



PARKS WATCH

Strengthening Parks to Safeguard Biodiversity

Park Profile – Peru Machupicchu Historic Sanctuary

Date of last onsite field evaluation: July 2004

Date published: September 2004

Location: Cusco

Year created: 1981

Area: 32,592 hectares

Ecoregion: Peruvian yungas, Humid puna of the Central Andes

Habitats: Subtropical moist forest; subtropical low montane moist forest; subtropical low montane very moist forest; subtropical montane rainforest; subtropical montane very moist forest; sub alpine, subtropical very moist paramo; sub alpine, subtropical rainy paramo; alpine subtropical rainy tundra; subtropical snowcapped mountain tops.



Summary

Description

Machupicchu Historic Sanctuary is a world-renowned protected area, known for its impressive Incan archeological complexes, sites, and monuments, which are of great historical and cultural value. The Sanctuary is also environmentally valuable since it contains forests and steeply sloped snow-capped mountains. It is a transition zone between the Andean and Amazonian ecosystems and has components of both. The terrain is predominantly rugged with steep slopes.

Biodiversity

Native vegetative remnants of the mountain ecosystem are protected in the Sanctuary. When considering native species, genetic banks, and ecosystems, biological diversity is extremely high and is a conservation priority. Flora is particularly diverse; species from nine life zones exist here, from species typical of high Andean forests, to those typical of lower altitude mountainous forests like epiphytes, shrubs, and palms. Vegetative formations present in the Sanctuary are fundamental to these unique ecosystems. The protected area is a habitat for threatened species like the spectacled bear, cock-on-the-rock, and Andean deer.

Threats

Threats to Machupicchu Historic Sanctuary include excessive tourism, absence of Environmental Impact Studies (EIA) and Environmental Adjustment Programs (PAMA), energy transmission lines, solid waste generation, burns and forest fires, unsustainable agriculture and grazing, landslides, material extractions, exotic plant introductions, incomplete physical and legal tenure of occupied lands, a multitude of stakeholders and a complicated management system, and a lack of alternative route studies for the Machupicchu Pueblo—Machupicchu Inca Village Highway.



Salkantay Mountain--snow-capped peak

Description

Machupicchu covers 32,592 hectares in the district of Machupicchu, province of Urubamba, Department of Cusco. It is located between 13° 10' 19" and 13° 14' 00" southern latitude and 72° 30' 5" and 72° 36' 33" western longitude.

UNESCO has declared Machupicchu a World Heritage Site. Numerous characteristics justify this designation, including its privileged geographic position in the transition/interaction zone between the Andes and the Amazon. It is sheltered by the snow-capped mountain chains of the Salkantay to the south and La Verónica to the north, which contribute to its unique and special environment.

Within Machupicchu Historic Sanctuary, in addition to the village of Machupicchu, there are several other world-renowned historically and culturally important sites and archeological monuments, including Inca Raq'ay, Intiwatana, Intipata, Choquesuysuy, Chachabamba, Wiñay Wayna, Phuyupatamarca, Sayacmarka, Runkurraq'ay, Wayllabamba, Torontoy, Waynaq'ente, Machuqente, Q'ente, Qoriwayrachiwa, Pulpituyoc, Patallacta, and Palccay. These sites and

monuments are associated with surprisingly complex water irrigation systems, terraces for crops, and paths between them. All of this indicates that the ancient Peruvians living here were highly developed.¹

Geography

Geology

The area is rugged with steep slopes. Its minimum elevation is 1,800 m in the Urubamba Valley and its highest portions reach 5,000 m. This zone belongs to the eastern chain. At its highest elevations there are glaciers (that are showing signs of retreat) and evidence of previous glaciers and their associated erosion. The drainage network is dendrical and rectangular-parallel, made up of the principal rivers, including Alccamayo, Aguas Calientes, Aobamba, Cusichaca, and their tributaries, indicating that tectonic movements influenced the Urubamba's tributaries.²

The protected area is in central Cusco along both sides of the Urubamba. Cambrian, Paleozoic, and Quaternary rocks in dominant formations such as Ollantaytambo, San José formation, intrusive rock, and quaternary deposits, cover the protected area. Fluvial deposits along riverbeds include everything from gravel to sand to mud and clay. Alluvial materials in the creek beds include heterogeneous mixtures of fragments and blocks with varying percentages of sand and clay mix. There are boulders and blocks of intrusive rocks in the riverbeds. Glacial materials are found mostly at the bases of the snow-capped Salkantay, La Verónica, and Chullunkuy mountains. Existing structures in the area have played an important role in developing its morphology, and in the past these structures controlled sedimentations and distorted sedimentary sequences.³

Physiographically, there are two major landscapes: the plains and the mountains, defined by their relief and the process of their formation. The plains include alluvial, coluvial, and glacial plains. The mountains are made up of metamorphic, sedimentary, volcanic, and intrusive rock.⁴

