Environmental Baseline Studies and Monitoring as a Platform for Marine Management

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How can we share the Norwegian experience?
Oil industry and fisheries, Norwegian experience.
Fisheries was the most important industry in Norway when oil exploration started 40 years ago.
A few years later the fast growing offshore petroleum industry took the lead as Norway’s economically most important industry.
The situation is similar in many developing countries.

Petroleum is an unrenewable resource that will be important for a limited period of time, while fisheries represent a renewable resource with a potential of development and increased production.
Norwegian Sea Areas

Source: Directorate for Nature Management
Petroleum provinces on the Norwegian Continental Shelf
Transportation of natural gas

Gas management system

- Gassco – independent operator
- Gassled – unified ownership
- Regulated access regime – flexible and transparent
Integrated Management Planning

Ecosystem-based

Assessment of cumulative environmental effects
Integrated management plan: Barents Sea – Lofoten Islands

Purpose:
Sustainable use of natural resources and safeguarding of the environment
Particularly valuable areas for fish: Cod, Haddock, Herring, Capelin
Particularly valuable areas for seabirds
Managing risk of acute oil pollution from sea transport
Scientific basis:

Particularly valuable and vulnerable areas that require special attention
Need for knowledge improvement

Seabed, coral reefs etc.

Seabird distribution

Screening of hazardous chemicals

Geological mapping
Steering group in MAREANO

- Ministry of fisheries and coastal affairs
- Ministry of environment
- Ministry of business and trade
- Ministry of oil and energy

Program group in MAREANO

- Directorate for fisheries management
- Directorate for nature management
- Norwegian Geological Investigation (NGU)
- Norwegian Polar Institute
- Norwegian petroleum Directorate
- Climate and Pollution Agency
- Norwegian Coastal Administration
- Working group: IMR, NGU and SK (mapping.authority)
The integrated management planning approach considers both environment and economic activity through an ecosystem approach.

- Provides a predictable framework for economic activities.
- Safeguards the especially valuable and vulnerable areas against acute oil pollution.
- Introduces more coordinated and systematic environmental monitoring and mapping, strengthening the basis for future decisions and measures.
Coexistence between Oil industry and Fishery

• **Norwegian experience**
  – 40 years of coexistence between Oil industry and Fishery
  – Marin Research (The Nansen Program)

• **Environmental monitoring**
  – Cooperation with Angola, Ghana and JDZ
  – 14 other countries expressed interest in a similar concepts for environmental monitoring
  – Environmental Monitoring Monitoring Plan according to standard procedures (OSPAR- guidelines)

• **Challenges**
  – Technical equipment
  – Preparation of samples
  – Capacity building (education)
  – Data management
Different users of the sea
Political ambition for co-existence between the petroleum industry and fishing industry both in Norway and other countries

Knowledge about environmental conditions is an important factor
Legislation and regulations are often in place but the systems for auditing, control and enforcement are not fully implemented.
Discharges from oil and gas production offshore

Samples analysed according to Norwegian standard (based on OSPAR guidelines)

- total organic material
- grain size distribution
- hydrocarbons (THC/PAH)
- heavy metals
- soft bottom macro fauna

Standard sampling design

Sampling in 4 directions

250 m
500 m
1000 m
Down stream
Video-Grab samples pictures and video down to 4000 meters depth
The 2006 Cabinda study
Significant contamination by Petroleum related chemicals (red dots)
The start of a Ghanaian Environmental Monitoring program?

Close cooperation between the various authorities Environmental, Petroleum and Fisheries and good communication with the Industry is the key to success.
Swimming sea cucumber
1000 meters depth
GHANA

Environmental sampling for baseline studies in shallow water with assistance from local fishermen
Local Shipyard in Sekondi are still building traditional fishing boats.
Remote sensing of the ocean using acoustics

1) Using multi-beam echosounders to obtain detailed maps of sea bottom
Deepwater coral reef in Ghana
Investigated using the Videograb
Development stages of marine fish larvae

Atlantic Halibut
Water column Monitoring

In situ deployment of fish, mussels and passive samplers to monitor accumulation and effects of contaminants.
SIMPLIFIED FOOD CHAIN

PHYTOPLANKTON

ZOOPLANKTON

SMALL FISH & JUVENILES

FISH

SEA MAMMALS

NUTRIENTS

USED FOR CAGING EXPERIMENTS
Experience from Caging Experiments

- Fish cages using light to attract food organisms has successfully been used in environmental monitoring both offshore and in coastal waters.

- Fish has been kept in cages up to 1 year without additional feeding.

- Growth rates up to 0.7% per day has been recorded.

- 3 different species - Cod, Saithe and Haddock have successfully been tested in caging experiments.

- Can use fish from a group with "known history".

- Blue mussels and passive samplers can be attached to the cages.

- Multiple sampling is easy, in some experiments cages have been sampled every 6 weeks over a 6 months period.
Mongstad Oil Refinery
Located in a Norwegian fjord

• Two cages 100 meters from the discharge diffuser

• Two reference cages 6 km away from diffuser - closer to the open ocean

• Low hydrocarbon concentrations in discharge water

• Accumulation of hydrocarbons in liver and elevated levels of bile metabolites are shown at both locations

• Accumulation and distribution through the food chain

• The largest components seems to have the widest distribution

Example of bile metabolites from caged Cod
Surface buoy with wind generator and communication

Cold water coral reef

Satellite with camera and current meter

Lander with acoustic Sensors and sediment trap
Fully equipped survey vessel designed to operate in protected waters. High-resolution, multi/single beam echo sounders and sidescan sonar are well suited for shallow water seabed surveys. ConCat can operate where other vessels normally dare not navigate and may be stowed in a standard container for Shipment world-wide.

**ConCat specifications:**
- **Length:** 9.40m
- **Width:** 3.70m
- **Draft:** 0.45m
- **Weight:** 4.8MT
- **Speed (max):** 18 knots
- **Main engines (two):** 164 Hp (each)
- **Gearbox:** Alamarin 230
- **Water jets (two):** Hurt HSW450D
Drinking water is a valuable resource

Lake Volta has good water quality. Production and sales of drinking water is an important industry

There are expectations for future oil production in this area

The value of 1 litre clean drinking water is approximately twice the price of 1 litre of crude oil
If we lose control with activities and discharges to sea and waters (industry, fish farming) "unexpected consequences can occur.

Thank you.