Water Resources in Norway

presented by

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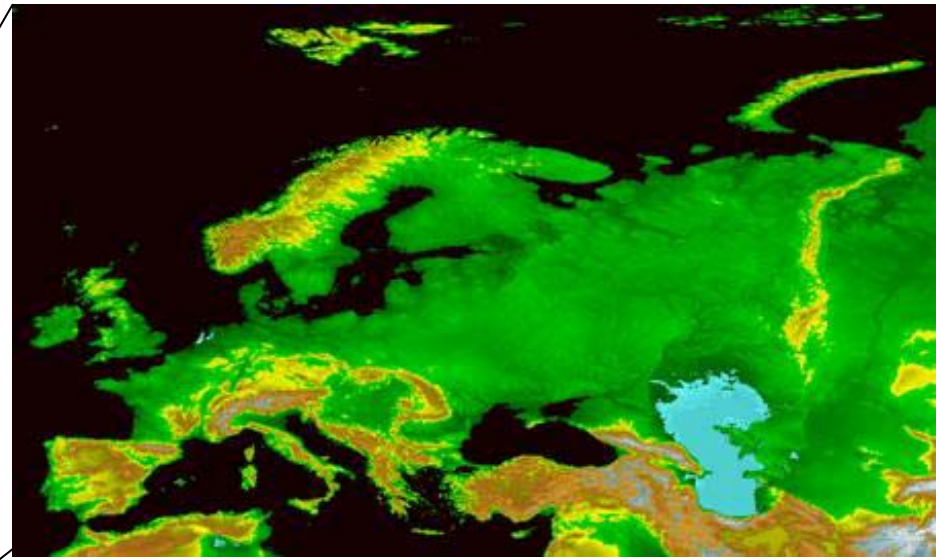
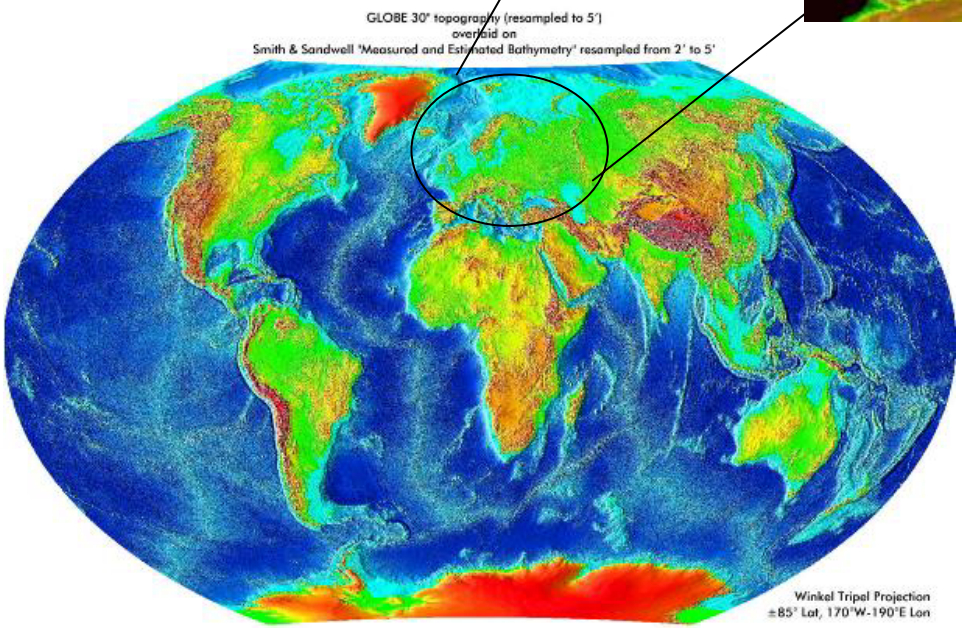
Norway:

- population — 4,3 mill.
- area – $324 \cdot 10^3$ Km^2
- pop. density – 13 cap/ Km^2





- Northern Europe
- Situated far north (55-70°N)
- long coast line
- temperate climate
- regulated by the Gulf stream

Photo Gallery:

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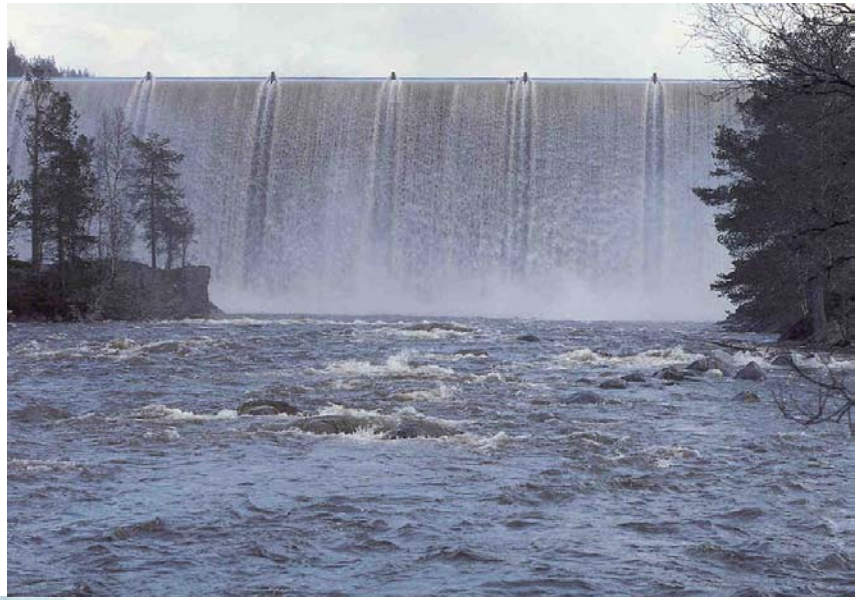
Hydrologic conditions:



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Flooding in urban areas:

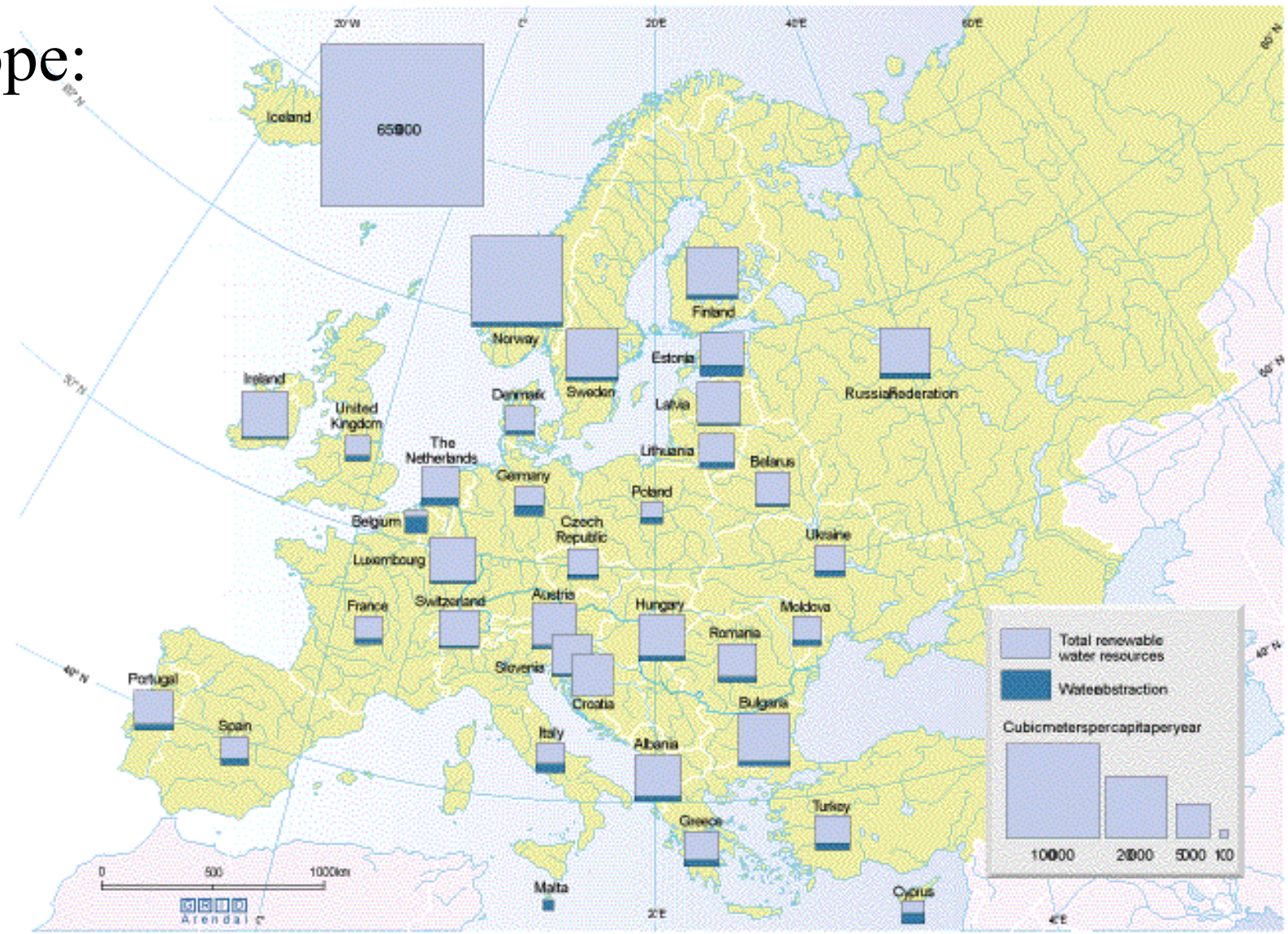
Flooding causes major material losses!
(Oslo area – September 1999)

Water resources in a nutshell:

Topography:
- mountainous
- very long coast line
- many fjords
- large valleys created by
- many rivers and lakes

Average yearly rainfall:
- north – ~300-500 mm
- west – ~3000 mm
- east – ~500-700 mm
- south – ~1000-1500 mm

Water resources Europe:



Source : The Dobris Report, map 5.1.