Hydrology

Hydrographically speaking, Machupicchu belongs to the Atlantic slope, the Urubamba River Basin. It includes parts of the Urubamba, from its confluence with Misquipuquio Creek at 2,700 m to its confluence downriver with the Aobamba River at 1,810 m. The Cusichaca and Aobamba Rivers form the Sanctuary's borders, and they are also left bank tributaries of the Urubamba. The snow-capped mountains (Salkantay, Chullunku, and La Verónica) are an important source of surface water. There are also some thermal waters.⁵ Other Urubamba tributaries include Pampacahua, Torontoy, Chakimayo, Miskipukyu, and Hualancay creeks.

Soils

Diverse materials in the zone have influenced the type of soil present. Soil types include soils derived from alluvial deposits, soils derived from colluvial-alluvial materials, soils derived from glaciers, anthropogenic influenced soils, and soils derived from residual materials. Gradients range from relatively no slope, to slightly inclined, moderately inclined, very inclined, moderately sloped, sloped, steeply sloped, and very steeply sloped.⁶

Biodiversity

Biological diversity of Machupicchu Historic Sanctuary is greater than neighboring ecosystems. In the Aobamba River watershed (the lower, western part of the Sanctuary), tropical vegetation is dominant. This ecosystem is known as “jungle brows,” representing tropical vegetation’s upper limit in this part of the Andes. The jungle brows contain great flora and fauna diversity, and combined with the mountainous ecosystems found within the Sanctuary, make Machupicchu a special place. Machupicchu is of great biological diversity in terms of the number of native species, genetic banks, and ecosystems it contains, and is therefore a conservation priority.

According to Holdridge’s life zone classification, which uses climate and vegetation to make its determinations, the Sanctuary includes nine life zones distributed at various altitudes from 1,850 to 6,270 m.



Mountains in the Aobamba River basin

- **Subtropical humid forest:** Located at the bottom of the Urubamba River Valley and in the lower elevations of the surrounding hills, from 1,850 to 2,000 m. It is flat to slightly hilly in the valley and inclined on the slopes, with gradients up to 50%. It is hot and humid. Average annual precipitation is 1,950 mm and average annual temperatures vary from 15 to 18 °C. Natural vegetation is rainforest, with tall trees (up to 30 m) that coexist with other flora including vines, epiphytes, and shrubs, among others. This type of forest covers 166.26 hectares (which is 0.51% of the protected area).

- **Subtropical humid low montane forest:** Located in the Urubamba and Cusichaca River Valleys and in the lower elevations of the surrounding mountains, from 2,400 to 3,000 m. Relief is flat to hilly in the valley, to steeply sloped on the mountainsides, gradients reach 50%. The climate is temperate and humid, average annual rainfall is 1,100 mm and average annual temperatures are 12 to 15 °C. Natural vegetation is also rainforest, with tall trees and other flora. It covers 1,196.79 hectares, which is 3.67% of the protected area.
- **Subtropical very humid low montane forest:** Found between 2,000 and 3,000 m. This is where the Machupicchu village and other archeological groupings like Intipunku, Chachabamba, Templo de la Luna, and Andenes are found. Relief is flat to hilly in the valley, to steeply sloped on the mountainsides, with gradients reaching 50%. The climate is temperate and very wet. Average annual rainfall is close to 1,950 mm and average annual temperatures are 12 a 15° C. This life zone covers 4,601.89 hectares, or 14.12% of the protected area.
- **Subtropical montane rainforest:** Found at the mid elevations, from 3,000 to 3,800 m. Includes archeological groupings along Urubamba’s left bank such as Intipata, Wiñay Wayna, Phuyupatamarca, Conchamarca, and Sayacmarca. Relief is sloping, up to 50% gradient. The climate is cool and rainy, average annual rainfall is 1,900 mm and average annual temperatures range from 6 to 12° C. Natural vegetation is rainforest with tall trees (that reach 25 m) that coexist with other floral species like vines, epiphytes, shrubs, etc. It covers 8,869.93 hectares, which is 27.21% of the area.
- **Subtropical very humid montane forest:** Found next to the subtropical montane rainforest in the mid elevations. Its slopes can reach 50% gradients or more. Its climate is cold and rainy; average annual rainfall is close to 1,500 mm and average annual temperatures are between 6 to 12° C. It covers 2,493.15 hectares, or 7.65% of the protected area.
- **Very humid subtropical sub alpine paramo:** This life zone is found on the mountainsides between 3,800 and 4,400 m. At its lowest portions, it is hilly to steeply sloped with gradients of 50%. It is cold and very humid; average annual rainfall is 1,000 mm and average temperatures range from 3 to 6° C. Its vegetation is mostly grass-like vegetation, mostly straw-like grass, and herbaceous coverage to a lesser degree. It covers 4,051 hectares, which represents 12.43% of the protected area.
- **Subtropical pluvial sub alpine paramo:** Covers the upper altitudes of the mountain slopes, between 4,000 and 4,400 m. It is hilly to steeply sloped, with gradients reaching



