Effect of wastewater irrigation and drainage on soil properties of sewage fields of Gdansk (Poland)

Prof. Piotr Kowalik
Prof. Ziemowit Suligowski
Gdansk Univeristy of Technology, Poland

Introduction

In this paper we are describing the use of plants and soils for wastewater treatment on wetlands, on previously sandy dunes. The terrestrial ecosystems and plants were used to solve pollution problem that otherwise would be more harmful to aquatic or maritime ecosystems of Baltic Sea.

Demographic growth (Seeger, 1999)

Table 1. The rise in population of German cities in the second half of the 19th century [1]

City	Population 1852	1900
Berlin	450,000	1.75 Mill.
Hamburg	180,000	650,000
München	105,000	500,000
Leipzig	70,000	455,000
Breslau	120,000	425,000
Frankfurt	65,000	285,000
Stuttgart	50,000	180,000
Essen	10,000	130,000
Danzig	100,000(1983)	

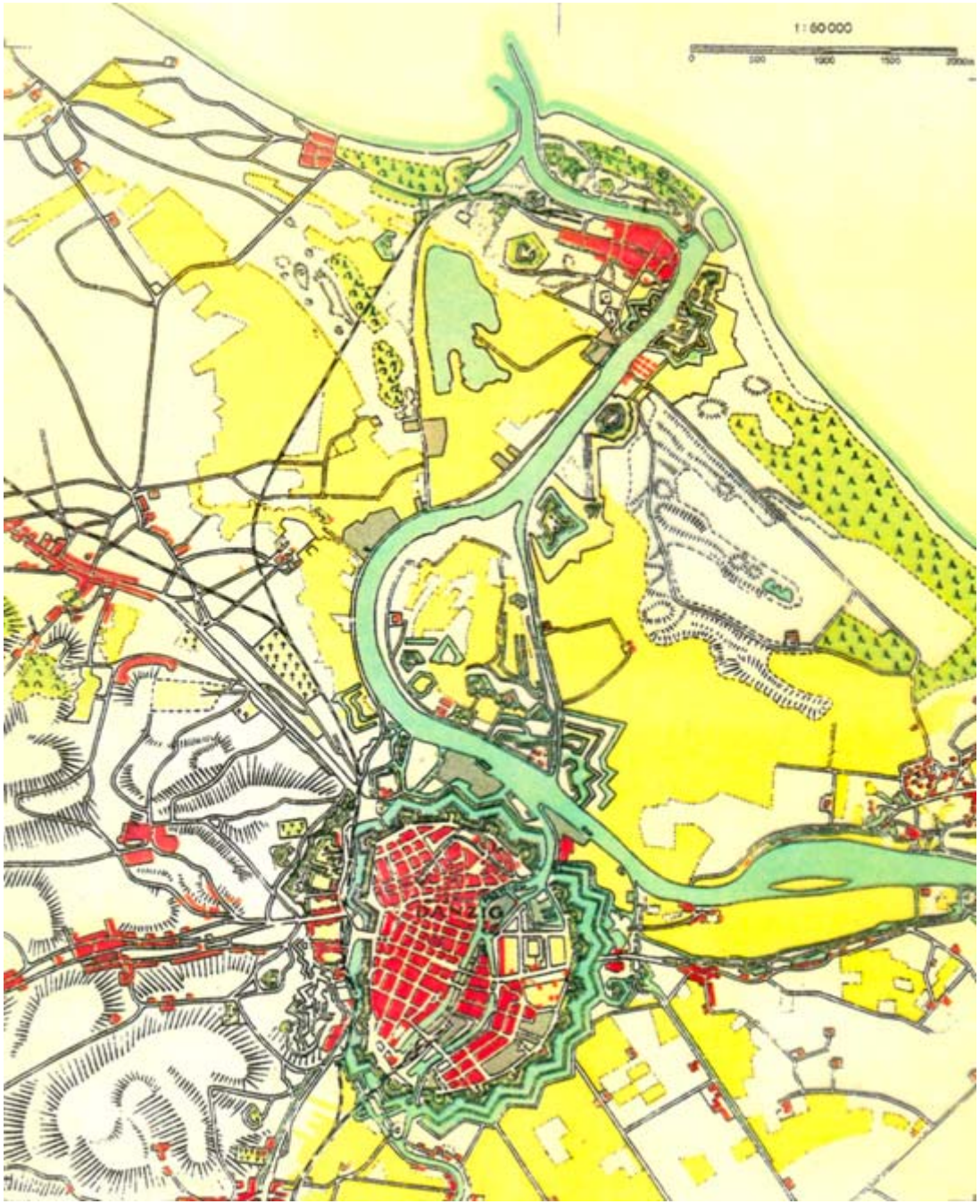
Solutions in different locations (Seeger, 1999)

