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## Information Sheet on Ramsar Wetlands

1. Date this sheet was completed/updated: 30 June 2000
2. Country: Nicaragua
3. Name of wetland: Tisma Lake System (Sistema Lagunar de Tisma)
4. Geographical coordinates:

12° 00' 00" - 12°08'25" North latitude  
85°51'55" - 86°00'00" West longitude

5. Altitude: between 32 and 34 metres
6. Area: 16,850 hectares
7. Overview:

The Tisma Lake System is a wetland of lacustrine origin that includes Lake Tisma, Playuela de Tisma, Laguna Amapa, Estero de Panaloya, part of the Río Tipitapa and marsh areas with species of fauna and plant formations very characteristic of these sites. This system is very special because in rainy periods it captures large amounts of water that flow from the upper part of the basin, making this site a very difficult area to penetrate during the rainy season, which comes from May to November, with a very marked hot period between July and August.

**Geology:** Its origins are in the Tertiary-Quaternary with material of lava (*toba*), agglomerates, lapilli and compacted ash, also formed during the Quaternary, moderately unconsolidated alluvial materials cemented with sand, mud and gravel and alluvial deposits formed by mud in the form of 10-metre-thick dunes.

**Geomorphology:** It is located in the Nicaraguan depression with lacustrine alluvial plains with a slope of 0–1.5 per cent.

**Vegetation:** There are three plant formations associated with the aquatic characteristics that determine the types of vegetation existing in each wetland.

Plant formations of the lake system

**Vegetation of the permanent bodies of water:** This is characterized by floating vegetation specific to this site, such as *lechuga de water* (*Pista stratiotes*) and the water hyacinth (*Eichornia crassipes*). These species are found in large numbers in the lake and ponds

as well as in the marsh areas. They form a dense emergent plant cover on the surface of the water.

Vegetation of the marsh soils: This is characterized by emergent species forming extensive plant formations, primarily *tule* (*Thypha latifolia*) and *junquillo* (*Selrpus lacustris*). There are also extensive formations of *tamarindo montero* (*Parkinsonia aculeata*) and to a lesser extent *botoncito blanco* (*Melanthera hastate*), *palma paceña* (*Sabal mexicana*) and large areas of *lechuga de agua* (*Pista stratiotes*) and water hyacinth (*Eichornia crassipes*).

Vegetation of the flood plains: This formation is characterized by native species or indicator species of the dry tropical forest associated with natural grasses, where *nacascolo* (*Caesalpinia coriaria*), *papalón papaturro* (*Coccoloba caracasana*), *guácimo de ternero* (*Guazumo ulmifolia*), *ceiba* (*Ceiba pentandra*), *vainillo* (*Senna atomaria*), *tiguilote* (*Cordia dentate*), *cimarra* (*Jacquina aurantica*), *aromo* (*Acasia farnesiana*) and others dominate.

The Tisma Lake System is an open system where there are natural processes that are being influenced by natural phenomena and anthropogenic activities. This wetland is a natural system of high biodiversity that is an irreplaceable resource for the inhabitants of Tisma and the rest of the surrounding inhabitants.

Functions of the wetland: Among the significant values for the environment and inhabitants of Tisma provided by the wetland, there are:

- Supply of water for farming activities, growing rice and irrigation of pasture for cattle;

- Control of underground water quality and its infiltration into the aquifer;

- Refuge for the biological diversity of the area, especially migratory birds that arrive each year in search of food and refuge;

- Protection from flooding, acting as natural reservoirs for water that flows through the basin;

- Retention of sediments and pollution arriving from the basin, the city of Masaya and the rice fields.

Among the most important direct and indirect benefits to inhabitants are:

- The supplying of water for local inhabitants, who use it for growing irrigated rice and for livestock raising;

- The supplying of wildlife for game meat and fish;

Extraction of natural fibres, such as *junquillo*, *tule* and *palma paceña* (although the latter is found in irrelevant quantities). The fibres of these plants are used for making saddle blankets, grass mats, fans and roofs.

Hunting of wild animals for food and sale;

There are improved pastures for livestock in the surrounding area using water from the wetland for irrigation and storage in the summer.

Potential for tourism, education and scientific recreation, but under proper management.

8. Wetland type: Its origin is natural, and according to the system of Ramsar classification it is continental. The following types of wetlands are found here.

Type O: Permanent freshwater lakes of more than eight hectares, including large main riverbeds and meanders or abandoned channels, swamps and marshes, including Lake Tisma, La Playuela, Amapa and a branch of the Río Tipitapa.

Type Ts: Seasonal freshwater marshes, swamps and ponds on inorganic soils, including flooded depressions (lakes for recharging), seasonally flooded grasslands, Ciperaceae marshes, seasonal marshes and ponds, including depressions at the site.

Type Tp: Permanent freshwater marshes, swamps and ponds (of fewer than eight hectares), marshes and swamps on inorganic soils with emergent vegetation in water at least during most of the growth period. In this category belong the marshes with their characteristic vegetation, such as *junquillo*, and the marsh with its own vegetation.

Type M: Rivers and permanent streams

Type Xf: Wooded freshwater wetlands, including woodlands, freshwater marshes, seasonally flooded woodlands and wooded marshes on inorganic soils.

The most relevant type of wetland in the Tisma Lake System is type O, which is dominant because of its characteristics. The factors that characterize it are permanence of a volume of water, diversity of native and migratory bird life and the fish fauna. This type of wetland has large populations of native and migratory birds, as well as fish, because of the diversity of food found in the water and on the shores (see map of wetland types).

