Assessment

Table 5 Scoring table for the Oyashio Current region.

Assessment of GIWA concerns and issues according to scoring criteria (see Methodology chapter)				The arrow indicates the likely direction of future changes.	
0 No known impacts	2 Moderate impacts			↗ Increased impact	
1 Slight impacts	3 Severe impacts			→ No changes	
				↘ Decreased impact	

Oyashio Current	Environmental impacts	Economic impacts	Health impacts	Other community impacts	Overall Score**	Priority***
Freshwater shortage	0* →	0 →	0 →	0 →	**0**	**5**
Modification of stream flow	0					
Pollution of existing supplies	0					
Changes in the water table	0					
Pollution	0* →	0 →	0 →	0 →	**0**	**4**
Microbiological pollution	0					
Eutrophication	0					
Chemical	0					
Suspended solids	0					
Solid wastes	1					
Thermal	0					
Radionuclides	0					
Spills	1					
Habitat and community modification	0* →	0 →	0 →	0 →	**0**	**3**
Loss of ecosystems	0					
Modification of ecosystems	1					
Unsustainable exploitation of fish	1* →	0 →	0 →	1 →	**0.5**	**2**
Overexploitation	1					
Excessive by-catch and discards	0					
Destructive fishing practices	1					
Decreased viability of stock	0					
Impact on biological and genetic diversity	0					
Global change	1* →	1 →	0 →	0 →	**0.5**	**1**
Changes in hydrological cycle	2					
Sea level change	0					
Increased UV-B radiation	0					
Changes in ocean CO_2 source/sink function	1					

* This value represents an average weighted score of the environmental issues associated to the concern.

** This value represents the overall score including environmental, socio-economic and likely future impacts.

*** Priority refers to the ranking of GIWA concerns.

This section presents the results of the assessment of the impacts of each of the five predefined GIWA concerns i.e. Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, Global change, and their constituent issues and the priorities identified during this process. The evaluation of severity of each issue adheres to a set of predefined criteria as provided in the chapter describing the GIWA methodology. In this section, the scoring of GIWA concerns and issues is presented in Table 5.

Freshwater shortage

The GIWA Oyashio Current region has abundant water resources. Within the boundaries of the drainage basin, total annual precipitation rates increase from south to north: from 1 000 to 1 400 mm in the Kuril Islands to 2 600 mm in the southeast of Kamchatka. However, humidity varies comparatively little over the same area as evaporation increases at nearly the same rate (from 100 to 250 mm annually) (Tersiev 1998, Logan 2001). This results in an extensive river and lake network. There are more than 110 rivers and thousands of streams which flow into the Pacific Ocean on the east coasts of the Kamchatka Peninsula and Kuril Archipelago, the largest being the Kamchatka River. There are also many lakes, the largest being the Nerpichye in the northeast of Kamchatka (Bortin 1999, Chernjaev 2001). As a result of these hydrological features, there is an abundant freshwater supply in the region, with more than 150 000 m^3 per person annually (Bortin et al. 1999).

Freshwater shortage is therefore not a significant concern for the region. Correspondingly, the GIWA issues of modification of stream flow, changes in the water table, and pollution of existing supplies were assessed as having no known impact. However, it should be noted that there is

evidence of localised pollution of surface waters in the regions of Kamchatka and on some of the Kuril Islands (Tkalin 1991a,b), although the impact of this contamination on the region's international waters is negligible as the Oyashio Current has a vast dispersion capacity. Industrial infrastructure that could result in the modification of stream flow, pollution, or aquifer draw-down is largely non-existent.

Conclusion and future outlook

Freshwater shortage is not a major concern for the Oyashio Current region neither at present, nor in the foreseeable future. Kamchatka, the Kuril Islands and Hokkaido have extensive supplies of high quality freshwater in their lakes and rivers.

Pollution

The GIWA assessment concluded that presently only the issues of solid wastes and spills have a slight impact for the Oyashio Current region. The issues of microbiological pollution, eutrophication, chemical pollution, suspended solids, thermal pollution and radionuclide pollution were considered to have no known impacts and are therefore not further discussed.

Environmental impacts

Avacha Bay, on the Kamchatka Penninsula, has increasingly become a source of chemical and radioactive pollution for the Pacific coastal water. However, there is currently no comprehensive assessment of the ecological health of the region's coastal zone.