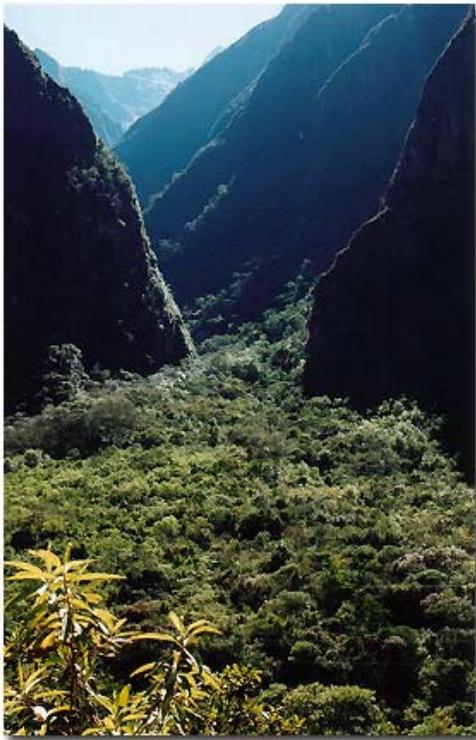
High altitude vegetation within the Sanctuary

50%. It is cold and rainy; average annual rainfall is 1500 mm and average annual temperatures range from 3 to 6° C. Its vegetation consists of straw-like grass (pajonal) and herbaceous grasses to a lesser degree. It covers 4,474 hectares, which is 13.73% of the area. There is hydro potential here as evidenced by the existence of several lagoons.

- **Subtropical pluvial alpine tundra:** Covers the highest portions of the mountain slopes, up to the snow-covered peaks, between 4,400 and 4,900 m. It is steeply sloped to hilly, as is typical of glacial-carved areas. The climate is frigid and pluvial; average annual precipitation is 1,000 mm and average annual temperatures are 1.5 to 3° C. High Andean pastures dominate this life zone. It covers 4,293.11 hectares, which represents 13.17% of the area.
- **Subtropical snow-capped peaks:** Covers the peaks and mountain crests greater than 4,600 m. Its topography is abrupt, typical of rocky surfaces lacking vegetation. Climate is snowy and freezing; average annual precipitation is 900 mm and the average annual temperature is less than 1.5° C. It covers 2,445 hectares, which is 7.5% of the protected area.⁷

Flora

Wild flora of the region is particularly diverse since there is vegetation from nine distinct life zones, including typical Andean forest species like *Polylepis* sp. in the higher altitudes and



A vegetation ecosystem formed in the mouth of a creek that flows into the Urubamba River

epiphytes, shrubs, and palms typical of lower altitude montane forests. The principal taxonomic groups include pteridophytes (ferns), gymnosperms, monocotyledons, dicotyledons, cryptogams, orchids, Poaceae, trees, moraceae, symplacaceae, roses (rosaceae), ericaceae, and vascular and non-vascular species.

Diversity in tropical cloud forests, or “the brows of the jungle” is typically 50 species per hectare (including individuals with diameters at breast height [dbh] of 10 cm or greater). However, in the Sanctuary, tree diversity is closer to 90 species per hectare. There is also an exceptional number of orchids in the Sanctuary: 200 species have been inventoried, which is more than 12% of Peru’s total number of orchid species (1,700). Because of the orchids’ beauty, they are often overharvested and as a result, their mere existence can become threatened, especially the rare species. Certain species that are particularly beautiful because of their size or color have seen population reductions due to forest fires and indiscriminant extraction by unscrupulous businessmen and area residents.⁸

Diverse vegetative formations present in the Sanctuary are fundamental components of unique ecosystems.

Certain bird species endemic to the Sanctuary and surrounding areas, such as *Thryothorus eisenmanni* and *Hemispingus parodi*, require bamboo species like *Chusquea* spp. and pintos (*Arthrostylidium*, *aulonemia*) in order to survive. Other important formations in the Sanctuary are the queñuales forests (*Polylepis besseri*, *P. microphylla*, *P. pepeii*, *P. sericea*, *P. subsericans - rosaceae*), which sustain endemic birds like *Leptasthenura xenothorax*—whose population does not surpass 100 individuals—and *Anairetes alpinus*. Other threatened birds that depend on this type of forest include *Aglaeactis castelnaudii*, *Chalcostigma olivaceus*, *Cranioleuca albicapilla*, *Asthenes ottonis*, and *A. urubambensis*.⁹

