Sanitary Engineering

Institute for Sanitary Engineering and Waste Management

Prof. Dr.-Ing. K.-H. Rosenwinkel

Contact

Institute for Sanitary Engineering and Waste Management

(**ISAH** - **I**nstitut für **S**iedlungswasserwirtschaft und **A**bfalltechnik, **H**annover)

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Lehrstuhl

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Telefon: 0511-762-2507
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Research assistants: Dipl.-Ing. Nina Manig

Consultation hour: Wednesday 13:00 to 15:00 pm
Friday 09:30 to 10:30 am
and according to prior agreement!

Hand-out download:

- **www.uni-hannover.de**
  - **Studium**
    - **eLearning**
      - **Stud.IP**
        - **Password: sludge**

Schedule SS 2012

Day of the Week	Date	Time	Topic	Lecturer
Tue	10.04.2012	09:45 - 11:15	Introduction and historical development	Rosenwinkel
Mon	16.04.2012	11:30 - 13:00	Water Cycle, Water Demand and Guidelines	Rosenwinkel
Tue	17.04.2012	09:45 - 11:15	Exercise 1: Water Catchment and Treatment	WiMi
Mon	23.04.2012	11:30 - 13:00	Water Catchment, Pump Dimensioning	Rosenwinkel
Mon	*23.04.2012*		*Paper 1: Water Supply*	*Issue*
Tue	24.04.2012	09:45 - 11:15	Drinking Water Quality	Rosenwinkel
Mon	30.04.2012	09:45 - 11:15	Drinking Water Treatment, Water Storage	Rosenwinkel
Mon	07.05.2012	11:30 - 13:00	Distribution and Hydraulic Calculations	Rosenwinkel
Tue	08.05.2012	09:45 - 11:15	Pumping and Pumps	Rosenwinkel
Mon	14.05.2012	11:30 - 13:00	Type, Amount and Collection of Waste Water	Rosenwinkel
Tue	15.05.2012	09:45 - 11:15	Exercise 2: Water Distribution	WiMi
Mon	21.05.2012	11:30 - 13:00	Design of sewer systems	Rosenwinkel
Mon	*21.05.2012*		*Paper 2: Sewer Systems*	*Issue*
Tue	22.05.2012	09:45 - 11:15	Mixed and Rain Water Treatment	Rosenwinkel
Mon	04.06.2012	11:30 - 13:00	Mixed and Rain Water Treatment	Rosenwinkel
Tue	05.06.2012	09:45 - 11:15	Exercise 3: Sewer Systems	WiMi

Schedule SS 2012

Mon	11.06.2012	11:30 - 13:00	Waste Water Substances and Waste Water Treatment	Rosenwinkel
Mon	*11.06.2012*		*Paper 3: Waste Water Treatment*	*Issue*
Tue	12.06.2012	09:45 - 11:15	Mechanical Treatment I	Rosenwinkel
Mon	18.06.2012	11:30 - 13:00	Mechanical Treatment II	Rosenwinkel
Tue	19.06.2012	09:45 - 11:15	Basics of Biological Treatment	Rosenwinkel
Mon	25.06.2012	11:30 - 13:00	Biological Treatment, Activated Sludge Tank	Rosenwinkel
Mon	02.07.2012	11:30 - 13:00	Biological Treatment in Rural Areas	Rosenwinkel
Tue	03.07.2012	09:45 - 11:15	Exercise 4: Waste Water Treatment	Rosenwinkel
Mon	09.07.2012	11:30 - 13:00	Biological Treatment	Rosenwinkel
Tue	10.07.2012	09:45 - 11:15	Sludge Treatment	Rosenwinkel
Mon	16.07.2012	11:30 - 13:00	Revision I	Rosenwinkel
Tue	17.07.2012	09:45 - 11:15	Revision II	WiMi

Module contents

Lectures:

- Water supply
- Waste water discharge
- Waste water treatment
- Lecture exercises and paper tutorial
- Lecture repetition and exam preparation

Examination: **Written examination**

Paper (optional):

