

# Causal chain analysis

**This section aims to identify the root causes of the environmental and socio-economic impacts resulting from those issues and concerns that were prioritised during the assessment, so that appropriate policy interventions can be developed and focused where they will yield the greatest benefits for the region. In order to achieve this aim, the analysis involved a step-by-step process that identified the most important causal links between the environmental and socio-economic impacts, their immediate causes, the responsible human activities and economic sectors and, finally, the root causes that determine the behaviour of those sectors. The GIWA Causal chain analysis (CCA) recognises that, within each region, there is often enormous variation in capacity and great social, cultural, political and environmental diversity. The CCA uses a relatively simple and practical analytical model. For further details on the methodology, please refer to the GIWA methodology section in the end of this report.**

The prioritised transboundary issues of oil spills in the Okhotsk Sea sub-system, eutrophication in the Amur River sub-system and overexploitation in the whole region are studied further in the CCA in order to identify their root causes so that policy options and priority actions can be developed by decision-makers in the region to address these driving forces of adverse environmental pressures. For further details of the environmental and socio-economic impacts, and immediate causes of the prioritised concerns, please refer to the Assessment chapter.

- penetration in the water column and, therefore, the productivity of photosynthetic plants;
- Increased ecological risks, including poisoning of fish;
- Decreased oxygen levels due to an increase in microscopic organisms which feed on decaying plant matter;
- Algal blooms in coastal and freshwater systems;
- Reduced biodiversity;
- Changes to the hydrological, chemical and temperature regimes;
- Deterioration of reproduction and spawning conditions; and
- Migration of species away from affected areas.

## Eutrophication

### Environmental and socio-economic impacts

#### Environmental impacts

- Poor water quality and pronounced eutrophication during minimal flow periods in the winter and summer;
- The water quality of the Lower Amur is classified as V-VI (i.e. contaminated, polluted, or heavily polluted);
- The growth of phytoplankton and zooplankton has reduced light

#### Socio-economic impacts

- Reduced fisheries productivity;
- Loss of recreation amenities and unpleasant odours during the winter;
- Decreased availability of potable water for the population in Priamurye;
- The consumption of contaminated fish is affecting the health of indigenous populations, particularly those living on the banks of the Amur, Nanaian, Ulchi and Niwchs rivers.

## Immediate causes

Considerable quantities of organic matter and biogenic material enter the Amur River within domestic and industrial wastewaters and surface run-off from the basin (particularly during periods of heavy rainfall). The run-off of fertilisers from agricultural areas also stimulates eutrophication.

The sectors responsible for eutrophication were identified by the GIWA regional experts as:

- Industry
- Urbanisation
- Agriculture
- Aquaculture

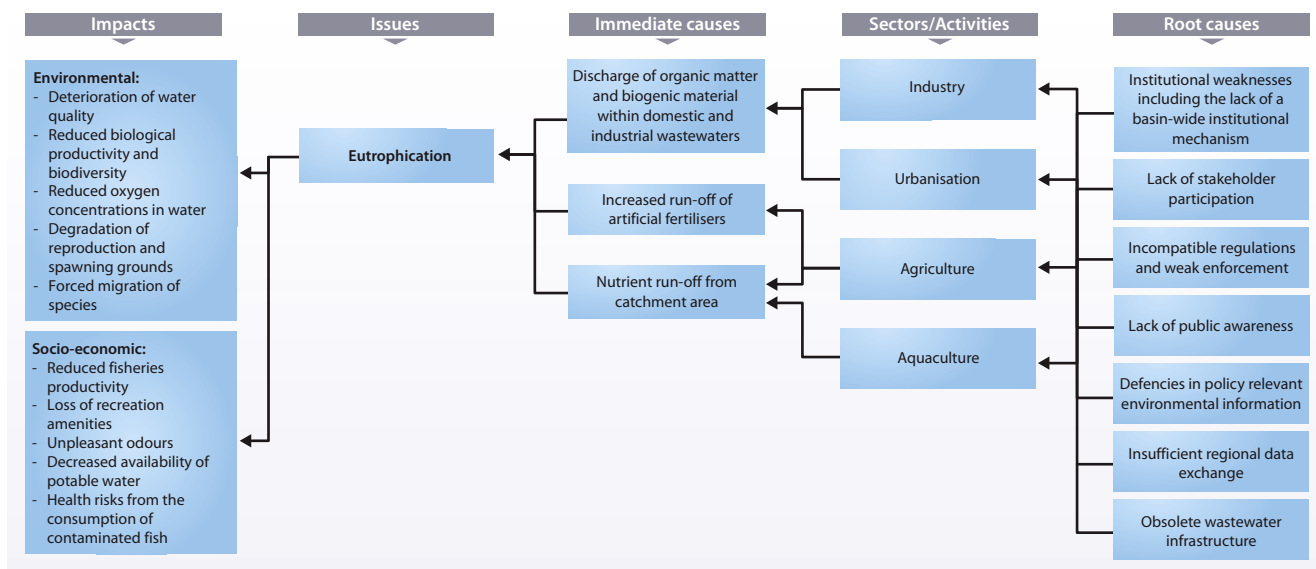
## Root causes

There are a number of institutional weaknesses which are either promoting or failing to prevent transboundary pollution in the Amur River Basin. These include, among others: (i) lack of economic planning harmonised with the need for conservation and sustainable use of living resources and ecosystem functions in the basin; (ii) inadequate basin-wide legal and institutional arrangements among the riparian countries in addressing transboundary environmental issues; (iii) inadequate capacities of institutions involved in water and other resource management and environmental protection, and lack of wider stakeholder participation; (iv) significant gap in information and monitoring activities in identifying transboundary environmental issues in the basin; (v) lack of harmonised designation of protected areas among the riparian countries and gap in the degree of enforcement

of regulations for protected areas; and (vi) lack of public awareness, and creation and mobilisation of civil communities in monitoring and management of land and water in the basin (GEF Concept paper 2005).

Each riparian country explores its own economic development and/or conservation of ecosystems. However, in the absence of a basin-wide institutional mechanism, transboundary issues were not given attention in national policy and each riparian country's conservation efforts were not conducted in an efficient manner. To date, there have been limited basin-wide cooperative actions, although local governments have demonstrated a willingness to work together in addressing transboundary issues. Further, stakeholders do not have platforms to discuss and provide suggestions for decision-making institutions with their country or regionally. Differences in regulations and weak enforcement capacities have led to uncoordinated approaches to the management of protected areas (GEF Concept paper 2005).

Each country has developed its own monitoring programmes to provide baseline environmental information. However, there is a serious gap in the amount of available data and their quality for the purpose of technically sound, policy-relevant decisions. Many of the data produced by the riparian countries are not comparable in their quality, and much of the information is not accessible by the public or decision-makers, particularly beyond the national boundaries (GEF Concept paper 2005). A major hindrance for policy-makers when setting priorities for remediation is the lack of knowledge of the ecological characteristics and their reaction to human activities. The



**Figure 13** Causal chain diagram illustrating the causal links for eutrophication in the Amur River Basin.

Khabarovsk and Amur Scientific Centres of the Far East Branch of the Russian Academy of Sciences have collated data on different natural parameters, complexes and ecosystems. There has, however, been no comprehensive assessment of this data (Voronov 2003). The true impact of pollution on freshwater ecosystems in the Basin is unclear. The public lacks awareness of the environmental issues, including eutrophication, affecting freshwater ecosystems and their well-being. Information exchange between the countries sharing the Amur River Basin is limited and policy-makers, the public and other stakeholders have insufficient access to ecological databases and information. There is also the absence of a basin-wide monitoring system.

