Strategy for phosphorus recovery and wastewater treatment in Amsterdam

M. V. Amosov[1], L. Zlatanovic[2], J. P. van der Hoek[2,3,4]

[1] Organic Village, Amsterdam, the Netherlands (E-mail: maxim.amosov@gmail.com)
[2] Delft University of Technology, Delft, the Netherlands
[3] Waternet, Amsterdam, the Netherlands
[4] Amsterdam Institute for Advanced Metropolitan Solutions, Amsterdam, the Netherlands

Introduction

Figure 1: Centralized phosphorus (P) recovery in Amsterdam West.

Waternet (water board in Amsterdam) **searches** for a **resilient and feasible strategy** to **expand the WW treatment plant** (WWTP) West with **decentralized or centralized** solutions and phosphorus (P) recovery. The study compared **systemic impacts of six solutions** on the WW system. As a result, **two generic strategies** and **specific recommendations** were identified to increase resilience, with evaluation of **costs and benefits** for WWTP expansion over **15 years** - an average life-span of a WW infrastructure.

Methodology

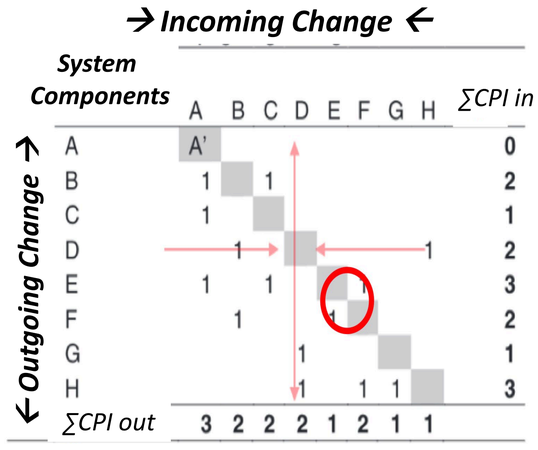

Figure 2: the DSM, where 1 shows a dependency e.g. A provides to B, C, E.

The **Design Structure Matrix** (DSM) was combined with the **Cost-Benefit Analysis** (CBA). The **DSM** is a square matrix describing **elements and dependencies**. The **Change Propagation Indicator** (∑CPI) quantifies dependencies: **incoming** and **outgoing**. The **ΔCPI** shows if an element **Multiplies**, **Carries** or **Absorbs** change. ∑CPI and ΔCPI unriddle **generic behaviour** of a system and **specific improvements** that increase resilience i.e. WW system. The **CBA** quantified **CAPEX and OPEX** for WW management e.g. **energy, materials**.

Results & Discussion

STRATEGY 1: solutions are linked by sewers to the centralized WWTP West and Waternet.