Consists of serveral individual exercises regarding the following subjects:

Water supply: Drinking water demand, dimensioning of wells, drinking water treatment, water storage, water distribution

Waste water discharge: Dimensioning of sewer systems

Waste water treatment: Mechanical treatment, biological treatment, sludge treatment

Student assistant jobs at the ISAH

Range of assignments:

- Construction and maintenance of experimental plants
- Laboratory analyses
- Data evaluation (experimental plants, laboratory analyses, etc.)
- Literature research
- Organisation help (e.g. chair)

Advantages:

- Practical application of acquired theoretical knowledge
- Contacts for master thesis
- And much more!!!

Interested students should contact:

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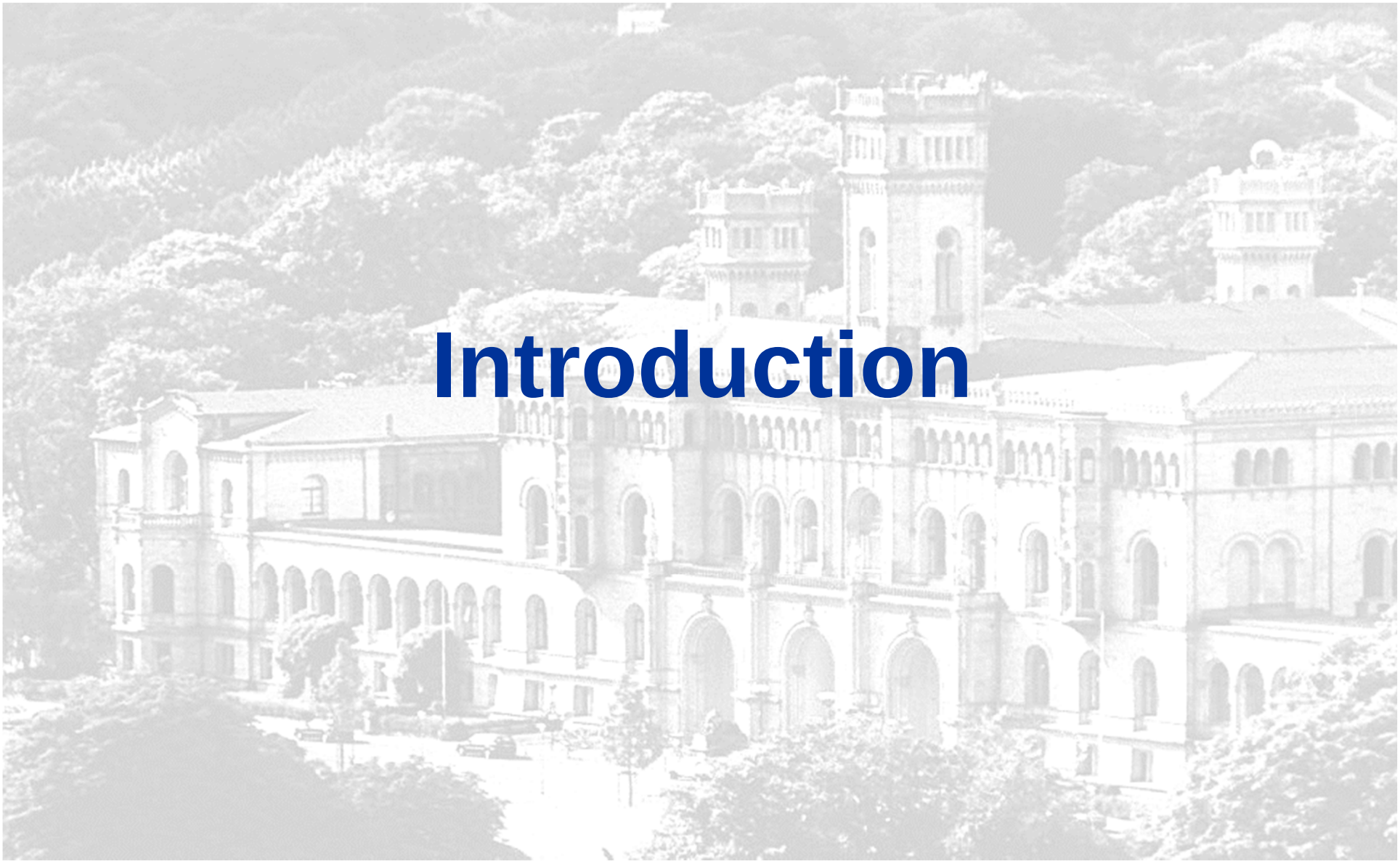


