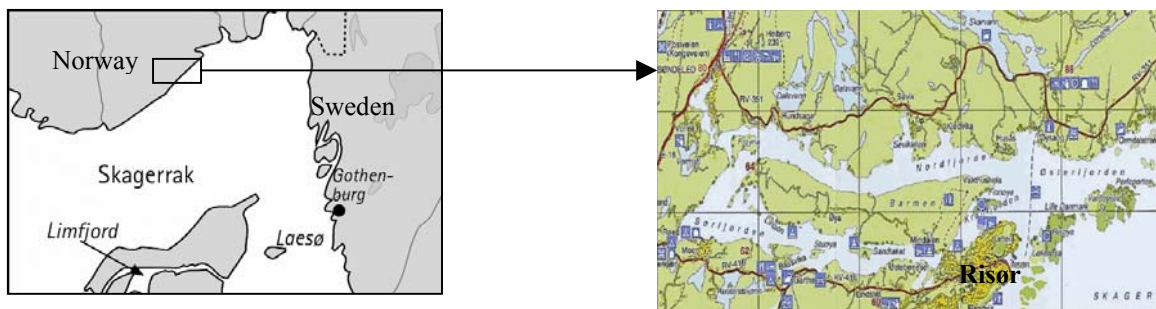


WT 7.6 NORWAY SOUTH-EAST – THE SØNDELED FJORDSYSTEM

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2. The Søndeled fjord-system (Østerfjorden, Nordfjorden, Sørfjorden and Kranfjorden) is situated at the southern coast of Norway. It is separated from the open Skagerrak by islands and sounds.

3. Characteristics

<i>Marine System</i>	The Søndeled fjord-system is a typical threshold-fjord along the southern coast of Norway, separated from the open Skagerrak by islands and sounds with sills of 30m or less. Inside the sills are sheltered fjord basins with depth up to more than 180 m. Above the sill-level the fjord has an efficient water-exchange with the open Skagerrak. The deeper parts of the basins may suffer from low oxygen and some of the innermost basins are permanent anoxic. There are fisheries of cod in the fjord and shallow areas with eel-grass are important nursery grounds. Some mussel plants are located in the fjord-system. The fjord is considered moderately eutrophicated due to input of nitrogen from local sources as well as long-distance transport with currents from the European continent.
<i>Watershed</i>	The watershed constitutes both urban and rural settings and is about 516 km ² . A river with a mean flow of about 8 m ³ /s enters the innermost basin. In addition about 2 m ³ /s of freshwater enter the fjord-system via brooks and as diffuse run-off. The nutrient loading is primarily from diffuse sources. Only 3-4% of the watershed is agriculture fields, while about 70% is forest. The outer part is most urbanized with about 6000 inhabitants, and there is also somewhat industrialized. In the Kranfjorden there is chemical pollution of the sediments from earlier wood-processing industry. Shoreline development with constructions as houses, cottages, landing stages, piers/quays, cables and pipes frequently has lead to conflicting interests in the area.
<i>Human Activities</i>	The area is important for <u>recreation and tourism</u> . There are <u>commercial fisheries and mussels plants</u> in the fjord-system.
<i>Impact Responses</i>	Eutrophication has caused enhanced oxygen consumption and changes in epi- and hyperbenthos communities, possibly changes in primary production and in the phytoplankton community, including higher frequency of harmful species. Shifts in the food web may further have affected the pelagic – benthos interactions and recruitment of marine species. The wood-processing industry has lead to accumulation of mercury and copper in the sediments. The fishery pressure may cause over-fishing of important commercial species. The construction activities in the coastal zone may cause habitat destruction (e.g. <i>Zostera marina</i>), by dredging, dumping, fillings and artificial beaches, reduced value of fishing and trawling grounds because of cables, pipelines and marine installations. Mussel plants may hinder sailing and leisure fishing and enhance local biodiversity and production.

4 Policy

<i>Policy issues</i>	Reducing input of nutrients. Estimate the contribution from local sources versus long-distance sources. Evaluate possible effects of leakage of toxic substances accumulated in the sediments of the fjord. Discussions of costs/benefits by cleaning up. Fish and lobster stock assessment. Marine protected areas for European lobster. Establishing of artificial reefs for European lobster. Causes to, and effects of oxygen deficiency. Habitat mapping and development of GIS-tools for ICZM. Improvement of the coastal zone plans. Conflicts related to shoreline development. <u>Benefits and drawbacks of mussel production.</u>
<i>Policy changes</i>	Change in discharges of nutrients and toxic substances to the fjord due to national and international agreements, which led to construction of treatment plants. Increasing effort to include marine resource and user area in the coastal zone planning. Stricter enforcement and control regarding building activity in the coastal zone. Establishing of MPA.

<i>Future Policy changes</i>	Establishment of Marine protected areas. New national regulations for Environmental Impact Assessment (EIA), incorporating the EU directive on Strategic Environmental Assessment (SEA). EU directives (e.g. water framework, Habitat, Nature 2000)
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5 Stakeholders and Institutional Governance

<i>Major organizations</i>	Municipality and County Administration, Ministry of Fisheries, Ministry of Environment, State Pollution Authorities, National Food Control Authorities, Fishermen organizations.
<i>Other leading Organizations</i>	Nature conservation organization “Naturvernforbundet Austagder” Aquaculture industry: “Skjelldyrker Forum” Sailboat owners organisation: “Risør Seilforening” Local fishermen’s organisation: “Fiskarlaget Sør”

6 Partner Collaboration

<i>SPICOSA Partner Collaborations</i>	Partners: NFH Univ. of Tromsø (Professor Ola Flaaten) and UCB :Univ. Bodø (Professor Audun Sandberg)
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7 Systems Data

<i>Long time series</i>	<ul style="list-style-type: none"> - Ocean climate/sea-temperature (80 years/55 years) - Oxygen in deep-water (since 1920) - Recruitment of cod and some other fish-species and biodiversity of littoral fish (since 1920) - Nutrients in coastal waters (Measurement of nutrients (N, P, Si) as well as salinity and temperature since ~1980 (25 years)) - Phytoplankton monitoring, including harmful algal (High frequent sampling at a fixed station and along a transect since ~1980 (25 years)) - Coastal-zone monitoring. (Hydrology, chemistry, plankton, hard-bottom and soft-bottom surveys since 1990 to date (14 years)) - Stock assessments, fish, lobsters and shrimps (various periods of official statistics and own data collection) - Official register of Ground Properties, Addresses and Buildings - GAB (20 years)
<i>Research Projects</i>	<ul style="list-style-type: none"> - Project title: The Flødevigen Beach Seine Surveys (1919 to date) - Objectives: 1. Study the recruitment of gadoid and other fish species at the Norwegian Skagerrak Coast. 2. Monitor the coastal fish community and its variation in time and space 3. Use variation in the biodiversity of the fish community as an indicator of the environmental situation. - Principal Investigator: J. Gjøsæter, Institute of Marine Research, Flødevigen - Project title: Environmental condition in fjords along the Norwegian Skagerrak coast - Objectives: Monitoring program on nutrient, chlorophyll and oxygen conditions in fjord along the Skagerrak coast. - Principal Investigator: E.Dahl, Institute of Marine Research, Flødevigen - Project title: The response of hyperbenthos, infauna, and foraminifera to hypoxia in fjord-basins: Searching for indicator organisms and controlling environmental factors. - Objectives: Increase the knowledge of the effects of eutrophication on the bottom-fauna of fjords and establish controlling environmental factors. - Principal Investigator: L. Buhl-Mortensen, Institute of Marine Research, Bergen. - Project title: Population structure in cod from the Skagerrak Coast - Principal Investigator: H. Knutsen, Institute of Marine Research, Flødevigen. - Objectives: Describe the genetical structure of coastal cod stocks, and study the exchange between them and the influence of oceanic cod stocks (North Sea cod) - Project title: MPAs in coastal Skagerrak - Principal Investigator: N. C. Stenseth, Institute of Marine Research, Flødevigen. - Objectives: A model system for understanding lobster demography and successful introduction of MPAs in temperate waters.