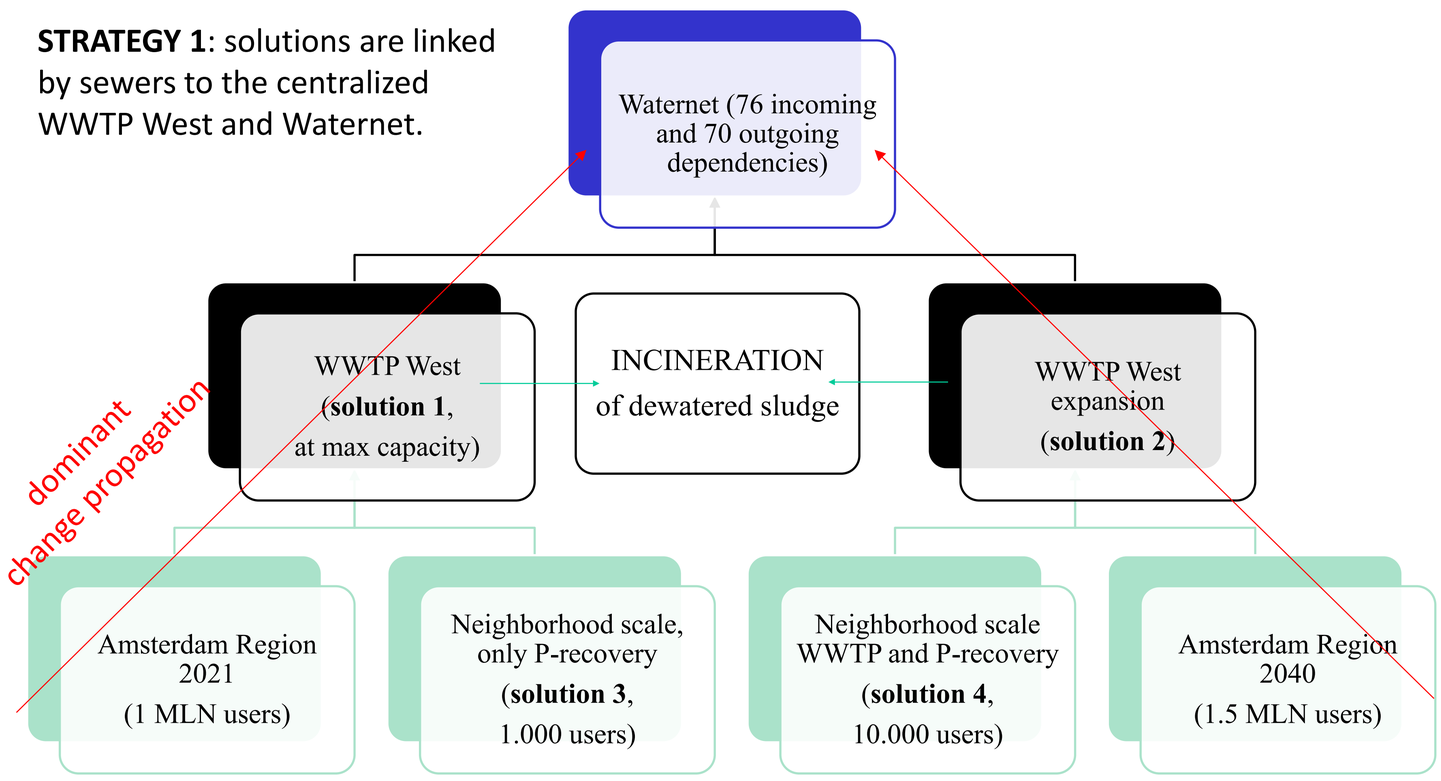

Figure 3: conceptual overview of solutions implemented in Amsterdam i.e. 1, 3; and envisioned i.e. 2, 4.

GENERIC BEHAVIOUR: Waternet is Absorber (owner) of changes propagated by the users, the solutions and the sewers towards the water and the sludge infrastructure at WWTP West and the sludge incineration afterwards, which is the only utilization chain.

SPECIFIC IMPROVEMENTS

I> **<u>Users</u>: top-multipliers of negative change**

RISK: growth in users will increase amount of WW and sludge ;
COST: replace 11 technologies in buildings with water efficient;
BENEFIT: reduce costs for energy, materials and transportation.

II> **<u>Digested sludge</u>: top carrier of change at WWTP**

RISK: growth in users/ incineration break will overflow WWTP;
COST: develop buffering capacity, or circular sludge value chain;
BENEFIT: delay overflow/ reduce costs for sludge management.

Due to a limited space, not all improvements are presented.

STRATEGY 2: solutions are disconnected from the centralized WWTP West via living machines (biofiltration) on site.

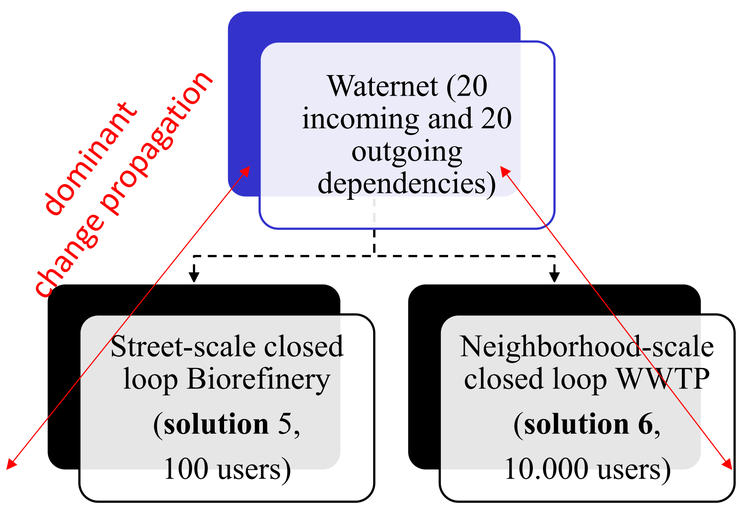

Figure 4: conceptual overview of solutions implemented (5) and envisioned (6) in Amsterdam.

GENERIC BEHAVIOUR: Waternet is Carrier (distributor) of changes propagated by the users to stakeholders i.e. waste utility, real estate, tech. providers and a P-valorisation company.

SPECIFIC IMPROVEMENTS

I> **<u>Users</u>: multipliers of positive change**

RISK: quality of discharged WW effluent / produced resources;
COST: online monitoring; incentives for users and stakeholders;
BENEFIT: increase sales of resources; reduce costs for WWTP.

II> **<u>Biofilter</u>: absorber of changes**

RISK: changes in quantity of WW → overflow/ dry-out;
COST: double the size, install rain water collection;
BENEFIT: robust technology; low mainteance.

Due to a limited space, not all improvements are presented.

COST-BENEFIT ANALYSIS

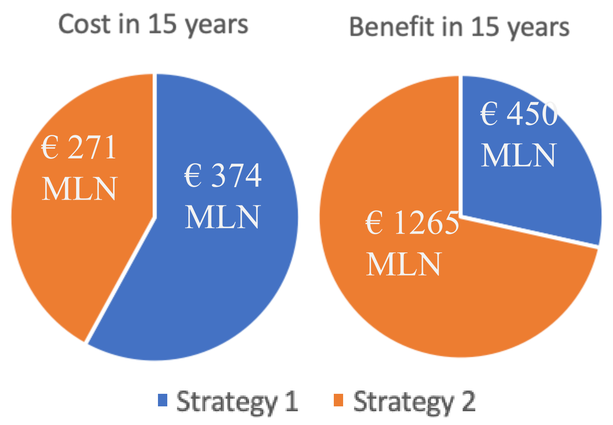

Figure 5: costs and benefits for the competing strategies, including WW tax. *Strategy 2 only possible if Strategy 1 is phased out over 15 years (average end of technology life cycle i.e. WWTP).*

Conclusions

1. **The strategy 1 is less resilient and cost-beneficial**. To increase resilience, Waternet has to reduce change propagation from up the WW chain i.e. Users, or buffer it; which will only increase costs i.e. awareness campaigns for the users, building silos for sludge storage or a mono-incineration or composting at the WWTP West site.
2. **The strategy 2 is more resilient and cost-beneficial**. To increase resilience, online monitoring of technology and business performance can be provided by actors other than Waternet. To increase benefits, the closed-loop solutions can be upgraded with technologies for production of water, energy and proteins sold to market.

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