Solid wastes

The impacts of solid wastes were assessed as slight due to the prevalence of such wastes near human settlements, including seasonal camps. These are predominantly timber and ligneous wastes, which are found along the entire coastline, and municipal waste of various origins and descriptions which accumulates in bays that are in close proximity to coastal settlements and ports. There is no quantitative information on solid wastes.

Radionuclides

This issue was considered to have no known impacts in the region. In the coastal waters of the Kamchatka Peninsula, however, there is some evidence of radionuclide contamination and there remains a potential for future incidents originating from disused nuclear submarines. Due to a changing political climate and deficiencies in the Russian economy, it has become no longer viable to maintain the submarine fleet. Consequently, many submarines remain inoperative at the dockside, resulting in the degradation of their nuclear reactors. As a result, accidents are becoming more common. In 1997 a decommissioned Charlie-class nuclear submarine sank at Rybachy after corrosion allowed water to seep into its hull (Ikeuchi et al. 1999, Petterson et al 1999, Newell 2004, Larin 2004)

The main potential sources of radioactive pollution in the region are: (i) nuclear submarine bases; (ii) ship-repair yards for nuclear submarines; (iii) civil enterprises, where civil vessels with nuclear energy installations are based, repaired and maintained; and (iv) sites used for the temporary storage of radioactive waste and spent nuclear fuel.

Spills

The issue of spills was considered to have slight impacts in the region. At present, crude oil spills in the Oyashio region are rare. Isolated and relatively minor oil spills have been recorded in the Kuril Straits and off the East Kamchatka coast. According to the GIWA Task team, oil slicks have been observed in the oil extraction areas of Sakhalin. Currents flowing from the Okhotsk Sea and the Soya Current transport this oil contamination to the southern Kuril Straits.

The region has a dense network of navigation routes traversing its waters. Many large vessels, including fishing and merchant vessels and tankers, sail through the waters of the Kuril Islands discharging oil hydrocarbons both deliberately and accidentally .

Further exploitation of hydrocarbons in the Sakhalin region and the subsequent increase in oil transport is likely to increase the quantities of contaminants in the Oyashio Current region. According to the GIWA Task team, there is currently a maximum of five spills per year originating from vessels carrying oil products from the southern ports of Far East Russia, particularly Kamchatka. All oil vessels from these ports travel through the Kuril Straits in close proximity to the islands. Furthermore, fishing vessels travel through the straits en-route to the Sea of Okhotsk, the Bering Sea and the northwest Pacific Ocean. However, there is a dearth of information on the adverse environmental effects of spills in the region.

Socio-economic impacts

The GIWA Task team concluded that there is no known economic, health or other social and community impacts as a result of pollution in the Oyashio Current region. If pollution intensifies in the future, however, there will be possible costs from the disruption of shipping, marine reserves and marine scientific activities during the assessment and clean-up of spills.

Conclusions and future outlook

Overall, the impact of Pollution under present conditions was assessed as slight. The most relevant GIWA issues for the Oyashio Current were identified as solid wastes and spills. At present the region's ecosystems, excluding Avacha Bay, are in a relatively satisfactory condition. However, due to the rapid development of oil and gas deposits on the Kamchatka and Sakhalin shelves and the increased volume of oil and gas transported through the Oyashio Current region, oil spills are considered to be a significant future threat to the region. Radionuclides have little effect on the regional environment at present, but their impact may increase with the further corrosion of Russian submarines.

Habitat and community modification

There is no record of serious loss of habitat in the region and there are consequently no known impacts from this issue. There is evidence, however, of some minor habitat modification as a result of the construction of ports, tourism activities and the construction of dams. This issue was considered to have slight environmental impacts.

Since the region has a relatively small economy and is sparsely populated, habitat modification in the region has had no known socio-economic impacts.

Conclusions and future outlook

Habitat and community modification is assessed as having no known impacts. The majority of the regional ecosystems are located far from the developed coastal regions of Japan and Russia, and consequently are not affected by economic development. Wetlands and rivers were considered by the GIWA Task team to have experienced slight environmental impacts but these are localised with no transboundary consequences.

Unsustainable exploitation of fish and other living resources

The fisheries of the Pacific coast of the Kuril Islands are among the most productive in the world. The Oyashio Current LME constitutes Russia's and Japan's largest fishing grounds. The majority of this productive area is situated in Russia's 200 nautical mile Exclusive Economic Zone (EEZ). Many commercially valuable fish species thrive in these waters. Russia's annual income from the regional marine bioresources is estimated to be between 2.5 to 5 billion USD (according to experts from the Russian State Committee for Environmental Protection and the Federal Border Guard Service). More than 4 million tonnes of bioresources are harvested annually in the Russian Far East EEZ. The most sought after species in this region are salmon, Walleye pollock, crab, shrimp, sea urchin and sea cucumber (Greenpeace 2000, Ozolin'sh & Spiridonov 2001, Baklanov et al. 2003).