9. Ramsar criteria:

10. Map of site included? Please tick yes -or- no

11. Name and address of the compiler of this form:

Asociación Ambientalista Audubon de Nicaragua (ASAAN)

General coordinator: Lic. René Pérez Torres  
Technical coordinator: Lic. Martha Verónica Quezada

Multidisciplinary support team

Lic. Fernando Palma Lacayo	Integration of thematic analysis
Lic. Chester Conrado Páramo	Adviser
Ing. Enoc Castillo Seth	Hydrogeoclimatology
Lic. José Ángel García	Cartography
Tecn. Jenny García Sánchez	Data processing

Tel./Fax: 244 3239, mobile: 07 780 277/08 882 729, Apto: SV-82  
E-mail: audubon@tmx.com.ni

Technical review

MARENA-DGAP	Lic. Milton Camacho
GTH-NI	Lic. Martín Lezama

12. Justification of the criteria selected under point 9, on previous page:

Criteria of representative or outstanding wetlands

1. This wetland plays a significant hydrological, biological and ecological role for the natural functioning of the basins, lakes Managua and Nicaragua and lacustrine systems and nesting and breeding areas of lacustrine species.

General criteria based on fauna and flora

3. Because of the special value for one or more endemic species or communities of fauna or flora.

4. Because of its special value as a habitat for plants or animals during a critical period of their life cycles

Specific criteria based on water birds

5. Because it regularly supports significant quantities of certain groups of water birds and indicator species of the productivity or diversity of the wetland.

Specific criteria based on fish

7. This wetland sustains a significant proportion of subspecies, species or families of indigenous fish, stage of their life cycle, interaction of species and representative populations of the benefits and values of global biodiversity.

The most significant criterion that gives the wetland international importance is criterion 5, because it is a habitat of significant quantities of resident and migratory aquatic birds, indicators of the importance, productivity and diversity of the wetland.

#### Criteria of representative or unique wetlands (1)

This is an especially good representative example of a wetland that plays an important hydrological role and is of biological or ecological significance for the natural functioning of a hydrographical basin or extensive coastal system (Ramsar Convention Handbook). The Tisma Lake System plays an important hydrological role because of the elevation of the lake with respect to the river and the two lakes with which it is connected, creating very special conditions.

Among the benefits that the Tisma Lake System provides to the local inhabitants are:

Supply of food and fibres or plant material of species such as *junquillo* (*Selrpus lacustris*), *tule* (*Thypha latifolia*) and *palma paceña* (*Sabal mexicana*), used to make local handicrafts, such as grass mats, chairs, hand-held fans and roof materials;

Subsistence fishing;

Provision of food from animals and wild fruit;

Potential of open natural landscapes that are a refuge for aquatic fauna and migratory and resident bird life;

Existence of archaeological remnants from the pre-Columbian period;

Provision of fuel and firewood for cooking;

Provision of water for agriculture and livestock raising;

Maintenance of food chains for existing biodiversity.

#### General criteria based on fauna and flora

This wetland is considered to be of international importance because of its special contribution to maintaining the genetic and ecological biodiversity of species of fauna and flora. It is also of special value as a habitat of plants and animals during a critical period of their life cycle. Among the aquatic flora in Tisma, there are the *tule* (*Thypha latifolia*), *junquillo* (*Selrpus lacustris*) and *ñambar* (*Dalbergia retusa*). These species play an important socio-economic, cultural and ecological role in the wetland. In the case of the aquatic fauna, this is an area for nesting, hatching and growth during a period of the life of aquatic species. This is the case of the *sanatillo* (*Cassidix nicaraguensis*), endemic to this wetland, which is found on both lakes. This criterion was chosen

because in Tisma there is the *sanatillo* (*Cassidix nicaraguensis*) that is endemic to this site, which is found on both lakes with representative populations.

#### Specific criteria based on aquatic birds

This wetland regularly sustains significant numbers of specimens of several groups of resident and migratory aquatic birds, species that are indicators of ecological productivity and diversity (Ramsar Convention Handbook).

These criteria are present in Tisma with very representative populations and are indicators of productivity and diversity at the site, for which we give several examples (see annex 6, Preliminary list of birds at Tisma).

Phalacrocoracidae: *pato chancho* (*Phalacrocorax olivaceus*) 300 to 450 specimens have been recorded.

Anatidae: *piche* (*Dendrocygna autumnalis*) 1,000 to 2,000 specimens, *zarceta* (*Anas discors*), this species has been recorded at the observation points of Playa de José and Playa los Pescadores in large flocks of 3,500 to 12,000 birds (Carlos Mejía, Monograph with field data, Aves Acuáticas de Tisma, Diversidad y Abundancia con énfasis en Anatidae, March 2000, UCA). Also, several local inhabitants reported having observed flocks of this species in numbers of 20,000 to 22,000 specimens, representing a marvellous spectacle.

Charadriidae: *chorlito real* (*Charadrius wilsonia*) from 500 to 1000 specimens. There are also significant populations of *patilla* (*Aythya affinis*), 250 to 300 specimens; *gallito de agua* (*Jacana spinosa*), 400 to 800 specimens; *guairón* (*Mycteria americana*) from 150 to 300 specimens and *Himantopus mexicanus* from 500 to 1000 specimens, with a very representative population.

#### Criteria based on fish

This wetland sustains a significant proportion of the subspecies, species and families of indigenous fish, life cycle stages, interaction of species or populations representative of the benefits or values of the wetland, contributing to national and global geological diversity. We consider this criterion to be very important because there are species used as food by local populations, the representative populations are very large and because there is a monthly catch of 300 fish per day for several species, for a total catch of approximately 432,000 fish annually, which represents a very important contribution to the diet of the local communities.

Among the species of important scientific value is the *gaspar* (*Lepisosteus tropicus*). Among the species of importance as food are the *guapote* (*Cichlasoma managuense*), *gaspar* (*Lepisosteus tropicus*), tilapia (*Tilapia* sp.) and *barbudo* (*Rhandia nicaraguensis*) (see annex III, Preliminary list of fish in Tisma).

Taking this into account, the Tisma Lake System has a large biodiversity of fauna and flora, which together with the role it plays in the functioning of the basin as a natural water reservoir, links this function with the role of an integrator of terrestrial and aquatic plant and animal species, creating a very important ecological interaction given the natural conditions of feeding and refuge, making this wetland unique in its category.

