

# Water Resources in Norway



presented by

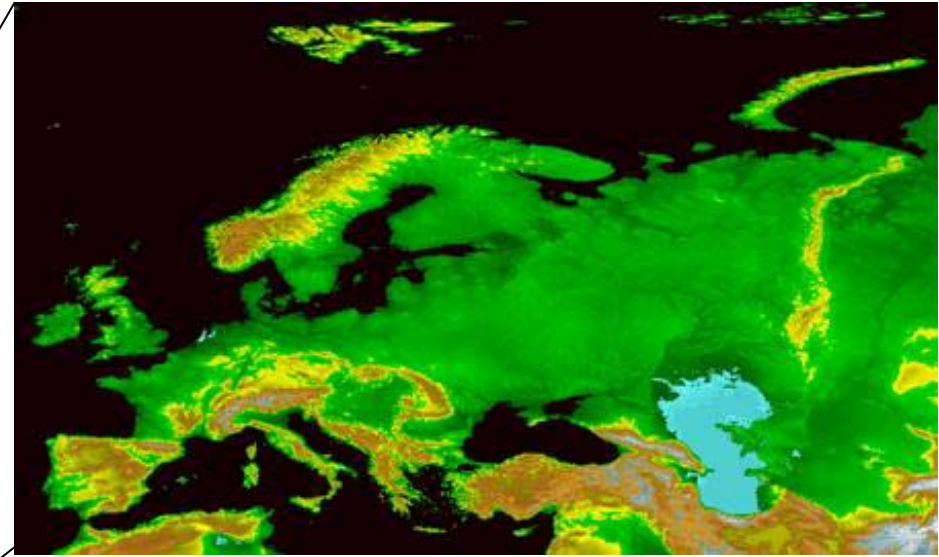
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Environmental Engineering

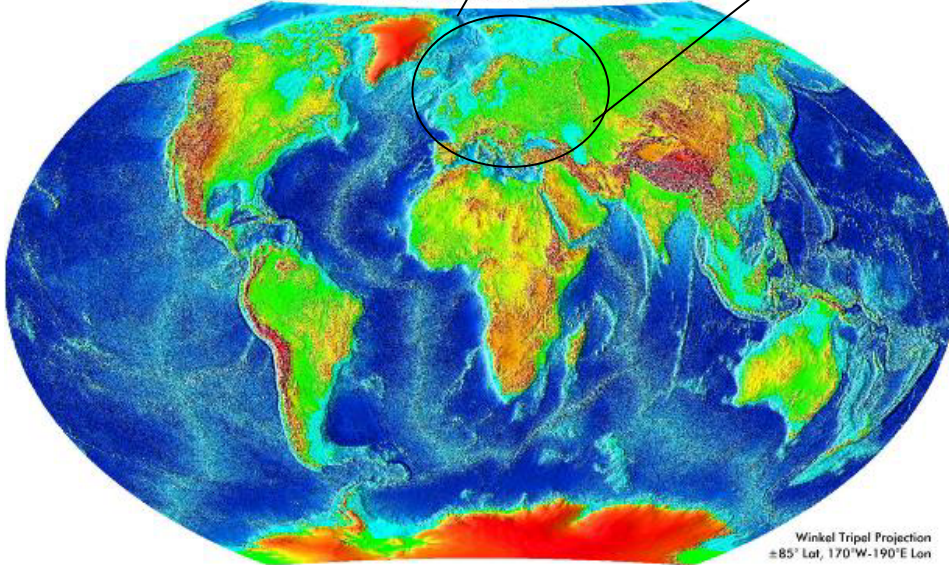
Dr. TorOve Leiknes

# Norway:

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



GLOBE 30" topography (resampled to 5') overlaid on Smith & Sandwell 'Measured and Estimated Bathymetry' resampled from 2' to 5'



- Northern Europe
- Situated far north ( $55-70^\circ\text{N}$ )
- long coast line
- temperate climate
- regulated by the Gulf stream