Fisheries regulations in the region stipulate that all by-catch should be landed, although it is generally believed that some discards occur. However, it is difficult to assess to what degree this is practiced due to an absence of control and monitoring programmes. The GIWA issues of decreased viability of stock, excessive by-catch and discards, and impact on biological and genetic diversity were assessed as having no known impacts and are therefore not discussed further.

Environmental impacts

Overexploitation

The commercial fisheries of the Oyashio Current, such as some stocks of Pacific salmon, King crab, scallop and Pacific sardine, are exploited above biologically safe limits (Ozolin'sh & Spiridonov 2001, Baklanov et al. 2003, Titova 2003). The issue of overexploitation was considered to be moderate only in the southern Kuril area and slight in the remaining part of the region.

Russia licenses foreign fishermen to operate inside the Russian economic zone. Catch quotas are allocated for the various fish species. Up to 150 Russian fishing vessels, as well as Japanese, Taiwanese and Chinese vessels, and flag of convenience ships are believed to practice illegal salmon and calamari fishing in the region during the summer. Records of illegal fishing activities in Russian territorial waters have not been disclosed. Figure 10 demonstrates how the marine catches of the main commercial species of the Oyashio Current LME have declined since the 1990s.

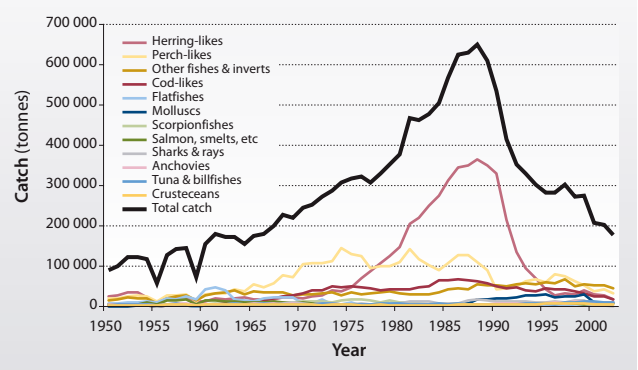

Figure 10 Marine catches in the Oyashio Current.
(Source: Sea Around Us Project 2004)

Figure 11 A team of fishermen pull in a net filled with fish on Kuril Islands, Russia.
(Photo: CORBIS)

Between 1990 and 1996, fisheries production in the Russian Far East declined by 35% (Baklanov et al. 2003, Titova 2003). Catches for each individual species have varied from this overall trend: salmon catches have not changed; catches of flounder have increased by about 15%; and crab and King crab catches have declined by almost 70%. The shelf of the Kuril Islands favours the harvesting of crabs, shrimp, bivalve and mussels (Arzamastzev et al. 2001). The populations of these species have been severely depleted, particularly the King crab, although this has not been attributed to any single factor, such as overfishing (Baklanov et al. 2003). Catches of Walleye Pollock have declined from over 55 000 tonnes in the mid 1980s to less than 15 000 tonnes in the last five years (Sea around us project 2004) (see figure 12).

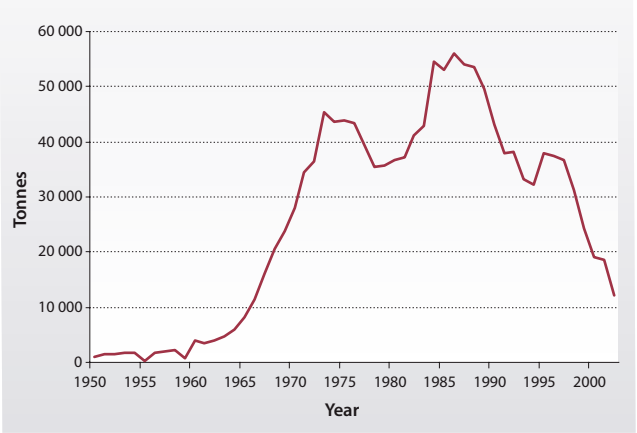

Figure 12 Catch of Walleye pollock (*Theragra chalcogramma*) in the Oyashio Current.
(Source: Sea around us project 2004)

