Water Reuse in Urban Areas

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UBA Project :
“Impact of climate change on water availability − adaptation to dryness and drought in Germany” (WADKlim)

Ecologic Institute
Science and Policy for a Sustainable World

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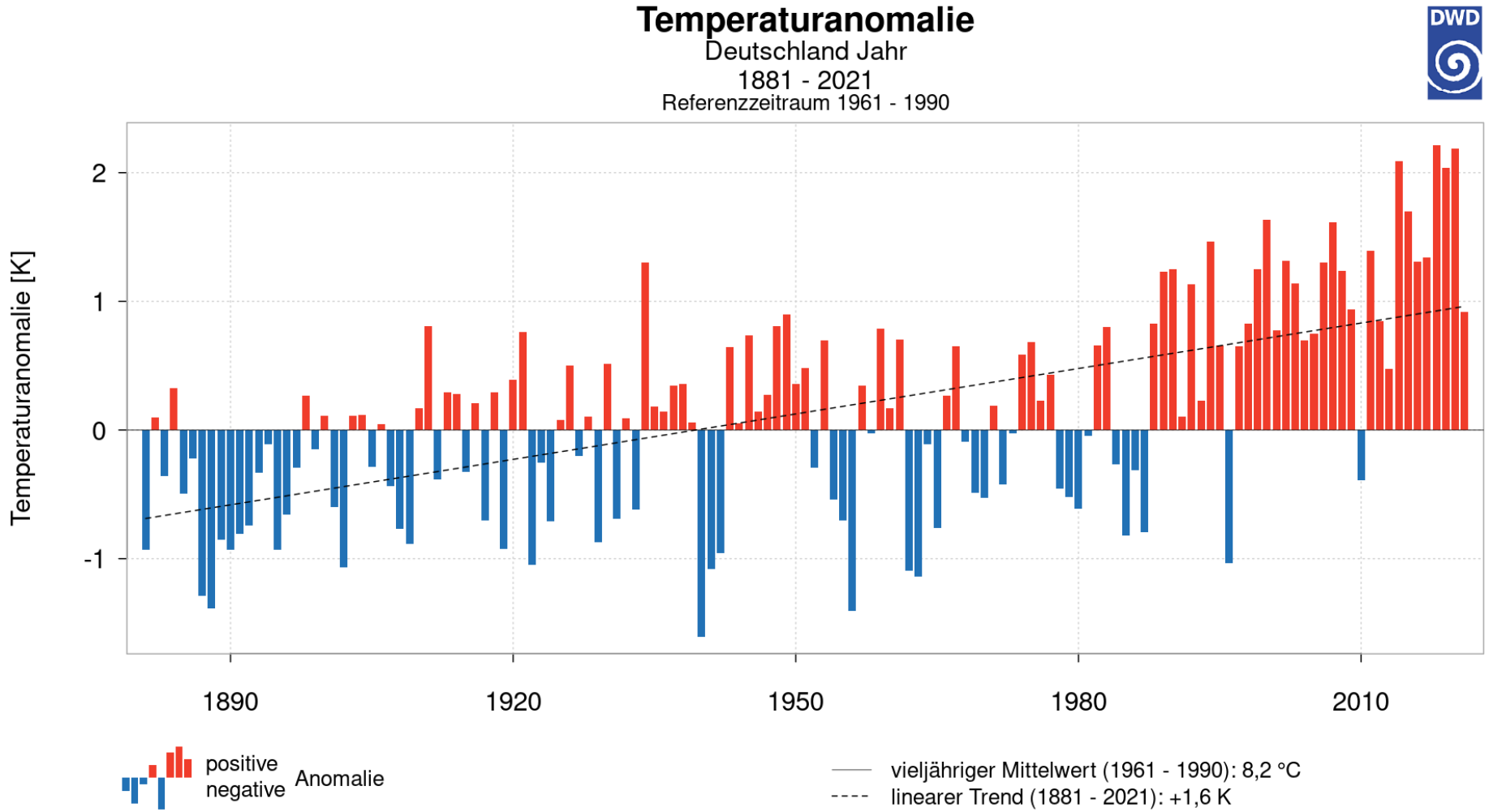
Motivation

Trend of warming (causing water shortage) in Germany stronger than worldwide



Germany	1,6 °C
World	1,0 °C

DWD, 2022

Definition of water re-use

Water reuse is the use of water obtained from treated wastewater of appropriate/sufficient quality for its intended use

- Agricultural application
- Urban re-use
- Industrial –reuse
- (Drinking water/household level)

taking into account

- health
- environmental risks
- local legislation.

•Drinking water quality is not always required to irrigate green areas

Different regulation for re-use in urban green areas

Biological parameters

Parameter/Country	Zypern (2015)	Frankreich (2014)	Griechenland (2011)	Italien (2003) *Ausschnitt	Portugal (2019)	Spanien (2007)	EU (2020) (Gütеklasse A)	EPA (2016)	DIN 19650 (öffentliche Parks)
E. coli [KBE^{x}/100ml]	5^{a} – 200^{b}	≤ 250	5 – 200	10	10	0^{*}-200^{**}-x^{***}	10	-	200
Fekal Coliforme [KBE/100ml]	-	-	2	-	-	-	-	0	-
Enterokokken [Log_{10} Reduktion]	-	≥ 4	-	-	-	-	-	-	100 KBE/100 ml
Legionella Sp. [KBE/l]	-	-	-	-	-	100	1.000	-	-
Salmonella Sp. [KBE/l]	-	-	-	N.N.	-	N.N.	-	-	N.N.
Anaerobe Sulfat Reduzierer [Log_{10} Red.]	-	≥ 4	-	-	-	-	-	-	-
Helminthen Eier (Intestinale Nemathoden) [Eier/l]	-	-	-	-	1	0,1	1	-	N.N.
Filamentöse Bakterio-phagen [Log_{10} Reduktion]	-	≥ 4	-	-	-	-	-	-	-
Min. Behandlungsverfahren	-	-	Bio. Stufe + Membranfiltr. + Desinfektion	-	2. Behandlung, Filtration + Desinfektion	-	2. Behandlung, Filtration + Desinfektion	2. Behandlung, Filtration + Desinfektion	-

Different Regulation for Re-use in Urban green areas

Chemical parameters

Parameter/ Country	Zypern (2015)	Frankreich (2014)	Griechenland (2011)	Italien (2003) *Ausschnitt	Portugal (2019)	Spanien (2007)	EU (2020) (Güteklasse A)	EPA (2016)	DIN 19650 (öffentliche Parks)
BSB5 [mg/l]	$10^a - 25^b$	-	5	20	10	-	10	10	10
CSB [mg/l]	$70^a - 125^b$	70	-	100	-	-	-	-	60
N_{ges} [mg/l]	-	-	15	15	15	-	-	-	1 [NH_4]
P_{ges} [mg/l]	-	-	-	2	5	-	-	-	-
AFS [mg/l]	$10^a - 35^b$	15	2	10	10	10^{*} - 20^{**} - 35^{***}	10	-	-
Trübung [NTU]	-	-	2	10	5	2^{*} - $10^{**/**}$ - X^{***}	5	2	-
Fette & Öle [mg/l]	5	-	-	0	-	-	-	-	-
pH [-]	6,5 – 8,5	-	-	6 – 9,5	6 – 9	-	-	6 - 9	-
Leitfähigkeit [µS/cm]	2.500	-	-	3.000	1000	-	-	-	-
Chlorid-Gehalt [mg/l]	300	-	-	-	-	-	-	-	-
Rest Chlorgehalt [mg/l]	> 2	-	> 2	> 0,2	-	-	-	> 1	-
Brom [mg/l]	1	-	-	-	-	-	-	-	-
Saprobienindex [mg/l]	-	-	-	-	-	-	-	-	2,3

Best Practice Examples

Results of selected treatment processes

	IRAD Alicante, Spain 41.600 m³/d	IRAF Caliagri, Italy 95.890 m³/d	IRIS Boca Raton, USA 36.718 m³/d	PWRP California, USA 30.238 m³/d	LCWRP California, USA 757 m³/d	VWRP California, USA 81.164 m³/d	LCOWRP California, USA 141.952 m³/d	LBWRP California, USA 94.635 m³/d	LAWRP California, USA 47.969 m³/d	PDWRP California, USA 45.424 m³/d
Treatment technology	Ultrafiltration Reverse Osmosis Storage	Sandfilter UV-Desinfection Cl-Desinfection	Storage Desinfection Sandfilter	Cl-Desinfection Sandfilter Cl-Desinfection	Cl-Desinfection Storage	Cl-Desinfection Sandfilter Cl-Desinfection	Cl-Desinfection Sandfilter Cl-Desinfection	Cl-Desinfection Sandfilter Cl-Desinfection	Cl-Desinfection Sandfilter Cl-Desinfection	Storage Cloth filter Cl-Desinfection
TOC	k.A.	k.A.	100 - 200	k.A.	k.A.	k.A.	k.A.	k.A.	k.A.	k.A.
COB	k.A.	k.A.	22,1 - 80	k.A.	181	k.A.	k.A.	k.A.	k.A.	k.A.
BOD5	k.A.	k.A.	k.A.	n.n	n.n	n.n	n.n	n.n	n.n	n.n
Turbidity	k.A.	k.A.	2 - 12	0,5	k.A.	0,62	0,8	0,76	0,66	0,88
Filterable solids	k.A.	k.A.	15 - 40	n.n	212	n.n.	n.n.	n.n.	n.n.	n.n.
N	k.A.	k.A.	15 - 40	<12	36	<8	<9	<11	<6	<5
P	k.A.	k.A.	k.A.	<0,3	k.A.	0,8	0,3	0,5	k.A.	k.A.
E.Coli [cbu/100ml]	k.A.	k.A.	k.A.	n.n	n.n	n.n.	n.n.	n.n.	n.n.	n.n.
Limit values complied with	k.A.	k.A.	-	Cy, Fr, Gr*, It, Po, Sp, EU, EPA	-	Cy, Fr, Gr*, It, Po, Sp, EU, EPA	Cy, Fr, Gr*, It, Po, Sp, EU, EPA	Cy, Fr, Gr*, It, Po, Sp, EU, EPA	Cy, Fr, Gr*, It, Po, Sp, EU, EPA	Cy, Fr, Gr*, It, Po, Sp, EU, EPA

Selection of systems for urban irrigation

- Often multiple usage options (e.g. agricultural and urban irrigation)
- The proportions of the usage options are often not known
- All processes follow at least a 3-stage treatment process

Parks and Gardening re-use

Examples from Australia

Region of Melbourne Water, achieved qualities and capacity

Aireys Inlet	Class C	120 ML/yr
Anglesea	Class B	230 ML/yr
Apollo Bay	Class C	220 ML/yr
Bannockburn	Class C	30 ML/yr
Black Rock	Class C	16,500 ML/yr
Colac	Class C	1400 ML/yr
Lorne	Class C	340 ML/yr
Portarlington	Class C	200 ML/yr
Winchelsea	Class C	40 ML/yr

Best Practice - results

- Urban reuse has been stable, successful and safe for decades
- Three-stage treatment process with subsequent sand filtration and disinfection necessary to comply with limit values
- 33% savings in relation to the price of drinking water might be possible
- Great synergy potential with advanced wastewater treatment

Potential water demand for re-use of irrigation in urban green areas in Germany

- Potential = max. needed amount of irrigation water for conservation and care of urban green
- Irrigation quantities = green areas x specific irrigation needs
  - Areas of urban green calculated with 5 different approaches (average)
  - specific irrigation needs determined by climatic water balance (CWB). Difference between the total precipitation and potential evapotranspiration over a cultivated area – (grassland)

Potential irrigation water demand in Germany for Urban Greens

Townsize	normal year	Dry year	Very dry year
	[Mio. m³/a]	[Mio. m³/a]	[Mio.m³/a]
Big city	144,70 (5%)	244,83 (9%)	451,82 (15%)
Middle city	126,00 (5%)	221,43 (9%)	425,30 (15%)
Small city	90,93 (5%)	154,95 (10%)	295,90 (19%)

Risk management
nach der EU-Verordnung 2020/741

Risk management involves proactive risk identification and management to ensure that **reclaimed water is used and managed safely and does** not pose a risk to the **environment** or **human** and **animal** health.

Four steps of risk management adjusted according EU-regulation 2020/741

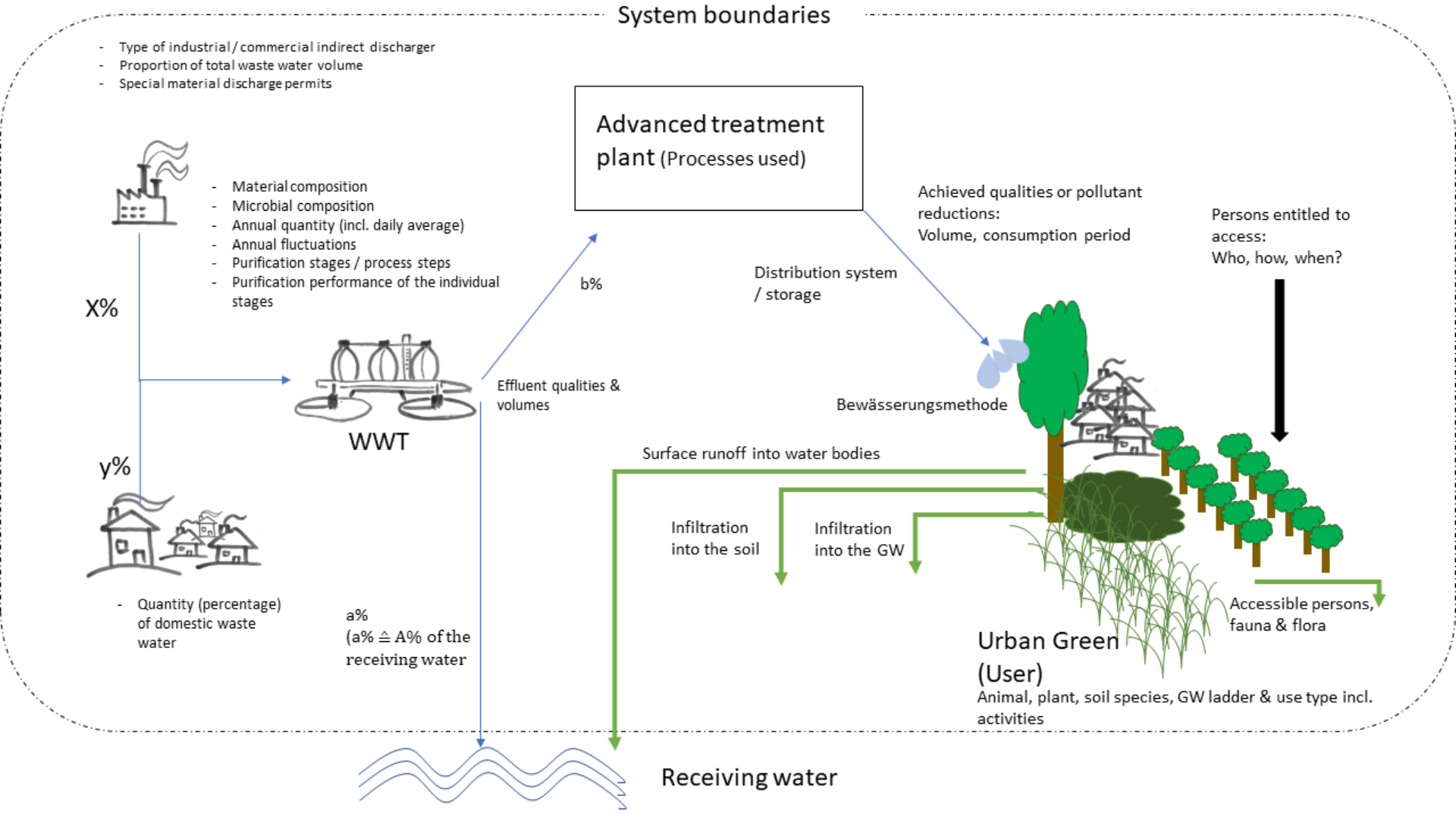
1. Description of the **entire water reuse system**, from **wastewater discharge** to **point of use**

2. Identify **all parties involved** in the water reuse system with a clear description of **their roles and responsibilities**.

3. **Identification of hazards**, particularly **pollutants and pathogens**, and the potential for hazardous events such as failure or contamination

4. Identify the **environments and populations at risk** and the routes through which exposure occurs

Boundary of the re-use system adjusted according EU-regulation 2020/741



Possible precautionary measures

a) **Access controls**;

b) **Additional disinfection** or contaminant removal measures;

c) **specific irrigation techniques** that reduce the risk of aerosol formation and contact (e.g. drip irrigation);

d) **Irigation** times in **relation to opening times** or number of visitors

e) special requirements for artificial irrigation (e.g. maximum wind speed, distance between the irrigation system and sensitive areas)

f) special **requirements for urban green spaces** (e.g. slope, water saturation of the soil,);

g) Promote the death of pathogens before free access to urban green spaces;

h) Determination of **minimum safety distances** (e.g. from surface water, swimming or other water sports activities; residential buildings, schools, retirement homes, hospitals; agricultural production facilities, drinking water fountains);

i) **Signage on irrigation areas i**ndicating that treated water and not water suitable for drinking water is being used.

Example for irrigation of a cities (Magdeburg)

Pipeline (Green/Parks) and trucks (trees)

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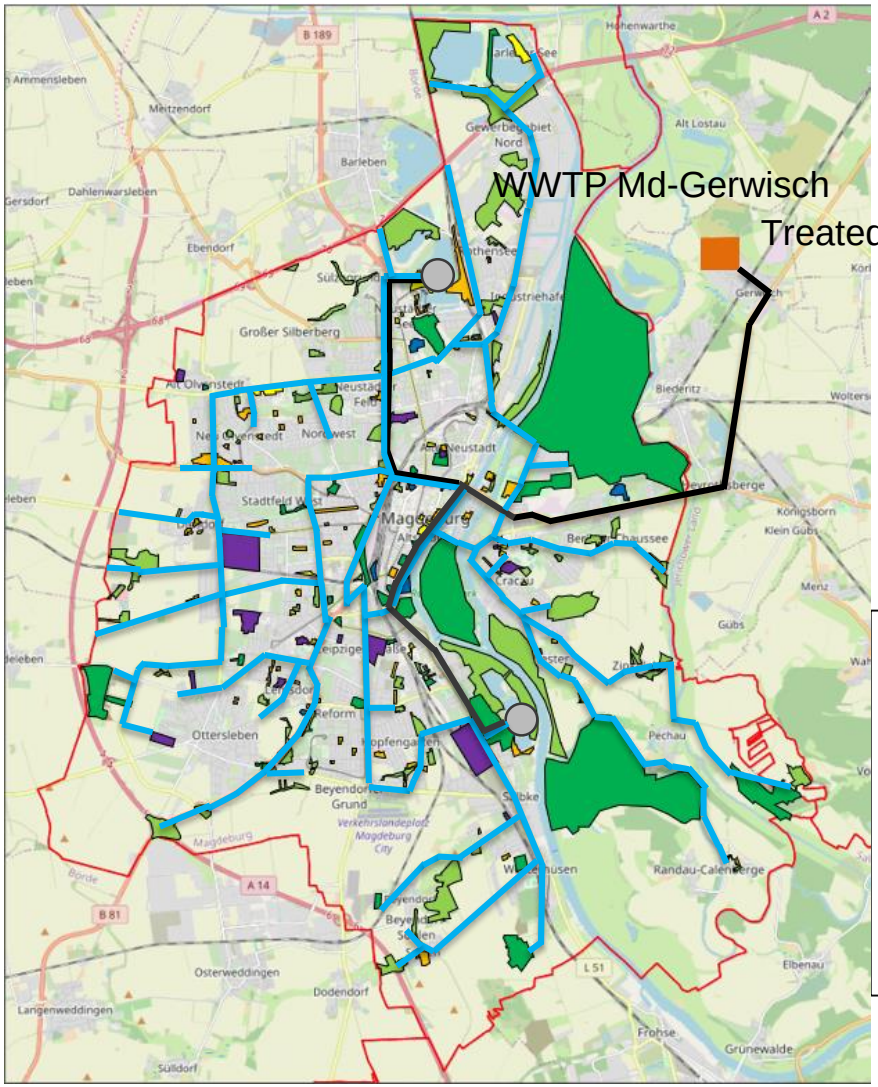
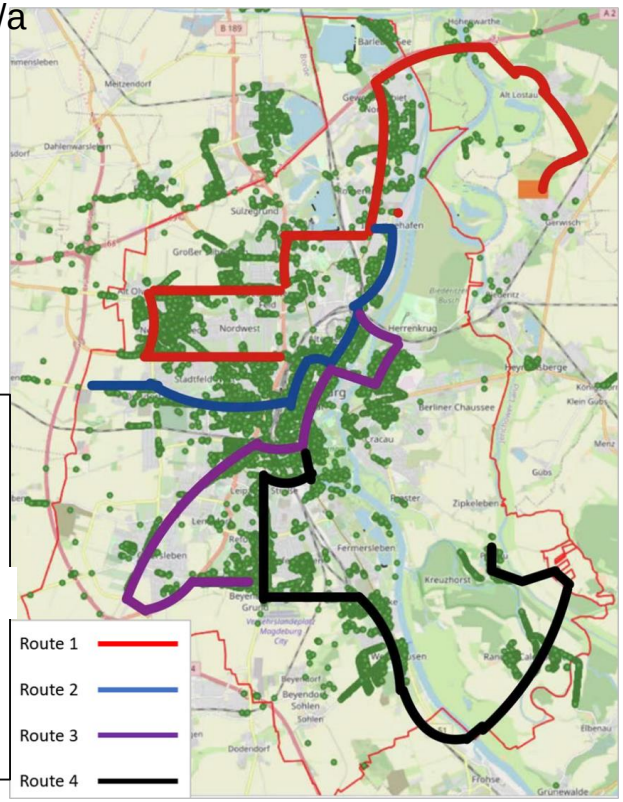
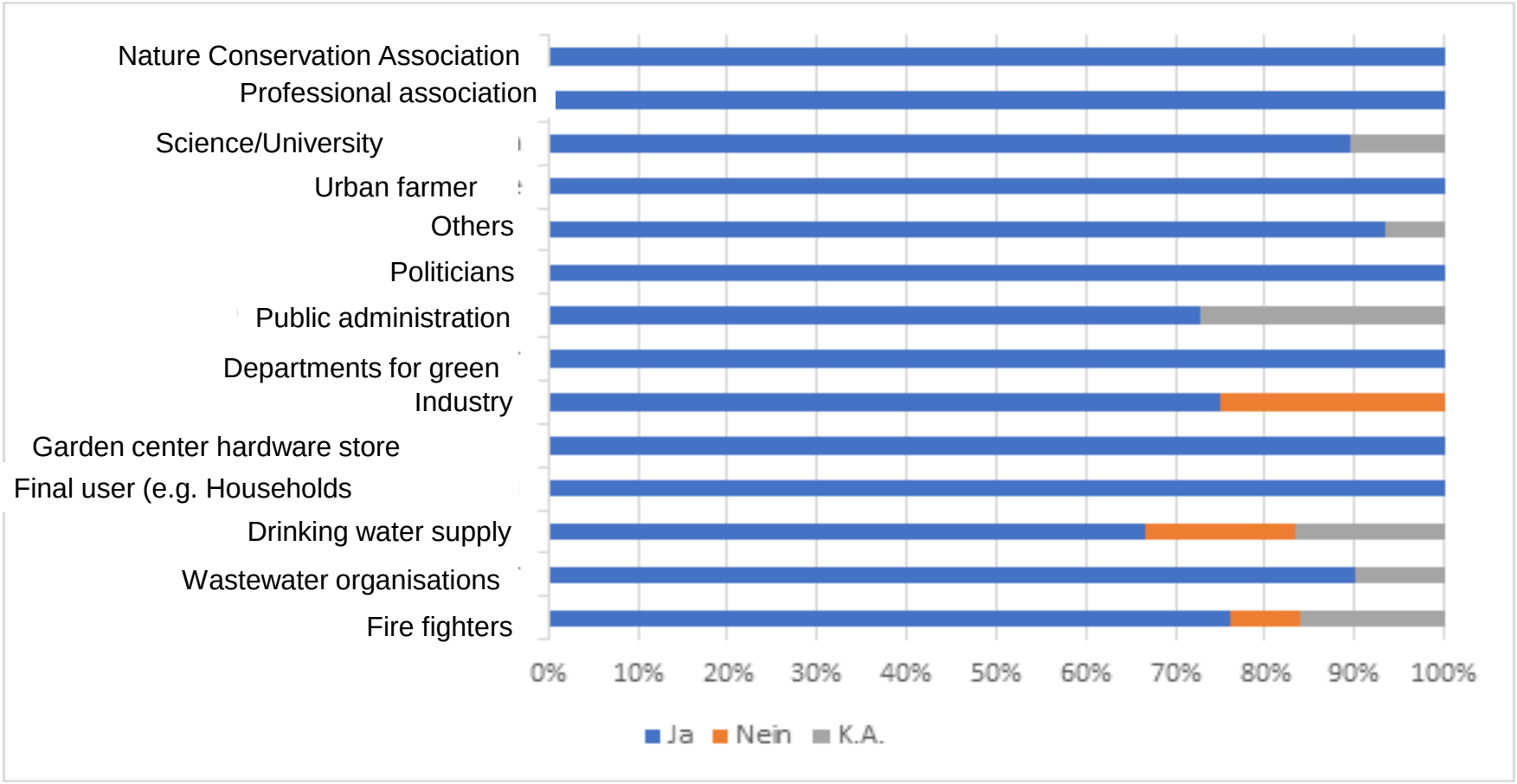