Wastewater treatment infrastructure is often obsolete due to insufficient funds for maintenance and a lack of investment in new facilities. Economic root causes of environmental degradation, including the demand for short-term economic gains, an inappropriate taxation system and financial-credit policies, inequitable development within the region, and the unattractive investment climate, stem from the Russian Far East's long economic recession and the major reforms in the economic and social structures of Russia.

The linkages between the root and immediate causes of eutrophication and their environmental and socio-economic consequences in the Amur River Basin sub-system are presented in Figure 13.

## Oil spills

### Environmental and socio-economic impacts and immediate causes

Despite four spills occurring in the region, the overall impact of oil spills has not been too severe. The rapid development of the Russian Sakhalin shelf for oil and gas exploration, exploitation and transportation will, however, increase the probability of oil spills. Despite providing many economic benefits, oil and gas production in Sakhalin may cause ecological problems. For example, oil spills would degrade spawning habitats of commercially important fish in the region. The northeastern coastal waters of Sakhalin Island will be particularly vulnerable to future oil spills (PICES 2004). Further, when drilling oil wells and during oil production, poisonous waste products are produced.

Oil and gas exploitation is likely to also commence on the northwest shelf of Kamchatka and in the lower reaches of the Amur River Basin. Oil refining and gas processing will be developed in Sakhalin Island and in Khabarovskiy Kray, but limited amounts will be processed in Kamchatka.

There are plans to establish an oil and gas distribution network to supply the markets of the Asian-Pacific Region. Pipelines from Siberia and Sakhalin to Vladivostok are planned, some of which would be laid along the Amur River. Two alternative oil pipeline routes and several transnational gas pipelines are proposed (Alekseev et al. 2001).

The future socio-economic impacts of potential spills in the Okhotsk Sea sub-system will include the cost of oil spill response and clean-up operations, the rehabilitation of habitats, and ecological protection and monitoring, as well as the rehabilitation and treatment of rare and commercially important species (Baklanov et al. 2002a).

### Root causes

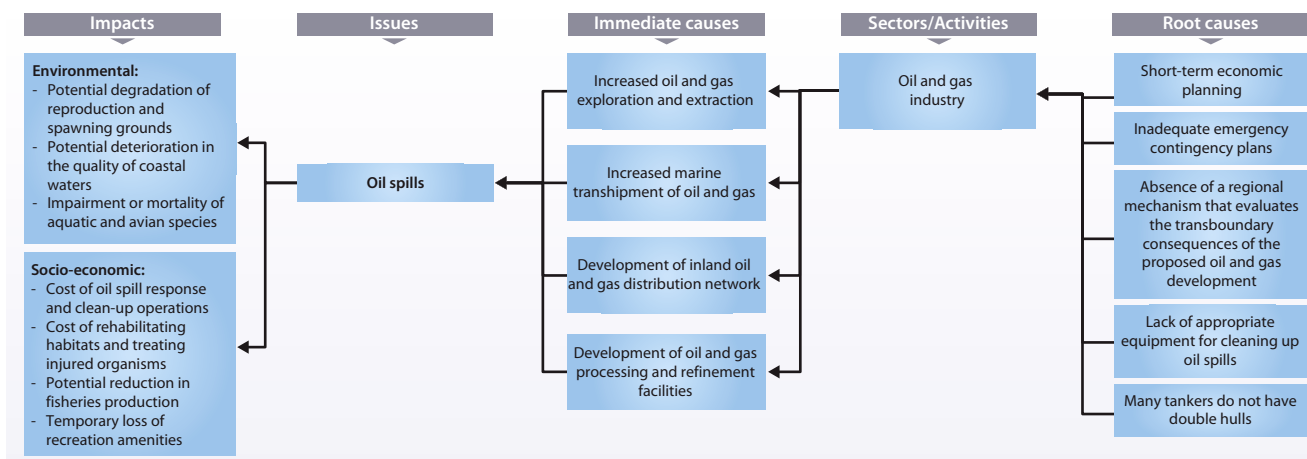
In the Russian Far East, oil and gas exploitation is seen as a means of generating immediate revenues. Government authorities, international companies, and public financial institutions have focused their attention on developing the Sakhalin's oil and gas fields as rapidly as possible. Limited effort has been made to strengthen Sakhalin's capacity to prevent and respond to oil spills (Lawn et al. 2001).

There is a lack of preparedness for an environmental emergency and insufficient measures have been adopted to mitigate any possible impact on coastal marine and freshwater ecosystems. There is an absence of a regional mechanism that evaluates the transboundary consequences of the proposed oil and gas infrastructure and associated economic development. Public discussion among the riparian countries about these issues has not been initiated (GEF Concept paper 2005).

Currently, there is a lack of funding for environmental protection and social welfare programmes in order to avoid the negative consequences of oil and gas development in the region. The region lacks the necessary equipment for cleaning up oil spills during periods of fast-ice consolidation. The Sakhalin Basin Agency for Emergency Situations has insufficient technical resources to decontaminate large and/or remote oil spills. Many oil tankers operating in the region do not have double hulls.

According to the GIWA regional experts, these root causes are determined by the poor economic development in the Russian Far East and the dramatic social and economic changes Russia has experienced over the past 20 years.

The linkages between the root and immediate causes of oil spills in the Okhotsk Sea sub-system and their environmental and socio-economic consequences are presented in Figure 14.



**Figure 14** Causal chain diagram illustrating the causal links for oil spills in the Sea of Okhotsk.

## Overexploitation of fish and other living resources

### Environmental and socio-economic impacts

#### Environmental impacts

- The main commercial fish stocks have been severely depleted;
- Regional populations of whales have declined dramatically, with many species endangered or critically endangered;
- Stocks and catches of the main commercial fish species – walleye pollock – reduced more than two-fold within two decades;
- Species which are valuable on the international fish markets, such as sea urchin and king crab, are at particular risk;
- Overfishing of the main commercial species has destabilised the aquatic ecosystems of the Sea of Okhotsk region.
- Populations of Chum and Humpback salmon, and sturgeon, among others species, have decreased in the Amur River due to overfishing.
- The average fish size in the Amur River Basin has decreased with catches containing a higher proportion of juvenile fish.

#### Socio-economic impacts

- Reduced catches has caused a downturn in the fisheries industry;
- High unemployment in the fisheries sector;
- Reduction in economic returns and investment activity;
- Consumption of fish products per capita has decreased;
- Social problems and reduced quality of life for inhabitants of fishing communities due to a loss of household income; and
- Increased competition for the limited fisheries resources has led to the growth of a black market in fish products, conflicts between groups of fishermen, and greater corruption.

### Immediate causes

#### Excessive fishing effort and fleet capacity

Over the past several decades, fishing effort has increased dramatically. The capacity of the fishing fleet operating in the seas of the Russian Far East exceeds catch limits by approximately seven-fold. Over 100 crab fishing boats have the capacity to far exceed the average annual allowable catch for King crab (Spiridonov 2001).

#### Excessive by-catch and discards

Although there is a lack of data to verify its impact, the volume of by-catch and discards of non-target species is also believed to be a significant cause of overexploitation (Spiridonov 2001, Ozolinsh & Spiridonov 2001, Kotenev & Zaytseva 2003).

#### Illegal fishing

The uncontrolled extraction of fisheries resources by the illegal fishing sector is contributing to overfishing. Account auditors of the Chamber of the Russian Federation believe that greater volumes of King crab and sea-urchin are often supplied illegally to the Japanese market than the entire catch limit for the Okhotsk Sea (Nazarov 2004). Poaching of Walleye pollock, which has a growing demand in markets of the Pacific region, exceeds established TACs by 2-3 times (Kotenev & Zaytseva 2003, Ozolinsh & Spiridonov 2001, Spiridonov 2001). Illegal fishing is believed to occur in the Amur River Basin sub-system but it has not been fully investigated.

#### Loss of spawning habitat

The spawning habitat of salmon and other fish species has been degraded due to eutrophication and other forms of pollution in the Amur River Basin and in the rivers of Sakhalin. Fishing and habitat

modification have led to the disappearance of sturgeons, salmon and other fish species in the Songhua River (China).

## **Root Causes**

### **Economic**

Economic policy and market trends have aggravated the problems faced by the fishing sector. The reform of Russian economic policy, market failures, and inappropriate taxation and financial credit systems are causing economic hardship for fishing communities and forcing fishermen to increase fishing effort in order to receive sufficient income. As a result of these economic conditions, the social and environmental problems of the fishery have been aggravated (Voitolovsky et al. 2003, Titova 2004).

The large number of intermediaries between fishermen and consumers has led to a significant rise in the prices on the domestic market which has decreased consumer demand. The decline in domestic fish sales has negatively affected the prosperity of fishing communities. While increased demand for specific species on the international fish market has resulted in their overexploitation, other species remain underexploited.

The excessive by-catch and discard of non-target species and small fish, as well as the growth of the illegal fishery, are associated with fishermen needing to increase their income in the short-term. Moreover, fishermen land their catches at the ports of other coastal states in order to avoid registering their catches in Russia.

The introduction of auctions of fish quota-rights, in addition to a burdensome tax system, has reduced the profitability of the fisheries, resulting in fishermen undertaking poaching and illegal fishing in order to supplement their income. For the purchase of a King crab quota to be economically viable, it is necessary to catch 3-4 times more crabs than the quota allows (Korelsky et al. 2003). The requirement of purchasing quotas has led to inflated fish prices, increased debt and a reduced income for fishing households (Zilanov 2004). Fishermen are forced to catch more fish in order to maintain their profit levels. The existing fishing auction system is perceived negatively by the majority of fishermen. The reduction in economic returns and investment activity in the fisheries sector has prevented the modernisation of the fleet and fishing gear.

### **Legal**

Russian and international fisheries laws and regulations are undermined by deep-rooted corruption and ineffective enforcement (despite vessel confiscations by the Russian coast guard). The weak legislative framework in Russia leads to the illegal export of fish products to Japan

and the Republic of Korea. The illegal export market to Japan is around 20 times more valuable than the legal market (5-7 billion USD compared to 300 million USD) (Okey 2003).

### **Governance**

Fisheries management is opaque to the public and fishermen, and highly corrupt. Coastguards detain no more than 2% of the fishermen who violate the law and some even participate in poaching themselves (Ozolins & Spiridonov 2001). In 2000-2001, annual illegal catches in the Far East seas of Russia caused by the inefficient monitoring and enforcement system have been estimated at 1.5 million tonnes of Walleye pollock and 27 000 tonnes of King crab (Kotenev & Zaytseva 2003). Russian fishermen are dissuaded from landing their catches in Russian ports due to complicated, bureaucratic procedures and having to pay fees. Bribing of officials is known to occur in the region (Voitolovsky et al. 2003). Small-scale fisheries and coastal fishing associations have not been supported during the periods of political and economic reform (Belyaev et al. 2004). Alternative employment opportunities are neither available nor created by the government.