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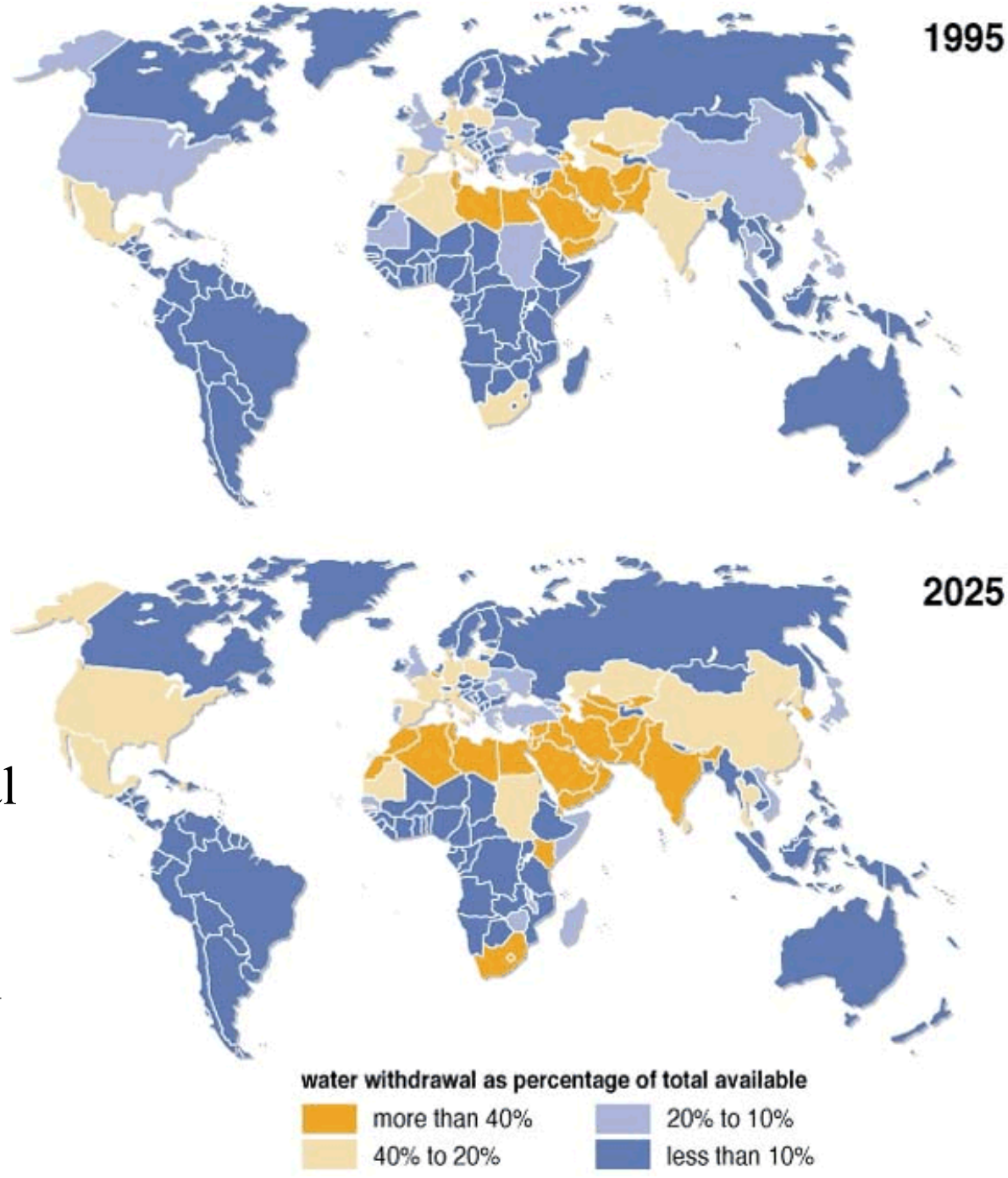
Global water stress:
1995-2025

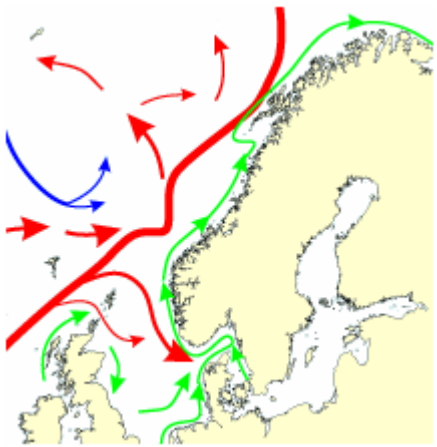


China:
40-20% withdrawal

Norway:
< 10% withdrawal

Precipitation in Norway

- predominant in coastal mountain range.
- Gulf Stream dominant factor
- Large snowfall in the mountains during winter



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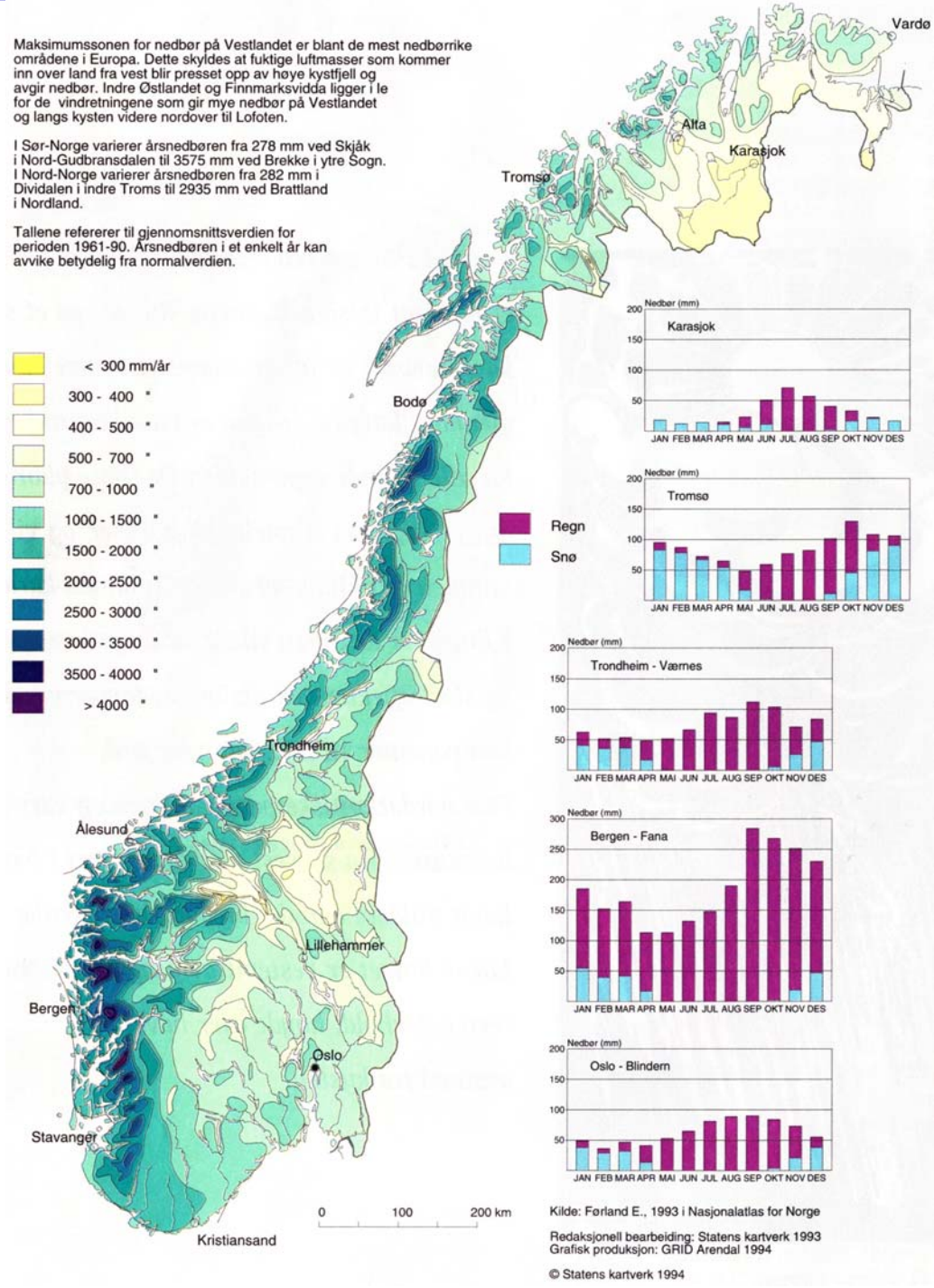


Comparing drinking water in Scandinavia:

	Norway	Sweden	Denmark
Water sources: • surface water • ground water	 90% 10%	 50% 50%(25% infiltr.)	 1% 99%
Characteristics:	High NOM, very soft, low ALK and pH	High NOM, high Ca, Fe and Mn in many cases	High hardness, high Fe/Mn, nitrates, pesticides
Typical treatment requirements	• NOM removal • corrosion control • disinfection	• NOM removal • turbidity removal • corrosion control • disinfection	• Fe/Mn removal • disinfection
Average water consumption	~ 250 l/pe.day	~ 150 l/pe.day	~ 150 l/pe.day

Drinking water:

Drinking water treatment plans:

- approximately 1600 registered in the national registry
- 77% of the population served

  (76,6% lakes; 15,2% rivers; 8,4% groundwater)
- 23% of the population served by private wells
- Costs: 1100 NOK/cap.yr - 5 NOK/m^3

Dominating treatment methods:

- coagulation/direct filtration
- membrane filtration
- Ca/CO_2 addition
- Chlorination / UV

Distribution system:

- 34.500 Km water supply network

  39% iron/steel

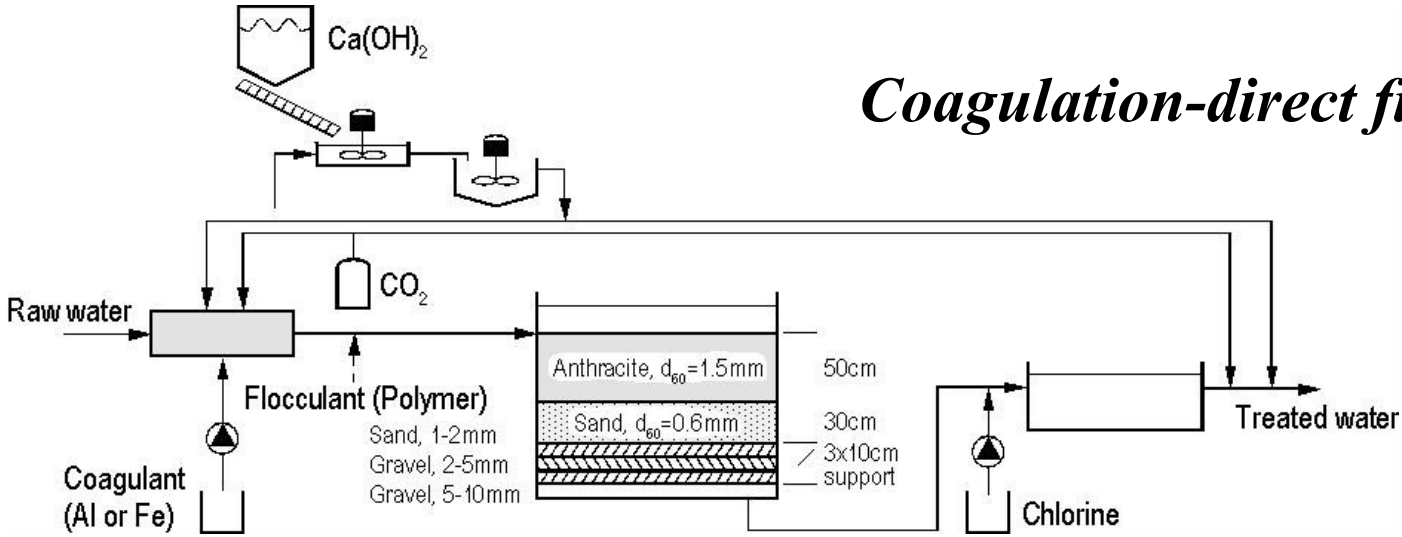
  48% PVC/PE/GUP

  9% Asbestos

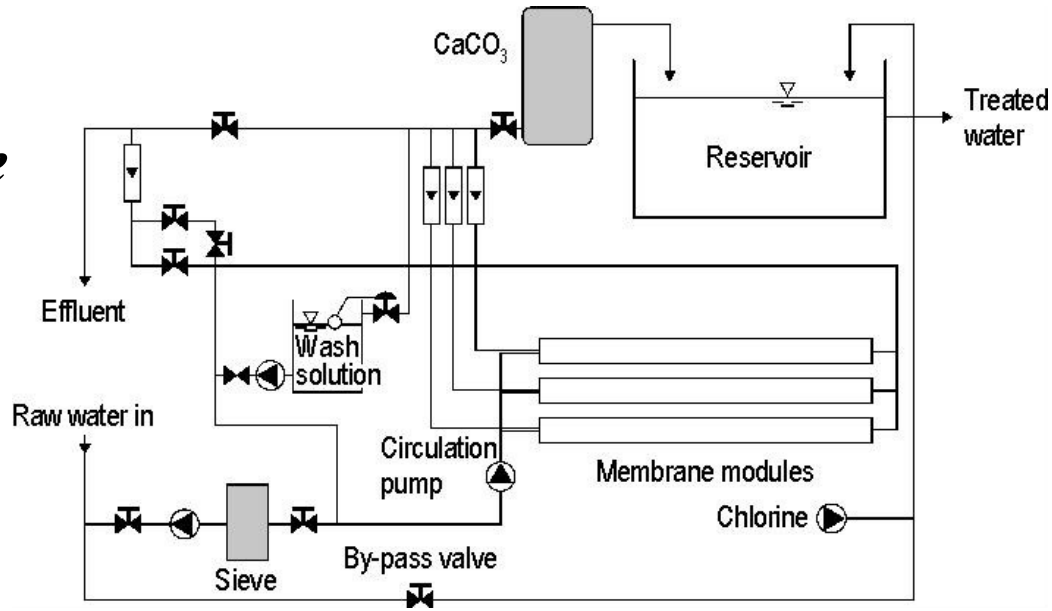
  4% others

Typical treatment plant design:

Coagulation-direct filtration:



Spiral-wound membrane Filtration plant:



Typical treatment plant:

Membrane filtration plant:

- all installations indoors
- highly automated

Wastewater in Scandinavia:

	Norway	Sweden	Denmark
Wastewater effl. stand. BOD N P	 10 – 20 70 % removal 0,3 – 0,8	 10 - 20 8 – 12 0,3 – 0,5	 10 – 20 8 1,0
Typical treatment plant	Many chemical plants Biol./chem., many biofilm plants	Biol./chem., many AS plants, pre- or post precip.	Biol./chem.. mostly AS, bio. P-removal w/simult. precip.
Typical size of treatment plants	Many small – sized 85 % < 2000 pe, < 5 > 100.000 pe	Many medium-sized 10 – 50.000 pe, > 20 > 100.000 pe	Many medium-sized 10 – 50.000 pe, > 20 > 100.000 pe
Sludge disposal	~ 50 % to agricult. ~ 10 % to compost ~ 30 % to landfill	~ 50 % to agricult. ~ 30 % to landfill ~ 10 % incineration	~ 40 % to agricult. ~ 20 % to landfill ~ 30 % incineration
Effluent disposal Fresh water Coastal water	 ~ 20 % ~ 80 %	 ~ 40 % ~ 60 %	 ~ 40 % ~ 60 %

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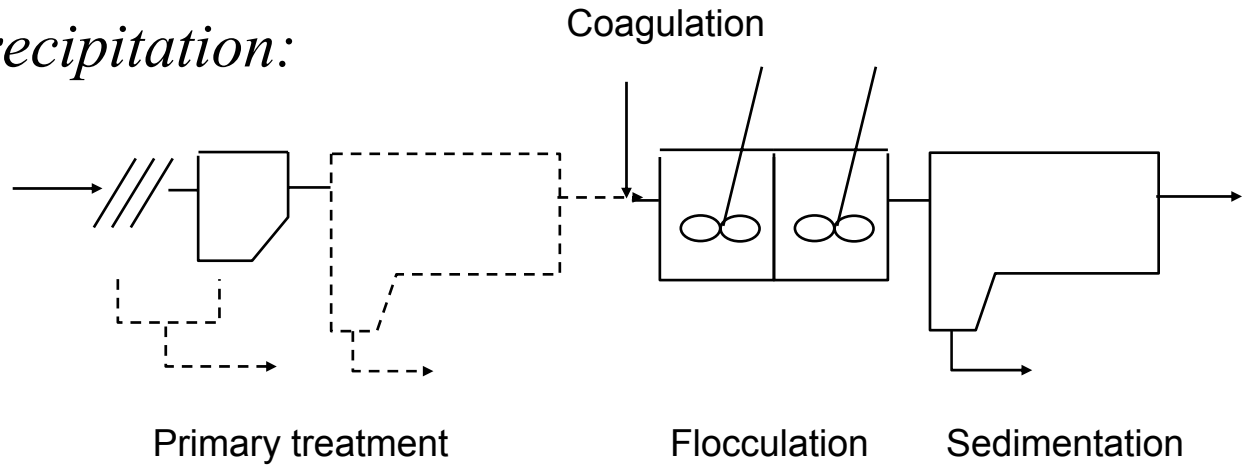
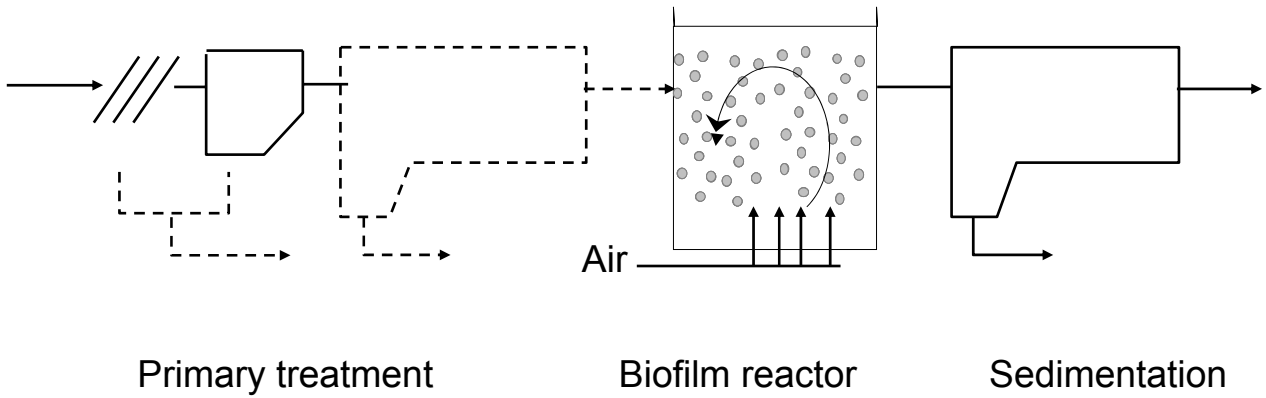
Typical WWTP flow sheets:

Chemical precipitation:

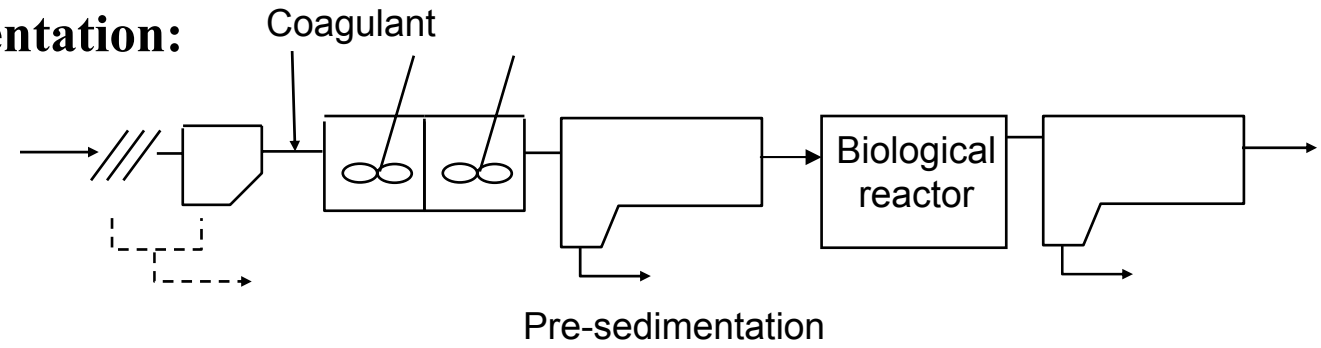


Biofilm reactor (MBBR):

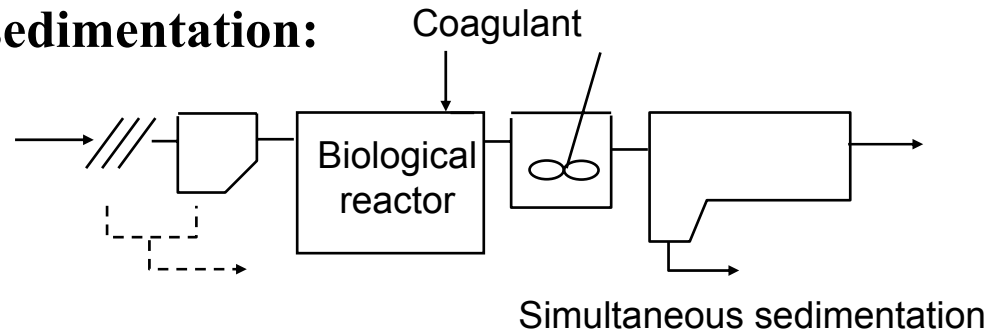


Flow sheets (2): *Biological / Chemical treatment plants:*

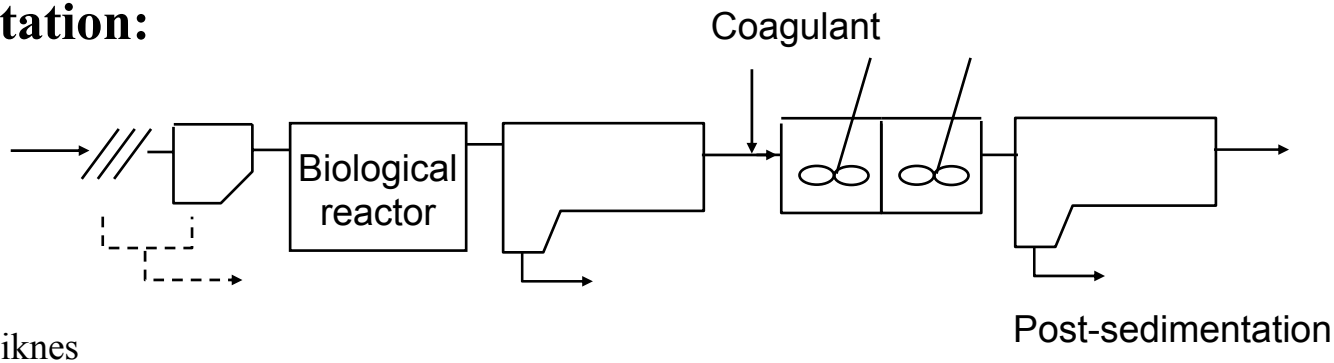
Pre-sedimentation:



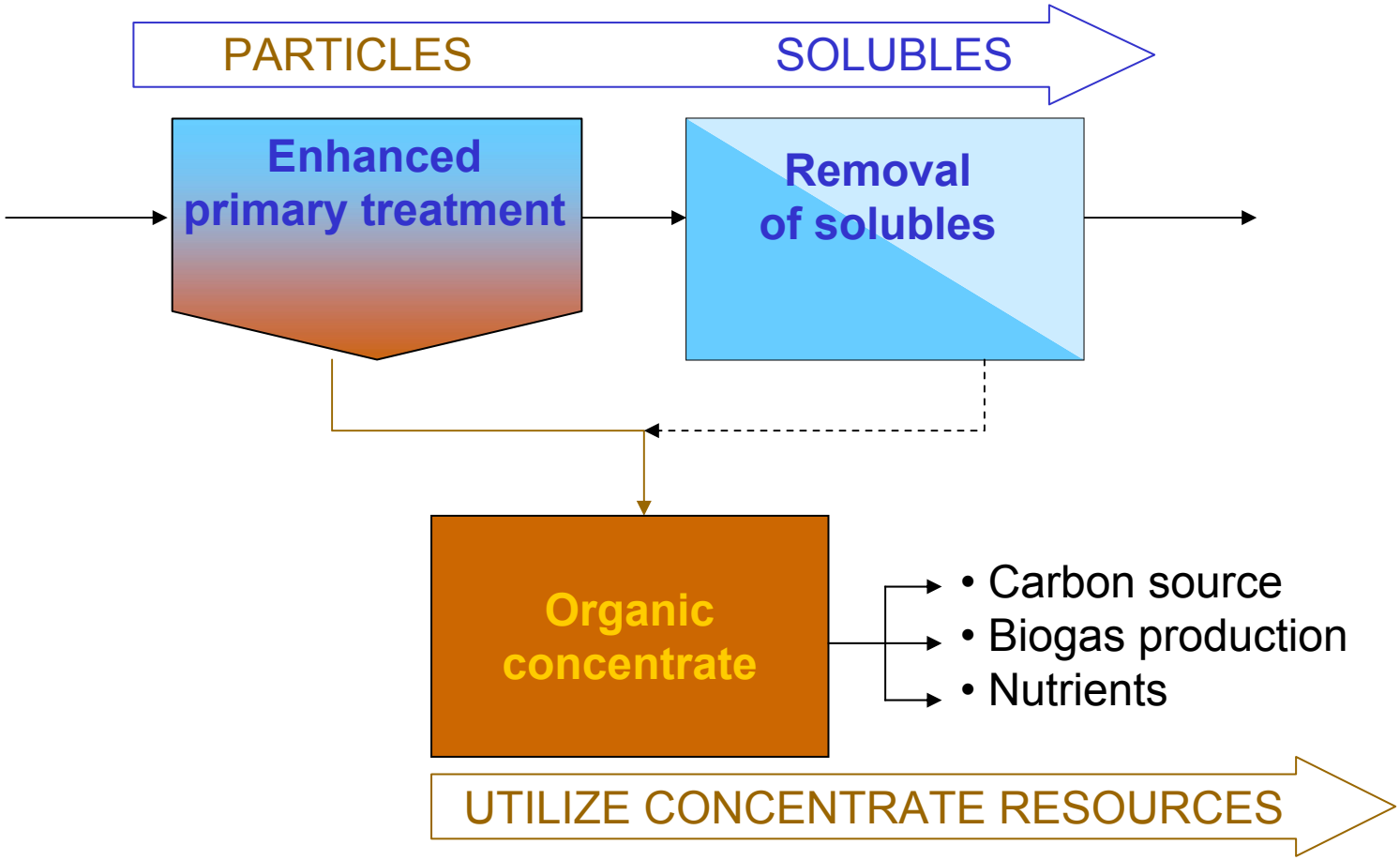
Simultaneous-sedimentation:



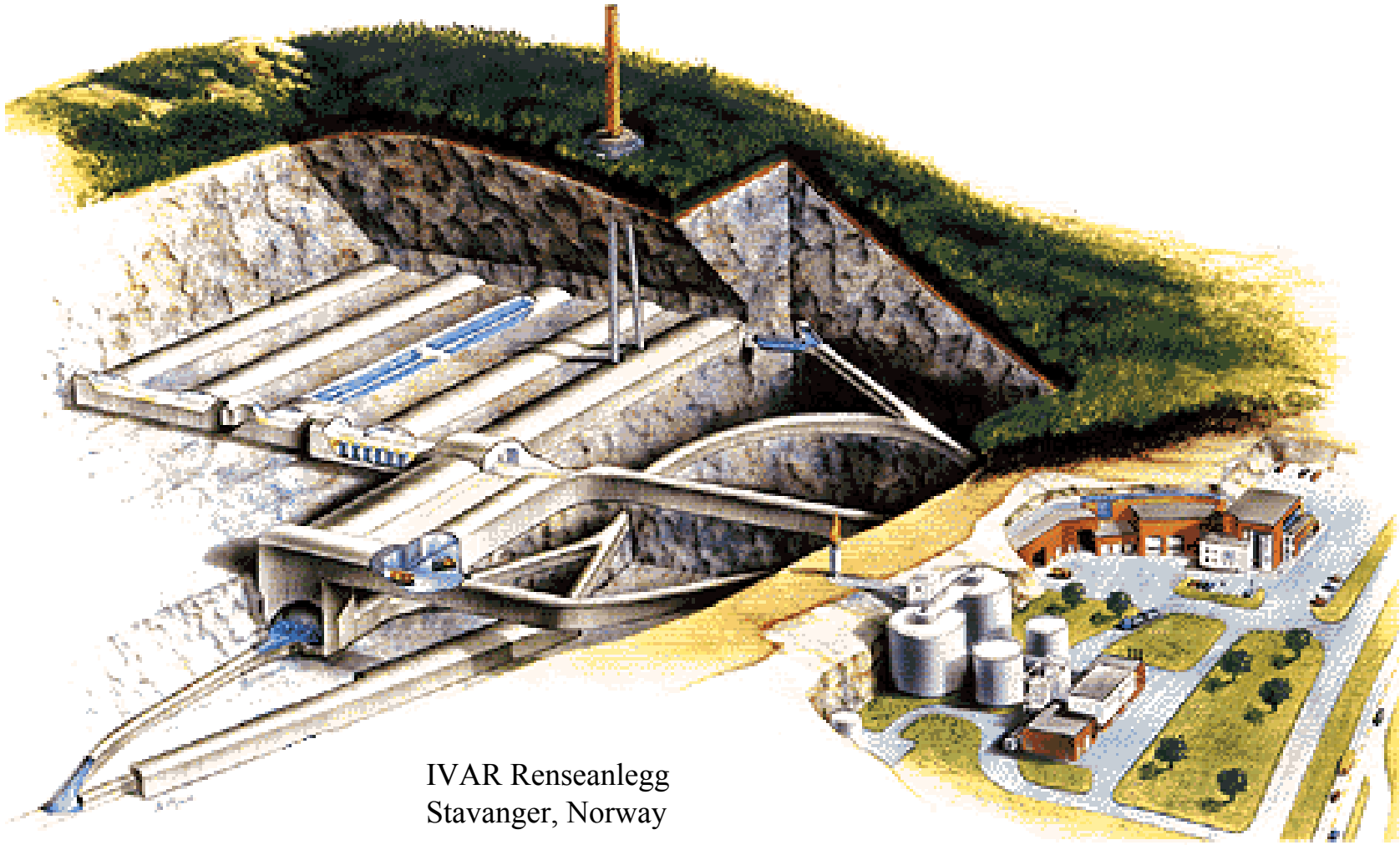
Post-sedimentation:



Wastewater treatment philosophy:



Typical treatment plant solution:



IVAR Renseanlegg
Stavanger, Norway

“The blue planet”:

Water resource management challenges:

- water use
- water quality
- water management

“Wastewater as a resources“

- the water itself
- constituents
- heat