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City-to-city learning to enhance urban water management: The contribution of the City Blueprint Approach

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ABSTRACT

Cities face several water challenges which ask for more pro-active management approaches. One option that cities have is to start networking and build learning alliances with other cities. Forming meaningful alliances however asks for clear and easily accessible city-matching methodologies which are based on a standardised assessment approach and the presence of structured and large databases. The City Blueprint Approach is an example of such a methodology. Aim of this paper is to demonstrate the potential of this approach as a substantive methodology for enhancing learning on urban water management. This is done by illustrating the use of the approach in four cities, which were studied in the H2020 project POWER (Political and sOcial awareness on Water EnviRonmental challenges) and by comparing the results found with good practices present in the City Blueprint database. These good practices however cannot simply be copy-pasted from one city to another. We therefore outline in what way more in-depth city-to-city (C2C) learning results can be achieved and be tailored to best-fit particular urban areas. The paper concludes with some suggestions for enhancing the potential for C2C learning in urban water management networks.

1. Introduction

The future is urban. In 2009, the number of people living in cities surpassed the number of people living in rural areas. Cities are projected to grow with an unprecedented 2.7 billion people amounting to two third of the projected world population of 9.7 billion in 2050 (UN DESA, 2009). Already approximately 80 % of the world's GDP is produced by cities, and 75 % of the global energy and material flows are consumed here too (UNEP, 2013). As a result, cities face many environmental challenges (Koop & Van Leeuwen, 2017). According to a global survey, one in four large cities (population > 750,000) is water stressed (water use / availability ratio > 0.4; McDonald et al., 2014). Prime examples, such as the nearly emptied water reservoirs in Melbourne in 2007, São Paulo in 2014 and Cape Town's threat of day zero in 2018, are likely to unfold more frequently, with far-reaching consequences. On the other end, too much water, in the form of floods already pose a projected 15 % of the global population at risk. This is mainly the case in urbanities including almost all the mega-cities that are situated along the world's coast, delta's and rivers (Ligtvoet et al., 2014). Sea level rise, extreme weather events and land-use change only further exacerbate their vulnerability. Cities are also a key source of pollution. Plastics, untreated sewage discharge, combined sewer overflow and stormwater runoff pollute local water bodies, rivers and oceans, causing eutrophication, biodiversity loss, threatening drinking water, fisheries, aquaculture and tourism (Zarf et al., 2011). Also the vulnerability to heatwaves is amplified by both climate change and the urban environment which often lacks a cooling effect of vegetation and water bodies (Yu et al., 2020). As such, the pressure exerted on cities but also their innovative potential are likely to increase exponentially (Meijer & Bolivar, 2016).

Although each city has its unique contextual setting (Koop et al., 2018), there are many cities facing rather similar challenges related to water, waste and climate change. The almost unlimited potential of sharing know-how between these cities is widely recognised in academia (e.g. Kern & Bulkeley, 2009; Shefer, 2019) and acted upon by Transnational Municipal Networks (TMNs) such as C40, 100ResilientCities, the Climate Alliance and Energy-Cities. The exchange of

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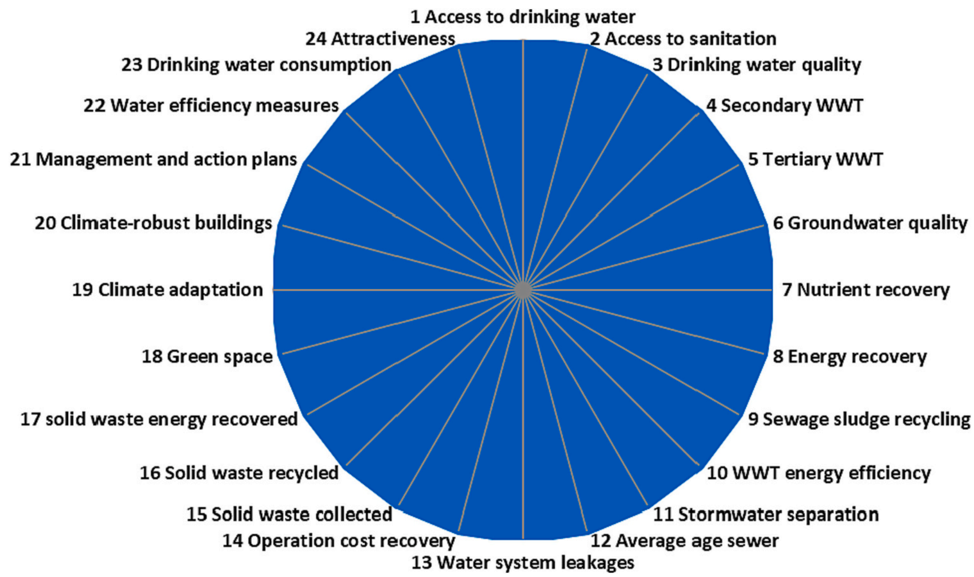

Fig. 1. Best scores of 135 cities for each of the 24 indicators of the City Blueprint Framework. The figure shows that there is always a potential for C2C learning as for all indicators good practices can be identified in the CBF database.

knowledge, experiences, learning practices, policies or governance models - within TMNs or bilaterally - is generally referred to as city-to-city (C2C) learning (though many authors point out the difference between knowledge exchange and learning) (Haupt et al., 2019). However, against the often praised learning potential, many studies show that actual C2C-learning generally provides a somewhat more disappointing picture (Castanho, 2019; Haupt et al., 2019; Kern & Bulkeley, 2009). The time, effort and thoughtfulness required to translate general expectations into a specific set of learning targets and activities that can bring about mutual learning, is all too often underestimated (Dolowitz & Marsh, 2000). In addition, based on the organisational structure of many TMNs, it may be observed that cities are often treated as being a single actor instead of the network of actors that they are. In order to learn from other city networks, it is necessary to first identify development priorities together with local stakeholders. Only then, specific city alliances may be established where various professionals representing different organisations can mutually learn from one another. Such a content-based 'city-matching' methodologies are however hardly addressed in the literature on urban water governance, TMNs or C2C learning. Hence, we aim to address this knowledge gap by showing the potential of the City Blueprint Approach (CBA) for enhancing C2C learning. The CBA is a standardised approach for assessing the performance of cities' urban water management and required governance capacity. The CBA consists of the City Blueprint Framework (CBF) that assesses the city's water management performance and the Governance Capacity Framework (GCF) that assesses the required capacities to govern water-related challenges (Koop & Van Leeuwen, 2020a, 2020b, 2020c) (Fig. 1). Central to the paper is the following research question. In what way can the CBA methodology contribute to C2C learning and thus to better urban water management?