Destructive fishing practices

The GIWA assessment considered the impacts of destructive fishing practices as slight. In Russia, driftnets – a destructive pelagic fishing method – are widely used. In 2000, 74 Japanese vessels using driftnets were licensed to exploit 16 500 tonnes of salmon in the Russian EEZ (Greenpeace 2000). The Russian fishing fleet began to employ driftnet fishing methods only in 1997. Today, approximately five Russian driftnet vessels are in operation, the majority of which are used for scientific studies of species stocks. For salmon fishing, ships tend to use standard 50x8 m driftnets that when interconnected with one another make up a 4 km long set of nets. According to regulations the total length of sets installed by one ship cannot exceed 32 km and the distance between the sets should be at least 4 km. The ends of each set are marked with buoys and radio beacons. Meshes with less than 110 mm diagonal are prohibited. Commercial ships commonly use nets with a mesh of 124 to 132 mm (Greenpeace 2000).

The fisheries quota system is also applicable to all vessels using driftnets, which are liable for inspection by Russian officials (Ozolin'sh & Spiridonov 2001). However, only five inspectors are employed for the entire Kuril Islands region, which covers an area of 840 000 km^2 (Ozolin'sh & Spiridonov 2001, Sea Around Us Project 2004).

Socio-economic impacts

The fisheries and its associated industries are the primary economic activities for the coastal communities of eastern Hokkaido (Japan) and the Russian coast of Kamchatka and the Kuril Islands. However, the

overexploitation of certain commercial species and reduced catches has not significantly affected the economy of these communities in terms of employment, income, and investment activity. Economic impacts from the Unsustainable exploitation of fish and other living resources were considered to be negligible.

There is no evidence of a direct link between the level of exploitation of the Oyashio Current fish stocks and the health of the population. Therefore, this concern was not considered to have any known health impacts on the region.

Illegal foreign fishermen are operating in fishing grounds that have been traditionally fished by the coastal communities. There is concern amongst these communities over the depletion and possible exhaustion of the fish stocks which are fundamental to their livelihoods (Figure 11). Therefore, this concern was assessed as having slight social and community impacts.

Conclusions and future outlook

According to the GIWA Task team, the Unsustainable exploitation of fish and other living resources has a slight impact on the Oyashio Current region. The issues of overexploitation and destructive fishing practices around the Kuril Islands were also assessed as having a slight impact. The overexploitation and discarding of fish in the Oyashio Current region is likely to remain a problem in the foreseeable future. However, the intensity of overfishing is generally not too severe, allowing stocks to restore themselves periodically . As a result of the development of other marine sectors in northeastern Russia and Japan, it is likely that regional dependency on the fishing industry will be reduced in the forthcoming decades, which in turn will reduce the socio-economic impacts of a downturn in the fisheries sector. The realisation of the Federal Program for the socio-economic development of the Kuril of the Sakhalin area (1994-2005) and cooperation between Russia and Japan will result in the creation of necessary infrastructure and a favourable investment climate for the development of the Kuril Islands and the waters of the Oyashio Current.

Global change

Environmental impacts

Changes in the hydrological cycle and ocean circulation

This issue was assessed as having moderate impacts due to the following environmental changes: (i) positive sea temperature anomalies and changes in the meandering path of the Kuroshio Current, which has influenced the productivity of the Longfin codling (*Laemonema longipes*) and mackerel; and (ii) changes in the energy active zone causing changes in the thermal flux, as well as an increased frequency of heavy storms and floods (Noto & Yasuda 1999, Yoshinari & Yasuda 1999).

The sub-arctic Kuril Current flows into Japanese coastal waters, providing a rich habitat for a variety of fish and making the region one of the most productive fishing areas in the world. The most significant effect of global warming on the region is predicted to be changes in epipelagic fish resources. Japan's future fishery production will mostly depend upon changes in the course and flow of the Japanese Current caused by global warming (Yasuda & Watanabe 1994, IPPC 2001).

Concerning long-term changes, some researchers believe that global warming will lead to reductions in the flows of both the Kuril and the Japanese currents, and that the thickness of the mixed layer will be reduced if marine winds also weaken (Noto & Yasuda 1999, IPPC 2001). Based on the primary production volume offshore of Kushiro in Hokkaido during years when the waters are relatively warm compared to those when it is relatively cold, it appears that global warming in this region will lead to a reduction in primary production. Additionally, the southern limit of salmon habitats is expected to move northwards as a result of global warming (IPPC 2001).

Research has identified a relationship between higher global temperatures and an increase in sardine numbers (Omori & Kawasaki 1995). This field however requires further study, including an examination of the influence of shifting climates on the ecosystems of the region.

In coastal areas, the primary production volume of phytoplankton will increase as a result of rising water temperatures, resulting in a greater food supply for fish. The quantity of coldwater seaweed may diminish which, in turn, could lead to a reduction in the populations of abalone, turbos, sea urchins and other sessile organisms, including macrophytic algae, corals, sponges, bryozoans and ascidians (Global Warming Impacts Assessment Working Group 2001). In coastal areas with breakwaters or other coastal protection structures where the shoreline cannot move further inland, productivity may fall when sea levels rise because of the loss of tidal flats and seaweed beds.

The average water temperature of streams and rivers is estimated to rise by between 1 and 4°C as a result of global warming. Consequently, the habitat of Dolly varden (*Salvelinus malma*) will decline by 25 to 74% and that of Whitespotted charr (*S. leucomaenis*) by 4 to 46% (Global Warming Impacts Assessment Working Group 2001).

Despite abundant precipitation, it is difficult for Japan to fully utilise its water resources due to physical constraints. Precipitation varies greatly throughout Japan and the nation's rivers are short and steep, with relatively small catchment basins. According to hydro-meteorological models, global warming may lead to lower precipitation rates in Hokkaido, higher evaporation from the land surface and a consequential reduction in water resources.

According to Global Warming Impacts Assessment Working Group (2001) the following conclusions have been drawn from the hydrological research conducted so far:

- The effects on flow from a 10% change in precipitation are greater than those from a 3°C temperature rise.
- If a 3°C temperature rise is accompanied by a 10% increase in precipitation, the average flow will not decline significantly in low-flow conditions but will increase by about 15% in high-flow conditions.
- A rise in temperature will mean that what was once snowfall will change to rainfall and winter snows will melt earlier. As a result, the flow will increase from January through to March and decrease between April and June.

The regional climate fluctuates as a result of variations in mean global characteristics and climatic phenomena such as the North Atmospheric Oscillation (NOA), the Pacific Decadal Oscillation (PDO) and the El Niño-Southern Oscillation (ENSO). To date, most studies considering the impacts of climate variability on the regional marine ecosystem have used correlation statistics of a given population and physical climate indices.

The effects of a shift in the climate regime on ENSO activities, winter monsoon patterns, western boundary currents and upper ocean stratification, as well as the resultant biological impacts are summarised as (Noto & Yasuda 1999, Omori & Kawasaki 1995, Global Warming Impacts Assessment Working Group 2001):

- Variations in atmospheric conditions influence the intensity of the winter monsoon, the depth of the upper mixed layer and the path of the Kuroshio and Oyashio currents.
- In the western sub-arctic Pacific, phytoplankton biomass was higher from the mid 1960s to mid 1970s than in the preceding and succeeding decades, corresponding to a transition of the westerly currents from a meandering to a straighter path.
- Plankton biomass in the Oyashio Current region has decreased since the early 1970s.
- In the northwestern sub-tropical Pacific a reduction in winter cooling and vertical mixing associated with the calm and warm winter of the early 1970s increased surface chlorophyll concentrations, which might have caused higher zooplankton production and better feeding conditions for sardine larvae.
- A considerable weakening of the southward intrusion of the Oyashio Current off the east coast of Japan from 1988 to 1991 led to a reduction in plankton biomass in the transition zone between the Kuroshio and Oyashio currents in late spring and early summer, and caused a series of recruitment failures of Japanese sardine.

Sea level change and Increased UV-B radiation as a result of ozone depletion

According to the GIWA Task team, this issue has no known impacts. There may be possible sea level rise on the coast of Japan, although only a limited stretch of the coastline, mainly in eastern Hokkaido, will be affected.

Changes in the ocean CO_2 source/sink function

Despite incomplete research, the GIWA Task team considered this issue to have a slight impact on the region as they had "reasonable suspicions" that current global change is impacting the aquatic system enough to alter its source/sink function for CO_2. However, there have been no measurable changes. The Oyashio region is a CO_2 source during the winter due to deepwater upwelling and also a CO_2 sink during the summer as a result of biological activities. In fact, the region has the highest biological CO_2 drawdown in the global ocean. Global change may influence both physical and biological processes in this region and change the function of the carbon cycle (DeGrandpre et al. 2002, PICES 2003). The influence of global change is observed not only in surface currents but also in deep water circulation, with subsequent impacts on biological production in the region.

