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Editorial

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There is a strong interdependence in the use of energy, land and water. Energy production needs water for hydropower generation and cooling thermoelectric plants, forestry and agriculture require energy and water, and water transfer and treatment require energy inputs. Recently, the effects of climate change, along with industrialisation and population growth, are further enhancing the interaction and competition in the use of the three resources. In a water-scarcity scenario, the use of water for cooling thermoelectric plants will compete with the use of water for agricultural land, bioenergy crops and domestic use in cities. In such scenarios, new synergies between the three sectors will need to be identified to overcome future conflicts. The reuse of reclaimed wastewater for irrigation, energy production from wastewater and the use of drought-tolerant energy crops could provide some of the solutions.

Due to the growing interest in this topic, the *Energy* and *Water Management* journals have created this themed issue on the energy, land and water nexus, with the aim to capture the interaction and competition between the three resources and to help civil engineers to evaluate the implications in decision-making and planning. In this themed issue, case studies are presented from different geographical contexts: South Asia, Africa and the EU. The interconnection between energy, land and water strongly depends on the geographical area, since resources availability, investments, infrastructures and the future demand for the three assets depend on special characteristics and constraints.

The first paper, by Chegwin and Kumara (2018), provides an example of energy, land and water nexus in Sri Lanka's Mahaweli basin. The authors describe a successful program that started in 1970 to transfer up to 900 million m^3 of water from the Mahaweli River basin to water-scarce areas of the country, with the aim to help the poorest and driest areas. The route selection for the water transfer was identified on the basis of a participatory multi-criteria analysis with mathematical simulation of the water transfer and its impact on agriculture production and hydroelectric energy generation. The authors show that a perfect synergy in the use of energy, land and water can only be achieved by applying a wide range of approaches with the awareness that such approaches may change in time due to a change in the resource availability and uses.

Africa, like South Asia, is struggling with energy, land resource and water availability. Muller (2018) reviews the energy, land and water nexus in Southern Africa. The author pays special attention to describing the situation in South Africa, where water uses across different sectors have been planned and coordinated for a long time. In the past, competing uses of water were hydropower generation and agriculture irrigation. Recently, the water demand for urban population and industrial uses have been added to the conflict. According to the author, the energy, land and water nexus offers a useful framework to view the water management challenges; however, a wider range of approaches and methodologies will be necessary to achieve an effective and sustainable management of water resources.

The paper by Tomlinson (2018) provides a further example of energy, land and water issues in Africa, with an insight from Nigeria. The author discusses the actions for a successful management of energy, land and water resources in the country, such as enhancing the agricultural value of floodplains rather than building water storage for failing irrigation projects.

The use of water for hydropower generation has always been in competition with the use of water for irrigation, especially in Africa, whose electricity generation is highly reliant on water. In Ethiopia, Malawi, Mozambique, Namibia and Zambia, for example, 90% of electricity comes from hydropower (Conway *et al.*, 2017). The construction of large dams has created

serious tensions among riparian countries – for example, the Grand Ethiopia Renaissance Dam on the Blue Nile which is the subject of disagreement between Ethiopia and Egypt. Rather than large dams, Zhang *et al*. (2018) argue that small hydropower generators may represent the solution, especially for increasing the electrification of rural areas. The authors examine the potential, barriers and design of small hydropower systems in sub-Saharan Africa. Such systems could be installed not only in river streams, but also in artificial channels such as irrigation canals, municipal water and wastewater pipelines.

In the last paper presented in this themed issue, Brandoni and Bošnjaković (2018) provide an overview of the energy, land and water nexus in the EU, with a focus on the energy axis. The authors emphasise the opportunities that arise from considering the interactions between the three resources. Examples are: heat recovery from grey water, use of food waste for heat and electricity production, electricity generation and recovery of energy and nutrients from wastewater. The authors look at existing EU policies and schemes that could favour a combined approach in the use of energy, land and water. One of the most significant examples is the concept of circular economy. A systems-based, integrated perspective for the analysis of the full life cycle of products may, in fact, be the necessary driver to move towards an integrated management of these three limited but essential resources.

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