

Talking about solutions inspired by nature (or nature-based solutions, NBS) and circular economy has become fashionable, but...why are they so important? What do they have in common? And, above all, what is the vision of ICRAtech on circular economy and NBS?

The terms are relatively new, although they include common concepts in the environmental field such as recycling, reuse, reduction (of waste), ecosystem services, green and blue infrastructure, and many other names that have been used to describe and optimize the interactions between the economy and the environment.

Although the concept of circular economy covers many other aspects, it has also been strongly adopted in the water sector, especially in Spain, where we find a multitude of applications aiming at water reuse. David Sedlack announced that the fourth revolution is on the way, and named it Water 4.0¹. We understand that this revolution includes direct and indirect potable reuse, energy optimization in the urban water cycle (including energy saving or production or the use of renewable energies) and, step by step, it must also incorporate innovative technologies that have already demonstrated the technical viability of nutrients recovery or other value-added compounds, although the number of real-scale implementations is still quite limited.

Cities already account for most of the world's population (72% in Europe). This has crucial effects on the environment and the well-being of people. Cities have taken advantage of this concept to define (or sell?) a comprehensive management and production strategies, based on circular economy, which facilitate the transition to more circular cities, with a closed flow of materials, circular production and design systems, and new business models of collaboration between sectors.

However, our vision of circular economy is much more ambitious, and we believe that it must go further to improve urban water management and increase the resilience of cities, especially to address the challenges posed by climate change. In this sense, there is evidence that NBS can facilitate this transition to circular economy, not only allowing a more sustainable management of water quantity and quality, but also the additional benefits or ecosystem services they can provide. The evidence of these benefits seem clear although still limited.

But what are NBS? They are actions to protect, manage in a sustainable manner, and restore natural or modified ecosystems, while at the same time effectively addressing societal challenges and providing benefits for human wellbeing and biodiversity (IUCN, 2016²). The construction of permeable pavements to reduce the risk of floods or green roofs to improve biodiversity in cities can be examples of NBS.

Among the current and emerging challenges that can be addressed by NBS, we want to highlight the need to produce food in cities in a more sustainable way. This involves water and waste resources recovery and reuse to promote proximity production and km0 food, lowering natural resources exploitation and food ecological footprint. In fact, urban agriculture for food production is becoming more common, although, to be truly sustainable, it should also use

¹ David L. Sedlack (Water 4.0, Yale Univ. Press, 2014)

² The International Union for Conservation of Nature IUCN, 2016, WCC-2016-Res-069

reclaimed water and nutrients or fertilizers recovered from waste or grey water (e.g. biochar, algae or sewage sludge), or granular byproducts as filtering substrate.

