Wastewater Management in Sweden

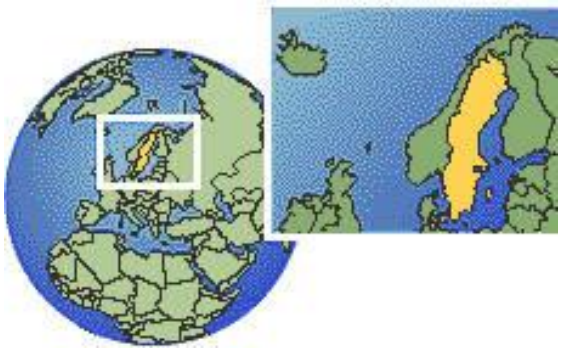
- Wastewater treatment plants

> 2000 persons

Bo Jansson

Sweden – geography and population

- On of the largest countries in Europe, 450 000 km^2
- Total population 9 million
- 20 inhabitants/km^2
- 85 percent of the population lives in the south part
- 1 600 km from north to south
- Long coastal line
- Baltic sea – a vulnerable sea

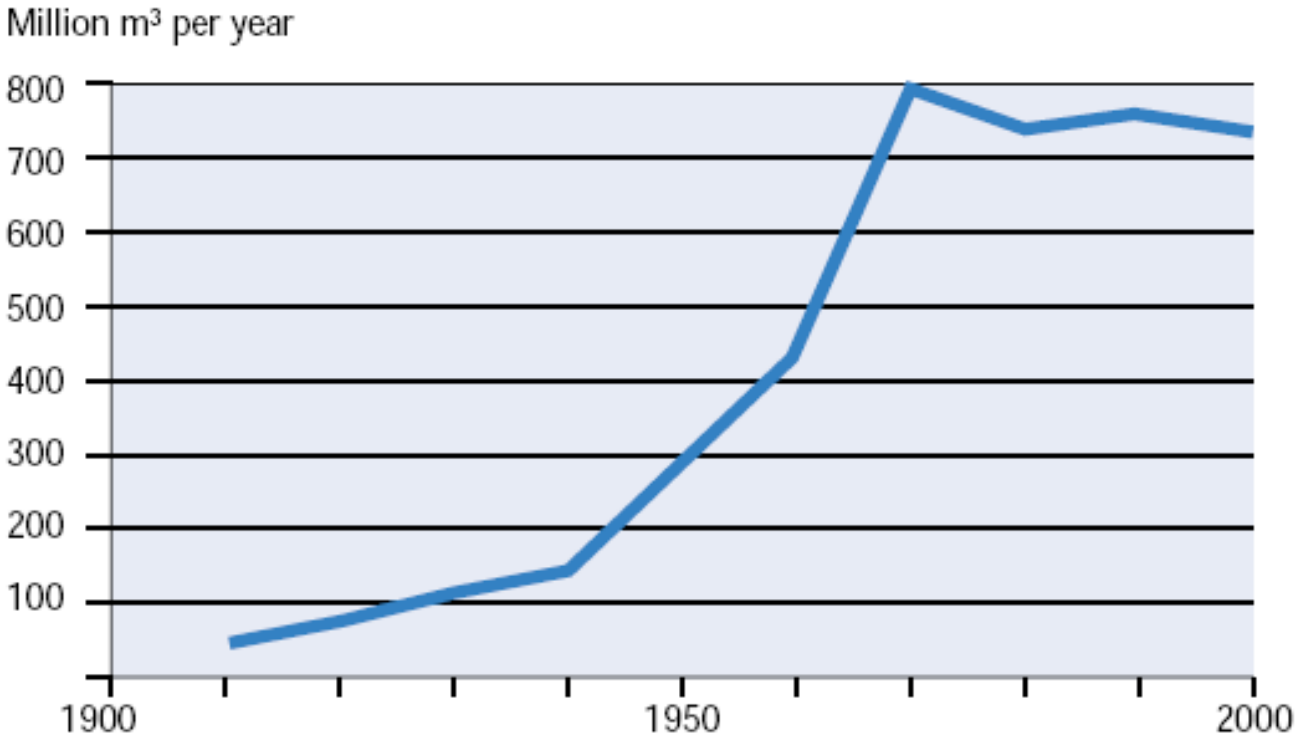


Regions with eutrophic waters

- The most eutrophic inland waters in Sweden are in the extensively farmed plainland and coastal areas of central and southern Sweden
- Most minor lakes in the green areas marked on the map have total phosphorus concentrations exceeding 25 µg/l