Introduction

Sanitary Engineering - Contents

Water Supply:

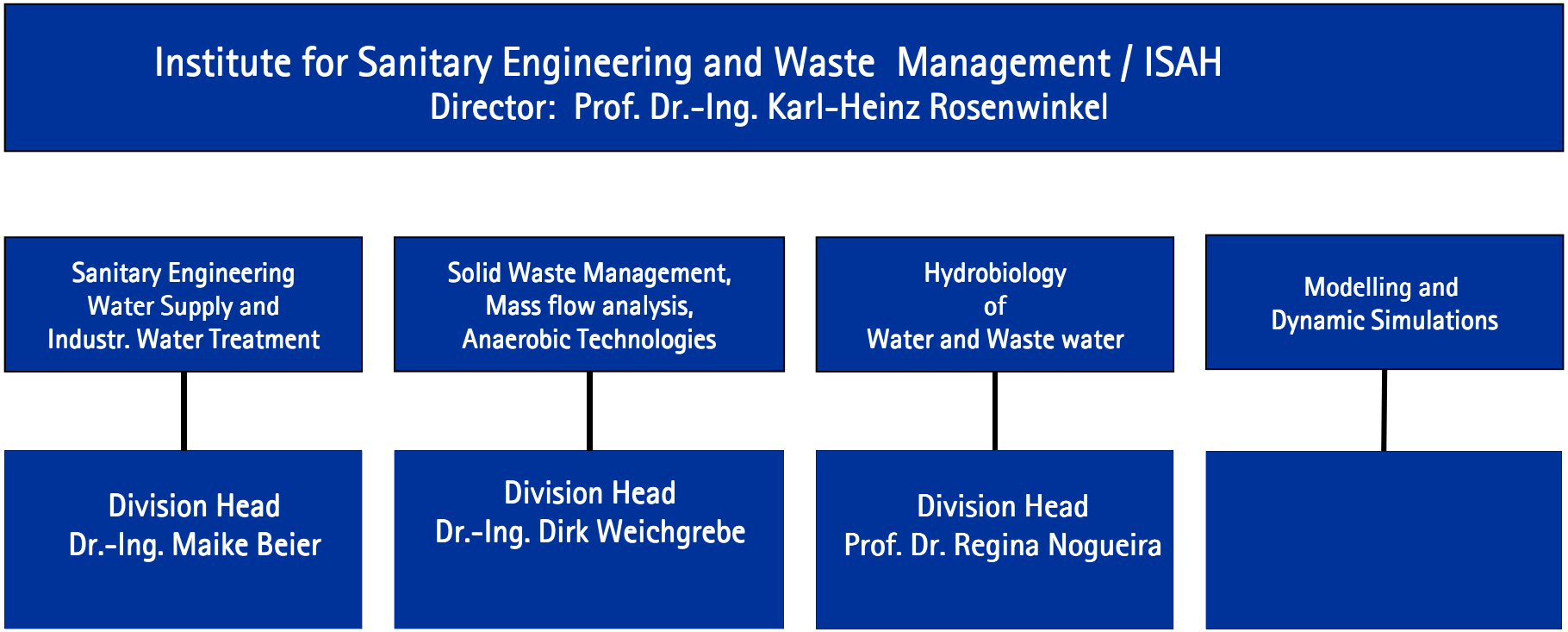
- Water cycle, water demand and usage
- Ground water and surface water catchment
- Drinking water quality requirements and water treatment
- Water pumpage
- Water storage
- Water distribution

Sanitary Engineering - Contents

Waste water discharge and treatment:

- Sewage systems
- Mechanical and biological waster water treatment
- Small and decentralized waste water treatment plants
- Elimination of carbon, nitrogen and phosphorus
- Disinfection
- Sludge treatment
- Anaerobic treatments

How is ISAH organised?



Research fields

Traditionally, engineers, biologists and chemists are working closely together at ISAH. Therefore, also biologists and chemists are always assigned the handling municipal water management tasks at the ISAH, so that the engineering work is characterized by interdisciplinary, scientific-technical methods.

Main focus of the cross-department research projects lays on:

- Nutrient recovery (N, P) from waste waters
- Industrial waste water purification
- Membrane technology
- Modelling and simulation
- Control of sewer networks
- Anaerobic technology / Bioenergy production
- Treatment of municipal solid waste (resource and energy recovery)
- Process water management of mechanical biol. waste treatment plants
- CO_2-balances and mass flow management
- Water supply and networks
- Bulky sludge analysis

Lecture No. 1

Historical development of Sanitary Engineering

Historical development of water management in settlements

STONE AGE (600.000 – 8.000 BC)

- Deposition *(Ablagerung)* of waste at certain places, e.g. Norway
- Primitive shaft-wells *(Schachtbrunnen).*

INDUS-CULTURE (about 6.500 BC, Punjab Pakistan)

- Arrangement of the secular buildings (non-churchy buildings).
- Draining of waste water into open street canals.
- Mechanical purification *(Mechanische Reinigung)* of the waste water through sedimentation tanks *(Sedimentationsbecken).*
- Shaft-wells: (Mohenjo-Daro Pakistan, oldest toilets, baths, waste water system).

OLD EGYPT (about 5.000 BC)

- Underground sewer system *(Kanalisationssystem)* which collected waste water and rain water in order to supply the neighbouring agricultural areas, drained pyramid of King Sahur´e 2.600 BC.

Historical development of water management in settlements

MINOAN CULTURE (figure of greek mythology, son of Zeus and Europa, about 3.000 BC Palace of Knossos at Crete)

- There were already proper flushing toilets and bathtubs.
- Solid waste material was stored in bricked collecting pits *(gemauerte Sammelgruben).*
- First time mentioning of pressure pipes *(Druckleitungen)* for fountains.

PALESTINE (about 1.000 BC)

- At waste-dumps *(Müllabladeplatz),* the organic components of the waste were collected in heaps and were composted.
- Combustible material was handed over to a continuously maintained fire (today: „High heating value fraction*"(„Heizwertreiche Fraktion")).*
- The drainage system *(Entwässerungssystem)* of Jerusalem joined at the city wall, wastewater trickled along the wall on the foreground in order to drain into the soil.
- Water-supply of Jerusalem: reservoirs *(Stauanlagen)* (salomonic ponds) outside of Jerusalem; transportation and distribution with gravity channels *(Freispiegelkanäle)* and tunnels.

Historical development of water management in settlements

GREECE (about 1.000 -180 BC)

- Water catchment out of water springs, long-distance supply *(Fernversorgung)* with pressure clay-pipes *(Tonrohr)*, development of the Archimedes screw *(Wasserhebeschraube)*, piston pump *(Kolbenpumpe)*, water supply of castle Pergamon 180 BC from Madras mountains, 60 km clay pipe, low-pressure 3 x 190 mm diameter *(Durchmesser).*

- Athens´ waste water were spread on the fields outside of the city (faeces was used for fertilization *(Düngung)* until the end of the 19th century).

- Athens´ clay pipes consisted of circular semi-monocoques *(kreisförmige Halbschalen)*, which were linked to each other by lead clips *(Bleiklammern)*, underground drainage systems)

Historical development of water management in settlements

ROMAN EMPIRE (300 BC – 300 AC)

- About 100 long-distance conduits (aqueducts, tunnels, further development of water lifting systems), conduits made of clay and lead, water valves (valves *(Hähne)*, plugs *(Stöpsel),* measuring nozzles *(Messdüsen)*).

- Rome´s water reservoir (100 AC) influx *(Zufluss)* 500.000 m³/d, about 500 l/(E·d), technology: reservoirs, clay- and lead-pipes, baths, thermal baths, fountains.

- In comparison: Cologne (100-200 AC) water transport out of the Eifel, long-distance conduits about 10.000 – 20.000 m³/d.

- Cloaca maxima‘ is the most significant building in urban drainage system of Rome.

Historical development of water management in settlements

MIDDLEAGES (about 1.300 AC)

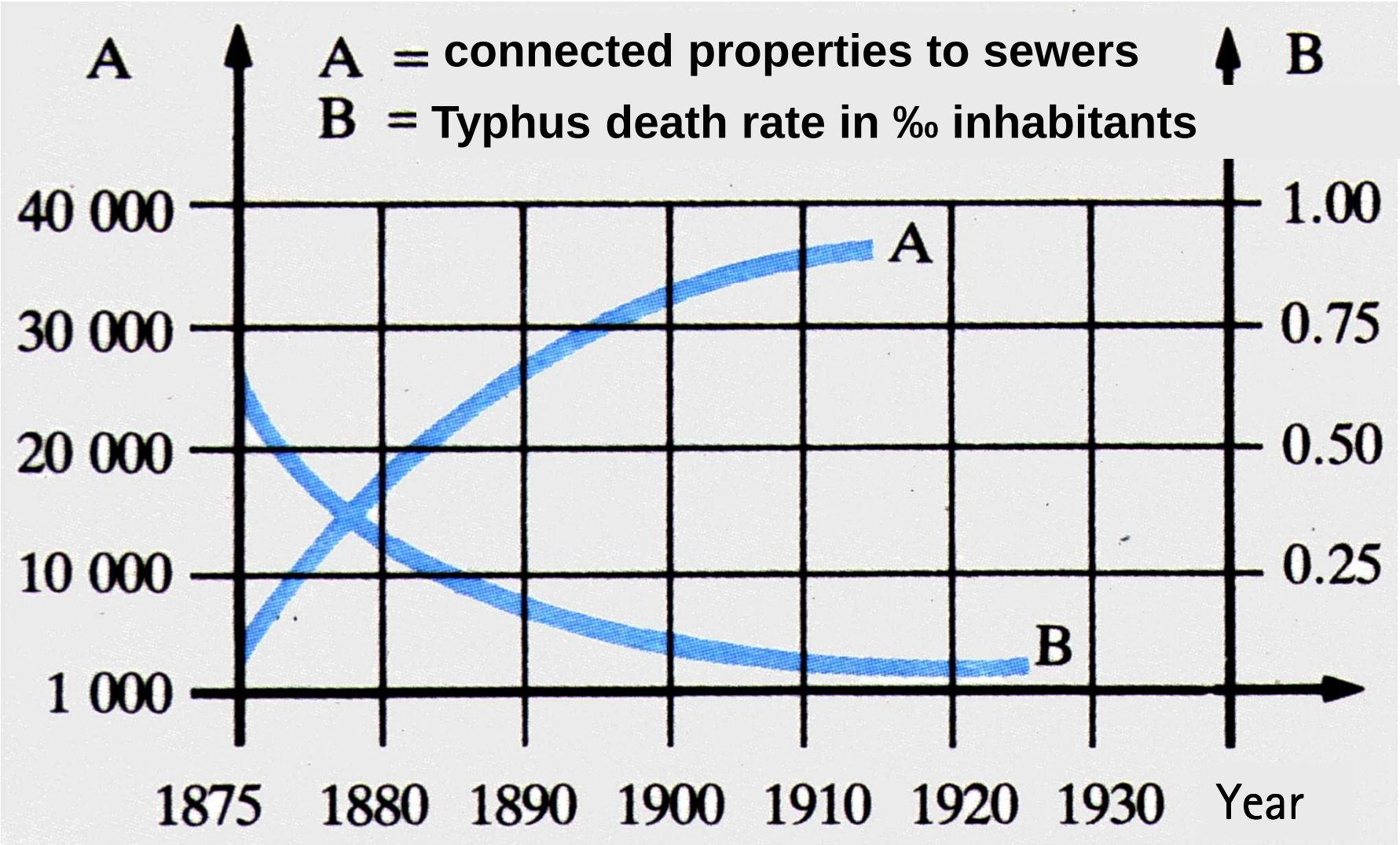
- While emperor Friedrich the first was holding the „Reichstag“ (Meeting of Imperial Council) at the castle in Erfurt in 1183, the half-rotten beams *(Balken)* of the ceremonial room collapsed *(einstürzen)* and the participants plunged into a cesspit, which was lying below. In this incident three princes, five earls, numerous aristocrats and more than 100 knights died. The emperor rescued himself by jumping out of the window.
- Technologies of sewage disposal of the ancient world fell into oblivion, knowledge about the correlation between water quality and hygiene got lost.
- No garbage collection *(Müllabfuhr)*, no street cleaning, no canalization *(Kanalisation)*.
- Devastating epidemics followed.