### 13. General location:

North: Municipio of Tipitapa, department of Managua  
South: Municipio of Granada, department of Granada  
East: Lake Cocibolca  
West: Municipio of Tisma, department of Masaya

Access is from the following highways:

Carretera Norte: Timal–Malacatoya–El Paso, a total of 64 kilometres

Carretera Granada: El Paso–Tisma, a total of 39.5 kilometres

Carretera Managua: Tipitapa–Zambrano–Tisma, a total of 36 kilometres

The distance in a straight line from Lake Tisma to the nearest town, which is Tisma, is three kilometres. The wetland is under the administrative authority of the departments of Granada and Masaya. The approximate population of the town of Tisma is 4,458 inhabitants.

The distance between the most representative points of the wetland taking Lake Tisma as the main centre is as follows: from the town of Tisma to Laguna la Playuela, there is a distance of approximately 11 kilometres in a north-east direction; in direction south-west following the coastline of Lago Cocibolca there is a distance of 10 kilometres, passing through La Playuela, El Hatillo, Laguna Amapa, Laguna los Charcos, until arriving at Estero de Panaloya; in direction east-west a distance of 14 kilometres; and in a north-west direction bordering Río Tipitapa until arriving at the town of Tisma, there is a distance of five kilometres.

### 14. Physical features:

Biophysical characteristics of the wetland

#### Unit 1

Geology: Tertiary-Quaternary of lava (*tobas*), agglomerate, lapilli and compact ash.

Climate: Annual precipitation of 1100 mm, temperature of 26° to 29° C, relative humidity of 70 per cent, dry tropical transition to subtropical life area.

Geomorphology: Located in the Nicaragua depression with a sub-landscape of an alluvial lacustrine plain with a slope of 0–1.5 per cent.

Soil: Very superficial to superficial, with the water table at a depth of 25 to 40 centimetres, texture clay to heavy, imperfect drainage, very frequent severe and permanent flooding.

Current land use: Shrub, herbaceous and grass vegetation, swamp vegetation and bodies of water with vegetation.

Area: 6,780 hectares, which represents 40.2 per cent of the total area.

## Unit 2

Geology: Tertiary-Quaternary of *toba*, agglomerate, lapilli and compact ash.

Climate: Annual precipitation of 1100 mm, temperature from 26° to 29° C, relative humidity of 70 per cent, dry tropical transition to subtropical life zone.

Geomorphology: Located in the Nicaraguan depression with a sub-landscape of an alluvial lacustrine plain with a slope of 0–1.5 per cent.

Soil: Very superficial to superficial with the water table at a depth of 25 to 40 centimetres, clay texture, good drainage, frequent and extended flooding.

Current land use: Bush, herbaceous and grass vegetation, swamp vegetation and vegetation of bodies of water.

Area: 6,180 hectares, which represents 36.7 per cent of the total area.

## Unit 3

Geology: Quaternary–alluvial of unconsolidated material moderately bonded with sand, mud and gravel, alluvial deposits formed by mud in 10-metre-thick dunes.

Climate: Annual precipitation of 1100 mm, temperature of 26° to 29° C, relative humidity of 70 per cent, dry tropical transition to subtropical life zone.

Geomorphology: Located in the Nicaraguan depression with a sub-landscape of an alluvial lacustrine plain with a slope of 0–1.5 per cent.

Soil: Very superficial to superficial with the water table at a depth of 25 to 40 centimetres, medium clay texture, imperfect drainage, very frequent severe to permanent flooding.

Current land use: Shrub, herbaceous and grass vegetation, swamp vegetation and bodies of water with vegetation.

Area: 710 hectares, which represents 4.2 per cent of the total area.

#### Unit 4

Climate: Annual precipitation of 1100 mm, temperature of 26° to 29° C, relative humidity 70 per cent, dry tropical transition to subtropical life zone.

Geomorphology: Located in the Nicaraguan depression with a sub-landscape of an alluvial lacustrine plain with a slope of 0–1.5 per cent.

Geology: Quaternary, alluvial of unconsolidated material moderately bonded with sand, mud and gravel, alluvial deposits formed by 10-metre-thick mud.

Soil: Very superficial to superficial with the water table at a depth of 25 to 40 centimetres, clay silt texture, good drainage, very frequent and prolonged flooding.

Current land use: Shrub, herbaceous and marsh vegetation.

Area: 480 hectares, which represents 2.9 per cent of the total area.

#### Unit 5: Bodies of water

Hydrology: Outstanding and types of habitat. Lake Tisma, Laguna Playuela de Tisma, Laguna Amapa, Estero de Panaloya and Río Tipitapa.

Area: 2,700 hectares, which represents 16 per cent of the total area.

Based on the information and maps of the biophysical environment, a map of types of wetlands was prepared using the parameter of flooding as the basic unit for planning (see map of types of wetlands).

#### Types of Wetlands

Symbol	Description	Area	
		ha	%
1	Type O: Permanent freshwater lakes (more than three hectares) including old main channels and meanders or the abandoned branch of Río Cienaga and Pantanos. It includes Laguna de Tisma, Amapa, Laguna La Playuela and the branch or meander of Río Tipitapa	2,600	15.4
2	Type Ts: Marshes, swamps and seasonal ponds. Intermittent freshwater on inorganic soils including flooded depressions (natural reservoir, potholes and seasonally flooded grasslands, Ciperaceae swamps. It includes swamps, seasonal ponds and	7,500	44.5

	existing depressions.		
3	Type Tp: Marshes/swamps/permanent freshwater ponds, (fewer than 8 hectares) swamps and marshes on inorganic soils with emergent vegetation in water, at least during most of the growth period. This includes Los Pantanos and Marsh with its characteristic vegetation.	5,590	33.2
4	Type M: Río Arroyo permanent	100	0.6
5	Type Xf: Freshwater wooded wetlands, including freshwater flooded woodlands, seasonal flooded woodlands, wooded marshes on inorganic soils	660	3.9
6	Coastal bar of Lake Cocibolca	400	2.4
	Total	16,850	100

The Tisma system of wetlands is located between two natural lakes: Lago Xolotlán and Lago Cocibolca.