### **Technology**

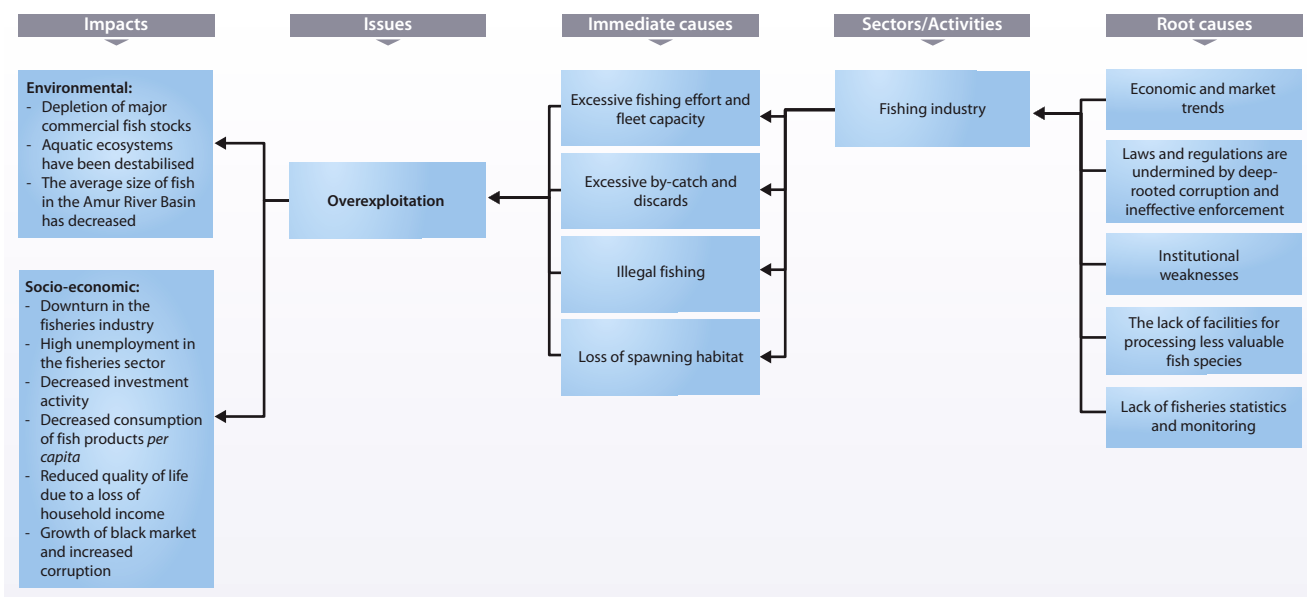
Drift nets are used in the salmon fishery of the Okhotsk Sea sub-system. Although the number of vessels using these nets has reduced considerably since the 1970s, one of these vessels can kill about 1 000 sea birds, ten dolphins and several seals in one year. Some sea birds are attracted to the searchlights of vessels fishing at night for crabs and become caught in the nets. When crab traps are disposed of overboard they pose a great danger to sea vertebrates and fishes. The number of such traps left on the sea bottom continues to increase every year (Ozolins & Spiridonov 2001).

Stocks of invaluable fish species, such as Green cod, flounder, squid and various shrimp species are underexploited. The fishing fleet and coastal processing plants are not equipped to process these less valuable fish species (Spiridonov 2001).

Today, the average ages of large-capacity vessels (with an operational age of 20 years), medium capacity vessels (with an 18 year operational age) and small capacity vessels (with a 12 year operational age) are 21.6 years, 15.6 years and 18.9 years respectively. Due to the ageing of fishing and tinned food mother-ship vessels, many are out of service and have not been replaced.

### **Education and knowledge**

According to the GIWA regional experts, there are a lack of fisheries statistics and monitoring programmes. An ecosystem approach is not



**Figure 15** Causal chain diagram illustrating the causal links for overexploitation in the Sea of Okhotsk region.

used to calculate TAC quotas. There is inadequate knowledge of the size of fish stocks and their maximum sustainable yield (Kotenev & Zaytseva 2003). Until recently, by-catch had not been considered in fisheries statistics or in establishing catch quotas (PICES 2004), and fisheries managers have insufficient access to ecological databases. Fishermen lack awareness of the long-term impacts of overfishing on the viability of regional fish stocks and, consequently, their future livelihood. There is insufficient exchange of fisheries information between the countries

fishing in the Sea of Okhotsk region (Ozolinsh & Spiridonov 2001, Novomodny et al. 2004). Additionally, environmental education and ethics are weak and there are few research agreements between Russia, China and Mongolia (Novomodny et al. 2004).

The linkages between the root and immediate causes, and the environmental and socio-economic impacts of overexploitation in the Sea of Okhotsk are presented in Figure 15.