Historical development of water management in settlements

MODERN PERIOD (1.800 – 1.900 AC)

- First German water plant according to LINDLEY Hamburg 1848, use of water from the river Elbe without conditioning despite of LINDLEY´s warning.
- 1892 cholera epidemics in Hamburg, subsequently use of slow sand filters *(Langsamsandfilter)*.
- 1870 fundamentals of water hygiene by Robert Koch (discovered anthrax pathogen, cholera pathogen and tuberculosis bacterium, Nobel Prize 1905) and Louis Pasteur. In 1850 Pettenkofer still believed that cholera and typhus was transmitted by air (consumption: about 9.000 l air/d, 3 l water/d).
- Starting industrialisation lead partly to a degradation of the hygienic circumstances → 1830 – 1870 nine cholera epidemics. In Prussia 380.000 deaths.
- Construction of canalisation in London started in 1831 after serious cholera epidemic (design by ROE and RAWLINSON).
- 1842 construction of canalisation in Hamburg (engl. Engineer LINDLEY), 1852 canalization in Berlin (Hobrecht and Virchow), 1860 Chemnitz and Leipzig, 1867 Frankfurt

Typhus


A
A = connected properties to sewers
B = Typhus death rate in ‰ inhabitants
B
40 000
30 000
20 000
10 000
1 000
1.00
0.75
0.50
0.25
A
B
1875
1880
1890
1900
1910
1920
1930
Year

Historical development of sanitary engineering

- 1762 first patent for precipitation *(Fällung)* (DE BOISSIEU).
- 1846 British patent from Higgs for chalk precipitation *(Kalkfällung)* (construction of a facility in Tottenham, sale as „Tottenham-wasterwater-guano“).
- First chemical wastewater treatment plants *(chemische Kläranlage)* were build at the beginning of the 20th century in London, Glasgow, Leipzig etc.)
- Digestion plants (septic tanks *(Faulanlagen)*) are the oldest procedure to stabilize sludge *(Schlammstabilisierung)*.
- Since 1902 DUNBAR has investigated sludge dewatering *(Schlammentwässerung)*. Filter presses *(Filterpressen)* exist in England since 1880, and already in 1855 first attempts with centrifuges *(Zentrifugen).*
- were carried out in Leicester). Sludge disposal into the sea (Hamburg, England), agricultural usage as fertilizer, sludge ponds *(Schlammteiche)* and disposal sites *(Deponien)*.

Historical development of sanitary engineering

- 1848: foundation of the „General Board of Health“ and the „Local Boards of Health“ in England.
- Foundation of the Imperial-health council *(Reichsgesundheitsrat)* in 1900 and the Emscher cooperative in 1904)
- Development of the percolating filter *(Tropfkörper)* by the Englishman CORBETT in 1893.
- Development of the acitvated sludge process *(Belebungsverfahren)* in England by LOCKETT and ARDERN, IMHOFF made it feasible by solving the problem of the surplus sludge *(Überschussschlamm)* in the ´20s in Germany.