

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 human activities and economic sectors responsible 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 in Annex IV.

Causal chain analysis of the Magdalena Basin

The GIWA assessment identified Habitat and community modification as the priority concern in the Colombia & Venezuela sub-system. The Magdalena Basin was selected for the Causal chain analysis (CCA) as there is a concentration of human activities located here which are resulting in severe habitat modification. A description of the basin can be found in the regional definition section of this report. The focus of the CCA is to determine the root causes of habitat and community modification in the sub-system, so that the driving forces of the issues can be addressed rather than the more obvious causes. This process traces the cause-effect pathways, from the socio-economic and environmental impacts of the concern identified in the assessment back to the root causes. The root causes can then be targeted by appropriate policy measures in the Policy options analysis (POA) section. For more detailed information on the environmental impacts, the responsible sectors and the immediate causes, please refer to the Assessment chapter.

Figure 9 shows the causal links between the environmental and socio-economic impacts of the habitat and community modification concern, the immediate causes, the responsible economic sectors, and the root causes that determine the behaviour of these sectors.

Environmental and socio-economic impacts

The main environmental impacts of habitat and community modification are:

- Loss of biodiversity;
- Impacts on estuarine and coastal ecosystems, particularly the loss of coral reefs and mangroves;
- Changes in community structure; and
- Increased vulnerability of flora and fauna to diseases.

The main socio-economic impacts of habitat and community modification are:

- Loss of income for the tourism and fisheries sectors;
- Loss of aesthetic and recreational value;
- Increased unemployment;
- Economic costs of ecosystem restoration;
- Recurrent morbidity and increased infant mortality rates; and
- Loss of cultural identity for indigenous people.

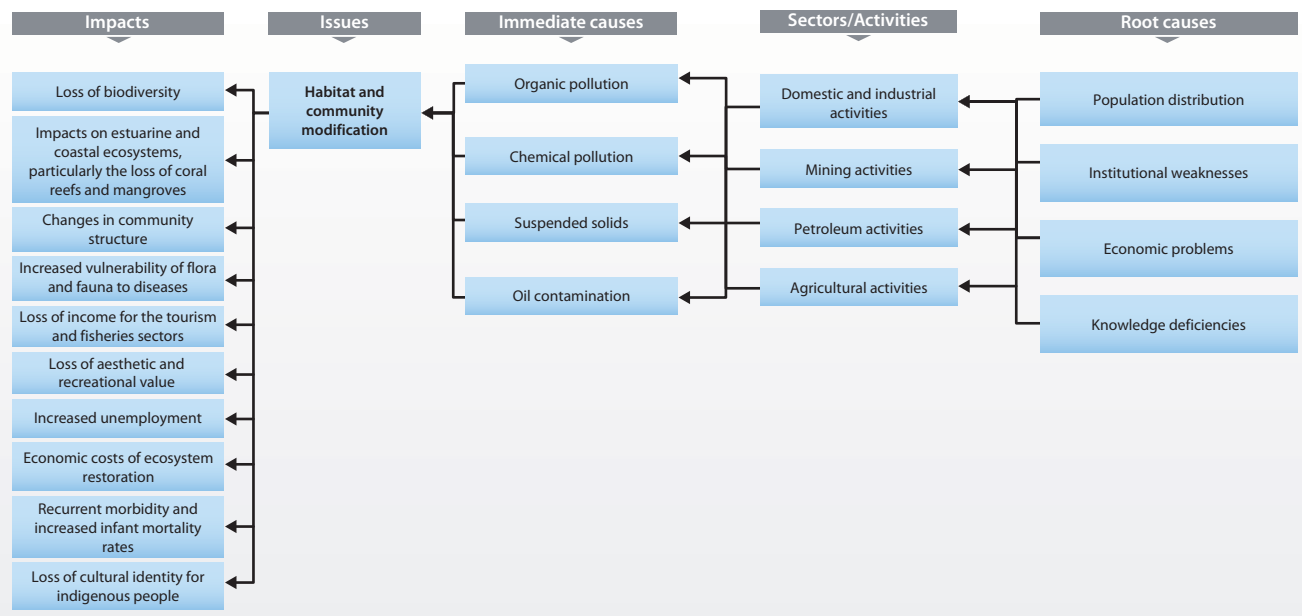


Figure 9 Causal chain diagram illustrating the causal links for habitat and community modification in the Magdalena Basin (sub-system 3b).