**Geomorphology:** Located in the Nicaraguan depression with a sub-landscape of alluvial lacustrine plain with a flat to slightly flat slope of 0.15 per cent.

**Geology:** There are Tertiary-Quaternary formations of unconsolidated materials, moderately bonded by sand, mud and gravel, alluvial deposits formed of agglomerates of *toba*, lapilli divided into the following four formations in the following order:

**Qelp:** Geological formation from the Quaternary of alluvial deposits formed by unconsolidated materials moderately bonded of sand, mud and gravel with a thickness of 10 centimetres.

**Qelpi:** Geological formation from the Quaternary of alluvial deposits moderately bonded of sand, mud, gravel, sand deposits and mud in the form of dunes.

**TQ ps (al):** Geological formation of Tertiary-Quaternary formed by volcanic ash of *toba*, agglomerates, lapilli and vertisols or *sonsocuitoso*.

**TQ ps-a:** Geological formation from the Tertiary formed by volcanic ash of *toba* and compacted lapilli agglomerates.

On the coasts at the site of Laguna de Amapa, there are former beaches and sand deposited in the form of abandoned dunes (Diagnostico System Lagunar de Tisma).

Origin (Natural or artificial):

Its origin is natural from the Tertiary and Quaternary alluvial volcanic.

Hydrology: The hydrology of the site is very outstanding, formed by a series of streams that empty storm runoff during the rainy season into Laguna de Masaya and Lake Tisma. From here there are smaller streams that drain towards Río Tipitapa and then towards Lake Nicaragua. These streams have been formed by the joining of several strong streams that begin in the higher parts of the sub basin, that because of the steep slope have eroded the land.

Depth, fluctuations in level and permanence of the water, watershed basin and runoff basin, especially in the case of wetlands of important for controlling flooding.

The seasonal water balance depends on average annual precipitation, which is 1070 mm. However, average long-term annual precipitation in the area is 1300 mm.

Supply and discharge of water: Supply is located in the area of the plateau where underground water is found at an elevation of more than 400 metres above sea level, drained partly by the Río Tipitapa and the other toward Lake Nicaragua. This is in addition to the annual recharging, which is 914.1 million cubic metres annually, representing a flow of 10 litres/second/kilometre for this area. The basic pattern of the permanent flow in the area, underground supply for lakes and small lakes, the aquifer reserve system and volume available is estimated to be 508.2 million cubic metres.

Discharge: Currently, the aquifer is losing through deep percolation and extraction from pumping 405.9 million cubic metres representing 44 per cent of the re-supply. This affects the bodies of water in the wetland.

Depth: The water table around Lake Tisma varies from 1 to 10 metres, and in the discharge area near the lakes the depth is less than one metre.

Type of soil and chemical characteristics:

The origin and classification of the soils of the wetland and their series carried out by survey showed a presence of salts and in some places alkali. The soils are volcanic in origin.

The soil types in the wetland are:

Soils of volcanic alluvial origin: There are deposits of stratified materials, resident, leached of top soil and volcanic ash, basalt, *toba*, are well drained, open textured clay and silt, with a slope of 0–1.5 per cent.

Soil of lacustrine volcanic origin: There are extremely poorly drained soils, grey to very dark, clay, shallow, they are derived from lacustrine deposits, bonded, of volcanic origin and slope of 0–1.5 per cent.

## Soil series

### El Charco soil series

These are soils of the Monmorillonita family with very superficial permeability, poor drainage and a very high water table during the rainy season and up to the first months of the dry season, usually containing salts and alkali. These soils are derived from lacustrine deposits on plains with almost flat slopes and are found southeast of Laguna de Tisma.

(7xwii): Superficial soils, heavy texture with a depth of 25 centimetres, slightly flat relief, slope of 0–1.5 per cent with very poor internal drainage with frequent and prolonged flooding;

(7swii): Soils with a heavy texture, depth of 25–40 centimetres, slightly flat relief, slope of 0–1.5 per cent, very poor internal drainage with frequent and prolonged flooding;

(7wii): Deep soils, heavy texture, depth of 40–90 centimetres, slightly flat relief, slope of 0–1.5 per cent, very poor drainage with, frequent and prolonged flooding;

(6xwii): Very superficial soils, medium clay texture with a depth of less than 25 centimetres, slightly flat relief, slope of 0–1.5 per cent, poor internal drainage with frequent and prolonged flooding;

(6swii): Superficial soils, medium clay texture, depth of 25–40 centimetres, slightly flat relief with a slope of 0–1.5 per cent, poor drainage with frequent and prolonged flooding;

(6wii): These are deep soils with medium clay texture of 40–90 centimetres, a slightly flat relief with a slope of 0–1.5 per cent; internal drainage is poor with frequent and prolonged flooding.

### Tisma soil series

These soils are in the family clay, fine muddy silt Monmorillonita with moderate permeability, poor drainage, which have developed below a fluctuating water table during the rainy season and the first part of the dry season, containing salts and in some places alkali, derived from lacustrine deposits on thick textured calcareous *tobas*, found on the plain southeast of Tisma and associated with the soils of the pond.

(2wii): Deep soils with fine open texture, with a depth of less than 60 centimetres, slightly flat relief, slope of 0–1.5 per cent with moderate internal drainage, water table in the subsoil with frequent and prolonged flooding.

(2rwii): Shallow soils with fine open texture, depth of 40–60 centimetres, with slightly flat relief, slope of 0–1.5 per cent, moderate internal drainage, water table with frequent and moderate flooding.

(2xwii): Very superficial soils, of fine texture, less than 25 centimetres in depth, slightly flat relief, slope of 0–1.5 per cent, moderate internal drainage, water table in the subsoil with frequent and moderate flooding.

(2swii): Superficial soils, texture clay, depth of 25–45 centimetres, flat relief, slope of 0–1.5 per cent, moderate internal drainage with frequent and moderate flooding.

Water quality: (physical and chemical characteristics)

The water is slightly bicarbonate with dissolved solids with values of 454–832 mg/litre these parameters provides fresh water for limited consumption.