Total area 757 ha;
Water demand 148.889 m³/a (April to September)
12.000 road and city trees 31.200 m³/a
Treated water 15.203.186 m³/a

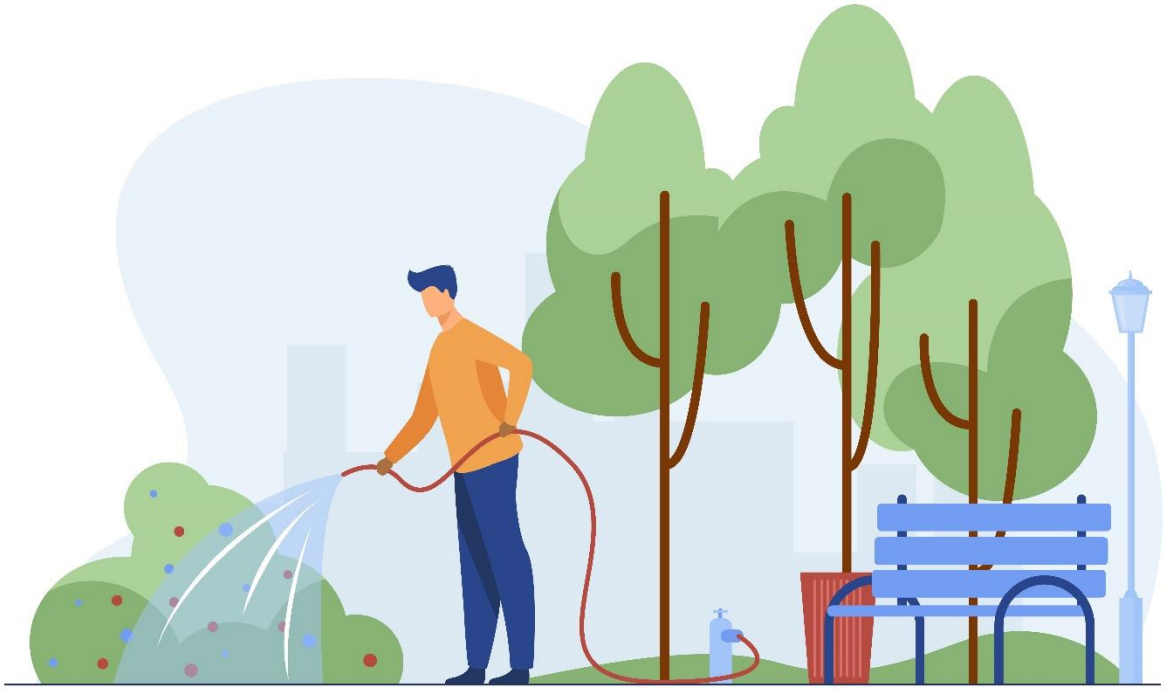


Stakeholder survey - acceptance

Attitude for using recycled water keeping in all hygienic- and health regulations?
85 % Yes; 3% no; 12% k.A.



Thanks for your attention



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