In order to answer this question, we first elaborate on the concept of C2C-learning and the potential role of TMNs for enhancing C2C learning and improving urban water management and policy. Next, Section 3 clarifies how the CBA can be used as city-matching methodology. Sections 4, 5 and 6 illustrate how it can be used to improve water management in four cities – Leicester, Milton Keynes, Sabadell and Jerusalem. These cities have been selected as illustration cases because (i) they are actively seeking to seize C2C learning opportunities, (ii) they represent a diversity in water management foci and hydrological and socioeconomic contexts that is common of TMN collaboration, and (iii) they are the key demonstration cities that have been engaged in the H2020 POWER-project (Political and sOcial awareness on Water EnviRonmental challenges) (https://www.power-h2020.eu/) which aims to strengthen digitally-supported citizen engagement in local urban water management and enhance the potential for comparison, benchmarking and ultimately learning between cities. The results of our application are provided in Sections 4 and 5 whereas Section 6 provides for the discussion and Section 7 for the conclusion.

2. C2C-learning and TMNs, some conceptual clarifications

City to city learning is a form of social learning, a process of change in understanding, that goes beyond the individual and aims at collective action. The notion of social learning as a process points to 'actors developing shared meanings, values, and understanding through interaction, which may provide the basis for joint future action' (Den Boer et al., 2019). Contrary to individual learning social learning is based on deliberation (Den Boer et al., 2019). As such the concept of social learning relates to notions of 'learning communities' and 'communities of practice', communities that consist of people that share a common concern and pursue knowledge through regular interaction, based in practice.

C2C-learning can range from more simple forms of translating and improving good practices up to long-term dynamics of monitoring, evaluation and cross-stakeholder learning both within and between city networks. The level of learning may be limited to incremental learning to refine current management practices and policies (i.e., single-loop learning). C2C learning can however also enable critical investigation of assumptions and key relations and reframe problems to arrive at more fundamental changes in a city's water management (i.e., double-loop learning). It can also foster a more radical form of learning by questioning underlying norms and values, and in doing so transform the wider social and institutional structure that shapes water management in a city (Pahl-Wostl, 2009). The level of learning depend strongly on the motive, length and depth of engagement (e.g. Betsill & Bulkeley, 2004; Hakelberg, 2011). Learning may inspire changes in behavior, but we do not argue that all learning directly results in behavioral changes.

Literature on TMNs reveals that their added value is largely determined by their ability to provide tangible results for their members (Fünfgeld, 2015; Haupt et al., 2019). Such results may include the enhancement of lobby and bargaining powers. TMNs however could also offer learning opportunities by enabling the exchange of knowledge, experiences and good practices.

TMNs may strengthen lobby and bargaining powers of like-minded cities that aim to get issues (like climate adaptation) higher on political agendas. International high-profile TMNs like the C40 network are an example of this. Due to their size, they may be an easy access to decision-makers. These global networks however lack enforcing bodies that can ensure compliance of member cities through common policies and guidelines. Regionally-oriented TMNs such as the Climate Alliance and Energy-Cities seem to be able to provide more incentives for members to develop a climate action plan than the international high-profile C40 network (Hakelberg, 2011). Apart from incentivising plan development TMNs can also provide access to existing financial resources (Betsill & Bulkeley, 2004). By joining TMNs, cities may get access to first-hand information about funding opportunities and new legislation (Fünfgeld, 2015).

The learning opportunities that TMNs may offer are of course not restricted to possible funding opportunities or emerging legislation. Since water management performances may differ between cities in a TMN frontrunners and laggards can be found. Implementation of innovative policies generally requires larger administrative staffs and in-house expertise typically associated with larger and wealthier cities that can allocate the necessary resources (Collier, 1997; Dannevig et al., 2012; Den Exter et al., 2014; Mathy, 2007; Rashidi & Patt, 2018). Such early adaptors or front-running cities are the ones that tend to be strongly committed to TMNs (Hawkins et al., 2016; Krause, 2012). This may result in TMNs that are effectively becoming 'networks of pioneers for pioneers' (Aall, 2012; Kern & Bulkeley, 2009). Within the TMN, the frontrunners may offer learning opportunities by exchanging their knowledge, experiences and (good) practices. Based on these knowledge exchanges, benchmarking or certification systems can be developed. Cities can use the latter to improve their reputation and visibility, which may be helpful for attracting additional funding for existing projects or ambitions (Heinrichs et al., 2013).

Regional networks can be established around frontrunner cities that can share tailored solutions to their neighbouring cities (Den Exter et al., 2014) that face similar regulations, often speak the same language and can also strengthen each other with a coordinated approach for regional challenges such as a joint lobbying, monitoring, education and professional training programmes. In this way, smaller municipalities with limitations in staff and resources can benefit from the know-how of their neighbouring frontrunners.

A more intimate option of C2C learning is twinning. Twinning is a form of collaboration between two institutions that have similar tasks and responsibilities through a peer-to-peer exchange of staff (Bontenbal, 2013; Jones & Blunt, 1999). The personal exchange of like-minded professionals is an important C2C learning strategy (Baud et al., 2010; Bontenbal, 2013; Johnson & Wilson, 2006). Since most adult learning occurs at the workplace and is largely self-directed (Brookfield, 1987; Tough, 1971), the exchange of professionals is arguably more promising in changing work routines and organisational approaches than professional training or the exchange of only information. Twinning approaches focus on establishing personal relationships, constructive dialogue and trust which forms a basis for long-term mutual learning (Johnson & Wilson, 2006).

