed as wetlands of international importance under the RAMSAR convention. The first tour was followed by a visit to the constructed wetlands of “Bouvron”, which is designed to treat 1900 population equivalents (Pe) of raw domestic wastewater with 6500 m² of reed beds in 3 stages. The final treated effluent is used to irrigate 4 ha of willows.

The second one went to the South, to visit the beautiful natural lake of Grand-Lieu, fed by the Ognon and Boulogne Rivers. Grand-



Fig. 2. Participants of the WETPOL 2013 symposium held in October 2013 in Nantes, France. Photo is taken at the mezzanine of “La Cité Nantes Events Center”.

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