Socio-economic impacts

The economic impacts for the whole region are assessed as slight. Global change has influenced the living conditions of fishermen and their communities. Because the economy of the area is based on fishing, depleted fish stocks as a result of global changes have had economic consequences. The following impacts have been identified that may be associated, to some extent, with global changes:

- Human migration from the Kuril Islands and Kamchatka. This has been attributed to severe climatic conditions and 90 years of weak economic growth in Russia (Russian Statistical Yearbook 1996, 2001, Eremina et al. 2000).
- Emergency response costs for severe environmental conditions e.g. flooding caused by increasingly frequent storm surges (Tersiev 1998, PICES-GLOBEC 2003).
- Increased cost of coastal protection.

- Loss of income and foreign exchange from a downturn in the fisheries sector.

There is concern about the possible effects of rising sea levels and increasingly frequent storm surges on Japan's socio-economic system. The existing social infrastructure and socio-economic system has been optimised for the present climate conditions. Concerning global warming, the effects of higher sea levels, higher temperatures and from changing precipitation and typhoon patterns would be serious and wide-ranging (Global Warming Impacts Assessment Working Group 2001, IPCC 2001).

There are no known health or other social and community impacts from global changes in the region.

Conclusion and future outlook

Overall, global change is considered to have slight impacts on the region. The following changes have been observed in recent years: positive temperature anomalies; changes in the meandering path of the Kuroshio Current, which has influenced the productivity of the fisheries; changes in the energy active zone; changes in the thermal flux; and increasing frequency of severe storms and floods. The economy of the region is predominantly dependent on fishing. Climatic changes have led to reduced catches, thus having economic consequences. Global climate trends are expected to exacerbate the environmental and economic impact of this concern in the future. Health and other community impacts will most likely not change.

Priority concerns

At present, the concerns with the highest severity for the region are Global change, in particular the issue of changes in the hydrological cycle, and Unsustainable exploitation of fish and other living resources, specifically the issue of overexploitation. The concerns were ranked as follows:

1. Global change
2. Unsustainable exploitation of fish and other living resources
3. Habitat and community modification
4. Pollution
5. Freshwater shortage

There is currently a lack of research on the influence of global changes on the productivity of the fisheries. However, specialists from academic institutes, including the Far East Branch of the Russian Academy of Science, TINRO-Centre and Japanese universities and institutions, are presently investigating this concern. According to the GIWA Task team, the influence of global changes on depleted fish stocks have increased unemployment rates and reduced income and investment activity.

Furthermore, the analysis suggests that overfishing in the Oyashio Current region could become less severe due to the implementation of regulatory and control measures. Overexploitation of fish resources was considered to be moderate only in the southern Kuril area where illegal fishing is prevalent.

The GIWA Task team identified a strong linkage between Global change and Unsustainable exploitation of fish and other living resources in the Oyashio Current region (Figure 13) due to changes in pelagic fish abundance caused by changes in water temperature and a reduction in the flow of currents. There are weaker linkages between Global change and Freshwater shortage as well as Habitat modification. The GIWA Task team also recognised a weak linkage between Habitat modification and the Unsustainable exploitation of fish and other living resources.

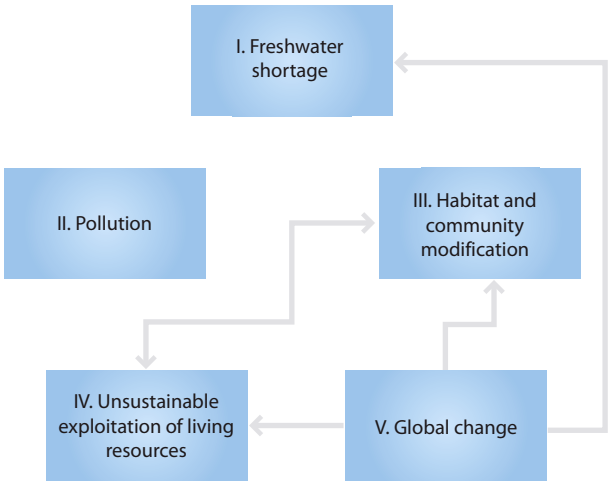

Figure 13 Linkages between the GIWA concerns.