Immediate causes/sector activities

Immediate causes associated with domestic and industrial activities: The Río Grande de la Magdalena Basin is the most populated basin in Colombia and has the highest intensity of socio-economic activities. Organic material enters the environment in waste from domestic sources and coffee, food and beverage industries. These wastes modify water quality and consequently the health of aquatic ecosystems (CORMAGDALENA 2002).

Immediate causes associated with mining activities: mining activities have degraded forest, soil and water resources in parts of the Magdalena Basin. Commonly, the practices employed are non-compliant with environmental guidelines and highly destructive (CORMAGDALENA 2002). Mining activities in the Magdalena-Cauca Basin have adversely affected the environmental quality of aquatic habitats. Areas where the rivers have a limited flow rate are particularly vulnerable to chemical pollution and increased sedimentation originating from mining activities. Municipalities at greatest risk are riparian to the following rivers: Vetás, Boque in Santa Rosa del Sur; Serranía de San Lucas; Tarazá in Bajo Cauca; Bagre in the mining region north of Antioquia; and Guavas and Guadalajara in the Ginebra district (CORMAGDALENA 2002).

Immediate causes associated with petroleum activities: Magdalena Basin contains a multitude of petroleum activities including exploration, extraction, refinement and transportation. These activities alter habitats by consuming large quantities of water and releasing pollutants. Petroleum activities are concentrated in the upstream areas of the basin, primarily in the municipalities of Neiva and Aipe in Huila, and in the middle

reaches of the basin in Barrancabermeja (Santander), Puerto Nare y Yondó (Antioquia). Large quantities of pollutants are discharged by petroleum-water separating stations, as well as occasional spills and leakages from oil pipelines (CORMAGDALENA 2002).

Immediate causes associated with agricultural activities: agro-chemicals used in crop production are used inappropriately and enter aquatic systems via runoff or leaching into groundwater. Aerial fumigation of rice, cotton and sorghum with excessive doses of pesticides and herbicides is a major source of water, air, soil and food contamination (CORMAGDALENA 2002).

Root causes

Population distribution

Even though the Colombian coast is relatively sparsely populated, approximately 80% of the population of Colombia and the majority of economic activities are concentrated in the Magdalena-Cauca River Basin. The water bodies in the basin are, therefore, subjected to a concentration of pollution which affects coastal biodiversity. Urban development has led to the deterioration of water quality for human use, modified river bank habitats due to construction, changed the drainage patterns and caused a loss of ecosystem functions.

Institutional weaknesses

Lack of integrated management

In general, planning is sectorial with little consideration of the affect on other economic activities or the environment. There is an absence of an integrated development strategy. The planning process does not incor-

porate environmental impact assessments or mitigation measures. In areas of agricultural development, informal settlements have emerged in ecologically sensitive areas as provisions are generally not made to accommodate migrant workers.

An evaluation of coastal zone management in the sub-system (Steer et al. 1997) concluded that the system of Integrated Coastal Zone Management had not been adequately adopted and the legal framework regulating activities in the coastal zone was particularly weak.

The monitoring capacity of the institutions responsible for environmental management in the basin is inadequate as there is a lack of professional expertise and financial resources. The National Report of the Office Controlling Public Expenses identified a range of institutional weaknesses including a lack of financial mechanisms and control measures, insufficient monitoring, a lack of investment evaluation and inadequate information dissemination to the public.