Physical parameters:

Turbidity: 40 unt  
pH: 8.21  
Conductivity: 624 us/cm  
Colour: 65 ucv

Chemical parameters:

Magnesium: 15.723 mg/l  
Sodium: 110.00 mg/l  
Potassium: 17.00 mg/l  
Calcium: 31.608 mg/l  
Nitrate: 005 mg/l  
Sulphate: 8.180 mg/l  
Carbonate: 6.281 mg/l  
Chloride: 31.72 mg/l  
Nitrates: 0.003 mg/l  
Ammonium: 0.043 mg/l  
Phosphorous: 0.104 mg/l  
Total hardness: 143.55 mg/l  
Fluor: 0.548 mg/l  
Total alkalinity: 316.6 mg/l  
Silica: 39.392 mg/l  
Organic nitrogen: 0.233 mg/l  
Total nitrogen: 0.267 mg/l

It is important to mention that in 1998 the Centro de Investigación de Recursos Acuáticos (CIRA) carried out an analysis of the BOD and COD of the lake, which did not show a high degree of pollution. According to information obtained through the ICA method, water in the lake is inappropriate for domestic consumption unless it is treated (flocculation, decantation, etc.). However, it is apt for aquatic life, recreation, irrigation and navigation (Database of the thesis “Evaluation del Recurso Pesquero de Tisma”, Lic. Mercedes Rueda, UNAN).

Fluctuations in the level and permanence of the water: The level of the lake fluctuates seasonally by about 0.35 million cubic metres, which implies a direct and dependent connection of the underground water. For the whole aquifer, the loss is about 0.40 million cubic metres annually on the average. Regional decreases of the aquifer have been recorded of an annual average of 0.96 million cubic metres.

The water basin: La Sierra aquifer has three directions of runoff: toward the Pacific, Lake Xolotlán and Lake Cocibolca. Lake Xolotlán is the main threat to the aquifer affecting the lake because it is polluted with domestic, industrial and rainwater waste.

Annual runoff from the sub-basin is 300 million metres with an infiltration of 235 million metres annually, and underground drainage to the aquifer of the Masaya-Tisma basin is 68.1 million cubic metres. Water catchment depends on the hydrological characteristics, which in the area of recharging is estimated to have a thickness of 600 metres. In the area of discharge near Lake Xolotlán and Lake Tisma, there is evidence that the bottom of the aquifer is just a bit more than 280 metres deep. Logically, in the area of Lake Tisma, the highest values are found in the southern part characterized by high transmission and permeability. In summary, there is a need for continuous measurements of parameters such as extraction of water by wells, levels of depth of the lake, volume of underground water, infiltration and consumption.

Climate: The climate of the Nicaraguan Pacific is classified as tropical savannah, with annual precipitation of 1000–1100 mm and temperature of 26°–29° C. The rainy season runs from May to October. The summer, the dry season, falls between November and March, with February and March being the hottest months (Ing. Enoc Castillo, INETER).

Drought has not occurred recently, but a few years ago the El Niño phenomenon occurred, causing the rainy season to be irregular and with less precipitation, causing desertification of the seasonal ponds, marshes and small lakes, and affecting the depth of the main lake, causing problems for the development of several species of flora such as *tule* (*Thypha latifolia*) food for the fauna. The phenomenon of Hurricane Mitch caused negative effects on the lake system, such as an increase in the water level, the carrying away of sediment and pollutants, the destruction of trees and topsoil and the destruction of wildlife. It should be pointed out that concessions of the stream between Lake Managua with the lake system have been granted up until now.

#### 15. Hydrological values:

The hydrological values are very high in this system, especially Lake Tisma, Laguna Amapa, Playuela de Tisma, marsh areas and the Estero de Panaloya, which function as reservoirs or natural accumulator of the water that flows through the basin, playing a very important role in recharging the soils with very poor drainage through slow filtration. Annual recharge is 914.1 million cubic metres, contributing to recharging the aquifer. Recharging of this wetland takes place in several forms: evaporation through solar radiation from bodies of water, evapotranspiration that takes place through the aquatic vegetation and the pressure on water resources by local inhabitants for irrigation in farming activities.

In the role of preventing flooding, there are the lake, small ponds and marshes that are accumulators and natural receptors of the water that flows from the highest part of the basin, preventing flooding of the low areas. Pollutants and sediments that are transported or eroded from other areas, especially from the city of Masaya, the rice fields that use agrochemicals and now the waters of Lake Managua, are trapped by these bodies of water, which act as reservoirs and contribute to the biodegradation of these pollutants. This has a repercussion on water quality and on the food chain by endangering the existence and development of aquatic and terrestrial life.

At the present time, there are no exhaustive studies that show the degree of existing pollution and sedimentation in the food chain in the cases of *guapote*, *gaspar* and other species that are eaten by the local inhabitants in their daily diet.

#### 16. Ecological features:

The main habitats in this system of wetlands are aquatic, among which the most important are Lake Tisma, La Playuela de Tisma, La Playuela, Laguna Amapa, Estero de Panaloya and Río Tipitapa. There is also flooded land always referred to as marshes. These habitats are a refuge for species of fish, molluscs, crustaceans and a large community of resident, native and migratory aquatic birds that find refuge, food, appropriate nesting sites and protection for young birds either temporarily or permanently at this site.

Lake Tisma is the habitat of fish species such as *guapote* (*Cichlasoma managuense*), *gaspar* (*Lepisosteus tropicus*), which are very important for their economic, scientific and food value because they are the substance of the inhabitants who eat them everyday. On the shores, there is herbaceous vegetation, which houses representative communities of aquatic birds with the result being interaction between water and the land environments.

Laguna Amapa is small, but very important given that this is where the *junquillo* (*Sclerpus lacustris*) grows, which is of cultural and commercial importance for local handicrafts. There is also a community of aquatic birds, characteristic of these sites. This lake dries up during the summer.