Table 2. Sewer construction in German cities

City	Construction date
Hamburg	1842
Frankfurt	1867
Stettin	1868
Danzig	1871
Berlin	1873
Breslau	1877
München	1881
Köln	1881
Düsseldorf	1884

Sewage fields

City		Year	Surface area
Danzig	Gdansk	1872	320
Bremen	Brema	1877	400
Breslau	Wroclaw	1881	1778
Berlin	Berlin	1884	12300
Königsberg Kaliningrad		1899	800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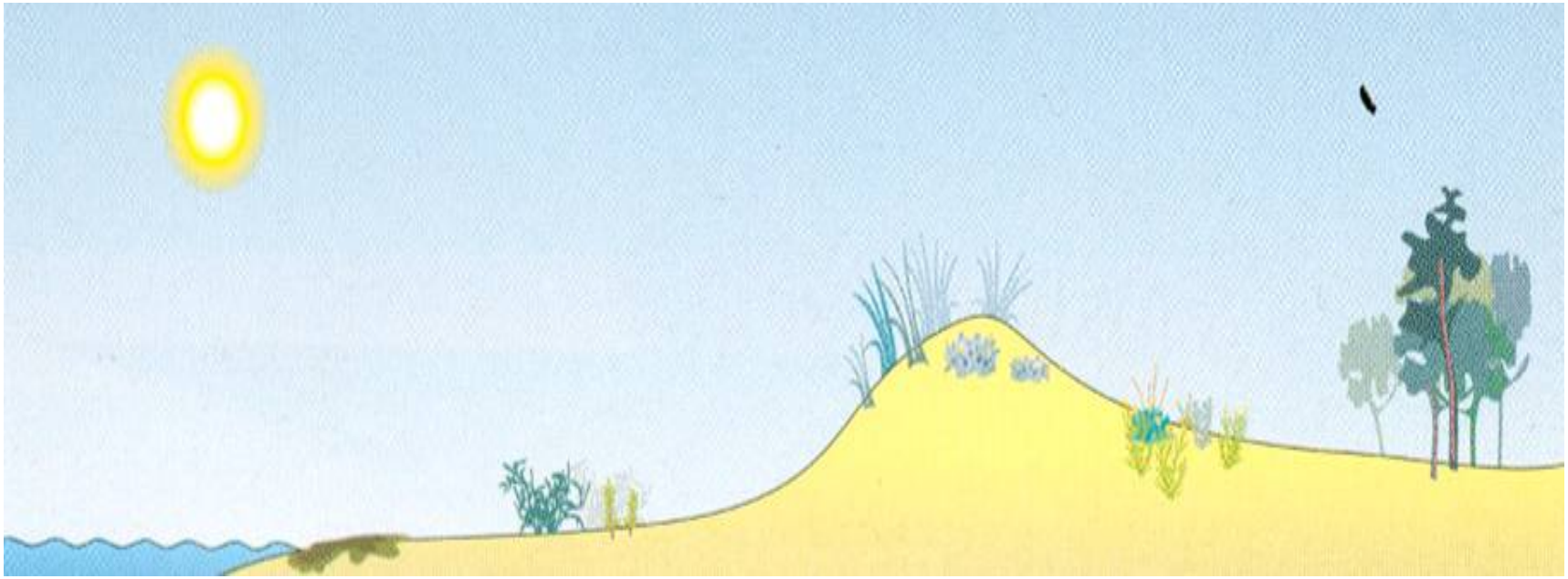
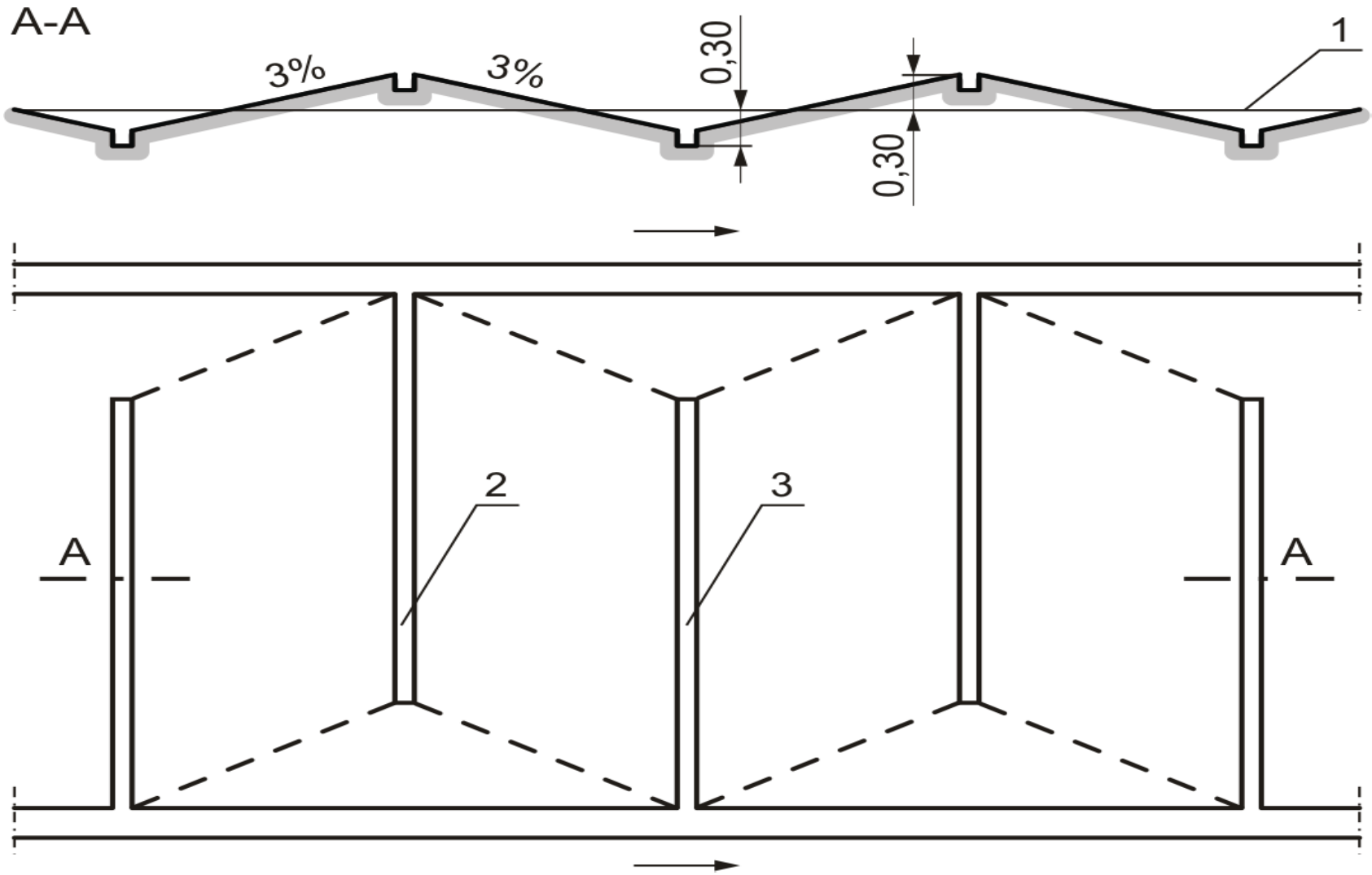
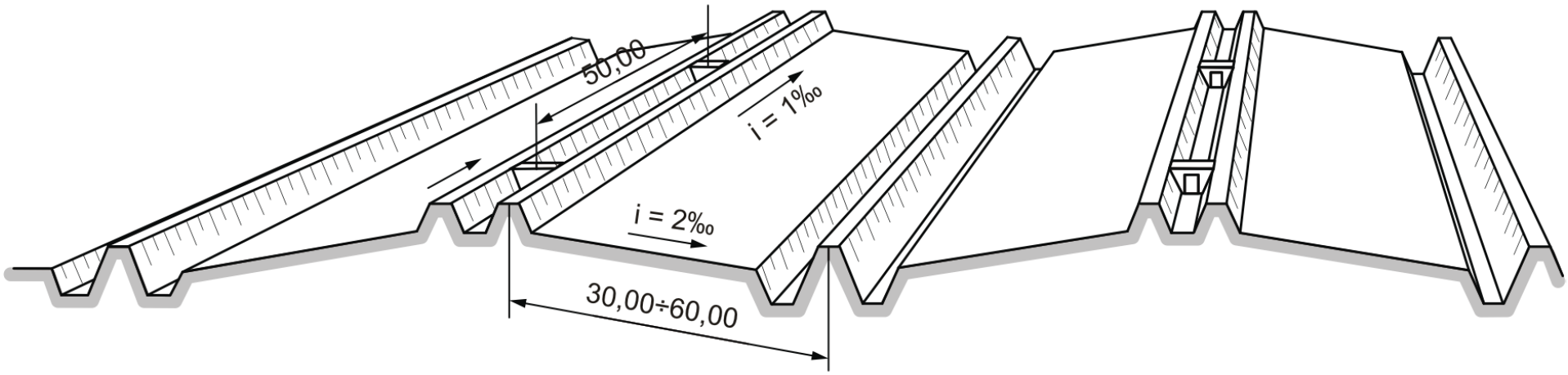
Sandy dunes at the Baltic coast



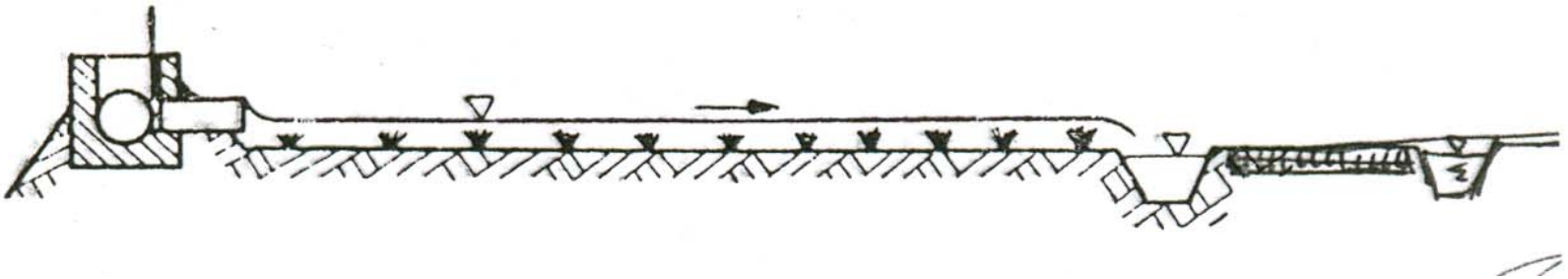
Irrigation and drainage system



Irrigation and drainage system (cont.)



Irrigation and drainage system (cont.)



Hydraulic load

The amount of wastewater was above 3000 mm per year during 1872-1962, increasing year after year and ending with 8000 mm per year in 1972.

Rainfall is 600 mm per year.

Efficiency

Efficiency of pollution removal was 80% at the end of XIX century. It was reported that the wastewater plant was eliminating nearly all ammonia and phosphorus from wastewater.

According to Helm [2, 3] and Salomon [10] the average results were as follows:

in summer phosphorus removal was 100% and ammonia removal 82%,

in winter the figures were 95% and 42%, respectively.

The sand dunes were rich in iron, which was the reason for the high degree of nutrient removal.

Vegetation

Fields were covered by grass monoculture for hay production of couch-grass (*Agrophyrum repens*).

In the locations of local sedimentation of sewage sludge the monoculture of nettle (*Urtica*) was developed.

Soils

Evolution of soils during 120 years:

- Sandy dunes
- Forest podzol on sandy dunes
- Irrigated meadow soils on sandy dunes
- Irrigated gley meadow soils on sandy dunes
- Irrigated wetland - peat soil on gley sandy dunes

End of the system

System was efficient during 100 years.

Due to the poor management, more and more wastewater was flowing on the surface of the fields, instead of infiltrating and percolating through the sandy soil, which reduced their purification efficiency from 80 to 10%. During the period of 1992-1994 the plant was closed after 120 years of continuous use.