Armed conflict

Armed conflict in the sub-system has resulted from a combination of social, political and institutional issues in Colombia. The influence of guerrilla armies has allowed the widespread production of illegal crops within their territories. The land is deforested in order to grow these crops causing ecological damage.

Economic problems

Inequity and poverty

In Colombia, industrial production is concentrated in urban areas. Rural populations survive by increasing cultivated areas and livestock farming and by growing illegal crops. After 35 years of precarious agrarian reform in Colombia, agricultural land is owned by relatively few individuals. 12 000 people (0.6% of the population) control 10 million hectares (20% of livestock farming land) and 82.4% of rural properties are small holdings which occupy 15.6% of the national rural territory (ACNUR 2001). According to The World Bank (2004), Colombia has one of the most concentrated land distributions in the world, with a land GINI of 0.86. Land distribution inequality is considered to be a source of poverty in Colombia, in addition to low agricultural productivity due to armed conflict in rural areas. Both issues, inequality and armed conflict, are forcing the poor to overexploit natural resources for their short-term survival, using shorter crop rotation cycles, clearing forests for agriculture and pastures, and overgrazing livestock.

Inappropriate incentives that encourage unsustainable practices

Farmers were encouraged to apply agro-chemicals in order to increase agro-productivity. This increased the prevalence of these substances in

the environment. It is now internationally recognised that artificial fertilizers and pesticides contaminate water resources and impact ecology and sanitary conditions (Láñes 2000). In Colombia, sales of herbicides and fungicides increased between 1975 and 1995 from 4 555 to 8 322 tonnes and 4 479 to 7 280 tonnes respectively (MMA & MA 1998). Various incentives were also given for converting forests to arable land and pastures. The high price for illegal crops encourages further deforestation to create more cultivated areas.

Ineffective economic mechanisms for pollution control

Only a limited number of industries have been charged water rates since they were introduced. At present, only 25% of Regional Autonomous Corporations (Corporaciones Autónomas Regionales, CAR) make payable taxes. Industries have therefore no incentive to improve their efficiency or reduce their waste discharges, even if only a minimal investment is required.

At present there are insufficient financial and technological resources to develop adequate treatment systems or to use cleaner technologies during production (CORMAGDALENA 1999). Although the Venezuelan Ministry of Environment and Natural Resources (MARN) has made some effort to implement environmental management, its success has been limited by a lack of financial and human resources. The environmental problems of the region require large financial investment in order to reverse degradation trends. Financial mechanisms are required that encourage industry to restore habitats they have disturbed (República de Venezuela 1995).

Knowledge deficiencies

The technologies currently employed by agriculture, mining, fisheries and other sectors are degrading the environment. There is a lack of studies evaluating the efficiency and environmental impacts of current practices. This has not favoured the adoption of cleaner technologies.

There is a lack of environmental information about the Colombian Caribbean coast where the sub-system's most important deltas are located, including the Magdalena, Canal del Dique, Sinú-Tinajones, Turbo and Atarato. In particular, the influence of upwelling, sediment dynamics and sea-level rise is poorly documented (Correa 2003).

Currently there is a dearth of information on the Magdalena River Basin. There are several deficiencies: (i) there is a lack of baseline information; (ii) data is dispersed between the various regional, national and international institutions; (c) the lack of standardized methodologies used to obtain biophysical and socioeconomic data in coastal zones makes it impossible to compare data and information (Steer et al. 1997); (d) there is a lack of information for vulnerability evaluation of coastal zones (INVEMAR 2002);

e) limited funding for research, assessment and environmental management; f) insufficient information on the active processes and their inter-

relations in the coastal zone, deltas, wetlands and river basins; and g) lack of appropriate information for management purposes.