The characteristic vegetation of the marshes is the *tule* (*Thypha latifolia*) growing widely throughout the marsh. This is the nesting habitat of the *sanatillo* (*Cassidix nicaraguensis*), endemic to this site, which should be protected as well as all the habitats of this wetland.

The Estero Panaloya and Río Tipitapa are characterized by riparian vegetation and by their diversity of species.

The terrestrial habitat has mammals such as the squirrel (*Sciurus variegatoides*), hare (*Syloilagus floridanus*), *mapachín* (*Procyonlotor*) and other species of equal importance, such as the reptile *tortuga de lago* (*Chrysemis ornata*) (see annex 5, Preliminary list of

reptiles in Tisma), amphibians such as the *sapo borracho* (*Rhinophrynus dorsalis*) (see annex 4, Preliminary list of amphibians in Tisma) and tree-dwelling birds (see annex 7, Preliminary list of large fauna in Tisma).

Among the types of vegetation in Tisma, the most dominant are the plant formation on marsh soils with emergent characteristics such as the *tule* (*Thypha latifolia*) and the *junquillo* (*Sclerophaga lacustris*) and vegetation of land subject to flooding where species of the dry forest dominate, such as *ceiba* (*Ceiba pentandra*), *guácimo de ternero* (*Guazuma ulmifolia*) and *cimarra* (*Jacquinia aurantiaca*). There are herbaceous and creeping plants such as *sandía de monte* (*Cucumis* sp.), *cardosanto* (*Argemone mexicana*), *botoncito blanco* (*Melanthera hastate*) and others. Scrub forest is also found on land subject to flooding (see annex 8, Preliminary list of flora in Tisma).

The most important associations or communities are the *junquillo* (*Sclerophaga lacustris*) and *tule* (*Thypha latifolia*). The association of *tamarindo montero* (*Parkinsonia aculeate*) is distributed over a total of 3,062.5 hectares and represents 29.1 per cent of the vegetation. Also of great importance are the species of the dry forest that grow on land subject to flooding, which are important because of their value for ecologically grown timber and food for wildlife and cattle. Among them are the *guácimo de ternero* (*Guazuma ulmifolia*), *acetuno* (*Simarouba glauca*), and for their economic importance there is *ceiba* (*Ceiba pentandra*), *pochote* (*Bombacopsis quinata*), *genizaro* (*Phytocellobium saman*), *guanacaste blanco* (*Albizia caribea*) and *guanacaste de oreja* (*Enterolobium cyclocarpum*).

Communities of aquatic vegetation grow in the water of the marshes, ponds and lakes, with the most frequent being *lechuga de agua* (*Pista stratiotes*) and water hyacinth (*Eichornia crassipes*) (Diagnóstico del System Lagunar de Tisma).

The Tisma Lake System has two well-marked seasons: a rainy season and dry season, with both drought and tropical meteorological phenomena with high volumes of precipitation in the form of hurricanes and tropical storms. In Tisma, the most frequent season has been drought. An example of this is the El Niño phenomenon, which caused drought and a drop of up to one metre in the water level in lakes and ponds, affecting the aquatic life. The opposite was the meteorological phenomenon of Hurricane Mitch, which resulted in an increase in water level, causing flooding, destruction of habitat, heavy erosion of sediments and pollutants.

For the past 50 years, changes have very slowly but quite clearly occurred, not only in Tisma but also in many other ecosystems in the country because of the extraction of firewood and cutting of wood for trade and construction. This brought with it that the original forest began to disappear, leaving less dense plant formations both in volume and in species. There are very few introduced plants in the wetland in quantities that can represent the complete substitution of the indigenous species. There are, nonetheless, very small quantities of neem (*Azadirachta indica*) and eucalyptus (*Camaldulencis* sp.) in the area near the lake. Among the fish, there is the introduced species: tilapia (*Tilapia* sp.) that is characterized by its propensity to invade bodies of water.

Among the original invading species, there is the *cola de alacrán* (*Heliotropus indicum*), *botoncillo* (*Melanthera hastate*) and *purgue de frayle* (*Jatropha gossypifolia*).

In the wetland, there is no intensification of annual crops, but a dominance of indigenous plant communities such as *tule* (*Thypha latifolia*) and *junquillo* (*Selrpus lacustris*). Among the shrub vegetation that grows on land subject to flooding is the *tamarindo montero* (*Parkisonia aculeate*). In the area next to the wetland, vegetables, basic grains, livestock and rice paddies are found, where the indigenous vegetation of the dry forest has disappeared.

#### 17. Noteworthy flora:

The species *junquillo* (*Selrpus lacustris*) and *tule* (*Thypha latifolia*) depend on the natural conditions that are found in the wetland, namely the stability of the hydrological systems of the wetland to hold the amount of water required for growth. These species are threatened by activities in the surrounding rice fields mainly in the northern part, which require large amounts of water. These plants are also used for use for handicrafts.

Also worthy of mention are the indigenous species because of their ecological, biological, economic and cultural importance: *ñambar* (*Dalbergia retusa*), cedar (*Cedrela odorata*) and *genizaro* (*Pithecellobium saman*), which is found very little at the site. Because of its cultural and educative value, the *madroño* (*Calycophyllum candidissimum*), in addition to being the national tree of Nicaragua, its cream-coloured flowers are used to celebrate the Virgin Mary in November and December. The *madero negro* (*Gliricidia sepium*) plays a multi role in ecology and is found from the dry forest up to the wet tropical wetland being used for fences, firewood and as forage. All of the above shows the importance of conserving the plant species in this system given the uniqueness of its nature (see annex 8, Preliminary list of the flora in Tisma).

#### 18. Outstanding fauna

The fauna in the wetland is diverse, in these aquatic habitats live fish, molluscs, crustaceans, turtles and other species of ichthyofauna that serve as food for the most outstanding fauna of this system. It is important to mention the mammals that live in the terrestrial ecosystem, such as rabbit (*Sylvilagus floridanus*), squirrel (*Sciurus variegatoides*), *cusuco* (*Dasyopus novemcincches*), reptiles and tree-dwelling birds, such as the *chocoyo*.