Source: Monitor 14, Swedish EPA

Historic background
Water use in urban areas - development

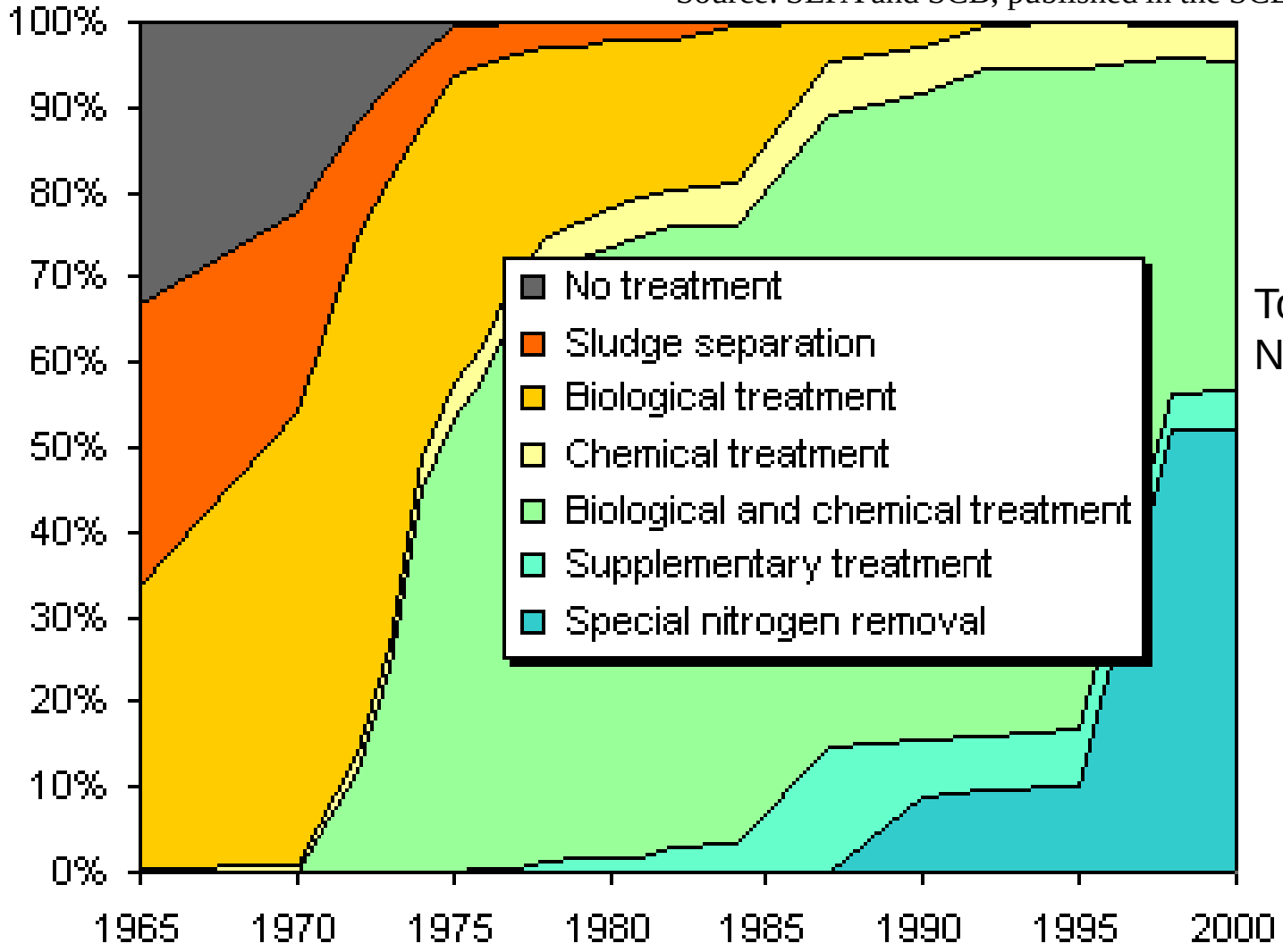


100 m^3/p,year

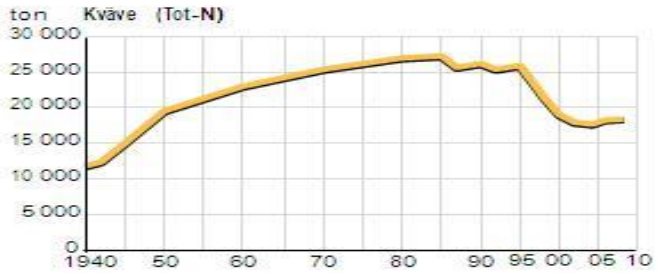
Water use in urban areas – development. The water production is 20 % higher. The differences are due to leakage in the network

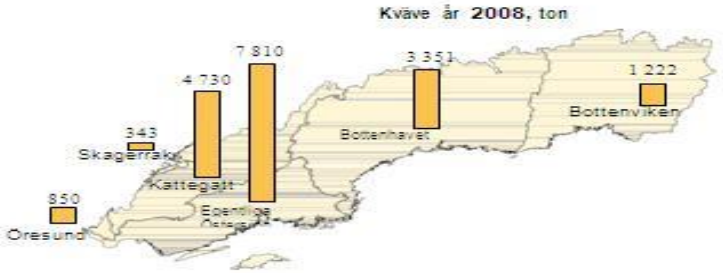
Increasing level of treatment in plants > 2 000 pe; percent of urban population