Causal Chain Analysis of the Central America & Mexico sub-system

The priority concern for sub-system 3c is habitat and community modification. The sub-system includes parts of the Central America countries draining into the Caribbean and the State of Quintana Roo in Mexico. Causal chain analysis (CCA) was performed for the whole sub-system. For detailed information on the physical and socio-economic characteristics of the sub-system refer to the regional definition chapter. For more detailed information of the environmental and socio-economic impacts, responsible sectors and immediate causes, please refer to the Assessment chapter.

Figure 10 shows the causal links between the environmental and socio-economic impacts of the habitat and community modification concern, the immediate causes, the responsible economic sectors, and the root causes that determine the behaviour of these sectors.

Environmental and socio-economic impacts

Environmental impacts:

- Decreased vegetation cover;
- Loss and modification of biodiversity;
- Erosion and sedimentation.

Socio-economic impacts:

- Limited employment opportunities for the local population;
- Loss of aesthetic and recreational values;
- Increased infant morbidity and mortality rates;
- Conflicts over resources use and land tenancy.

Immediate causes/sectors

Immediate causes associated with agriculture: Runoff from agricultural lands has adversely affected water quality. Pesticides are applied to cultivated areas in order to control weeds, plagues, fungi and other diseases, and fertilizers (rich in N, P and K) to replace lost nutrients and increase the productivity of soils. According to studies made by the OPS and the WHO in Central America, 50 000 hectares of banana plantations use 117 200 tons of polyethylene, polypropylene, fertilizers and nematicides. These chemicals accumulate in soils, runoff into surface water supplies and leach into groundwater. Other solid residues are also generated including *raquis* (225 000 tons) and banana residues (278 000 tons) (Gaitán 1998).

Immediate causes associated with tourism: In the coastal zone of the sub-system, many protected areas are accessible to tourists. There is usu-

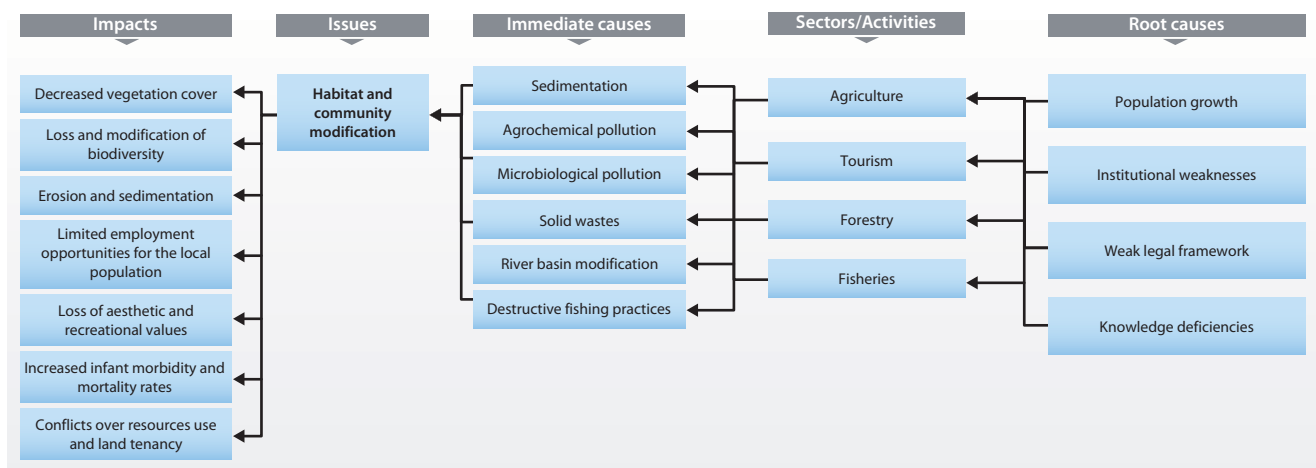


Figure 10 Causal chain diagram illustrating the causal links for habitat and community modification in the Central America & Mexico sub-system (3c).

ally a conflict of interest between conserving the natural resources in these areas and accommodating tourism. Many of the sub-system's natural assets such as the beaches, forests, coral reefs have been degraded as a consequence of tourist activities.

Immediate causes associated with forestry: Forestry is an important economic sector in Central America. Deforestation is resulting in increased erosion and sedimentation in the sub-system.

Immediate causes associated with the fisheries sector: Habitats are degraded by the employment of trasmallo (fixed fishing nets in shallow waters), illegal nets, trawling, dynamite and poison.

Root Causes

Population growth

Costa Rica has experienced one of the highest rates of population growth and deforestation in the world. In the last 50 years, the population has multiplied five-fold and, in the same period, 11 000 km² of forest, equivalent to the area of Jamaica, have been deforested (Perez and Protti 1978, Hartshorn 1983, Bonilla 1985). Several studies have shown the correlation between population growth and deforestation (FAO 2000). Population growth and the lack of development planning have led to the establishment of settlements in environmentally sensitive areas.

With population growth, the demand for land escalates and environmental degradation intensifies as urban and agricultural areas expand. Land tenancy conflicts have been provoked mainly in zones of collective land use. The institutions responsible for land tenure (e.g. in Mexico the Secretariat of the Agrarian Reformation, National Agrarian Registry and Commission for the Regulation of Land Tenancy) have insufficient capacity to resolve these conflicts.

Institutional weaknesses

Many of the root causes behind habitat modification in the Central America & Mexico sub-system stem from a lack of institutional capacity. There are no management plans at a national or regional level governing the majority of the sub-system's surface water (CATHALAC 1999). There is a lack of regional policies which promote the development of river basin planning and management. Additionally, the lack of democratic participation mechanisms that allow the involvement of all stakeholders has hindered cooperation between governments and the community in the conservation of habitats. Economic and political interests often take precedence over social and environmental improvements, and during the planning and implementation of development projects little consideration is given to its sustainability or the long-term impacts on the environment. For example, on the Caribbean coasts of some northern areas

of the Central America & Mexico sub-system, large hotel complexes are constructed without consideration of the environmental and social costs because central government and industry have the most influence in the decision-making process with limited stakeholder participation.

The institutions responsible for environmental management have insufficient financial and technical resources to adequately monitor and control environmental problems. Developers are able to violate planning regulations as their activities are not monitored. There are insufficient economic and human resources to purchase and operate the necessary equipment for pollution control and monitoring activities. Pollution levels in Guatemala are unknown as there is no institution responsible for water quality monitoring (FAO 2000).

The exploitation of species and other environmental goods and services with high commercial value is insufficiently managed. There is little consideration of the periods of reproduction, the population and sustainability of the species, and of the economic benefits of the species when they are alive. The institutions responsible for managing the coastal fisheries lack the resources to enforce fisheries regulations. In Nicaragua and in Costa Rica, because the marine and coastal zone is poorly monitored, fishing occurs without any controls. Water is used inefficiently, since water users are not charged for the costs of treatment and distribution (CEPAL 1995). In Costa Rica, there is a lack of water conservation or management, particularly in urban areas that consume 80% of the total freshwater abstracted.

Legal framework

Because regulations on the use of pesticides and fertilizers are very weak or non-existent, these materials are applied in excessive quantities which do not improve productivity further but, instead, affect wildlife and contaminate superficial and underground water supplies. The main deficiency in water law in sub-system 3c is regarding coastal and marine regulations.

Knowledge

Decision-making processes are hampered by the limited information availability regarding the environmental and economic characteristics, and environmental degradation trends, of river basins. There are insufficient research initiatives regarding sustainable technologies and very few environmental education programmes. There is no reliable information on the recharge rate and capacity of aquifers (CATHALAC 1999). The benefits that ecosystems in the sub-system provide the population are poorly documented or valued. In the San Juan River Basin, there is little knowledge of the capacity of fish stocks to recover or the population dynamics.