Cities may be inspired by other cities' objectives, strategies, action plans, implementation, or monitoring and evaluation approaches. Good water management practices in frontrunner cities may offer learning opportunities for other cities. However, following Mukhtarov (2014) we don't argue that that the good practices can simply be transferred from one city to the other. The good practices have to be tailored – translated to fit the particular local context. Such a policy translation must therefore be understood as a "process of modification of policy ideas and creation of new meanings and designs in the process of cross-jurisdictional travel of policy ideas" (Mukhtarov, 2014, p. 6). Minkman et al. (2018) refer to several factors, such as transferability, process design and adoptability, that can have an influence on such translation processes.

However, in order to learn and translate policies from another city to meet their own needs, cities first have to get a holistic view on their water, management performance. Next they have to find cities to learn from. The CBA can help them to structure these processes by identifying C2C learning opportunities.

3. Four steps in C2C-learning

We argue that in general C2C-learning is a four steps approach. First a city's water-related performances and challenges have to be assessed. Next in order to allow for city matching frontrunner cities must be identified that may offer learning opportunities. In a third step an in-depth analysis of the frontrunner cities must be done in order to find out what governance capacities have enabled the implementation of water management solutions. These capacities form the starting point for the development of programmes for policy translation.

3.1. Assess a city's water management performances

Water managers that are willing to learn must first develop an understanding of the key water-related challenges of their city and how well they perform in addressing these challenges. The CBF can be used for this. This framework consists of 24 performance indicators that are divided over seven broad categories covering key components of urban water management: i. basic water services, ii. water quality, iii. wastewater treatment, iv. water infrastructure, v. solid waste, vi. climate adaptation, and vii. plans and actions (Koop & Van Leeuwen, 2020a, 2020b, 2020c). As Fig. 1 shows many of the City Blueprint indicators refer to the implementation of technological measures (see a.o. the indicators on secondary and tertiary waste water treatment, nutrient and energy recovery, sewage sludge recycling etc.). The indicators are scored from 0 (ample room for improvement) to 10 (high performance) and are scored through an indicator specific standardised scoring method that is available online: https://library.kwrwater.nl/publication/61397318/.

The scoring of the indicators is done in co-production with local stakeholder such as utilities, municipalities, regional water authorities and private parties. In this way, the most accurate and timely information available is collected. The City Blueprint results are presented in a spider web (Fig. 1) with the simple message 'the bluer the better'. The geometric average of the 24 indicators provides an overall score named the Blue City Index or BCI.

At present, the method has been applied in 135 cities in 57 countries. The results of the analyses have been published in academic papers (Koop & Van Leeuwen, 2015a, 2015b, 2017; Koop et al., 2022) and in popular media such as the Urban Water Atlas for Europe (Gawlik et al., 2017).

3.2. Find comparative cases to learn from

The priorities identified by the application of the City Blueprint indicators may form the starting point to consult the database of 135 city assessments to find a match with another city that scores higher on particular indicators. Even the best performing cities such as Singapore, Seoul or Amsterdam, still show ample room for improvement in their indicator scores (e.g. Kim et al., 2018). However, when the highest CBF scores of each indicator for all cities assessed so far are plotted, a completely blue CBF spider diagram is obtained (see Fig. 1). This implies that for all indicators good practices can be found and that know-how, experiences and policy approaches are available. These good practices can serve as a starting point for cities that want to improve their performances. As a first step some more insights in the frontrunners' good performance can be obtained by exploring the frontrunners' scores using

Table 1
The Governance Capacity Framework (Koop & Van Leeuwen, 2020a, 2020b, 2020c). More details about the meaning and scoring of the indicators can be found at https://library.kwrwater.nl/publication/61397218/.

Dimensions	Conditions	Indicators
Knowing	1 Awareness	1.1 Community knowledge
		1.2 Local sense of urgency
		1.3 Behavioral internalization
	2 Useful knowledge	2.1 Information availability
		2.2 Information transparency
		2.3 Knowledge cohesion
	3 Continuous learning	3.1 Smart monitoring
		3.2 Evaluation
		3.3 Cross-stakeholder learning
Wanting	4 Stakeholder engagement process	4.1 Stakeholder inclusiveness
		4.2 Protection of core values
		4.3 Progress and variety of options
	5 Management ambition	5.1 Ambitious and realistic management
		5.2 Discourse embedding
		5.3 Management cohesion
	6 Agents of change	6.1 Entrepreneurial agents
		6.2 Collaborative agents
		6.3 Visionary agents
Enabling	7 Multi-level network potential	7.1 Room to maneuver
		7.2 Clear division of responsibilities
		7.3 Authority
	8 Financial viability	8.1 Affordability
		8.2 Consumer willingness to pay
		8.3 Financial continuation
	9 Implementing capacity	9.1 Policy instruments
		9.2 Statutory compliance
		9.3 Preparedness

reports in the CBA database and additional data to be retrieved by search engines like Google Scholar or Scopus.

3.3. *Identify lessons by assessing governance capacities*

In a next step it must be found out why the good practice could have emerged. How have the frontrunners managed to get things done? How did they manage to get new technologies implemented? Which societal and institutional conditions were needed to make it happen? Akhmouch (2016) has stressed the importance of institutional conditions for water management in a clear statement. "If you want to fix the water pipes, you must fix the institutions" and in line with this the OECD (2015a, 2015b) states that water crises often emerge from poor governance such as institutional fragmentation, ambiguous legislation, poor implementation o, as well as matters such as limited capacity at local level, unclear allocation of roles and responsibilities, fragmented financial management and uncertain allocation of resources. Often, long-term strategic plans and sufficient resources to be able to monitor performance and implementation are lacking, which leads to weak accountability and little transparency. These challenges tend to result from a lack of coordination between goals and a lack of steering of the interactions between relevant stakeholders. Plans are developed but, all in all, they do not add up to a clearly signposted route heading in a common sustainable direction (Makarigakis & Jimenez-Cisneros, 2019; Romano & Akhmouch, 2019). Frontrunner cities however have overcome these issues by continuously developing their governance capacities.

So, in order to find more in-depth and more encompassing lessons the existing governance capacities in the frontrunner cities must be analysed and explained. The dimensions, conditions and indicators of the GCF (Koop et al., 2017; Koop & Van Leeuwen, 2020c) can be used as an diagnostic tool for supporting this. Table 1 gives an overview of the GCF dimensions, conditions and indicators. The indicators scores range from very limiting (1), to very encouraging (5). In order to find out what is needed to implement a good practice (and what a learning city needs to improve) correlations can be sought between the good practice indicator and the capacity indicators shown in Table 1.

Capacity indicators that have a positive correlation with the good practices indicator seem to be relevant and need a more in-depth analysis. This selection of most positively correlated capacities can form a basis for more in-depth contextual learning and the translation of policies that enabled good practices in the frontrunner city. The correlations are based on a growing number of governance capacity assessments done across the globe (n = 27 at present).[1]

3.4. *Develop programmes for policy translation*

As said before insights in the good performance and underlying governance capacity characteristics of frontrunner cities have to be tailored to improve water management of cities that want to do better. They have to be tailored to deal with local peculiarities and capacities. By organising exchange programmes, a more in-depth understanding of the frontrunner's capacities and the possibility to translate them, can be identified. The lessons learned from the frontrunner city can serve as an input in societal debates with important stakeholders at the municipal level. For getting societal acceptance of a policy design we want to stress that it is important to involve relevant stakeholders in an early stage of the process (Koop et al., 2017; OECD, 2015a, 2015b; Romano & Akhmouch, 2019). In this way "water-only" or "water-smart" discussions that overlook other policy challenges in cities can be avoided and options for co-creation and effective and efficient win-win solutions can be found (Koop & Van Leeuwen, 2017). Leading question in the deliberations that follow will be to what extent the identified success conditions are already present in the municipality, which are lacking and what leverage points can be identified in order to change things for the better. This asks for an in-depth analysis of the local situation for which the indicators of Table 2 can be used.

Next the general public must be involved. This can be done by organising hearings, referenda or by using online platforms (Mukhtarov et al., 2018). Finally for the actual implementation of the policy tender procedures may be organised which creates competition between potential implementing agencies. The latter must further tailor the policy (also into technological designs) and in the end the best option must be selected by the local council.

In the following sections we illustrate how these steps can be worked out in practice.

4. Step 1 & 2: the identification of water management gaps and learning parties in four cities

As Table 2 shows both Leicester and Milton Keynes (United Kingdom), Jerusalem (Israel) and Sabadell (Spain) face challenges in their urban water management.

Table 2 shows that none of the four cities has got the maximum BCI score of 10. For some indicators however maximum scores are given.

[1] The 27 cities are Ahmedabad (Aartsen et al., 2018), Amsterdam, Rotterdam, Utrecht (Brockhoff et al., 2019; Koop et al., 2017), Antofagasta (Šteflová et al., 2021), Bandung (Rahmasary et al., 2020), Cape Town and Durban (Madonsela et al., 2019), Cork, Jerusalem. Lagos, Leicester, Milton Keynes (Koop et al., 2018), Libreville, Lusaka, Melbourne, New York City (Feingold et al., 2018), Quito (Schreurs et al., 2018), Sabadell (Šteflová et al., 2018), Rio de Janeiro (Okumura et al., 2021), Seoul (Kim et al., 2018), Seville, Taipei (Rahmasary et al., 2019), Tianjin (Chang et al., 2020), Toronto, Ulaantaabar (Munkhsuld et al., 2020) and Windhoek. We calculated linear correlations using the following formula:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Table 2
City Blueprint indicator scores for the cities of Leicester (Lei) in the United Kingdom (UK), Milton Keynes (Mil) in the UK, Jerusalem (Jer) in Israel and Sabadell (Sab) in Spain.

Category	Indicator	Lei	Mil	Jer	Sab
I Basic water services	1 Access to drinking water	10.0	10.0	10.0	10.0
	2 Access to sanitation	10.0	9.9	9.9	10.0
	3 Drinking water quality	10.0	9.9	10.0	10.0
II Water quality	4 Secondary WWT	10.0	9.9	9.0	8.7
	5 Tertiary WWT	5.0	9.9	5.0	6.8
	6 Groundwater quality	6.0	10.0	5.0	6.9
III Wastewater treatment	7 Nutrient recovery	4.5	0.0	8.2	0.0
	8 Energy recovery	1.0	0.3	7.0	1.0
	9 Sewage sludge recycling	8.6	10.0	8.2	8.7
	10 WWT energy efficiency	8.0	10.0	9.0	4.0
IV Water infrastructure	11 Stormwater separation	0.0	5.0	10.0	0.0
	12 Average age sewer	2.0	4.0	7.4	0.0
	13 Water system leakages	5.1	7.8	7.5	6.2
	14 Operation cost recovery	7.4	5.3	4.1	1.9
V Solid waste	15 Solid waste collected	3.6	2.9	1.4	3.0
	16 Solid waste recycled	6.4	5.6	1.4	3.7
	17 solid waste energy recovered	4.5	5.4	0.0	1.5
VI Climate adaptation	18 Green space	2.0	10.0	1.3	3.8
	19 Climate adaptation	9.0	10.0	10.0	6.0
	20 Climate-robust buildings	8.0	10.0	9.0	7.0
VII Plans and actions	21 Management and action plans	8.0	10.0	10.0	7.0
	22 Water efficiency measures	6.0	10.0	10.0	4.0
	23 Drinking water consumption	7.9	9.9	9.4	10.0
	24 Attractiveness	4.0	10.0	9.0	4.0
Blue City Index (BCI)		5.3	6.7	6.1	4.0

(Source: Koop and Van Leeuwen (2019).)

The table also shows that each city performs far from optimal on particular indicators (0–2 points). Lessons can be learned from other cities that score high on these indicators (8–10 points). By screening the scores of 135 cities in the CBF database, it was possible to identify forerunner cities that may offer learning opportunities for the improvement of urban water management in each of the four cases (Table 3). Some additional desk research has been conducted to further explore what the high scores of the frontrunner cities entail.

Table 3
Overview of water governance improvement options for the four case studies.

City	Improvement options	Frontrunner cities	Best practices
Leicester	Improving stormwater separation & increasing green space	Melbourne Amsterdam Malmö	Stormwater is separately collected. Comprehensive stormwater harvesting schemes where stormwater is collected, treated and used to irrigate gardens, sport fields or public parks. Green roofs that create green space, have a cooling impact, enhance biodiversity and store the stormwater (Kruuse & Verchou, 2005; Van der Hoek et al., 2014; Van Leeuwen, 2017)
Milton Keynes	Improving nutrient and energy recovery from waste water	Amsterdam	Biogas installation for sewage sludge. Local heating system using waste water and production of struvite which can be used to produce fertilisers (Van der Hoek et al., 2016)
Jerusalem	Improving solid waste recycling and energy recovery from solid waste	Copenhagen Oslo Stockholm	Prevention, preparing for reuse, recycling, other recovery and disposal approach for solid waste treatment (City of Copenhagen, 2014). Campaigns for waste reduction and separation (Luccarelli & Røe, 2013). Efficient biogas and bio-fertiliser production from separately collected food waste (Scandinavian Biogas, n.d.)
Sabadell	Strengthening public participation Minimising the average age of the sewer	Rotterdam Melbourne Amsterdam	Citizen's jury to make recommendations about the 10 Year Financial Plan to address climate change and promote long-term liveability, including new strategies for waste management and recycling, drainage, tree coverage and adoption of new technologies (Dean et al., 2016). Real-time sewer control system and multi-value creation and multi-benefit planning for long-term sewer refurbishment plans (Van der Hoek et al., 2014)

4.1. Leicester

In Leicester, a city with approximately 330,000 residents (ONS, 2011a), the performances on stormwater separation and green space could be strengthened to minimise flood risk in cases of downpours and to improve urban water quality. In cases of downpours, sewers have to process so much water in a short time that they overflow. As a result dirty sewage is discharged into the surface water. By disconnecting stormwater from the waste water sewer, peak volumes in the sanitary sewers will decrease. Consequently, wastewater treatment plants will perform better and rainwater can be infiltrated into the soil and thus supplement groundwater.

If we check the City Blueprint database we see that both Melbourne and Amsterdam score high on the priority indicators and therefore could serve as good practices in stormwater separation (Van der Hoek et al., 2014; Van Leeuwen, 2017). In Melbourne, the State Government of Victoria together with the local water supplier "Melbourne Water" have developed a "Stormwater Strategy". As a result of this urban stormwater is collected and treated to irrigate gardens, sport fields and golf courses (State Government of Victoria, 2021). The percentage of households with a rainwater harvesting tank also increased substantially. With advanced water storage control systems based on storage monitoring and weather forecasts, rainwater can be optimally used to mitigate drought and flatten peak water demands. Amsterdam is pioneering with a strategy that combines flood adaptation with infrastructural renovations and with measures to reduce heat stress, air pollution or water issues as a result of extreme precipitation (Dai et al., 2018; Koop et al., 2018). Amsterdam is implementing a real-time sewer control system that optimises the storage capacity of the sewer to ensure a constant flow to the wastewater treatment plant (De Korte et al., 2009). Moreover, new gutters and storm water collection systems are constructed to temporarily store rainwater (Van der Hoek et al., 2014). In Amsterdam's new neighbourhoods, rainwater and waste water flows are separated (Waternet, n.d.). On the online platform "Amsterdam Rainproof", ideas, initiatives and information on how to make Amsterdam rainproof are shared.

The implementation of Urban Green Infrastructure (UGI), e.g. parks, green roofs as well as blue and green spaces can make a significant contribution to reduce stormwater runoff (EEA, 2012; Zimmermann et al., 2016), facilitate temperature reductions in cities while delivering co-benefits such as pollution alleviation and biodiversity (Norton et al., 2014). In order to achieve a certain amount of green space and to minimise sealed areas, the city of Malmö uses a “green space factor”. Different types of surfaces are given credits. No credits are given to sealed surfaces, whereas plant beds, climbing plants, green roofs and ponds get high credits (Kruuse & Verchou, 2005). Developers can use the tool for calculating green space requirements for new developments (Lehner, 2017). To educate people about green roofs, guided tours and in-depth technical visits are organised. The rooftops in the Augustenborg Botanical Garden contain >20 vegetated areas with “inspiration gardens for urban farming and biodiversity” (SGRI, n.d.).

4.2. Milton Keynes

Milton Keynes is a relatively new city with approximately 249,000 inhabitants which is expected to increase considerably in the future (ONS, 2011b). Despite its high BCI score energy and nutrient recovery from waste water remain as Milton Keynes' main water governance challenges. Wastewater has for a long time been considered a human health concern and environmental hazard, but the paradigm is shifting towards a proactive interest in recovering nutrients and energy from waste water. Nutrients especially phosphorus and potassium are finite resources and will become increasingly expensive and more difficult to mine (Cordell & White, 2011; EC, 2014). Zeeman (n.d.) calculated that recovering phosphates from black and grey water could satisfy “a quarter of the present worldwide artificial phosphorus fertiliser use”. Nutrient recovery is also beneficial for decreasing surface water pollution. Subsequently, treated waste water can be reused for various purposes which in turn can provide ecological benefits, reduce the demand of potable water and augment water supplies (Van der Hoek et al., 2016). The reuse of nutrients can either be done by using the sewage sludge as fertiliser on agricultural land or by producing struvite (a phosphate mineral) from wastewater (Van Leeuwen et al., 2018).

Amsterdam could serve as a source of inspiration for Milton Keynes as it has adopted and specified the circular city concept in documents like the “Sustainability Agenda Amsterdam” (Waternet, 2016). Recovery of resources and materials is one of the targets mentioned in this document. Waternet, Amsterdam's public water utility has invested in the recovery of resources from the city's waste water (Van der Hoek et al., 2016). Waternet produces 13 million m^3 biogas per year at 12 wastewater treatment plants. This biogas is used to heat Waternet's buildings, in the sludge digestion process at the treatment plant. Most of it (80 %) is distributed to households or used as fuel for company cars (Van der Hoek et al., 2016). Waternet has also developed an installation (called “Fosvaatje”) for recovering struvite. Fosvaatje is one of the pilot projects of the “Energy and Raw Material Factory” programme, in which regional water authorities, businesses and universities try to boost innovation and explore new markets for the recovered materials (Van Leeuwen et al., 2018). The installation produces 2500 kg of struvite per day (enough for the annual fertilisation of 10,000 football fields) (De Jong, 2017; Nutrient Platform, n.d.). Waternet is also actively exploring the possibilities of thermal energy in the Buiksloterham district. By linking heat exchanger to a heat-cold storage at each household or apartment block, heat is extracted from greywater and transported back to the households for reuse. Furthermore, a bio-refinery is developed within this district which is a small-scale treatment unit in which materials and energy can be recovered from black waste water (Waternet, 2019).

4.3. Jerusalem

Jerusalem, 882,700 residents (JIPR, 2018) is situated in a dry climate. The city has a low score on indicators related to green space and indicators related to solid waste. The per capita waste production is relatively high, whereas the recycling of waste is low and there is no energy recovered from the collected solid waste. Issues related to solid waste - air, water and soil contamination (Rahmasary et al., 2020) - form a key point for improvement. For addressing these challenges the city may find inspiration in Copenhagen, Oslo and Malmö.

Copenhagen sends <2 % of waste to landfills. Approximately 60 % of the waste is recycled and maximum use is made of residual waste to generate heat for the city's district heating network. The city has six local recycling hubs (City of Copenhagen, 2014). All households separate recyclable waste like paper, cardboard, metal, rigid plastic, hazardous waste, glass and electronic waste. Bulky waste and garden waste can be collected from the households by agreement with the municipality or be delivered at the recycling stations (Urban Waste, n.d.). The international demand for Danish waste solutions is growing (Copenhagen Capacity, 2012).

In 2006, Oslo established the “Waste Management Strategy towards 2025”. This strategy sets ambitious goals linked to a circular economy (EC, 2019). The strategy mainly focuses on waste reduction, reuse and recycling and is considered to be inspirational as the European Commission has awarded Oslo the European Green Capital 2019 title (City of Oslo, 2019). In Oslo (and Norway at large) landfills are prohibited since 2009. Household waste is separated at source and collected accordingly in order to get homogenous waste streams which can be better recycled. A green bag is used for food waste, a blue bag is used for plastic waste, and a white bin is used for paper and cardboard; whereas there are also separate containers for other waste including glass, fabric, electronic and hazardous waste (City of Oslo, n.d.; Ruhm, 2016). In the world's biggest optic sorting plant the various coloured bags are separated by means of optic recognition. In order to support waste separation Oslo has initiated several awareness raising activities including advertising campaigns in media and public spaces, involving celebrities and door-to-door campaigns. The City of Oslo is also considering sanctioning housing cooperatives if waste separation rates are low (EU, n.d.). Waste handling is fully financed by citizens, the “pay as you throw” principle is applied as household charges depend on the bin size, beginning at 443 Euros per year for 140 litre bins with weekly collection. Collected waste is recycled. Garden waste is composted and sold to citizens as soil for their gardens. Oslo also has its own biogas plant, which can process 50,000 t of biological substances into biogas and bio-fertilisers. Biogas is used as fuel by buses and garbage collection trucks in the city, while the bio-fertilisers are used by farmers to produce food (Luccarelli & Røe, 2013; EU, n.d.).

Sweden recovers more energy from each tonne of waste than any other country (SCS, n.d.). In Stockholm landfills are almost non-existent. Most of the household waste is incinerated. The City is ambitious its “Waste Management Plan” for 2017–2020 since one of the objectives mentioned in this plan is that at least 70 % of food waste is to be collected for biogas production and nutrient recovery (Stockholm Vatten och Avfall, n.d.). In 2015, a new plant was taken into operation for the digestion of food waste in Stockholm. On an annual basis the plant can convert 50,000 tonnes of food waste into biogas and biofertiliser (Scandinavian Biogas, n.d.), approximately one third of all food waste created in Stockholm. The plant has a capacity of 80 GWh biogas which equalises 8.8 million L of petrol. Moreover, approximately 14,000 tonnes of bio-fertiliser can be generated every year (ibid).

4.4. Sabadell

Sabadell (211,000 residents, GENCAT, 2018) faces several water management challenges including a high average age of the sewer and a lack of public participation. Sabadell's sewage infrastructure is old. Degradation of the city's sewer pipes can lead to seepage of eroded fine particles to the surrounding soil which may lead to pipe cracking and groundwater pollution. Water losses can amount up to 19.4 % (Šteflová

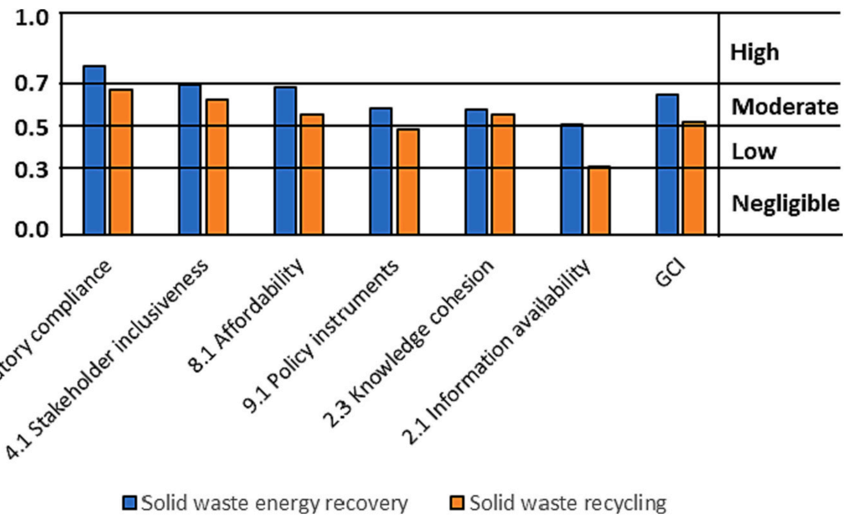

Fig. 2. Governance capacity indicators with the highest correlation with solid waste energy recovery and solid waste recycling based on 27 city assessments.

et al., 2018).

Amsterdam has an extensive sewage system (1658 km) which functionality is tested on a regular basis. As said before Amsterdam aims to separate stormwater from wastewater. New gutters and stormwater collection systems are constructed to temporarily store rainwater (Van der Hoek et al., 2014). Amsterdam is also implementing a real-time sewer control system that optimises the storage capacity of the sewer to ensure a constant flow to the wastewater treatment plant (De Korte et al., 2009). In order to make the sewage infrastructure more resilient and sustainable, the local water utility Waternet has set out various objectives in the "Municipal Sewage Plan Amsterdam" (Waternet, 2016).

For improving its performance on public participation Sabadell may find inspiration in Melbourne or Rotterdam. In Melbourne public participation is considered an essential part of planning projects and decision making. The City of Melbourne has developed the platform "Participate Melbourne" where people can sign up and join the conversation to influence the plans like the "City River Strategy". Such participation guides the Council's future planning of the inner section of the river. Citizens can provide feedback by attending an in-person meeting, completing an online survey and by submitting an idea to the Ideas Forum. All ideas submitted are publicly displayed and citizens can like the ideas that they support (City of Melbourne, 2019). In 2014, the City of Melbourne implemented a citizen's jury to make recommendations about its 10 Year Financial Plan. The jury provided recommendations to address climate change and promote long-term liveability, including new strategies for waste management and recycling, drainage, tree coverage and the adoption of new technologies. Evaluations showed that jury members supported greater citizen involvement in policy making. Moreover, increased levels of trust and confidence in the Council were reported, as well as a greater satisfaction with future plans for the city of Melbourne (Dean et al., 2016).

Public participation is also very much embedded in Rotterdam's decision-making processes. Multiple networking initiatives exist to share opinions and ideas. The "Blue Cityinitiative" for instance focuses on the idea of circular entrepreneurship and the circular economy, and gives start-ups space, guidance and a network. A 150 members strong citizen jury provides the municipality with recommendations twice a year. Public participation is always organised in cases in which measures are foreseen with an impact on a neighbourhood (City of Rotterdam, n.d.).

5. Step 3 & 4: the identification of lessons and the development of programmes for policy translation

In the previous section we have shown have cities can find learning opportunities by identifying frontrunner cities they can learn from. In this section we will illustrate how the governance capacity indicators can be used to identify more in-depth lessons. This will be done for two of Jerusalem's water management challenges, solid waste recycling and energy recovery from solid waste.

So far the governance capacities for 27 cities have been assessed. The Pearson correlation coefficients we can calculate can be interpreted as negligible (r = 0.0–0.3), low (r = 0.3–0.5), moderate (r = 0.5–0.7) or high (r = 0.7–1.0). As a result we are able to show that there is a correlation between solid waste recycling and energy recovery, the overall governance capacity score (the arithmetic average of the 27 indicators scores listed in Table 1) and some capacity indicators in particular.

Fig. 2 shows 7 governance capacity indicators with the highest correlations with solid waste energy recovery and solid waste recycling.

Although these correlations are not proven to be causal, they are an important pointer for identifying further learning opportunities (Fig. 2).

Fig. 2 shows that advanced waste recycling and energy recovery turn out to be associated with statutory compliance, stakeholder inclusiveness, affordability, the effective use of policy instruments and knowledge. By outlining what these indicators entail we can identify pointers to focus on for a more in-depth C2C-learning.

5.1. *Statutory compliance*

The extent that legislation and compliance is well-coordinated, clear and transparent, and that stakeholders respect agreements, objectives, and legislation seems to be an important for both energy recovery from solid waste and waste recycling.

5.2. *Stakeholder inclusiveness*

The level of interaction with all relevant stakeholders in the decision-making process – ranging from being only merely informed, stakeholder consultation up to having the opportunity to be actively involvement correlates with solid waste recycling and energy recovery. More active stakeholder engagement coincided with more waste recycling and energy recovery. An active engagement of stakeholders is an important conditions for setting up a separate collection and in turn recycling of both industrial and domestic solid waste.

5.3. Affordability

Availability and affordability of waste management services is found to be moderately correlated with both indicators too. Affordability issues particularly limit waste recycling and energy recovery in poorer cities like Ahmedabad (Aartsen et al., 2018), Bandung (Rahmasary et al., 2020) or Naivasha (Ddiba et al., 2020). In some cases, the tariffs of waste collection are kept low to ensure a larger service coverage. However, these low tariffs limit investments in waste separation and treatment infrastructure. Thus, our data indicates that affordability can be understood as a precondition for implementing more advanced waste recycling and energy recovery.

5.4. Policy instruments

Presumably, compliance with legislation is achieved through the effective use of policy instruments. Indeed, the use of advanced policy instruments such as price incentives, permits and quality requirements for solid waste collection and treatment correlates with the actual level of recycling and energy recovery practices. These correlations emphasize the important role of policy implementation.

5.5. Knowledge cohesion and information availability

Last but not least, the role of knowledge and information coincides with higher levels of waste recycling and energy recovery. Especially, the extent that the use, production and sharing of information from different sources is cohesive is important. Different methods are used and an integration of short-term targets and long-term goals amongst different policy fields and stakeholders can be found. For waste recycling, the cohesion of knowledge can be decisive in identifying new resources, applications and markets.

For a city such as Jerusalem that may want to learn more on improving its solid waste recycling and energy recovery, these indicators can form key foci in their C2C learning efforts and policy translation to their own context. The indicators must be used in a more in-depth studies to figure out how they are manifest in (one of) the frontrunner cities Copenhagen, Oslo or Stockholm and how they relate to solid waste recycling and energy recovery.