The most outstanding community in this wetland is the migratory and resident bird life merit special mention because they are the targets of hunters who enter the site and the repercussions growing rice. The species *cuaca* (*Nycticorax nycticorax*), *paloma ala blanca* (*Zenaida asiatica*) and *paloma llanera* (*Zenaida macroura*), which migrate from North America settle in the Tisma marshes for up to three months from November to January. The *garza del ganado* (*Bubulcus ibis*), cosmopolitan species that is considered to be a resident because of its adaptation to this area (Reported by local inhabitants and José Morales, IRENA/CITES, 1986).

*Piche* (*Dendrocygna autumnalis*) and *zarceta* (*Anas discors*), found in large populations in flocks of 3500–12,000 specimens at several observation points such as Playa de José, the fishermen and the cooperative. In the mornings, flocks of 100–1800 *zarceta* (*Anas discors*) have been recorded arriving from the North (Carlos Ramiro Mejía Urbina, Fieldwork for the thesis, Aves acuáticas de Tisma, diversidad and abundancia con énfasis en Anatides 19 March 2000, UCA), also local inhabitants have reported flocks of 15,000–18,000 specimens.

Among the species found in the area, there are *san andrés* (*Himantopus mexicanus*) with very representative populations of 500–1,000 specimens, *garza del ganado* (*Bubulcus ibis*) with representative populations of 300–600, *garza real* (*Casmerodius albus*) with populations of 150–300, and *garza coca* (*Eudocimus albus*) with populations of 30, recorded by local farmers. Because of its endemic importance, there is the *sanatillo* (*Cassidix nicaraguensis*). It is found towards the two lakes where it nests near the marshes and linked to an important cultural value because it forms part of a song in Nicaraguan folklore.

All the species of migratory and resident bird life are endangered by the uncontrolled hunting and by the use of pesticides and agrochemicals used in the rice fields.

Among the species of fish of economic importance worthy of mention are the *guapote* (*Cichlasoma managuense*) of major food value for the local communities. The *gaspar* (*Lepisosteus tropicus*) is a very ancient fish, popularly considered a living fossil, which has an important food and historical value, because it is caught, salted and dried during the rainy season for consumption during Easter as a typical dish of Nicaraguan gastronomy. There is also the tilapia (*Tilapia* sp.), very abundant and of value as a commercial product and as food (see annex 3, Preliminary list of fish in Tisma).

#### 19. Social and cultural values:

Eco-tourism: Ecological tourism has not developed although the site shows a high potential within and outside the wetland because of its areas and natural resources, landscapes, migratory bird life, fishing potential, outdoor recreation, education and scientific research.

Grazing: There is no grazing that causes a substantial change of the natural processes that occur within the wetland or that vary at some time the ecological characteristics of the site. There are natural pastures for extensive livestock raising. It has been impossible to obtain data that leads us to think that there is a change or harmful alteration of the wetland. This is in truth compatible because the cattle eat the plants that cover the water in the wetland.

Water supply: The value of water is very high, because it is used for human consumption, domestic uses and livestock. Livestock require large volumes of water. Above all, the rice fields which are found over a wide area north of the site. This situation results that this resource is immediately submitted to heavy pressure by the

rice growers, the communities and the local population. As a result, this resource has to be carefully managed in order to ensure its sustainability.

Fishing production: Fishing is another resource with commercial and food value, being submitted to pressure by local inhabitants and the surrounding communities, making it a very dynamic activity. This is carried out with small-scale methods using hooks and *chinchorro*. Fishing is the most important activity within the wetland. There are two types of fishing: commercial and subsistence. It is necessary to regulate the extraction of this resource in order to avoid its over-exploitation.

Agriculture: There is no large-scale agriculture within the wetland that can cause harmful changes, which can somehow change the natural processes of the wetland.

Cultural aspects: It is public knowledge that in Tisma there is a cultural heritage of pre-Colombian archaeological objects in the northern and southern parts of Tisma, which has been plundered in the private properties where they are found. There is a need for an archaeological study together with a programme of protection of this cultural heritage (Diagnóstico System Lagunar de Tisma, ASAAN).

The name Tisma comes from the term "*tisma*", which means *tis de tizal* (white stone), *tiza* or *terrón* and *ma* (llenarse) and *yan* (place). The complete name, *tismayan*, means "place where there is white stone" (Kraudie, M.E., M.L. Padilla and M. Rivera, 1990. Estrategias and Políticas para la Conservación de la Laguna de Tisma. (Thesis, Universidad Centroamericana UCA, Managua).

Tradition and culture: The patron saints days of Tisma are held every year in honour of Santa Cruz and the Virgin de la Asunción. The Municipio of Tisma has two Catholic churches of excellent and old construction.

All the values mentioned earlier must fit within the framework of sustainable use in order not to change the processes or ecological characteristics of the system of wetlands. There is an urgent need for a management plan because human activities have already weakened this ecosystem.

## 20. Land tenure/ownership of:

Land tenure is one of the greatest problems in regulating land use. The institutional policies for the adequate use for conservation of these ecosystems classified as wetlands are incipient and their application is still unsatisfactory.

Historically, within the study area, there have been three categories of property:

- Private (AP)
- Public Property Area (APP)
- Collective (C)

At the present time, most of the land and wetlands are in private hands (Diagnostico System Lagunar de Tisma, ASAAN).

#### 21. Current land use:

The main human activities at the site are fishing, which is carried out at a commercial and subsistence levels by the local inhabitants that live within and outside the wetland and extraction of vegetable fibre, such as *junquillo* (*Selrpus lacustris*) and *tule* (*Thypha latifolia*), which are used by local craftpersons.

Among the activities of lesser importance are extraction of firewood, cutting of valuable timber and hunting of wild animals. In the surrounding are, there is livestock raising and agriculture (cattle, watermelon, tomato, sorghum, maize and irrigated rice in the northern and eastern part of the wetland). The growing of rice is putting strong pressure on water resources, because large volumes of water are used for the fields. There are no statistics on the effects of human activities in the wetland, but it is known that there are 4,458 inhabitants in the town of Tisma. Agriculture and livestock raising are the main activities surrounding the wetland and at the site, there are fishing and the extraction of plant fibres (Diagnóstico System Lagunar de Tisma ASAAN).

#### 22. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land use and development projects:

Historically and now, human activities have concentrated on forest extraction, fishing, the hunting of wildlife and extraction of plant fibre. With regard to the traditional land use, it was broadleaved forest and pastures, Gramineae but this began to disappear through uncontrolled extraction of the forest resource (firewood and timber), substituted by agriculture and livestock raising. The projects for expanding monocultures, mainly the rice fields that use water resource, are directly affected by the wetland, its biodiversity (for example, aquatic communities affected by agrochemicals and the low level of the bodies of water).

Among the projects in the area, there are the following:

**Arrocera Cabañas:** located north of the Río Tipitapa and Lake Tisma with an area of 4,500 manzanas; its land is within and outside the wetland. It is known that several thousand hectares of forest were destroyed for growing rice with environmental authorization of the EIA.

**ECOCANAL, S.A.:** Negotiations are being held with private investors and the national assembly for authorization and implementation. This project consists in dredging the Río Tipitapa and Río San Juan, communicating with the Atlantic Ocean, Río San Juan, Lake Managua, Río Tipitapa, Lake Nicaragua and the Pacific Ocean.

Justification for this mega project is that of obtaining better communication for human and commercial transport. It is important to point out that this project can have possible negative effects, but in that case it is recommended that an environmental impact study

be carried out in order to take measures that mitigate the undesired effects in the protected areas of Refugio de Vida Silvestre Río San Juan, Reserva Natural Punta Gorda, Reserva Biológica Indio Maíz and Reserva Natural Laguna de Tisma.

Irrigation project for growing rice: This project that is being developed by the Ministerio de Agricultura, Ganadería and Forestal (MAGFOR) with funds from the government of Taiwan and will benefit large private producers. It will use the water of Lake Nicaragua, dredging of the Río Tipitapa up to the mark of 40 metres above sea level in order to pump water and use large amounts for growing rice on the Tipitapa-Malacatoya plain. This would lead to destruction of the nature systems legally protected by decree.

Of these projects, one ongoing project (Arrocera Cabañas) has raised the concern of the environmental organizations. This will make it necessary to carry out exhaustive studies of environmental impact, in order to measure the consequences and ensure mitigation of the negative impacts. Another large problem that affects the quality of the wetland is contamination of the groundwater and surface water through Lake Managua and the underground aquifer.

### 23. Conservation measures taken:

In the wetland, the only protected area under decree 13-20 of 8 September 1983 is the Lake Tisma Nature Reserve. The rest of the wetland has no legal protection.

There are draft management guidelines that will lead to preparation of the management plan for the Lake Tisma System, for which it is hoped that the existing economic resources will be provided for implementation.

The participation of local communities in the management of the wetland is a involvement clearly in the extraction and use of the natural resources from the place, because of which, the mayor's office is involved in promoting awareness and interest in the challenge of development and preservation of the resource.

For Tisma Lake System, the Ramsar information sheet has been completed for submission to the Ramsar Convention for approval as a wetland of international importance, obtaining protection of the proposed site.

Taking into account all of the above, the team responsible for completing the Ramsar sheet considers and proposes that this site be included in the Ramsar Convention and in the Montreux registry because the following negative effects: potential threat of the proposed mega projects to be implemented in the medium term within the wetland, pollution of its waters by Lake Managua, the growing of rice, livestock raising and extensive agriculture.

### 24. Conservation measures proposed but not yet implemented:

The conservation measures adopted for Lake Tisma are the creation of the nature reserve through decree 1320 of 8 September 1983. There are management guidelines

prepared by the Asociación Ambientalista Audubon-ASAAN (Conceptual Framework for the management plan of the Reserva Natural Laguna de Tisma carried out by AUDUBON). There are several initial protection measures at the level of the municipio and at the national level in order to protect the existing natural resources; an example is fishing which is under heavy pressure.

#### 25. Current scientific research and facilities:

There are no facilities available for research because of the economic and environmental conditions of the area. Among the studies that have been made are:

- a. Diagnóstico del System Lagunar de Tisma (ASAAN);
- b. Strategic conceptual framework for the management plan for the Reserva Natural Laguna de Tisma, ASAAN;
- c. Aquatic Birds in the Tisma Wetland: Diversity and abundance with focus on Anatides (Thesis of Lic. Carlos Mejía);
- d. Evaluation of Fisheries in Tisma (Lic. Mercedes Rueda, in preparation);
- e. Master Plan for Municipal Development. Municipio de Tisma, INIFOM–GTZ).

#### 26. Current conservation education:

There are no programmes of environmental education or training that are being carried out oriented to wise use and conservation of the wetland. The wetland has a high value for education based on its biodiversity and in the strategic location near large cities. Knowledge of the importance that the Tisma Lake System represents for the tourist, economic, cultural and scientific importance of the area.

#### 27. Current recreation and tourism:

There are no tourist and recreational activities in the wetland, although there is a high potential for developing this activity.

#### 28. Jurisdiction:

Part of the wetland is under the jurisdiction of the municipio of Tisma, department of Masaya. There is a delegate of the MARENA, for protected areas in this department. The rest of the wetland is under the jurisdiction of the municipio of Granada, department of Granada. There is a delegate of MARENA for the protected areas in that department.

#### 29. Management authority:

At the national level:

Ministerio del Ambiente y Recursos Naturales y del Ambiente (MARENA)  
Direction General de Areas Protegidas (DGAP)  
Lic. Mauricio Fonseca DGAP-MARENA  
Direction: Kilometre 12½, Carretera Norte  
Managua, Nicaragua  
Tel. (505) 263 3617/19

At the local level:

Alcaldía de Tisma and alcaldía de Granada  
Delegaciones Departamentales of MARENA in Masaya and Granada

30. References: