Information Sheet on Ramsar Wetlands

Official translation by Charles Akin

1. **Date this sheet was completed/updated**: 14 February 1999

2. **Country**: Costa Rica

3. **Name of wetland**: Cuenca Embalse Arenal

4. **Geographical coordinates**: 84 51' west longitude
10 30' north latitude

5. **Altitude**: 540 metres above sea level

6. **Area**: 50,050 hectares (8,077 hectares of water and 41,733 hectares of land)

7. **Overview**:

Average annual temperature in this wetland is 24.3 C and annual precipitation is between 2000 and 3000 mm. It lies in a area of premontane, very humid forest, in a depression of volcanic origin. Arenal dam creates a lake with a maximum depth of 55 metres. The hydroelectric station produces approximately 70 percent of Costa Rica's needs in electricity and is the main source of water for irrigation in the Tempisque irrigation district in Guanacaste. The valley is flat and crossed by two or three rivers and very few surface streams.

8. **Wetland type**:

Artificial water storage area; lacustrine; permanent limnetic lacustrine; lake and ponds
Dominant type of wetland: lacustrine and mangrove

9. **Ramsar criteria**:

1c, 2b, 2d, 3b, 4a

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

Yes

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

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

This wetland is an outstanding representative example because it fulfils a significant hydrological, biological and ecological role for the natural functioning of the Arenal resevoir hydrographic basin. It is on the divide between the Atlantic and Pacific watersheds and provides water for irrigation in the Tempisque Arenal, which suffers from five to seven months of drought, leading to a loss of crops and low yields.

It is of special importance for the conservation of genetic and ecological diversity of Tenorio Volcano National Park, Arenal Volcano National Park, the Tenorio buffer zone, the Arenal Monteverde buffer zone, the Arenal Volcano forest reserve, the Lago Cote wetland and the Arenal resevoir. This wetland is of special value because of one or more species or endemic communities of fauna and flora in the above-mentioned wildlife reserves. It is also a frequent habitat for significant numbers of several groups of aquatic birds, indicators of the productivity and diversity of this wetland. In summary, this wetland offers benefits in terms of hydroelectric energy, recreation, tourism and research.

13. **General location**:

It is in the provinces of Guanacaste and Alajuela; cantons of Tilarán, San Ramón and San Carlos; districts of Tilarán, Tronadora, Tierras Morenas, Fortuna and Santa Rosa. The dam is two kilometres northwest of the town of Tilarán, which has 16,800 inhabitants.

14. **Physical features**:

Geology: The Arenal resevoir water basin is a graben related to the Cote Arenal, Danta and Castillo faults. It is located in an area of Tertiary volcanic activity between the Guanacaste and Tilarán cordilleras. The main geological formation found here is the Aguacate.

Geomorphology: Alluvial terraces formed by sedimentary deposits from the subbasins. Piedmont areas created by a break in slope at the base of the mountains. Recent volcanic activity (Laguna Cote, Arenal Volcano and Cerro Chato) from the Tertiary and Upper Holocene.

Climate: Subject to prevailing winds from the Atlantic, absence of a long dry period

Precipitation: 2100-6000 mm annually

Average temperature: 23 C

Winds: Subject to northeastern trade winds, prevailing winds from the southeast and offshore winds from the southwest (15-30 kilometres/hour)

Hydrology: The resevoir produces 1567 x 10^6 cubic metres/year and receives a volume of 165 x 10^6 cubic metres in direct precipitation. The water surface is 87.8 square kilometres with a total volume of 2.5 x 10^9 cubic metres, an average depth of 25.6 metres and a shoreline of 170.6 kilometres.

Topography: The shores of the resevoir have an average slope of 40 percent along the edges, with broken topography, where slightly rolling hills dominate. About 1.4 percent of the land has a slope of less than 30 percent, while 98.6 percent is flat.

Soil: An Alfisol (Hapluland), derived from volcanic ash over basic buried soil, deep clay texture, dark or greyish brown, well drained and of low fertility.

Watershed: The Arenal water basin covers 50,050 hectares; the equivalent of almost one percent of Costa Rica.

15. **Hydrological values**:

The Arenal resevoir produces 1567.4 x 10^6 cubic metres of water annually, which is used for the production of hydroelectric energy and has a potential for irrigating more than 60,000 hectares. Currently only 18,500 hectares are irrigated.

In large part as a result of small farm holdings and land use practices in inappropriate areas, suspended sediments in the hydrological network of the Arenal Basin range from 83.7 to 757 tons/year/km^2 with an average of 329.86 tons/year/km^2, decreasing the useful life of the resevoir. The mouths of the Cano Negro, Chiquito and Aguas Gatas rivers are subject to frequent flooding during the rainy season creating torrential flows and broad deposition deltas.

Moving water in the watershed is fit for human consumption, while water stored in the resevoir is fit only for irrigation. There is broad trophic activity ranging from phytoplankton to man. Because of the effect of waves on the shore, constant variation in water level and steep shores, the aquatic flora is poorly developed and does not contribute to the prevention of shore erosion.

16. **Ecological features**:

Habitat: Area of very humid tropical forest, characterised by the presence of species of aquatic plants such as *choreja* (*Eichornia crassipaes*); semiaquatic plants, *Typha* spp.; Gramineae, *lagrima de San Pedro* (*Coix lachryma*); plants such as the *Heliconia* (*Scheelia rastrata*); trees such as the *espavel* (*Anacardium excelsum*) and *caña brava* (*Gynerium* spp.). There are conspicuous epiphytes such as *barba viejo* (*Tillandia* spp.), many orchids, some tall palms (*Socratea durissima, Iriartea gigante, Euterpe longipedio*) and abundant herbaceous creeping plants.

17. **Noteworthy flora**:

The flora of the Arenal conservation area includes 884 species of ornamental plants, 20 species of medicinal plants, 55 species of timber-producing trees, 63 species of edible plants, 15 species of toxic plants and 94 species considered to be weeds in crops and pastures. Near the wetland, bushes cover the greatest area (645 hectares) and herbaceous plants cover 171.5 hectares. There are timber-producing species that are in danger of extinction or that are vulnerable, such as *guayacán*, *plántano danta* and *corteza amarillo* (*Tabebuis ochracea*). There is one endemic species of Bromelia (*Piticairnia funckiae*), 24 species of algae threatened because of their small populations (11 species have been recorded only once and 10 very abundant species, most of which are green algae among the Chlorococcales).

In among the plant communities, there are a total of 58 species of zooplankton including rotifers, copepods and cladocerans. Recently introduced species include bamboos, palms, several medicinal plants, timber-producing species such as teak (*Tectona grandis*), *melina* (*Gmelina arborea*) and three species of eucalyptus.

18. **Noteworthy fauna**:

0. Number of species by taxonomic group in the Arenal basin

Taxonomic group	Species
Mammals	43
Birds	110
Amphibians	30
Fish	23
Reptiles	32
Insects	259

There is one endemic species of fish in the wetland, the *olomina* (*Priapichthys annectens*), among the 16 endemic species found in Costa Rica. A total of 7 families of fish are found in the wetland in 12 genera and 20 species, 10 of which are of commercial interest. The fish most frequently consumed by local inhabitants are the *guapote* (*Cichlasoma dovii*) threatened by over exploitation and the tilapia (*Oreochromis aurens*), an introduced species.

The most endangered or threatened species are the Baird's tapir (*Tapirus bairdii*), jaguar (*Panthera onca*), cougar (*Puma concolor*), ocelot (*Leopardus pardalis*), tree ocelot (*Leopardus wiedii*), little spotted cat (*Leopardus tigrinus*), Eyra cat (*Herpailurus yaguardondi*), *tepezcuintle*, *chancho de monte*, *mono colorado*, *carablanca* and *congo*. There are several birds: the umbrella bird (*Cephalaopterus glabricollis*), red-fronted parrolet (*Touit costaricensis*), mangrove hummingbird (*Amazalia boucardi*), *garza pechicastana* (*Agamia agamia*), black-and-white hawk-eagle (*Spizastur melanoleucus*) and the yellow and red *copete lora*.

19. **Social and cultural values**:

Tourism: The Arenal hydroelectric project has had the secondary effect of creating the landscapes of the Arenal resevoir and Arenal volcano.

Education: The percentage of illiterates in the basin is 7.3 percent, which reflects limited access of the rural communities to schools.

Scientific research: In addition to 13 research projects listed in the management plan for the Arenal basin, there is a volcanic research centre and a limnology research laboratory.

Provision of water: This basin not only provides water for the generation of electricity and for irrigation but also supplies drinking water to the local population through a system of more than 15 aqueducts.

Fisheries: Implementation of projects for the production of tilapia has been entrusted to small producers. Most of the productive activities in the basin are related to livestock, tourism, agriculture and mining (see item 21).

Culture: There has been colonisation in this area since the middle of the nineteenth century, and there is archaeological evidence of the presence of pre-Columbian groups since 4000 B.C. Colonisation has taken place primarily on the Pacific slope of the Tilarán and Guanacaste Cordilleras, based on mining and the exploitation of valuable timber. This process occurred around monasteries, giving strong roots to Catholicism.

20. **Land tenure/ownership of**:

A large number of small holdings are subject to excessive division, without separation of the original holding. There are no land surveys, and claims sometimes overlap. Urban development is poorly planned, which, together with productive activities, adds to the process of sedimentation of the reservoir.

Land in the wetland is government property and is administered by the Instituto Costarricense de Electricidad (ICE).

According to the 1984 national census, 59 percent of all farms are smaller than 10 hectares, occupying 4 percent of total cultivated land. Slightly more than 6 percent of all farms are larger than 40 hectares and occupy 61 percent of the land. Land is classified as minifundia, rural farms, medium-sized farms and latifundia, interrelated to available labour, type of crop, credit and technology.

Definitions: Minifundia: Commercial farms with intensive use of soil, dense rural population with subdivision in small properties and commercial crops. Rural farm: between 4 and 35 hectares. Medium-sized farm: between 35 and 200 hectares. Latifundia: farms of more than 200 hectares.

21. **Current land use**:

At the site: production of hydroelectricity, irrigation, tourism (aquatic activities), sport and subsistence fishing, grazing, agriculture, domestic and agricultural irrigation and aquaculture.

In the surrounding area: Extensive livestock, mixed activities, tourism, traditional and ecological agriculture, mining, industrial activities (use of wind), reforestation (nurseries and agroforestry systems), deforestation (under management plans and isolated illegal extraction) and extraction of sand from controlled sites. The total population in the area of the basin is approximately 12,700 persons.

Current land use: 1.4 percent of the area is used for grazing or is thick bush and 98.6 percent is covered by the resevoir.

About 4 percent of the available Arenal basin is used for agriculture, 18 percent is covered by forest or mountains, 5 percent is bush and 73 percent is used for grazing.

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

a) The most important adverse factors in the wetland are:

1. Along the shore, there is a series of erosional processes caused by a lack of adequate vegetation protection and changes in water level.

2. Heavy erosion caused by water and wind, concentrated in the northeast part of the resevoir. In this area, winds blow stronger (more than 40 km/hour), and changes in the resevoir's water level cause major destabilisation through share erosion.

3. Overuse of surrounding areas for activities that tax land use capacity leads to accelerated deterioration of natural resources and a loss of productivity. An example is land used for grazing in areas whose use capacity is classes VI and VII, apt only for reforestation, natural regeneration or use as a reserve. This leads to a high level of sedimentation in the rivers that empty into the resevoir, decreasing the resevoir's useful life.

4. Infrastructure and tourist services have developed around the resevoir without planning. Contamination and hunting and fishing are described in section b).

b) At the level of the water basin:

1. Elimination of buried or burned garbage and there are open garbage fields on the Arenal and Tronadora peninsulas and garbage is thrown into streams and lakes.

2. Erosion associated with grazing and the climate.

3. Sedimentation caused by removal, slides and other causes.

4. Contamination by liquid and solid waste, use of pesticides and chemicals in mining and solid waste from dairy and pig farming and coffee production.

5. Slides caused by nature or productive activities.

6. Hunting and fishing through the use of inadequate techniques and without permits near protected areas and within the resevoir.

7. Recreation and sports using the water and land without regulation or natural control.

8. Inadequate use of pesticides, internationally prohibited chemicals without regulation, orientation or natural management.

9. Quality and quantity of water: deficient and poor coverage of the provision of potable water needed for expansion.

c) For both the resevoir and the basin

1. Pollution from solid waste
2. Illegal hunting
3. Pollution of the water, ground and air
4. Illegal use of fauna and flora
5. Irresponsible large-scale tourism
6. Mining (extraction and irrational exploitation)
7. Changes in forest use
8. Inappropriate use of chemicals

Introduced exotic species

There are three species of introduced fish that do not belong to this part of the basin: two from the Caribbean watershed (*Cichlasoma nicaraguense* and *Bryconamericus scleroparius*) and one from the Pacific watershed (*Poeciliopsis turrubarensis*). They may have been introduced by the accidental use of certain species as bait and at engineering sites (canals, coffer dams and others) before construction of the dam. The tilapia (*Oreochromis aurens*), originally from North Africa, was introduced to the reservoir, but is not valued by the local population because of its taste and size. Furthermore, timber producing species, *melina* (*Gmelina arborea*), teak (*Tectona grandis*) and eucalyptus (*Eucaliptus* spp.), have been introduced. There are also several species of palm, bamboos and medicinal plants introduced primarily by local inhabitants and traders.

23. **Conservation measures taken**:

The Arenal Conservation Area includes seven wildlife areas and two wetlands (a total area of 86,771 hectares), representing a total of 32.3 percent of the Arenal Conservation Area. (See map of the Arenal resevoir basin and wildlife reserves in the Arenal Conservation Area.)

Protected Nature Area	Area (hectares)	Percent of ACA
Parque Nacional Volcan Arenal	12,123	4.5
Parque Nacional Volcan Tenorio	12,871	4.8
Reserva Biológica Alberto Manuel Brenes	7,799	2.9
Reserva Forestal Volcan Arenal	231	0.1
Zona Protectora Arenal Monteverde	28,264	10.5
Zona Protectora Miravalles	11,676	4.3
Zona Protectora Tenorio	5,530	2.1
Humedal Embalse Arenal	8,087	3.0
Humedal Lago Cote	188	0.1
Total	**86,769**	**32.3**

In the Zona Protectora Arenal two private reserves: Monteverde, there are Niños, owned by the Bosque Eterno de los Conservacionista de Asociación Reserva del Bosque Monteverde, and the owned by the Centro Nuboso Monteverde, All of the protected Científico Tropical. the Arenal resevoir areas provide water to Biológica Alberto except Reserva the Zona Protectora Manuel Brenes and Miravalles.

A management plan for the development of the Arenal basin was established in 1992 and has been implemented since 1997. It is based on criteria established by scientists and institutions participating in the Arenal resevoir's area of influence. The definition of a series of variables and technical criteria will make it possible to recommend the creation of the following three large areas for management of the resevoir.

Area 1 (High risk)

a) Because of its geographical location and the effect of winds during most of the year, especially the trade winds from December to March (part of the dry period), with average velocities close to 36 kilometres per hour, this area is especially apt for windsurfing and sailing. In addition, it offers the possibility of developing recreational activities such as motor boating, sport fishing in small bays and swimming in Bahía San Luis. This bay has a potential for the development of aquaculture and water-oriented recreation such as water skiing, motor boating and rowing.

Area 2 (Moderate risk)

a) The use of high-speed motorboats and special events are permitted subject to authorization and regulation between the Peninsula de Nuevo Arenal and the area in front of the Arenal Volcano.

b) Fishing is permitted outside the reserves and during open season (June-February), subject to quotas per person.

c) Aquaculture projects are authorised, especially for native species. The introduction of exotic species is subject to prior environmental impact studies.

d) Within this area, there are reserves for the protection of wildlife.

Area 3 (Low risk)

a) Protection and conservation of wildlife, primarily at sites for the reproduction and feeding of fish and algae.

b) Regeneration and management of habitat or floating aquatic communities or flooded ground to favour the presence of wildlife.

c) Survey and monitoring of the populations of existing species to learn more about population dynamics.

d) Recreational uses such as wildlife and landscape photography and low-velocity excursions in boats.

e) Sport and subsistence fishing should be reduced to a minimum and, if permitted, should respect the closed season.

f) Apt for aquaculture projects.

There are other management plans for the overall area of the resevoir now being implemented: agroforestry projects, commercial and conservation forestation, natural regeneration, agriculture, research and management, extension services and training, conservation, infrastructure and services, environment, agroforestry systems, tourism, animal husbandry and agroindustries.

The reserve was created in October 1991 with a surface of 260, 562 hectares. The area of the wetland in the reserve is 8,076 hectares.

A management and development plan for the Arenal basin is currently being implemented by the Ministry for the Environment and Energy (MINAE), based on agreements between the Dirección General Forestal, the Servicio Nacional de Aguas Subterráneas, Riego y Avenamiento and the InterAmerican Development Bank with the support of the World Conservation Union (IUCN) through financing provided by the Canadian Agency for International Development. The project was approved in April 1997 and has been carried out since then.

The rule of law, legal principles and precedents make possible legal solutions and the creation of technical and legal mechanisms to manage the hydrographic basin wisely. In the opinion of the consultants, these mechanisms and well-thought-out legislation will make possible specific, clear and accurate solutions for wise management of the Arenal basin. At the present time, approximately 80 percent of existing legislation is used to regulate activities in the wetland and the reserve.

Taking into account the participation of local and indigenous communities in the management of the wetland, about 13 organisations and leaders can be identified for possible participation in activities related to conservation, use and sustainable management of biodiversity in fields such as agroforestry, grazing and agriculture, environmental activities, biological corridors, tourist itineraries, conservation of fauna and flora, handicrafts and educational activities.

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

In order to ensure adequate protection for the resevoir and to improve the quality and quantity of water, it is proposed to increase the protected land area within the basin to 20,715 hectares. It is recommended that a single management category of national park be created. The national park would be called the Arenal National Park, covering an area of approximately 16,400 hectares and would include an increase of 2,434 hectares to protect the upper subbasin of the Río Chiquito, Río Negro and the micro basin of Quebrada sin Nombre. It is also proposed that the water surface and the islands (8,317 hectares) be declared a special use area in order to ensure the establishment of wise management practices and to regulate existing and future productive activities. It is suggested that this area be declared a mixed or private wildlife reserve around the resevoir. The area of total protection within the basin would be 29,032 hectares and would represent 58 percent of its surface.

A management agency for the Arenal basin should also be created to include all of the parties working in the basin, both public and private, to draw up management plans, carry out a survey of the basin and provide clear guidelines for these activities, in order that the permanent technical authority for each of the sectors and involved parties can contribute human, technical and financial resources to equip the technical departments that set policies and that take decisions, carry out economic and financial studies and set management policies for

the basin in general. At the same time, a department for the management of the basin should be created in the ICE to carry out some of the functions until a Cooperative is formed.

These proposals have not been developed, primarily for the following reasons:

a) The impossibility of enforcing legislation granting jurisdiction and power through mechanisms to achieve wise management of the Arenal basin and general protection of the natural resources to the MINAE and other ministries and institutions.

b) Isolated interpretation of regulations on natural resources and the existence of several management categories, especially with respect to the reserves around the resevoir and the public domain entrusted to the MINAE.

c) A conflict of jurisdiction between the Instituto Costarricense de Electricidad (ICE), MINAE, the Instituto Costarricense de Turismo (ICT) and local governments with regard to jurisdiction for granting concessions for the exploitation of public property in the region, the form of use plans, the setting of rates and the enforcement of regulations and incentives for development.

d) A lack of willingness and political commitment.

e) Omission of MINAE, the Dirección General Forestal (DGF), ICE, the Instituto de Desarrollo Agrario (IDA), the Ministry for Health, local governments, the Instituto Costarricense de Turismo and other ministries and institutions that have administrative responsibility for the defense of the national heritage.

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

Ongoing research:

1. Study of the capacity for tourism at public use sites
2. Management of vegetation on Isla Santa Elena and nearby sites
3. Creation of pilot breeding schemes
4. Creation of pilot projects of organic agriculture
5. Monitoring of erosion at the resevoir
6. Monitoring of the stability of tributaries feeding the resevoir
7. Study of potential aquaculture projects
8. Study of wildlife in the basin
9. Study of the ecology of key and indicator species
10. Environmental monitoring of the Arenal resevoir and areas of its influence
11. Study of fisheries at the resevoir
12. Projects for consolidation and conservation in wildlife areas and the resevoir
13. Consolidation of protected areas
14. Survey of current and potential habitat for the tapir (Parque Nacional Volcán Tenorio)

Conservation of these forests will make it possible to create an important area for many types of research and infrastructure and support services for research. This is the case of the Estación Biológica La Liga Monteverde, Centro de Investigación Vulcanológica del Volcán Arenal, the Laboratorio de Investigaciones Limnológicas and the Centro Científico Tropical.

26. **Current conservation education**:

General objective: Promotion at the community level of a clear idea of the need to conserve, maintain and leave for present and future generations a balanced environment for the development of sustainable productive activities.

Activities:

Formal education and extension services: Provision of educational programmes organised and oriented to specific objectives for the primary, secondary schools and universities.

Informal education and extension services: Training and updating of knowledge, technical assistance, production and distribution of technical information for government employees, community leaders and educators. Use of the media for general distribution of information.

Community education and extension services: Community outreach through organised groups in an attempt to find solutions to environmental problems and to define alternatives of sustainable development.

An environmental education programme in the Arenal resevoir basin is urgent in order to promote the participation of organised groups, farmers, community leaders, teachers and students in the search for opportunities for the wise use of natural resources. Education in the basin is very basic because of a high rate of illiteracy among adults. Illiteracy is 11 to 17 percent in this region, justifying a special effort to increase training and participatory environmental education, using illustrations and concrete facts for implementation of immediate actions.

27. **Current recreation and tourism**:

The resevoir is used for sailing, windsurfing, water skiing, excursions in row boats or motorboats, rallies or demonstrations and sport fishing. There also are camping sites, trails, horse riding and observation sites.

Because of the wetland's attractions for tourism and recreational activities, there is substantial investment in the development of hotels, accommodations and other services (more than 20 projects) concentrated around the Arenal and Sangregado reservoirs.

Installations for foreign tourists predominate, in a relationship between 85 to 15 percent. The high season is from November to January (the windsurfing season), when occupation is sometimes 90 percent, although the average is 60 percent. During the rest of the year, demand for accommodation ranges from 10 to 20 percent.

28. **Jurisdiction**:

Land within 100 metres of the shoreline belongs to the government. Areas beyond this strip were acquired by the Instituto Costarricense de Electricidad (ICE) through expropriation. The Ministerio del Ambiente y Energía is responsible for the administration of conservation.

29. **Management authority**:

Ministerio del Ambiente y Energía
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30. **Bibliographical references**: