SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA17133
STSM title: Fundamentals of NBS circularity performance evaluation and its application to Watch List 2018/840 micropollutants
STSM start and end date: 01/02/2019 to 31/03/2019
Grantee name: Lucia Gusmaroli

PURPOSE OF THE STSM:

This project had the following main objectives:

i. To carry out literature and case studies reviews for the evaluation of nature-based solutions (NBS) circularity performance assessment in order to obtain proper knowledge on the state-of-the-art methodologies.

ii. To set the strategy to define a preliminary list of the most suitable key performance indicators and indexes for circularity assessment (based on the results of activities i. and ii. to be applied in future activities of WG5 and the whole COST action.

iii. To review the outcomes of CircularCity Re.Solution COST action related projects. ID cards, collected from COST partners in the context of WG5, include a brief outline of the projects as well as a chart with outcomes. Thus, feedback on previous and ongoing studies provided WG5 with data including the considered key performance indicators (KPI) and the used methodologies (e.g. life cycle assessment - LCA, life cycle cost - LCC, cost benefit analysis - CBA etc). Special attention was given to projects including Watch List compounds and/or other organic micropollutants.

iv. To acquire knowledge on risk assessment strategies thanks to the know-how of the hosting research group.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

The objectives of the STSM were redefined according to the hosting research group needs once the trainee joined. In particular, objective *iv.* was set aside, while more importance was given to objective *i.*

In addition, after discussing with the host researcher, an important bottleneck was identified in legislation and chosen as the preferred research subject.

- The trainee focused her attention on the state-of-the-art of policies on water reuse, especially, but not only, at EU level. Importance was given to the link between regulations and possible positive or negative impacts on the implementation of NBS.
  The European Commission proposal for regulation setting EU standards for reclaimed water, as well as the JRC report on minimum quality requirements for water reuse in agricultural irrigation and aquifer recharge were examined. The policies of the EU member states having legislation setting requirements for wastewater reuse were reviewed and summarised. With regards to micropollutants, attention was posed to the EU prioritization process for contaminants of emerging concern (CECs), including the Water framework directive, the priority pollutants lists and the introduction of the watch list system (Commission Implementing Decision 2015/495 and 2018/840). Lastly, the policies on water reuse of Switzerland, California, Australia and Singapore were reviewed. Research and policy gaps

were identified.

- Firstly, a review of selected studies focusing on the environmental sustainability assessment of the water resources/urban water systems was carried out. The studies were categorized based on their differences in concept and purpose. Two macro categories of system analysis tools were identified:
    a. System Engineering Models such as simulation models, optimization models, forecasting models, cost-benefit models or multi-criteria decision-making (MCDM). These models focus on supporting the design of the system.
    b. System Assessment tools such as LCA, MFA, risk assessment etc. These tools focus on assessing the performance of current systems.

  System Assessment tools can be further classified in two sub-categories as follows:
    a. Territorial/Metabolism-based approaches such as Urban Metabolism, Urban Water Metabolism, Territorial Metabolism
    b. Consumption-based approaches such as LCA, EIO, Water footprint

  We identified a lack of widely accepted methods for assessing hybrid water systems (grey infrastructure coupled with NBS) or NBS especially at the macro-scale level. Therefore, based on the literature we tried to identify the most appropriate methodologies for a holistic assessment based on circularity and sustainability of water systems including NBS. At present, there is no systematic methodology assessing NBS for water security (water quantity and quality).

- A preliminary list of suitable KPIs and indexes was drawn up based on the available literature.

- The ID cards containing the outcomes of CircularCities Re.Solution partner projects were examined obtaining insights onto the most commonly applied methodologies.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

- The EC proposal on EU standards for reclaimed water would solely apply to reclaimed water for agricultural irrigation purposes with microbiological and physico-chemical parameters requirements only, while CECs have not been considered. Moreover, the proposal considers only reclaimed wastewater, that is, water regulated in the Urban Waste Water Treatment Directive, excluding other possible sources (e.g. harvested rainwater, greywater, etc). CECs have been targeted in other pieces of legislation, in particular in the watch list, which includes pollutants posing a possible significant risk to or via the aquatic environment but with insufficient data to support their prioritization. However, the watch list does not mention wastewater monitoring. Therefore, there is a missing link between their occurrence in wastewater and the risk associated to their presence when reclaimed wastewater is reused. Little or no relevant data on the risk posed by micropollutants were found in literature on NBS. This research gap reflects the legislation gap: if CECs are not addressed by regulations, they are not taken into account in NBS, for which might represent a constraint. The absence of adequate legislation on water reuse might represent a barrier for NBS implementation: there is no common EU regulatory framework for water reuse/greywater/harvested rainwater (which could prevent from adopting NBS) and the lack of regulations on CECs might bring to risk underestimation.

- We were unable to find a case study measuring the effectiveness of a NBS, incorporated into a wider network of measures (e.g. water system, grey and green infrastructure) as well as impact assessment of measures at larger scales (e.g. meso-scale, urban scale, catchment scale etc.). Therefore, the chosen combination of methodologies applied to assess the performance of the water system as a whole (but so far without the integration of NBS) seems more reasonable. These methodologies are: LCA to assess system environmental sustainability, addressing the climate change mitigation; Urban Water Metabolism to map all the water flows (anthropogenic and hydrologic), addressing the impact on the ecosystem services; Harvest to harvest approach to quantify the degree of system self-sufficiency, obtained by water reuse. Additional indicators used as metrics of performance should be used to assess additional benefits and/or costs.

- The following KPIs and indexes were found suitable for circularity assessment:
    - *Total use of centralized supply*
    - *Replaceability of total use with wastewater and rainwater/stormwater*
    - *Internal recycling ratio*

- *Internal harvesting ratio*
- *Nutrient recovery from urban water*
- *Water pollutant load within safe operating space*
- *Demand minimization index*
- *Self-sufficiency index*

- An examination of the methodologies listed in the ID cards highlighted high variety and variability among the COST partner projects. Projects consider NBS under different aspects (of which 38.6% on Urban water), and at different implementation and application scales. The methodologies of assessment are diverse, the most used one being LCA followed by Mapping and Assessment of Ecosystems and their Services and CBA. Only few projects take directly into account micropollutants (21%), while most of them focus on water footprint, land use and biodiversity.

FUTURE COLLABORATIONS (if applicable)

This STMS has been largely successful also in terms of present and future collaborations between the STMS applicant, the host researcher and their two institutions (ICRA and Brunel University).
First of all, a review article, including also the topic of this STMS and its results, is in preparation and will be submitted to a scientific journal for publication.
The activities are then going to be further developed in the context of WG5, which Brunel is leading, and has already led to the inclusion of another ICRA researcher as WG5 sub-task leader.
Moreover, the performed activities fit perfectly within the funded EU project HYDROUSA (*Demonstration of water loops with innovative regenerative business models for the Mediterranean region*) of which both ICRA and Brunel University are partners and that is, of course, a project included in this COST action.
As a conclusion, general much stronger connections between ICRA, where the applicant and her supervisor (COST MC for Spain) work, and Brunel University have been established.