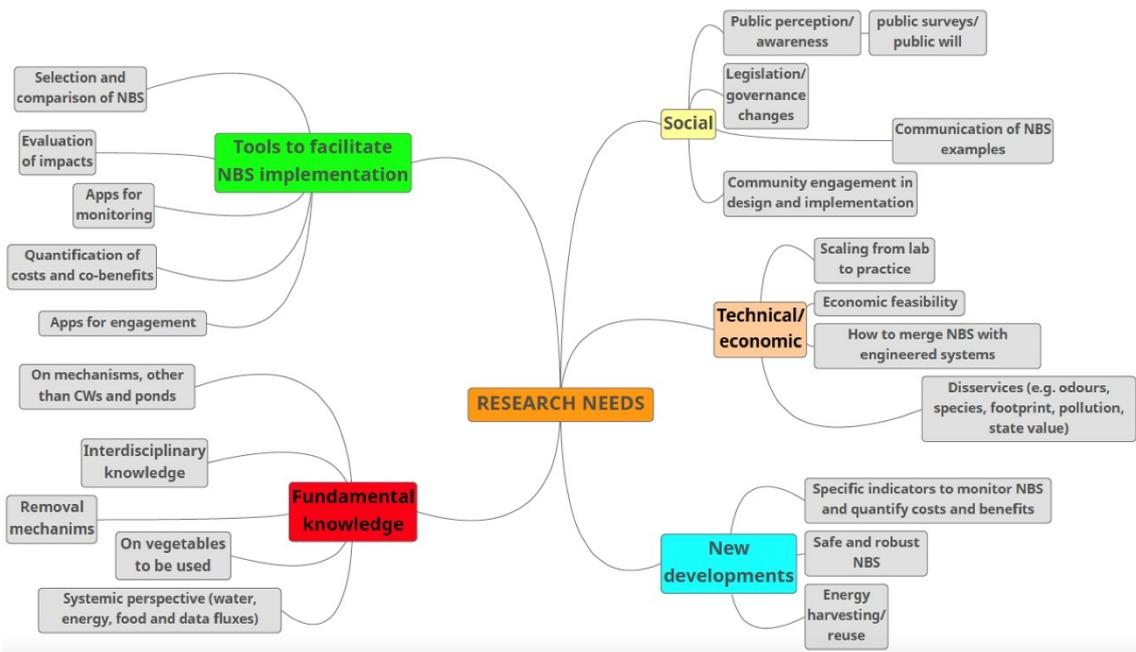


Figure 1. Mental map developed by ICRAtech during a collaborative seminar.



Figure 2. Seminar on solutions inspired by nature at ICRA facilities.

The production of food with local resources through urban gardens must be complemented by a greater implementation of green roofs/walls and other types of solutions inspired by nature. These solutions, beyond water reuse, provide additional positive impacts at different levels: environmental (for example, increase of green space per inhabitant, thermal insulation, air

quality improvement, biodiversity increase or floods prevention), economic (local products commercialization, "green" or microenterprise jobs creation), and social (regeneration of degraded or abandoned urban areas, reintegration of vulnerable and at risk of exclusion people, or training). Thus, local food production simultaneously allows addressing the great challenges posed by climate change and population concentration in cities.

However, there are still knowledge gaps in the design, implementation, operation and maintenance of NBS that limit or hinder their application. Among them, ICRAtech identifies the following research points as priorities (see mental map in Figure 1):

- Tools to facilitate the design, implementation and effectiveness evaluation of NBS;
- Deepen the knowledge of the system' basic mechanisms to ensure, for example, that there are no safety issues in the case of food production;
- Consider NBS as a part of a systemic approach to urban water management (along with energy, food and information streams);
- Social aspects: how to involve the stakeholders in the co-design of the NBS in order to ensure multiple social benefits in different communities? How to communicate positive and negative examples of NBS? How to raise awareness and create a better understanding of NBS among local populations?
- Criteria and indicators to monitor, evaluate and control the effectiveness of the NBS, especially NBS costs and benefits aspects.

An adequate selection of indicators (EKLIPSE, 2017³) would allow a proper assessment of the functioning of the NBS for food production and water treatment, and also quantification of the additional benefits or ecosystem services they provide (e.g. stress reduction, encouragement of physical activity, surface water runoff reduction, improvement of social cohesion, well-being and human health, increase of neighborhood or community sense of inclusion, provision of habitats for wildlife, temperature regulation, reduction of noise levels and dust, production of oxygen or reduction of carbon dioxide).

We therefore believe that NBS are key elements to promote circular cities and make them more resilient to face possible environmental, economic or social problems. That is why ICRA actively participates in 5 research and innovation projects: at European level (HYDROUSA, EdiCitNet), at national level (CLEaN-TOUR <http://clean-tour.000webhostapp.com/>), in the COST action Circular City (<https://circular-city.eu>) and the SANNAT network (<https://snappartnership.net/teams/water-sanitation-and-nature/>) with tasks and activities related to the above-mentioned issues.

Among these projects, [HYDROUSA](#) will offer innovative solutions inspired by nature for water management in islands and coastal areas of the Mediterranean (the treatment of wastewater and the recovery of nutrients, supplying freshwater from unconventional water sources). The solutions will be demonstrated in three Greek islands. In addition, 25 extra locations will be evaluated in detail. EdiCitNet, on the other hand, will develop a network of cities committed to water, nutrient and inter-sector waste management, oriented towards reuse, through the implementation of [Edible City Solutions](#) (solutions based on nature for food production). In CLEaN-TOUR project, technologies and tools will be developed to facilitate water reuse in touristic cities. Finally, Circular City and SANNAT are two international networks that promote the use of NBS to implement circular cities and to achieve the [UN Sustainable Development Goal number 6](#), respectively.

³ An EKLIPSE Expert Working Group report. (2017) An impact evaluation framework to support planning and evaluation of nature-based solutions projects. www.eklipse-mechanism.eu

The recovery and reuse of wastewater and waste resources, food production, and increased resilience of cities and their citizens will have beneficial effects on the environment, but above all on social welfare and human health. Thus, more resilient and healthy societies might hopefully also be happier :-).

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- *SANNAT: Water Sanitation and Nature. SNAPP working group.*