# Photo Gallery:



# Hydrologic conditions:



# 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:*

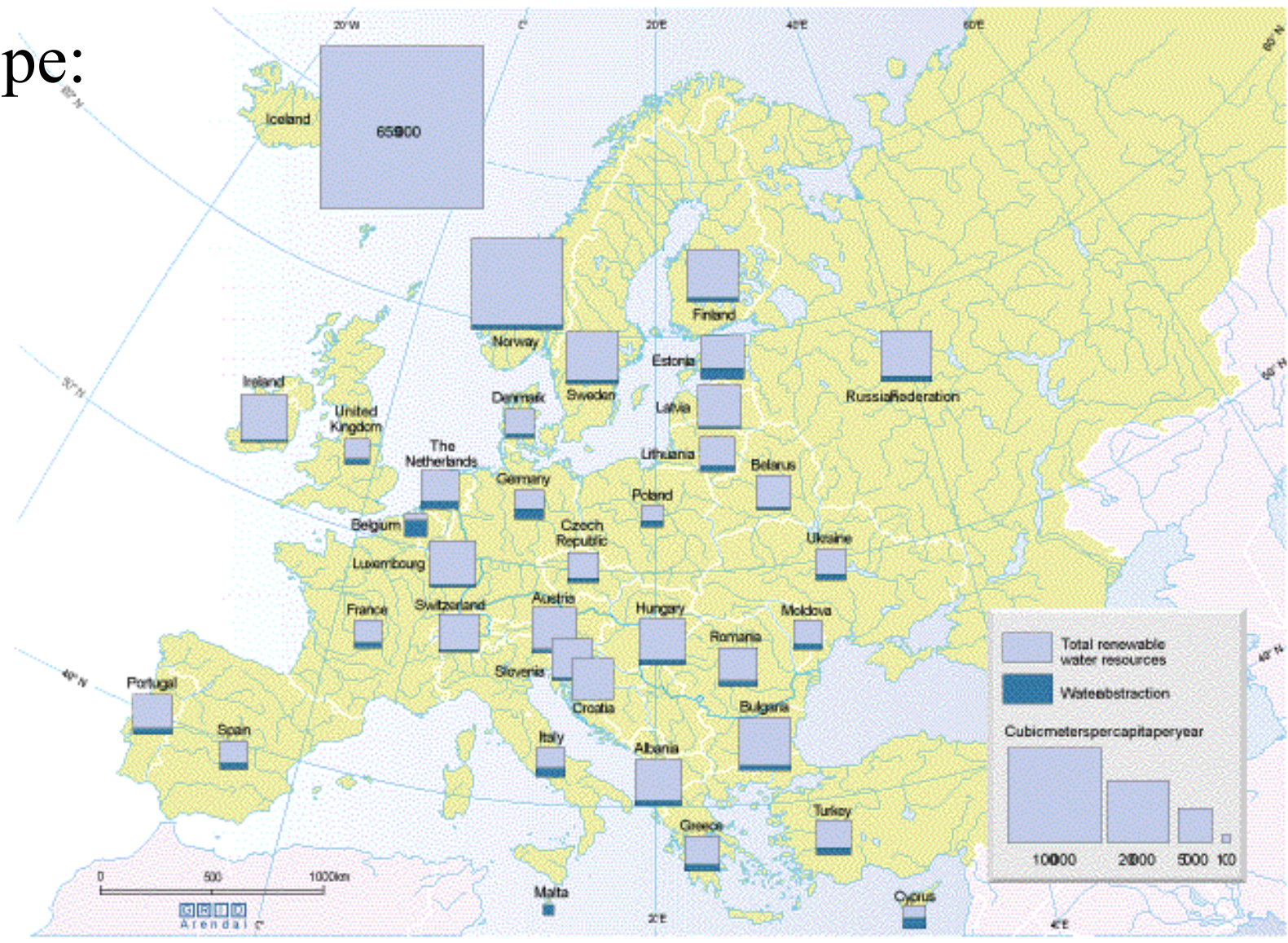
- north – ~300-500 mm
- west – ~3000 mm
- east – ~500-700 mm
- south – ~1000-1500 mm



# Water resources

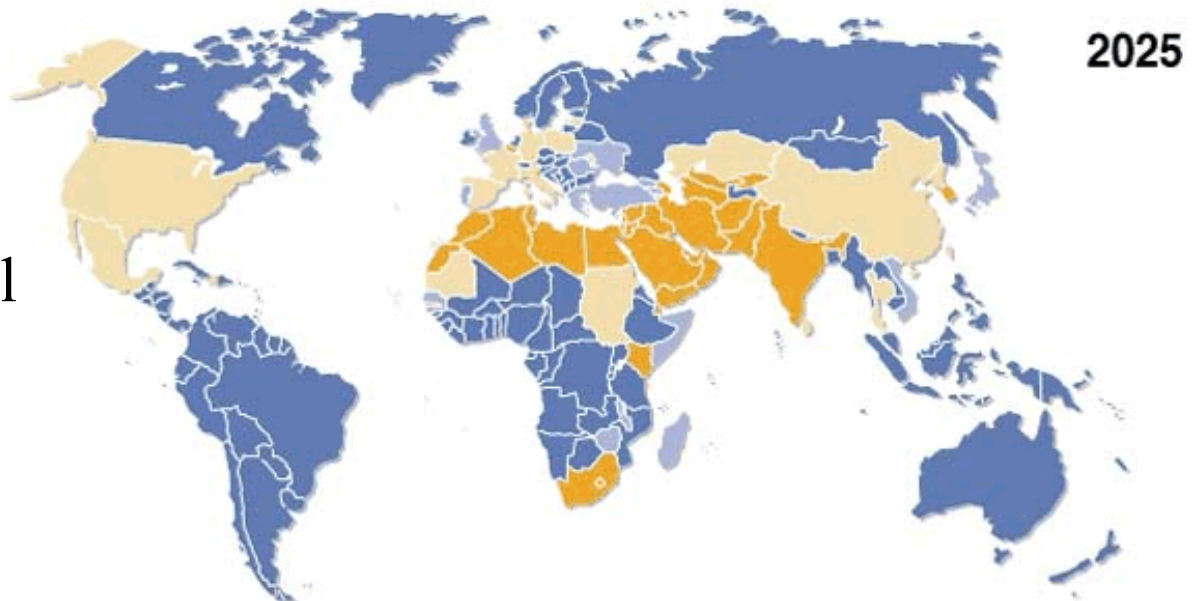
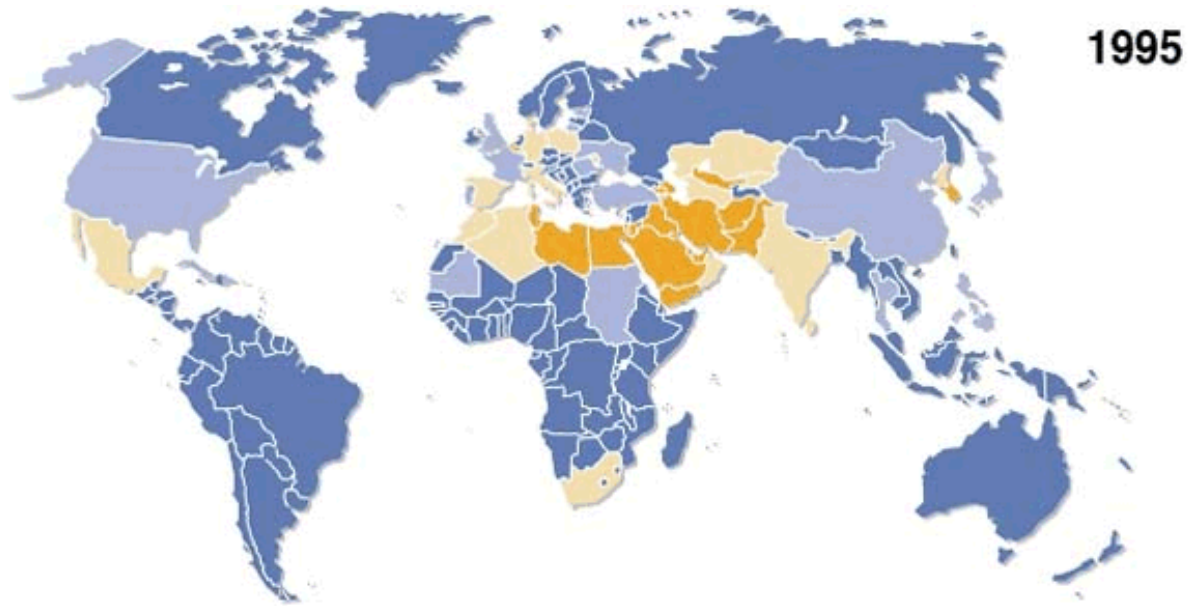
## Europe:

Water resources in Europe



Source : The Dobris Report, map 5.1.

# Global water stress: 1995-2025



China:  
40-20% withdrawal

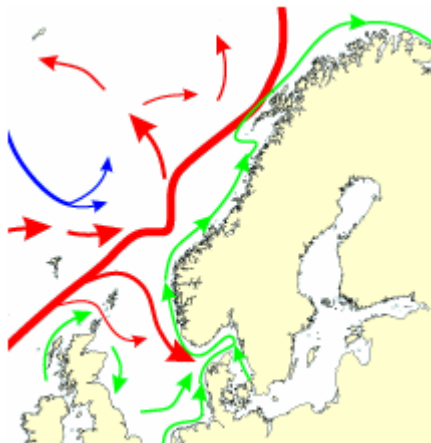
Norway:  
< 10% withdrawal





# Precipitation in Norway

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

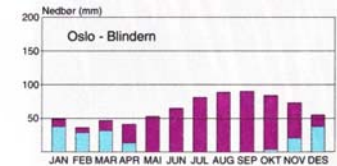
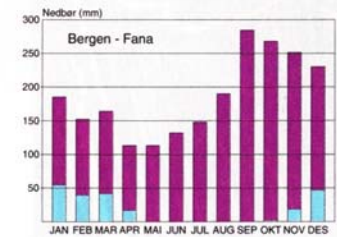
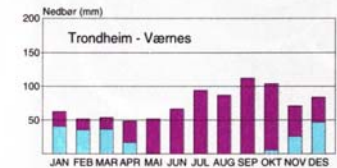
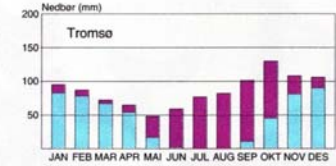
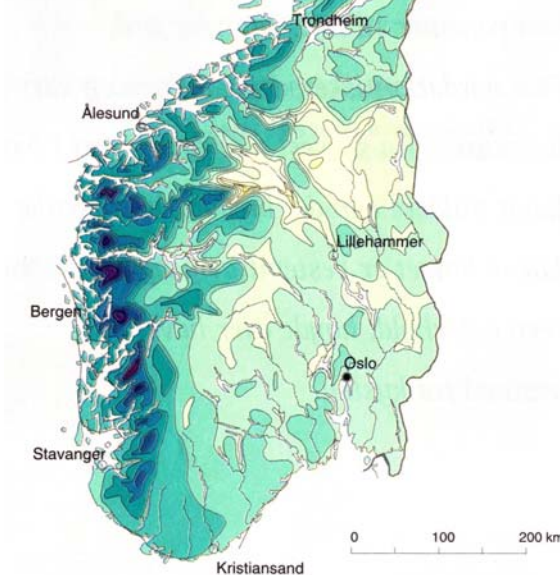


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Maksimumssonen for nedbør på Vestlandet er blant de mest nedbørrike områdene i Europa. Dette skyldes at fuktige luftmasser som kommer inn over land fra vest blir presset opp av høye kystfjell og avgir nedbør. Indre Østlandet og Finnmarksvidda ligger i le for de vindretningene som gir mye nedbør på Vestlandet og langs kysten videre nordover til Lofoten.

I Sør-Norge varierer årsnedbøren fra 278 mm ved Skjåk i Nord-Gudbrandsdalen til 3575 mm ved Brekke i ytre Sogn. I Nord-Norge varierer årsnedbøren fra 282 mm i Dividalen i indre Troms til 2935 mm ved Brattland i Nordland.

Tallene refererer til gjennomsnittsverdien for perioden 1961-90. Årsnedbøren i et enkelt år kan avvike betydelig fra normalverdien.



Kilde: Forland E., 1993 i Nasjonalatlas for Norge  
 Redaksjonell bearbeiding: Statens kartverk 1993  
 Grafisk produksjon: GRID Arendal 1994  
 © Statens kartverk 1994

# Comparing drinking water in Scandinavia:

	Norway	Sweden	Denmark
<i>Water sources:</i>			
• surface water	90%	50%	1%
• ground water	10%	50%(25% infiltr.)	99%
<i>Characteristics:</i>	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
<i>Typical treatment requirements</i>	<ul style="list-style-type: none"> <li>• NOM removal</li> <li>• corrosion control</li> <li>• disinfection</li> </ul>	<ul style="list-style-type: none"> <li>• NOM removal</li> <li>• turbidity removal</li> <li>• corrosion control</li> <li>• disinfection</li> </ul>	<ul style="list-style-type: none"> <li>• Fe/Mn removal</li> <li>• disinfection</li> </ul>
<i>Average water consumption</i>	~ 250 l/pe.day	~ 150 l/pe.day	~ 150 l/pe.day

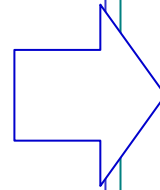
# Drinking water:

## *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<sup>3</sup>

## *Dominating treatment methods:*

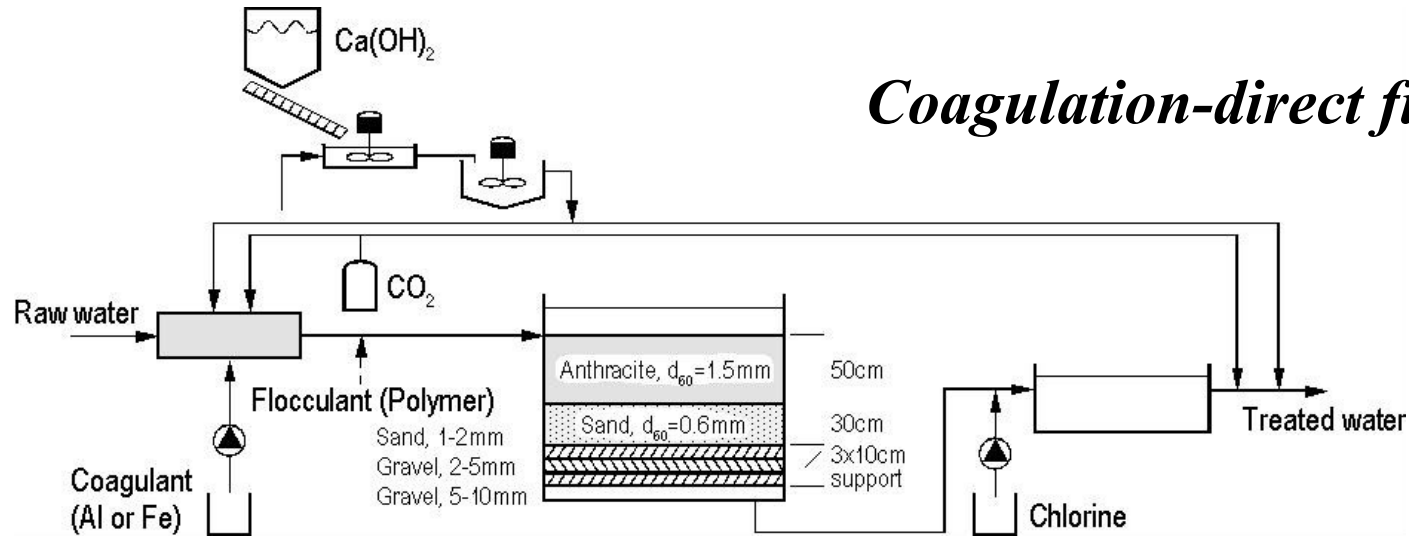
- coagulation/direct filtration
- membrane filtration
- Ca/CO<sub>2</sub> addition
- Chlorination / UV



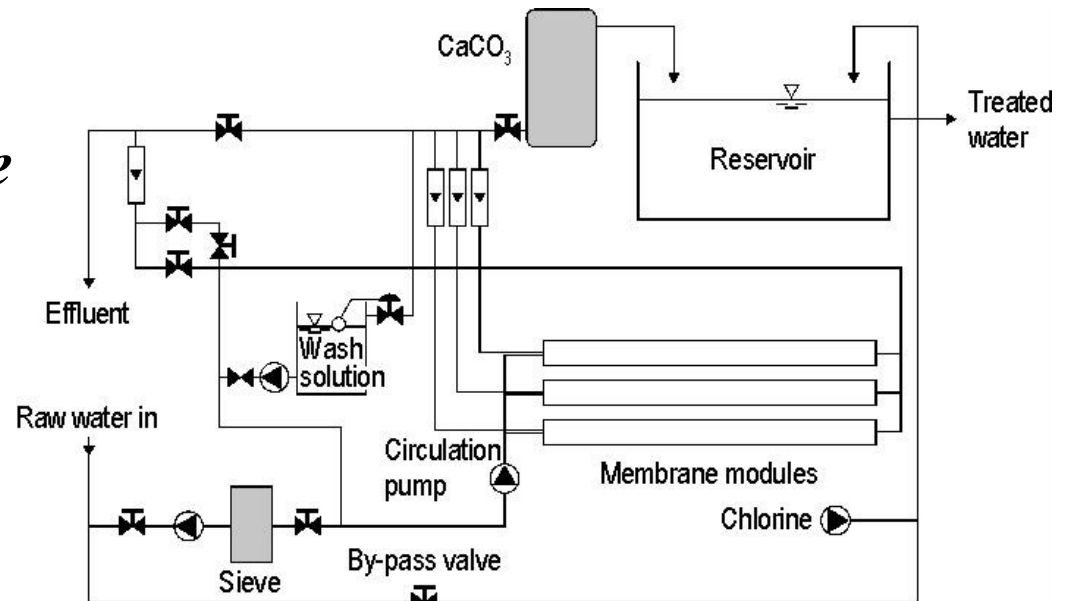
## *Distribution system:*

- 34.500 Km water supply network
  - 39% iron/steel
  - 48% PVC/PE/GUP
  - 9% Asbestos
  - 4% others

# Typical treatment plant design:



## *Spiral-wound membrane Filtration plant:*



# Typical treatment plant:



*Membrane filtration plant:*

- all installations indoors
- highly automated



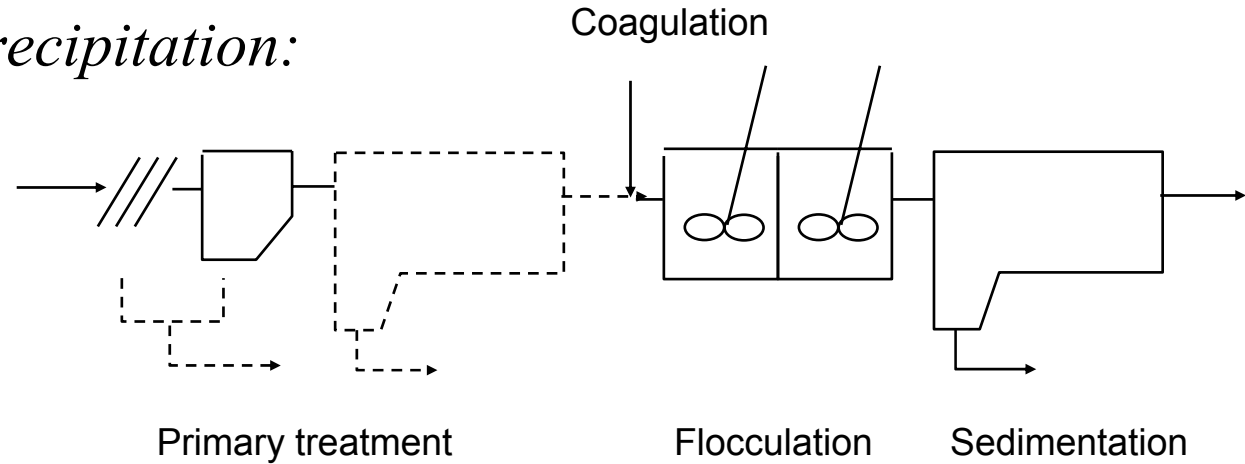
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# Wastewater in Scandinavia:

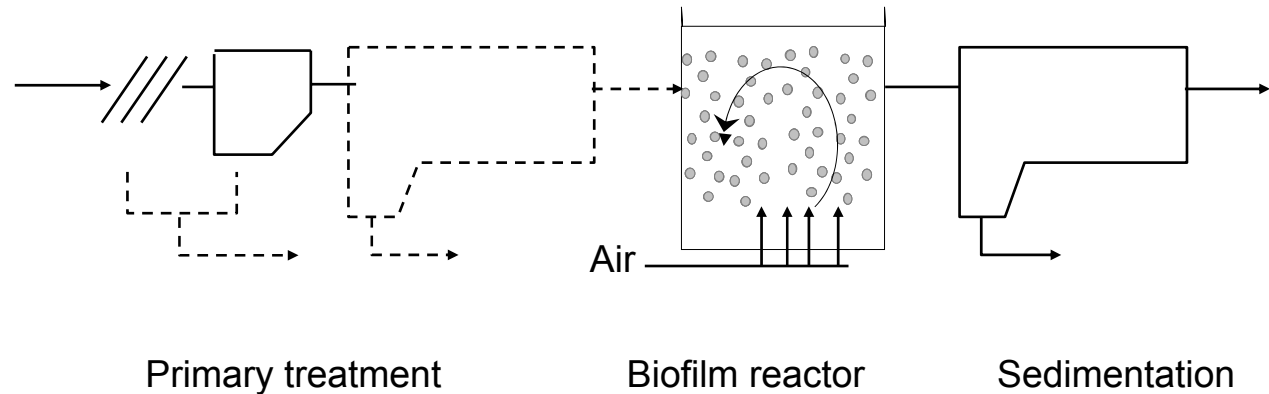
	Norway	Sweden	Denmark
Wastewater effl. stand.			
BOD	10 – 20	10 - 20	10 – 20
N	70 % removal	8 – 12	8
P	0,3 – 0,8	0,3 – 0,5	1,0
Typical treatment plant	Many chemical plants Biol./chem., many biofilm plants	Biol./chem., many AS plants, pre- or post precip.	Biol./chem.. mostly AS, bio. P-removal w/simult. 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	~ 20 %	~ 40 %	~ 40 %
Coastal water	~ 80 %	~ 60 %	~ 60 %

# Typical WWTP flow sheets:

## *Chemical precipitation:*

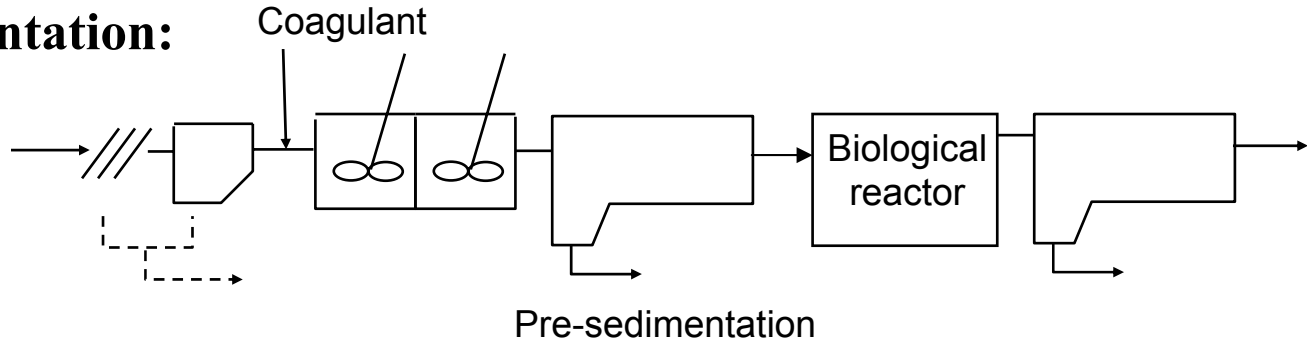


## *Biofilm reactor (MBBR):*

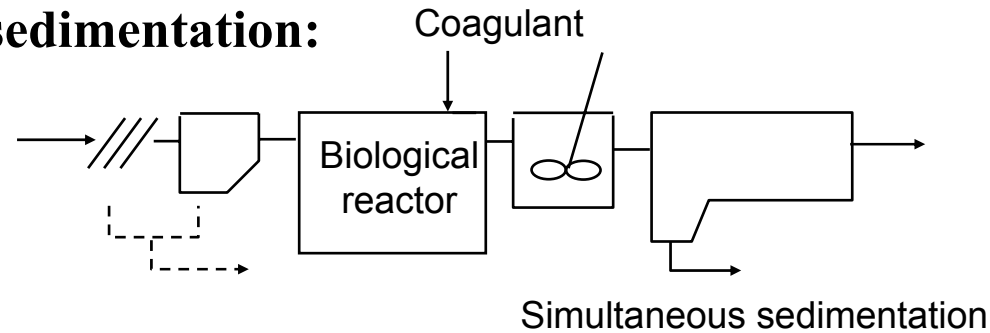


# Flow sheets (2): *Biological / Chemical treatment plants:*

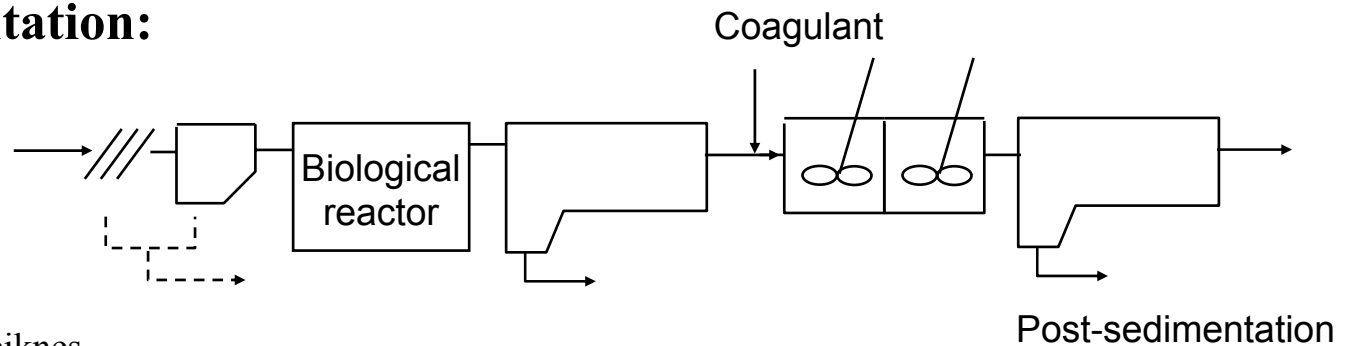
## Pre-sedimentation:



## Simultaneous-sedimentation:

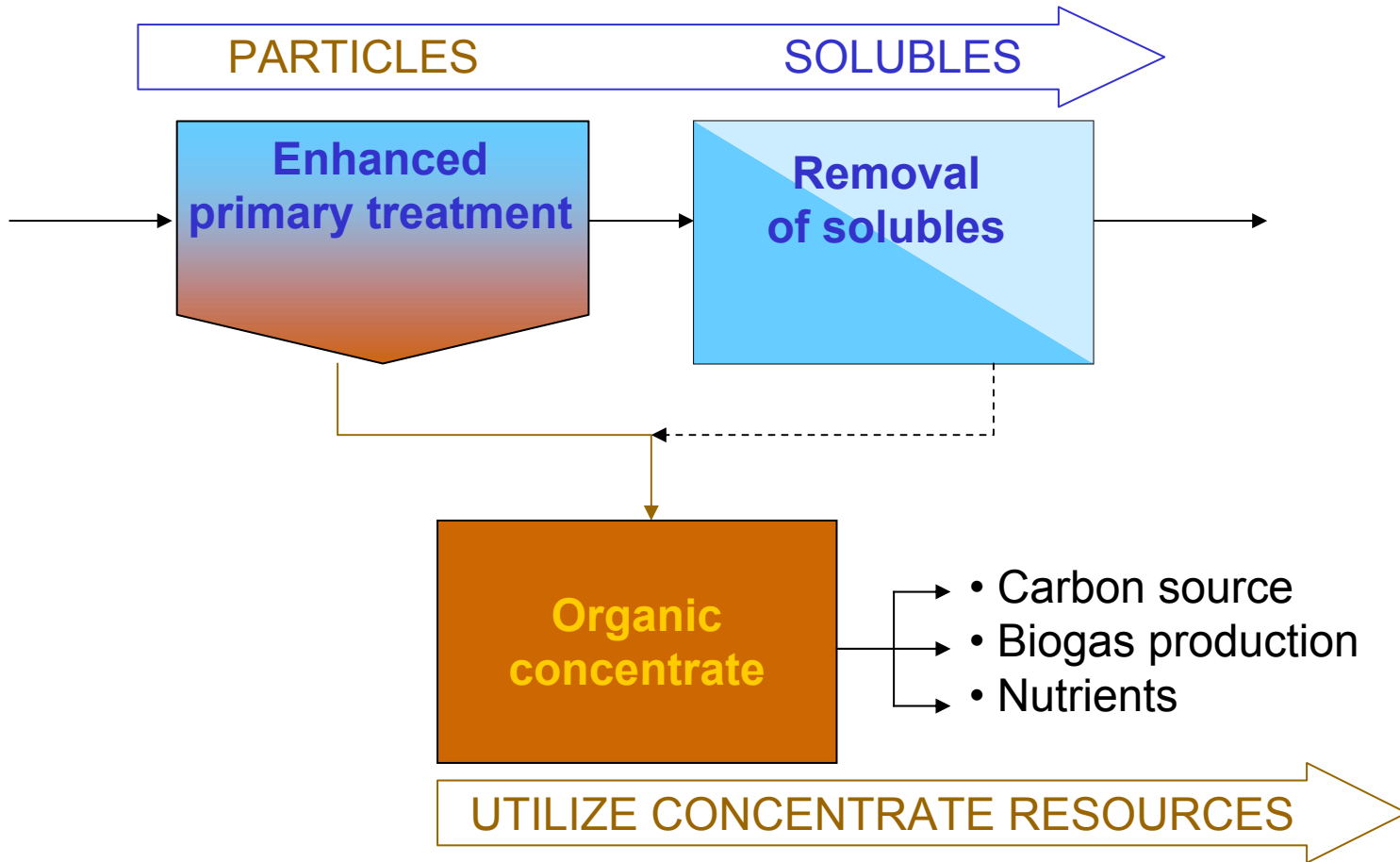


## Post-sedimentation:

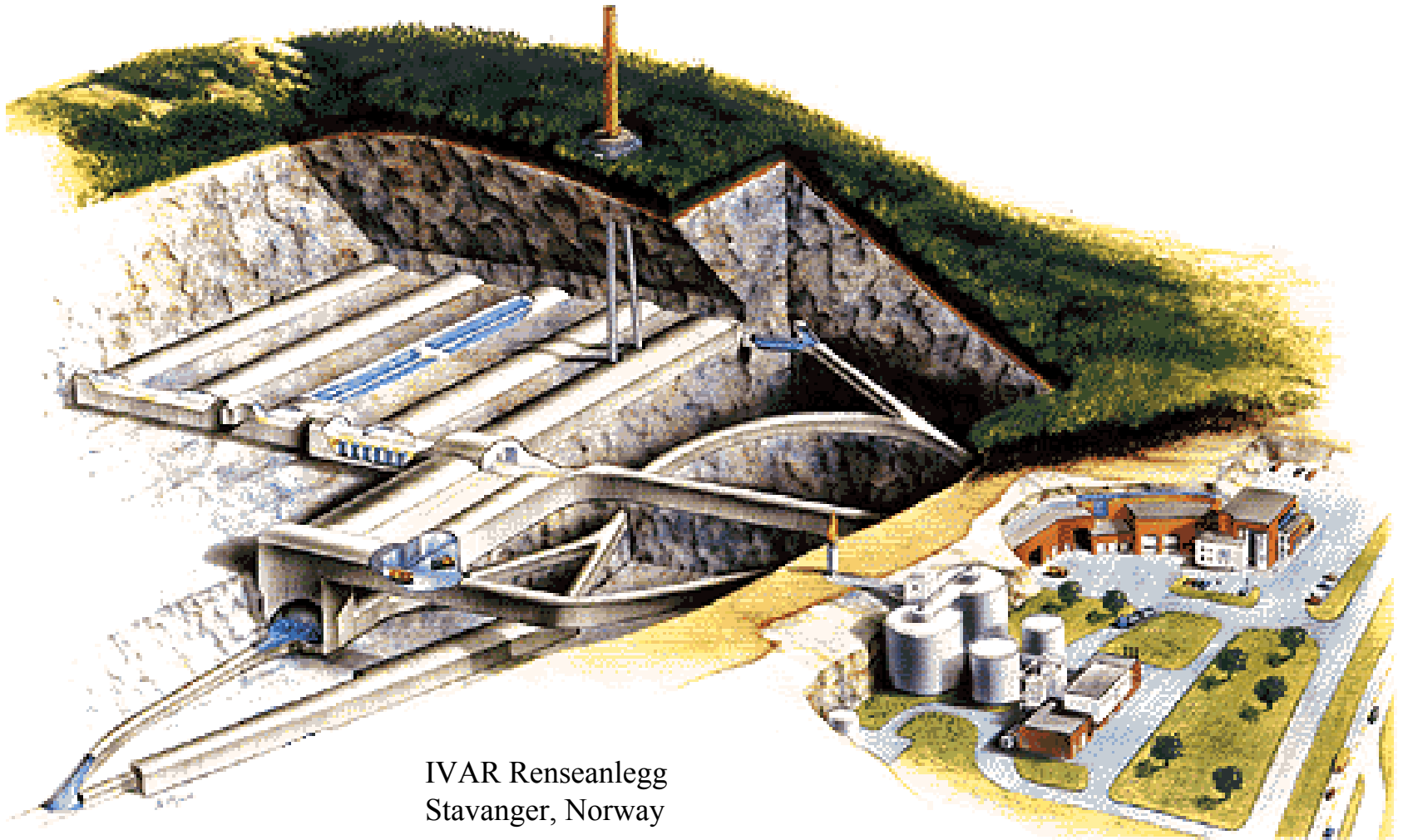




# Wastewater treatment philosophy:



# Typical treatment plant solution:

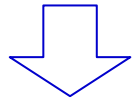


IVAR Renseanlegg  
Stavanger, Norway

# “The blue planet”:

Water resource management challenges:

- water use
- water quality
- water management



## “Wastewater as a resources”



- the water itself
- constituents
- heat