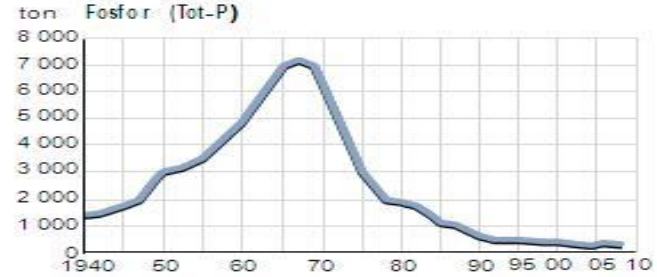
Source: SEPA and SCB, published in the SCB series Mi 22

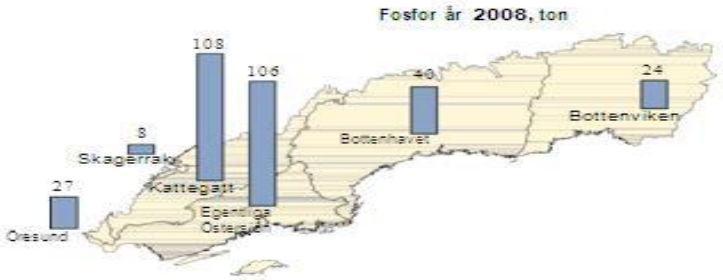


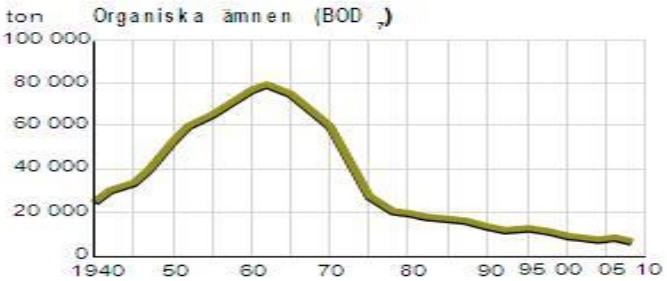
Today 70 % N-reduction

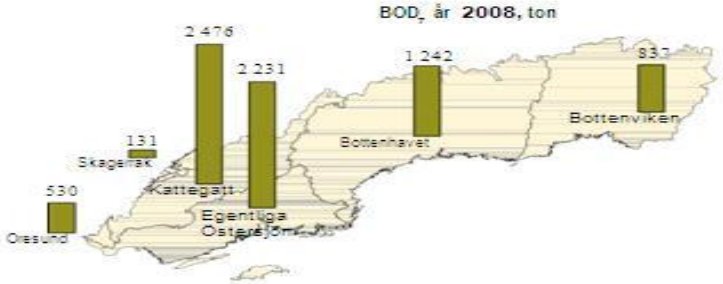

ton Kväve (Tot-N)
30 000
25 000
20 000
15 000
10 000
5 000
0
1940 50 60 70 80 90 95 00 05 10


Kväve år 2008, ton
343
4 730
7 810
3 351
1 222
850
Skagerrak
Kattegatt
Egentliga Östersjön
Bottenhavet
Bottenviken
Öresund

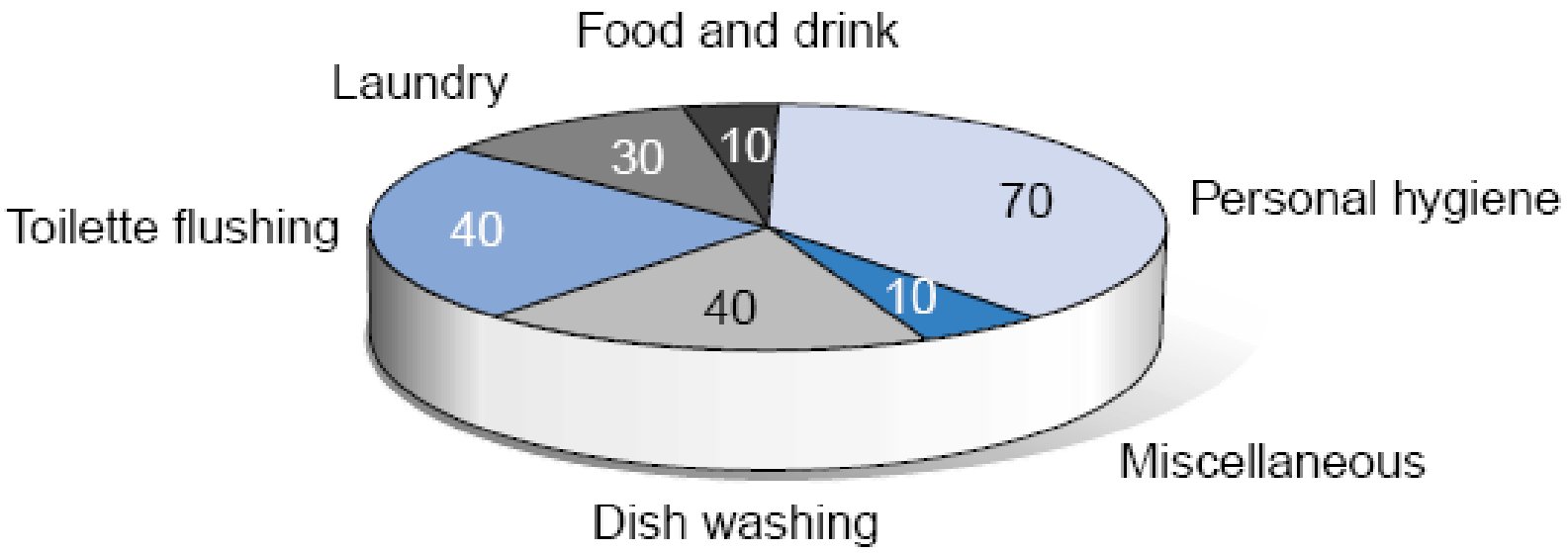

ton Fosfor (Tot-P)
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
1940 50 60 70 80 90 95 00 05 10


Fosfor år 2008, ton
8
108
106
40
24
27
Skagerrak
Kattegatt
Egentliga Östersjön
Bottenhavet
Bottenviken
Öresund


ton Organiska ämnen (BOD 7)
100 000
80 000
60 000
40 000
20 000
0
1940 50 60 70 80 90 95 00 05 10


BOD7 år 2008, ton
131
2 476
2 231
1 242
837
530
Skagerrak
Kattegatt
Egentliga Östersjön
Bottenhavet
Bottenviken
Öresund

The use of water in households



The use of water in households

DISCHARGES OF N AND P FROM DIFFERENT SECTORS

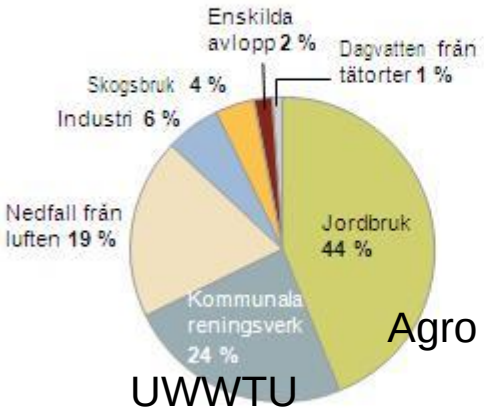
N

p

Small scale WWTI

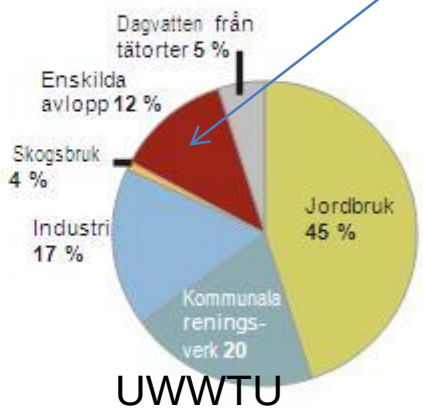
Agroculture

Deposition from air



Agro

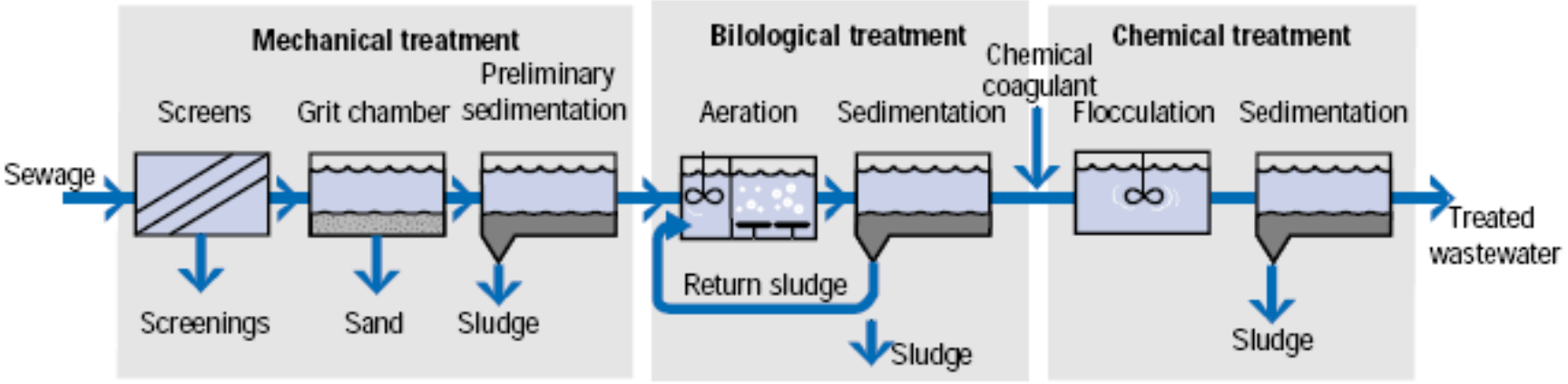
UWWTU



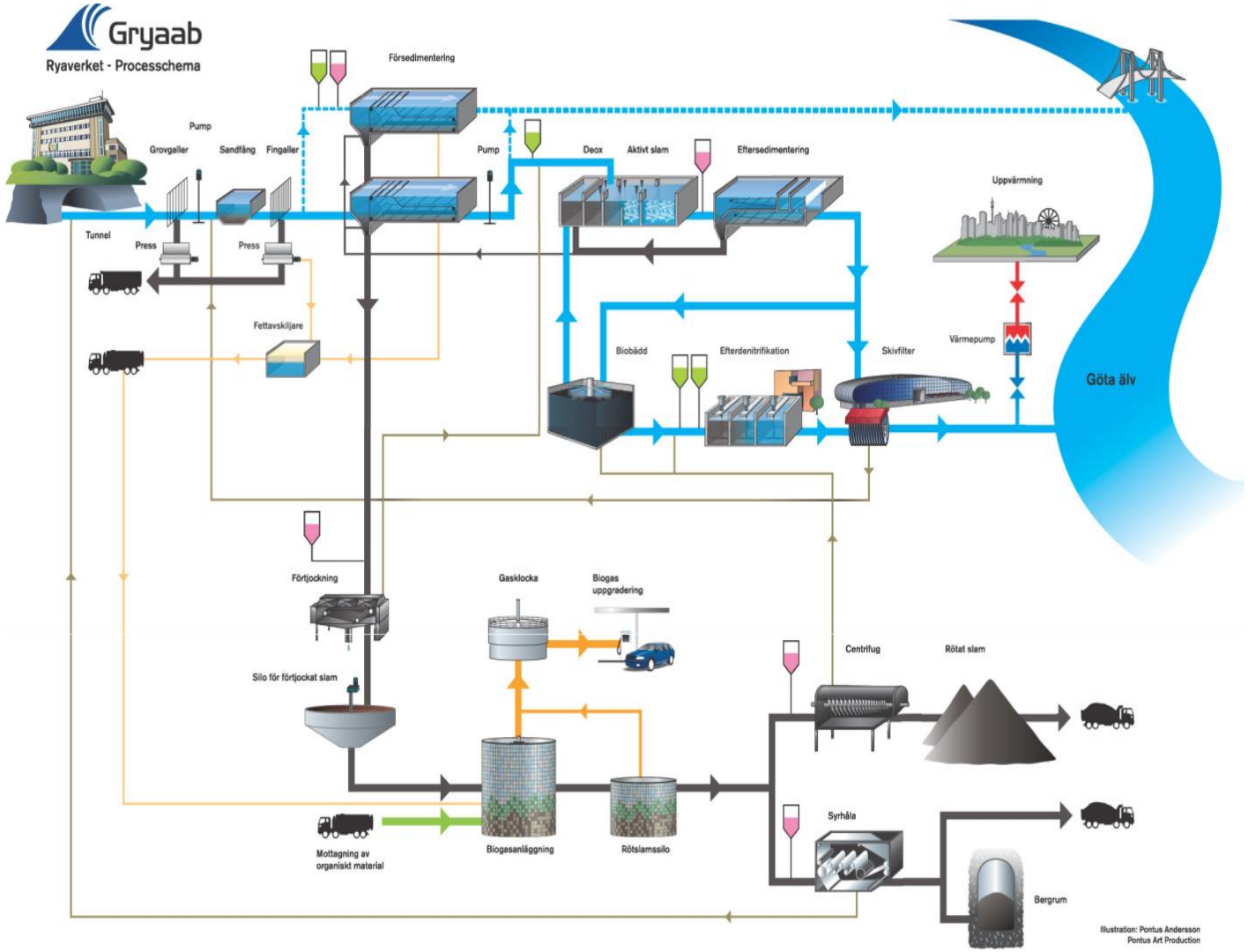
UWWTU

Treatment of waste water

- Mechanical treatment
- Biological treatment
- Chemical treatment
- Nitrogen removal



Typical wastewater treatment plant with mechanical, biological and chemical treatment


Gryaab
Ryaverket - Processchema
Försedimentering
Pump
Grovgaller
Sandfång
Fingaller
Pump
Deox
Aktivt slam
Eftersedimentering
Uppvärmning
Tunnel
Press
Press
Fettavskiljare
Biobädd
Efterdenitrifikation
Skivfilter
Värmepump
Göta älv
Förtjockning
Gasklocka
Biogas uppgradering
Centrifug
Rötat slam
Silo för förtjockat slam
Syrhåla
Mottagning av organiskt material
Biogasanläggning
Rötslamssilo
Bergrum
Illustration: Pontus Andersson
Pontus Art Production

Gothenburg UWWTP(the largest one in Sweden)

Technique

700.000 pe

Mecanical cleaning (4 step)

Chemichal treatment

Anaerobic treatment

Aerobic treatment (active sludge)

Sedimentation

Nitrifying biotreatment (biological treatment)

Secondary Nitrogen removal (biofilm carrier)

Filtration (15 micrometer, P-reduction)

	Level 2012
BOD7 10 mg/liter	7
Total-P 0,4 mg/liter	0,2
Total-N 10 mg/liter	8

Rya WWTP, Gothenburg

Urban wastewater treatment

- all urban households are connected to sewage treatment plants
- 95 per cent of urban wastewater undergoes both chemical and biological treatment
- there are some 500 treatment plants treating wastewater from at least 2,000 persons

Individual environmental permits for each plant

Based on

- General regulations based on UWWTD
- Water Frame Directive
- Local environmental conditions
- BAT
- Requirements for the plant are made based on what is environmentally justified, technically feasible and economically reasonable.

Urban Wastewater Treatment Directive 91/271/EEG

- Adopted by the European Council 1991
- Adressed to EC Member States
- States minimum requirements

Objectives UWWTD

- Protect the environment
- Urban wastewater (>2 000 pe) and wastewater from agro-food industry
- Collection and treatment of urban wastewater
- Requirements depending on size of the treatment plant and the sensitivity of the recipient water body
- Dead-lines end of 1998, 2000 and 2005

Effluent requirements in the UWWT-Directive

	>2000 pe		>10 000 pe		>100 000 pe	
	mg/l	%	mg/l	%	mg/l	%
Tot-P	-	-	2	80	1	80
Tot-N	-	-	15	70-80	10	70-80
BOD_5	25	70-90 %				
COD	125	75 %				
SS	35 mg/l (optional)					

Swedish Statistics 2008: UWWTP >2 000 pe

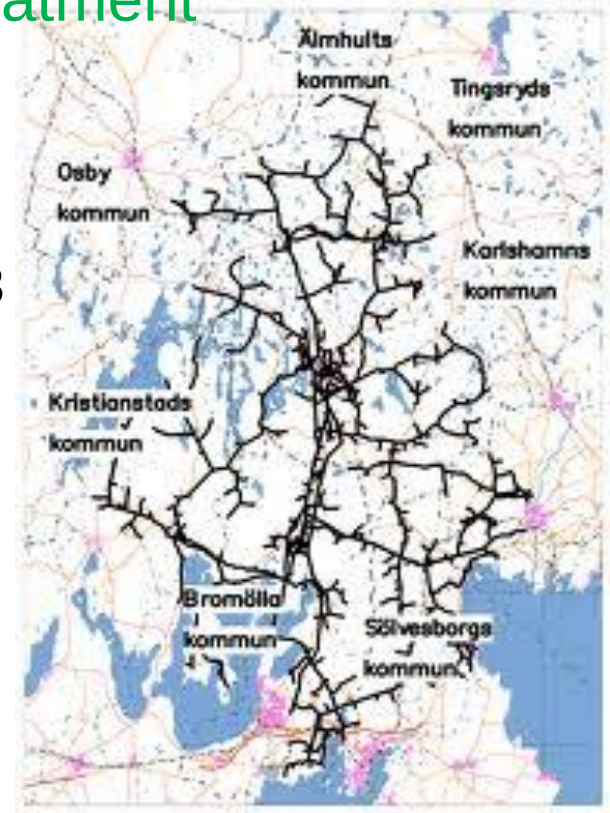
	mg/l	%
BOD_7	5,9	96
Phosphorus	0,25	95
Nitrogen	15	56

Financing of water treatment

Public water supply and waste water systems act

Responsibility for local authority to supply drinking water and waste water treatment

- Users pay for treatment
- Local charge, 170 rupies/m3



Sewage sludge

National ideal that sludge is recycled to cultivated lands

National goal for use of sewage sludge

60% re-use by 2015

Half of this amount should be used for cultivation

Industies connected to waste water systems

Bio gas production

Regulations for sewage sludge

National regulations for

- content of heavy metals
- conditions for the spread

Limits for use of sewage sludge for cultivation.

Metal	mg/kg dry substance
• Lead (Pb)	100
• Cadmium (Cd)	2
• Copper (Cu)	600
• Chromium (Cr)	100
• Mercury (Hg)	2,5
• Nickel (Ni)	50
• Zinc (Zn)	800

Use of sludge to make biogas

Sludge is digested to make biogas at the biggest plants.

Previously the biogas was used to warm up the plant and the rest was often burnt off.

Nowadays in some cases the gas is purified so it can be used for car fuel. Development and use of purified gas will continue to evolve.

Most buses in Stockholm and Gothenburg are run on biogas

Some future areas of development

- Increased nitrogen removal
- Production and use of biogas
- Use of sludge
- Recovery of P from sludge
- Emissions of pharmaceuticals

- Maintanance of pipe system

Small-scale wastewater treatment in Sweden

- Brief introduction 5-2000 pe
- Regulation
- Current situation
- Most common technologies

Regulation of water and wastewater

- Environmental standards - Swedish environmental code
- Provision of water and wastewater
  - Public Water Supply and Wastewater Systems Act
  - Councils must supply water and sewerage for villages (20-30 households)

Regulation 5-2000 pe

- Environmental board at local council responsible for permits
- 290 local councils

- Each plant must apply for a permit for establishment and operation
- Requirements for specific plant or property suited to locality

- Detailed regulation
  - 5-25 pe general recommendations
  - 25-2000 pe no general recommendations
  - 200-2000 pe testing and control
- Most common
  - larger plants according to regulations for >2000 pe
  - smaller plants according to recommendations

Current situation – sewage systems 5-25 pe

- 850 000 properties with on-site sewage treatment system
- 60 % permanent residence
- 40 % holiday residence

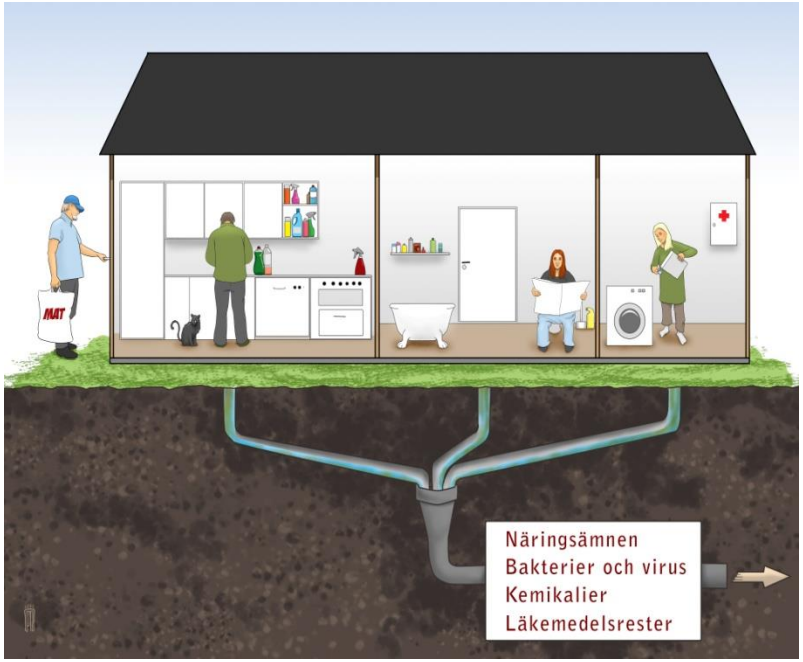
- 65 % black and greywater
- 35 % greywater only or no sewage

- 60 % of properties have an approved sewage system

EPA Recommendations (from 2006)

- Treatment level for nutrients dependent on environmental sensitivity
  normal and high
- No risk for human health
- Dimensioned for 5 pe, year-round
- Enable recycling of nutrients
- Easily controlled
- Maintenance instructions

- High: 90 % BOD, 90 % P, 50 % N
- Normal: 90 % BOD, 70 % P



Most common technologies for 5-25 pe

- Soil-based system predominate
- Complementing technologies to soil-based systems
- On-site small treatment plants
- Source-separation systems with recycling of nutrients
  - Urine-diversion
  - Black-water separation
  - Dry toilets

Soil-based treatment systems; complementing technology

- Soilfiltration with existing soils
- Additional sand layer in areas with clay soi

- To meet requirements from 2006
  - Phosphorous trap
  - Chemical treatment in septic tank

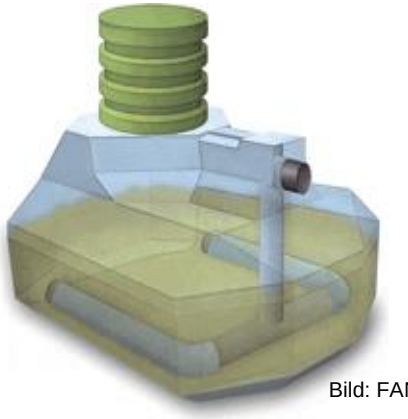
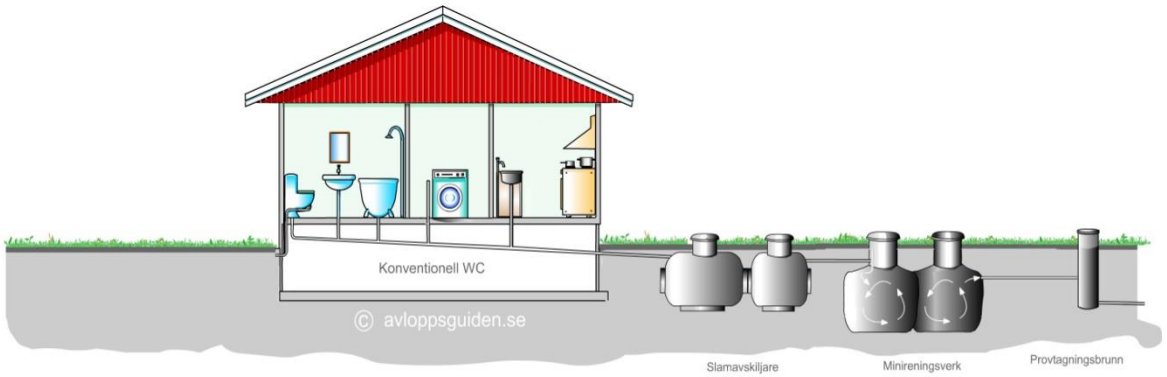


Bild: FANN

On-site small treatment plant

- Many different manufacturers and models
- EU-standard, additional swedish parameters
- Mechanical, biological and chemical treatment
- Manufacturer provide on-going service

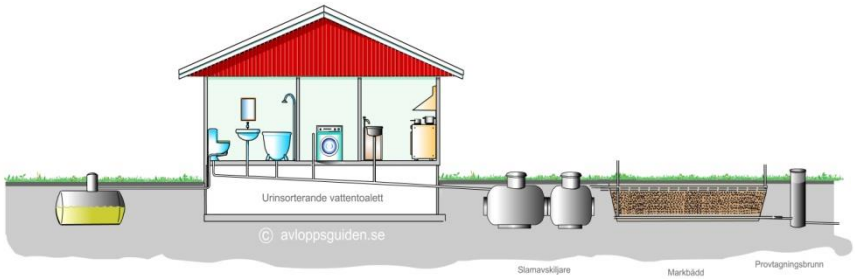


Source-separation systems : nutrient recycling

Source-separation systems : urine-diversion

- Special toilet with 2 ”bowls”
- Urine leads to separate tank
  - Reduced release P (40 %) N (60 %)
  - Reduced water use
- Complete system for other wastewater

- Urine collected by council, delivered to nearby farms
- Replace fertiliser in farming
- Approx 20 000 toilets installed in Sweden



Source-separation systems: blackwater

- Special toilet with vacuum-unit
- Blackwater leads to separate tank
  - Reduced water use
  - Reduced risk to human health
  - Reduced release P (85 %) N (90 %)
- Simpler system for greywater treatment

Bild: Wostman

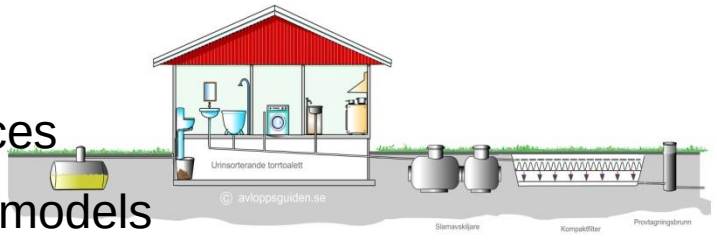
- Blackwater collected by council, delivered to wet-compost system
- Increasingly popular

Source-separation systems : dry toilet

- Toilet model varies – dry, compost, urine-separating, combustion
  - Reduced water use
  - Reduced risk to human health
  - Reduced release P (85 %) N (90 %)
- Simpler system for greywater treatment, often only summer-time


Bild: Separett

- Toilet-waste collected by local council or on-site composting



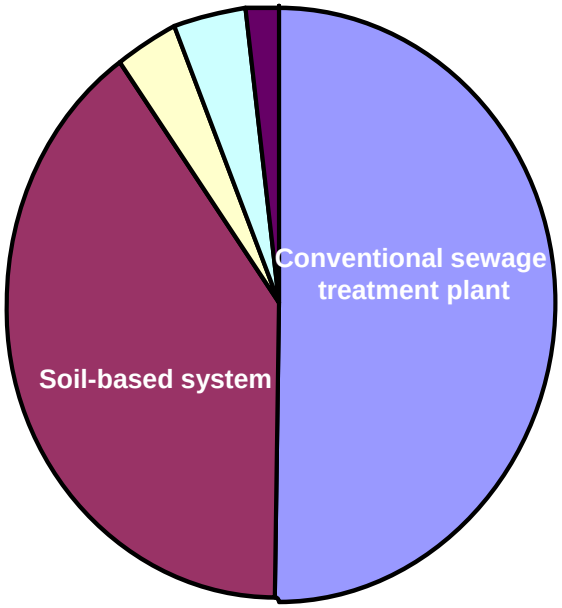
- >35 % of properties, common in holiday residences
- Development of more reliable and attractiv toilet models

Ownership and management : 25-2000 pe

- Approximately 3000 sewage systems of this size
- 50 % council owned and managed
- 50 % privately owned or property owners together own and managed
- Environment board at local council
  - control 1/year

Most common technologies : 25-2000 pe

- 50 % conventional sewage treatment plants
  - most have primary, secondary and tertiary treatment
- 40 % soil-based treatment systems
- 4 % biological or chemical treatment in open dams
- 4 % system with source separation
- 2 % only septic tank separation
  (no treatment system)



Conclusions

- Individual permits with site-specific solutions
- Currently lot of activity to renovate on-site sewage systems
- Many of systems for 25-2000 require upgrading
- Possibility for developing and marketing new technologies
  - market of 1 million households