In addition to this, exchange programmes must be set up and in-depth reporting on the capacities of the frontrunners must be organised. The lessons learned can provide inputs for the multi-stakeholder discussions to be started in Jerusalem. As said before the ideas that result from matching activities however are no panaceas but must be tailored in order to deal with local particularities and context factors of the city that wants to learn.

6. Discussion

Transnational Municipal Networks are often being criticised for having a dominant focus on information sharing instead of actually achieving professional learning (Haupt et al., 2019). We think that this can be done better. In this paper we have therefore shown how the CBA approach can support more in depth C2C-learning.

Successful C2C learning starts with knowing what to learn. Here the CBF may help by providing benchmarks and showing improvement options and that are already realised in other cities. Cities that score high on the practices that a city would like to improve form an important pool for more meaningful C2C learning. In cases in which an ideal match with one city can be found it is not necessary for a city to engage with other cities. However if this is not the case, a city may be inclined to find different other cities to learn from. Such multiple engagements are of course disproportionately more costly as compared to engaging with one city. Next, understanding what capacities are associated with these good practices is important in order to focus learning activities beyond exchanging general experience or technologies. Since the limited number of cities for which a governance capacity analysis has been done (n = 27) does not allow to identify statistically significant correlations and moreover if these correlations would be significant they are not proven to be causal re the proposed approach is only meant as a supportive exercise for strengthening contextual learning. The alternative would be to rely on anecdotal information only. Although anecdotical information can be valuable, we think that it is essential to bring a bit more focus to strategic learning processes. Empirically-based diagnoses based on the CBA can support this effort.

In our approach we match cities based on performance scores. One may however argue that comparability of social and physical characteristics is also a point in case. Literature reveals that cities not always focus on frontrunners as partners for initiating a learning alliance. Other factors are also relevant in the selection of partners. Practical factors such as language, logistics and similarities in social, economic or environmental contexts play an important role in determining from who to learn in what way. Particularly, compliance to similar legislation and policies, increased access to joint funding sources (getting access to first-hand information about funding opportunities) as well as allocating the resources to exchange personnel and collaborate in long-term programmes seems to play a key role (e.g. Betsill & Bulkeley, 2004; Bontenbal, 2013; Fünfgeld, 2015). Cities may be more eager to learn from frontrunner cities with similar context characteristics. So adding and if possible quantifying social and physical geographical characteristics as well as institutional context characteristics can be of added value for the further identification of cities that match best. It is also relevant to have such (quantified) data available in a database in the phase of the more in-depth analysis of the frontrunner city as these factors may interfere with the governance capacity factors that show high correlations with the performance indicators.

Some authors suggest that particularly regional C2C learning programmes seem to be most promising for C2C-learning because they can build on already existing networks, do not face substantial logistical or financial barriers and need to align with similar policy requirements and contextual conditions (Betsill & Bulkeley, 2004; Bontenbal, 2013; Fünfgeld, 2015). In cases in which the institutional context is similar (Amsterdam and Malmo – both share the EU legal context) single loop learning between cities may occur. Double (Amsterdam and Melbourne) and triple loop (an African city and Melbourne) and learning may occur between cities with (highly) different institutional contexts.

Apart from regional C2C-learning programmes, long distance learning programmes may be set up as well, for instance in the context of aid programmes. For such exchange programmes to succeed, long-term exchange of personnel seems to be key as well as establishing clear mutual expectations (Bontenbal, 2013). The development of long distance learning programmes is not limited to the aid programmes as they can also be established between frontrunning cities that have sufficient resources and are primarily interested in expanding their already advanced practices by collaborating with other frontrunners (Betsill & Bulkeley, 2004).

The approach outlined in this paper may sound appealing but can also be criticised as being too rational and forward-looking. In many real world cases the policy focus is short-term based on the political life cycle and not proportional to the life cycle of people or the life cycle of cities (Koop & Van Leeuwen, 2017). Practice also teaches that changes in urban water management often take place after shock events like a storm (New York; Feingold et al., 2018), water scarcity (Melbourne and Cape Town; Van Leeuwen, 2017; Madonsela et al., 2019), urban heat incidents (Aartsen et al., 2018) took place. In our opinion however, urban water management is of such a high importance that more pro-active approaches are needed in which C2C learning can play an important role.

7. Concluding remarks

In this paper we have shown and illustrated how the City Blue Print approach (CBA) can contribute positively to city-to-city (C2C) learning and thus to better urban water management. Four steps must be taken to apply the CBP-approach to enable C2C learning. Cities first must identify their water related performances and challenges. The CBF-approach is helpful for doing this and for the identification of frontrunner cities from which other cities can learn. After having identified these frontrunner cities an in-depth study of the frontrunner's capacities can be undertaken by focusing on capacity indicators that have been found to correlate with the key challenges. Next in-depth learning must be organised and facilitated by the development of exchange programmes. The lessons learned however have to be translated to deal with local peculiarities of the city that wants to improve performance. Multi-stakeholder dialogs must be set up to do this. We want to conclude this paper with three suggestions.

We invite international networks to set up network secretariats that actively facilitate C2C-learning. They secretariats must have access to large open-access data bases – like the CBA – that can be used as a starting point for identifying improvement options and city matching options. Secretariats could also support the development of (long term) exchange programmes and invite cities to invest time, resources and expertise in this.

The City Blue Print approach is now based on 51 indicators which we believe are key in understanding urban water governance challenges. However, our selection can be criticised. We therefore invite other researchers to do so and to revise or complement our set of indicators. In this way they can contribute to a further enabling of C2C learning and a better urban water management.

Another step forward can be the construction of an urban cooperation model. Cooperation between cities may differ in depth and frequency depending on the level of learning cities aim for. The development of such a model asks for more in-depth research on actual C2C-learning processes, their set-up as well as their performance. This could be a good step forward in the further development of C2C-learning tools.

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CRediT authorship contribution statement

Carel Dieperink: Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Writing – original draft. **Stef H.A. Koop:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft. **Mado Witjes:** Formal analysis, Investigation, Methodology, Writing – original draft. **Kees Van Leeuwen:** Conceptualization, Funding acquisition, Writing – review & editing. **Peter P.J. Driessen:** Funding acquisition, Writing – review & editing.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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