Vegetative coverage types within the Sanctuary include mountain humid forest, humid scrubland, puna grasslands, tundra grasslands, cultivated areas, and secondary growth.¹⁰

Regarding threatened flora species, those considered vulnerable include: Orchidaceae: *Bletia catenulata*, *Epidendrum bambusiforme*, *Elleanthus aurantiacum*, *Masdevallia veitchiana*, *Sobralia dichotoma*, *Sobralia setigera*. Betulaceae: *Alnus acuminata var acuminata*. Begoniaceae: *Begonia cyathophora*, *Begonia erythrocarpa*, *Begonia peruviana*, *Begonia veitchii*, *Begonia pilosella*. Meliaceae: *Cedrela lilloi*, *Cedrela odorata*. Rubiaceae: *Cinchona officinalis*, *Cinchona pubescens*. Onagraceae: *Fuchsia apetala*, *Fuchsia austromontana*, *Fuchsia corymbiflora*, *Fuchsia decussata*, *Fuchsia denticulata*, *Fuchsia inflata*, *Fuchsia sanctaros*. Cyatheaceae: *Cyathea caraccisanai*. Anacardiaceae: *Mauria heterophylla*, *Mauria subserrata*. Myrtaceae: *Myrcianthes indifferens*, *Myrcianthes oreophylla*, *Myrica pubescens*. Podocarpaceae: *Podocarpus glomeratus*. Rosaceae: *Polylepis besseri*, *Polylepis sericea*, *Polylepis subsericans*. Buxaceae: *Styloceras laurifolium*.

Those considered rare include: Orchidaceae: *Anguloa virginalis*, *Bletia mandonii*, *Cyrtopodium virens*, *Lycaste longipetala*, *Masdevallia sp. nova*, *Masdevallia amabilis*, *Masdevallia barleana*, *Masdevallia dudley*, *Odontoglossum praestans*, *Oncidium zebrinum*, *Phragmipedium caudatum*, *Schomburgkia weberbaueriana*, *Stanhopea hasseloviana*, *Telipogon boissierianus*, *Telipogon bowmanni*, *Telipogon papilio*. Podocarpaceae: *Podocarpus oleifolius*, *Podocarpus rusby*, *Prumnopitys harmsiana*. Rosaceae: *Polylepis microphylla*, *Polylepis pepeii*. Buxaceae: *Styloceras columnare*.

And those considered in an “undetermined” state include: Orchidaceae: *Masdevallia davisii*. Poaceae: *Arthrostylidium harmonicum*.¹¹

Fauna

Establishment of Machupicchu as a protected area, specifically as a Historic Sanctuary, has had positive benefits since its inauguration in 1981. Despite some serious environmental conflicts, the Sanctuary has helped wildlife in some sectors. Sightings of animals like the spectacled bear (*Tremarctos ornatus*) and neotropical river otter (*Lontra longicaudis*) along the highway (at km markers 107 and 112, respectively) are proof of this.¹²

Regarding threatened wildlife, those considered to be in a vulnerable situation include: Mammals: *Cebus albifrons*, *Cebus apella*, *Tremarctos ornatus*, *Hippocamelus antisensis*. Birds: *Merganetta armara*, *Vultur gryphus*, *Falco peregrinus*, *Fulica gigantea*. Rare species include: Mammals: *Procyon cancrivorus*, *Felis jacobita*, *Mazama chunyi*, *Pudu mephistophiles* (outside

of the Sanctuary's limits), *Dasyprocta kalinowskii*. Birds: *Leptasthenura xenothorax*, *Ampelion stresemanni*, *Agriornis andicola*. And those species whose category has been undetermined include: Mammals: *Felix pardalis*. Birds: *Nothoprocta tacsanowskii*. Amphibians: *Gastrotec Ochoai*.¹³

Management

Background

The territory that is now Machupicchu Historic Sanctuary used to be home to colonial plantations and farming estates such as Cupisa, Q'ente, Santa Rita, and Primavera. Historical references indicate that tea was cultivated in the Mandon sector as early as 1700. More recently, during the 1940s and 1950s, Cusco's newspaper "El Comercio" published different announcements regarding timber sales (romerillo, cedar, laurel) coming from Cedrobamba and neighboring areas along the Urubamba River. This activity deforested many important parts of the Sanctuary. At the same time, high Andean forests were intensely harvested for firewood.

The Sanctuary's problems increased in the years to come and it became evident that it was in a critical situation. Therefore on January 8, 1981 the Peruvian Government declared Machupicchu a protected natural area (at that time it was called a conservation unit) and incorporated it into the National System of Natural Protected Areas (then, the National System of Conservation Units, SINUC) under the category of Historic Sanctuary, in an effort to remove the threats and pressures on the area. Supreme Decree 001-81-AA (passed January 8, 1981) is the actual legal statute protecting Machupicchu's 32,592 hectares. Several years later, the Peruvian Government requested that UNESCO's World Heritage Committee declare the Sanctuary a World Heritage Cultural and Natural Site under the terms of the World Heritage Convention. It was registered as such on December 9, 1983 in Register No. 54.¹⁴



Map of the Sanctuary (in green) and buffer zone (yellow)



Location: Department of Cusco
(Map: IANP INRENA)

Objectives

Machupicchu Historic Sanctuary’s objectives are: 1) Protect the natural environment and landscape, as well as the archeological monuments and other existing cultural properties. 2) Conserve natural ecosystems and native flora and fauna species, taking actions to recuperate and restore them if needed. 3) Maintain a representative sample of the Inca culture’s integrated use of the ecosystem. 4) Maintain samples of pre-Spanish water works and soil conservation technologies, as well as Andean crops. 5) Promote scientific, biological, historical, archeological, and anthropological research. 6) Permit development of appropriate recreational and tourism use that creates income in the area, region, and country, in a way that maintains its ecological equilibrium and scenic beauty. 7) Ensure that visitors enjoy and understand the cultural values. 8) Contribute to socioeconomic development of local communities, helping them to improve their quality of life.¹⁵

Zoning

Zoning is a fundamental tool for planning and managing natural protected areas. It allows the protected area to reconcile its diverse management objectives, in particular those mandating biological diversity conservation and those calling for unaltered representative samples of the country’s diversity, with those objectives relating to that particular protected area’s use mandates.¹⁶

Machupicchu Historic Sanctuary’s Master Plan specifies the following zones:

Strict Protection Zone: Public use is limited in this zone. Only authorized scientific research that does not result in modification, alteration, or manipulation of the environment or natural elements is permitted. Archeological research is permitted even in the case that it may alter the environment. Tourism and recreation are prohibited here; no construction is allowed.

Wildlife Zone: Control and research activities are permitted, as well as low-impact tourism and recreation, as long as the sites’ natural states are preserved. Construction of permanent infrastructure is prohibited, as are motorized vehicles and non-native pack animals. Here, llamas are to be used for travel. Traditional populations, with recognized rights, should minimize their



Train signals

impacts on these areas when carrying out their activities. Permanent monitoring is conducted here to guarantee that people are following the permitted-use regulations. Resource extraction in any form, except firewood extraction by high Andean communities done as trimming and with management plans in designated areas, is prohibited.

Tourism and Recreation Zone: Infrastructures for lodging, interpretation, and other services are permitted as long as there are site plans, the carrying capacity is determined, and an environmental impact

evaluation is completed. The activities cannot interfere with cultural or natural values. Research and education are permitted.

Special Use Zone: This zone intends to demarcate areas within the Sanctuary with inappropriate uses, those that were in existence before the protected area was established. This zone tries to stop expansion and mitigate any negative impacts by implementing appropriate management. Adequate monitoring is needed in this zone to guarantee that activities do not affect the Sanctuary's objectives and to take action when activities do impact the Sanctuary. A specific plan is needed to address the situation in each corresponding site within the zone in order to help an eventual recuperation, or at least stabilize and minimize the impacts on the Sanctuary and its conservation.

Restoration Zone: This zone is designed to facilitate ecological restoration in portions of the Sanctuary affected by inappropriate uses via special measures and assigning them to corresponding zones. Use in these areas is limited to restoration measures.

Historic-Cultural Zone: This zone attempts to assure maintenance, conservation, and appropriate restoration of archeological monuments within the Sanctuary and guarantee that those engaging in the permitted uses, such as scientific research, educational, tourist, and recreational activities, strictly respect the natural environment surrounding the monuments. This zone integrates the Sanctuary's cultural and natural values by promoting efficient conservation and by making this area available to the public for research, education, and enjoyment. This is possible because of the program that includes internal ordering that coincides with the Sanctuary's general objectives. These plans should correspond to criteria defined by specialists in cultural aspects and should be approved by the National Cultural Institute, the corresponding authority.

Buffer Zone: Machupicchu Historic Sanctuary is between the Sacred Valley Andean ecosystems and the Amazon forests. This fact was taken into account when determining the limits of the buffer zone and when its role within a greater biological corridor was determined. The buffer zone tries to help the Sanctuary reach its general objectives and tries to stop surrounding area activities from harming its cultural and natural resources. Provincial development plans and other land use planning activities should acknowledge the buffer zone's special designation and incorporate it positively in local governmental strategies and in diverse public sectors' requirements.¹⁷

Machupicchu Historic Sanctuary's Management Committee

The Natural Protected Areas Law 26834 states that in every protected area a management committee is to be formed whose role is to bring together any public and private institutions and any other stakeholders interested in the protected area. The purpose of the management committee, according to Article 16 of the Natural Protected Areas Law, is essentially consultative. Article 16 states that the committee shall: 1) Propose development policies and protected areas plans to the national authority for approval that fall within the scope of the natural protected area's policies. 2) Ensure that the area functions properly, that approved plans are executed, and that there is compliance. 3) Propose measures that harmonize resource use with the protected area's conservation goals. 4) Supervise and control completion of contracts and

agreements relating to the protected area. 5) Facilitate intersectorial coordination to help park staff manage the protected area. 6) Propose fund-raising initiatives.

Machupicchu's Management Committee was formally created in June 2001, under the Presidency of the Transitory Administration Board of Cusco (CTAR). The organizations involved in the committee include Machupicchu's Management Unit (UGM), the National Institute of Natural Resources (INRENA), the National Cultural Institute (INC), the Urubamba Provincial Municipality, the Machupicchu District Municipality, the Regional Industry and Tourism Office, and the San Antonio Abad de Cusco National University, among others. During the two years following its creation, an executive commission worked almost exclusively to strengthen the management committee institutionally because it is weak with poor planning, latent conflicts, and limited management tools at its disposal.

Generally, INRENA is the sole administer or manager of a natural protected area. In Machupicchu's case, there is also an Archeological Office run by an anthropologist. The management committee is the Sanctuary's advisory committee. Overall, Machupicchu's situation is complex. First, the Sanctuary has the INC responsible for cultural resources and INRENA responsible for its natural resources. Then, the Machupicchu Management Unit (UGM), which includes the Regional Government, INC, INRENA, and the vice-minister of the Tourism Ministry, was created via Supreme Decree 023-99-AG in 1999 to lead efforts to rehabilitate the Sanctuary. Overall, the UGM serves to facilitate interinstitutional coordination. This institutional grouping complicates the Sanctuary's management and usually results in conflicts regarding roles and responsibilities.

“The Management Unit (UGM) is being completely reengineered. A consultant is analyzing the UGM in order to make recommendations. We hope that the UGM is restructured to be more efficient and competent in its functions.”¹⁸

Machupicchu's Technical Group

The Regional Environmental Commission of Cusco's Regional Government (CAR), which was created 7 years ago, works on regional environmental issues. It brings together state and civil society organizations that are committed to resolving local environmental problems. CAR promotes forming thematic and specialized groups that operate as long as needed to accomplish their mission and assigned specific task(s). Examples of such groups include environmental education, solid waste, biodiversity, economic/ecological zoning, and air quality. All of these working groups are backed by a presidential resolution under the National Council of the Environment (CONAM). This is how the specific technical groups for Machupicchu came into existence. All groups are supposed to support adequate Sanctuary management and promote planning and conciliation among involved stakeholders (Article 2 of Supreme Resolution #037-2001-CD/CONAM).

CAR's functions, according to Article 3 of Supreme Resolution # 037-2001-CD/CONAM, include: 1) Support the process to identify and prioritize outstanding environmental problems; 2) Bring stakeholders together to discuss and reconcile their organizational, social, and/or cultural differences that affect proper handling of diverse environmental problems; 3) Propose regulatory measures and management strategies to find solutions to existing environmental conflicts and

problems and to secure guarantees from participating institutions to change behavior and/or take action.

The following lists the members of the Machupicchu Technical Group:

- President of the Regional Environmental Commission
- Regional Director of Cusco’s Cultural Office
- Machupicchu Historic Sanctuary’s Director (INRENA)
- Another INRENA representative
- Technical Manager of the Sanctuary’s Management Unit (UGM)
- Provincial Municipal Mayor of Urubamba
- District Municipal Mayor of Machupicchu
- Director from the Regional Industry and Tourism Office (DRIT)
- The Titular with Cusco’s Ombudsman
- President of the Cusco Hotel Association
- President of Cusco’s Tourism Agency Association
- Executive Secretary of the National Council of the Environment (CONAM)

The Technical Group has had a certain level of success regarding its ability to bring together Machupicchu’s main institutional stakeholders. It represents an appreciated forum for information exchange and holds a degree of prestige even though it does not directly manage the Sanctuary. The Technical Group was formed at a time when the management committee was not functioning. Now however, since the group specializes in the environment, it is of valuable support for the management committee and other local and regional authorities. Like Cusco’s CAR group, the Technical Group reinforces regional attention on environmental problems.¹⁹

Administration

The Natural Protected Areas Agency of the National Institute of Natural Resources (INRENA), within the Ministry of Agriculture, is responsible for Peru’s natural protected areas. Law Number 26834, Natural Protected Areas Law passed June 30, 1997, and its corresponding Supreme Decree 038-2001-AG published on June 26, 2001, regulate their administration.

In Machupicchu Historic Sanctuary’s case, there are two administrative entities. First, like all other natural protected areas, INRENA is the responsible office. However, cultural artifacts and Machupicchu’s archeological sites (including the complexes and the Inca Trail within the Sanctuary) are under the responsibility of the National Cultural Institute (INC). Some difficulties have arisen because of this dual management situation.



Dissemination action by INRENA

INRENA staffs one director and 32 park guards distributed in six guard stations (Piscacucho, Q’oriwayrachina, Wayllabamba, Wiñay Wayna, Aguas Calientes, and Intihuatana). The Sanctuary’s office has administrative personnel as well as 10 professionals with expertise in the

natural sciences and tourism, as well as university interns who rotate between different areas. The areas include planning, public use, vigilance and control, environmental monitoring, and legal council.

INC staffs approximately 40 control agents distributed in diverse park stations, such as Chachabamba, Q'oriwayrachina, Pacaymayo, Guayllabamba, Machupicchu, among others.

Budget

Machupicchu National Sanctuary is one of the few protected areas in Peru that generates its own income. This money is divided between INC (responsible for charging entrance fees) and INRENA.

As a result of a debt-for-nature swap, Finland's International Aid Agency provided Machupicchu approximately \$6 million. The National Natural Protected Areas Fund (PROFONANPE)—the organization responsible for administering all internationally donated funds for protected areas—administered these funds. The Finish aid agency requested that an independent office in Cusco be created, with PROFONANPE presence, to administer the \$6 million. The project, ended in December 2002, was named “Machupicchu Program” and received technical assistance from PROFONANPE. Due to various political problems, not all of the money was spent and funds had to be returned to the agency, who was clearly not happy about the situation.

Entrance fees for the Inca Trail and Machupicchu Inca Village reach 50 USD per person. Of that, INC receives \$20 for entrance into the village and the remaining \$30 is split evenly between INC and INRENA. INRENA makes approximately 1,600,000 USD per year (approximately 5,400,000 Nuevos Soles), which it manages in a special account exclusively earmarked for Machupicchu (as established by law, DS#032-2002-AG). Unfortunately, this has generated interest and false expectations among other institutions like the Regional Government, provincial municipalities, and district municipalities that want access to the funds.

Unlike INRENA, INC appropriates approximately 12% of their income earned by Machupicchu entrance fees to Machupicchu itself and uses the remaining funds to support work in other archeological sites throughout Cusco and southern Peru.

Human Influence

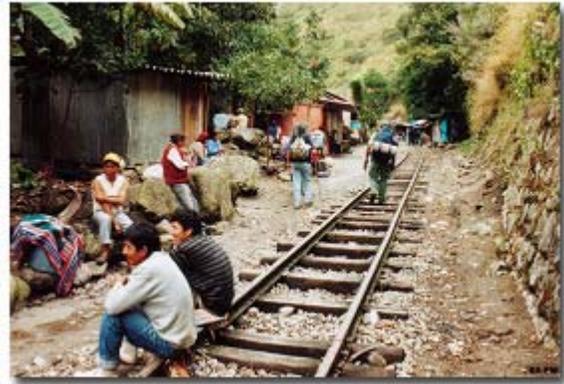
Major population centers within the Sanctuary include: Aguas Calientes (Machupicchu pueblo), which is an important location near Machupicchu's archeological complex; Aobamba/Intihuatana/Hidroeléctrica with approximately 600 people (120 families); Mandor with approximately 50 people; San Antonio de Torontoy with 300 people (60 families); Quente with 40 people (8 families); Wayabamba with 400 inhabitants (130 families); Pampacawana with 25 people (8 families). In the buffer zone, Santa Teresa has 4,000 people (including its annexes with 500 families); Qollpani with 350 people in 80 families; Chillca with 150 people; Piscacucho with approximately 630 people (100 families); Quesca with 80 people (20 families); and Mollepata – Soray with about 60 residents. Between Aguas Calientes and the Sanctuary's eastern border, there are 40 families settled along the rail lines. In total, within the Sanctuary, there are 3,500 people.²⁰

Aguas Calientes (a.k.a. Machupicchu) is the administrative capital of Machupicchu District and is the most important rural/urban center within the Sanctuary. There are approximately 3,000 people in the entire district, more than 2,000 of whom are in Aguas Calientes. More than 50% of the residents are temporary; they come from other parts of the country to work during the high tourism season between June and September.

As a result of the 1998 heavy rains that threatened and destroyed many homes in the area, a group of 60 families relocated temporarily to the hydroelectric sector of Intihuatana. Of these original 60, 15 families do not want to leave. They receive political support from the Machupicchu District Mayor, who is most likely looking to gain more votes and thus does not work to relocate these families outside of the Sanctuary.

The municipal government of Machupicchu is helping to build certain infrastructure within the Sanctuary, such as a church and a medical center in Wayllamba and bridges that facilitate access to the protected area. These public works help consolidate existing settlements and attract new residents.

The mayor states, “As mayor, I should confront INC and INRENA. For example, there are many communities without electricity, yet there are high-tension towers and electricity production within the Sanctuary. As mayor, I must attend to their rights and carry out my job according to the municipal laws. The main political authorities within the districts are the municipalities, but here, INRENA and INC want to have the most power. As mayor, I reclaim our municipal authority; I am not against following the norms associated with legal jurisdictions, but the corresponding authority of each institution must be respected.”²¹



Hydroelectric Center, Intihuatana

Towards the west of the protected area, residents of Aobamba have land both within and outside of the Sanctuary, mostly because the town is bordered by a river and there are properties on both sides. There are four families living within the protected area, but there are many more that cross the river regularly to access the protected land. There are 65 families within the Aobamba Producers Association (*La Asociación de Productores del Aobamba*). San Antonio de Torontoy is a campesino group with 10 sectors: Parawachayoc, Lucmachayoc, Cedrobamba, Lucumayo, Pampacahua, Chakimayo, Retamal, Qoriwayrachina, Qanabamba, and Choquellusca. Wayllabamba has no legally defined status; it has only been recognized by the community. It has eight sectors: Patallaqta, Yuncachimpa, Tarayoc, Wayllabamba, Matara, Palccay, Pampacahuana, and Paucarcancha. The villages of Santa Teresa and Qollpani are in the buffer zone northwest of the protected area; Piscacucho villages (including the sectors of Miskay, Piscacucho, Qarpamayu, Yawar Waqaq, San José de Chamna), Qesca and Chillca in Ollantaytambo district are in the buffer zone, east of the protected area; and Soray, Marcqoqasa, and Challacancha in Mollepata district are in the buffer zone south of the protected area.

Social organizations within the Sanctuary are of rural nature and function within a communal structure. They have a board of directors, and in most cases specialized committees, whose functions are to provide access to basic services for the population. Community cohesion is not homogeneous in all of the sectors; it is better in communities with daily tourism activity. There are directors' boards in Intiwatana-Aobamba, Qollpani, San Antonio de Torontoy, Piscacucho, Chillca, and Mollepata. Wayllabamba has the largest number of specialized committees: a water/irrigation committee, milk program committee, Inca Trail cargo carriers association, parents association, young persons Wayllabamba sport club, female Wayllabamba sport club, potable water administrative board, pro-electrification association, pro-medical center association, and a pro-Latrine board. There is also the Apu Salkantay Muleback Riders Association that includes people from Mollepata, Pampacahuana, Wayllabamba, Quesca, and Santa Teresa.

The producers settled within the Sanctuary are small farmers or domesticated animal owners. In the jungle brow zone, on the Aobamba side, small farmers that grow annual crops and vegetables are predominant as are those who grow coffee, avocados, and other fruit. More than 2/3 of these producers use some sort of pesticides, 1/3 use chemical fertilizers, 1/3 use organic fertilizers, and 1/3 do not use any fertilizers. Domesticated animals, such as guinea pigs, chickens, ducks, and turkeys, are raised for consumption. Not many have cattle, sheep, or horses.

Within the Inter-Andean valleys of the Sanctuary, there are two types of producers depending on the location. There are farmers with small farms located near the rail line, who grow annual crops for consumption, and permanent peach groves or other fruits. On average, they cultivate 2 hectares. Most use animals to harrow their fields. They raise small, domesticated animals, such as guinea pigs, chickens, ducks, and turkeys, for consumption. More than half own cattle; on average there are four animals per family that use six hectares of natural pastures (mostly of communal nature) located on the upper slopes. There are also farmers who farm small plots located far from the rail line. They are even more dedicated to growing annual crops for consumption and they also cultivate about 2 hectares on average. More than half use pesticides on their crops, 2/3 fertilize (1/3 use chemical fertilizers), and 1/3 do not fertilize. They also use animals to harrow the land and raise small, domesticated animals for consumption. On average, each family has five cattle, and three horses (for transportation). Fewer families possess sheep. On average, each family uses six hectares of common-land pastures located on the slopes. In the case of the Huayllabamba village, most also earn a living from tourism.²²

Access

In 1905, Senator Dr. Telémaco Orihuela of Cusco initiated a railroad construction project to connect Cusco with Santa Ana Valley (La Convención). The railroad route was built between 1914 and 1919 and reached km 72 (between Ollantaytambo and Chilca). Transportation service began several years later in 1924. In 1929, the lines were extended to Aguas Calientes (km 110). On May 1, 1931, the



Homes in the Pampakahuana Sector

State took over administration of the railroad and extended it all the way to Puente Ruinas (km 112) within the village of Machupicchu.²³

In 1999, the Peruvian government privatized the state-run Empresa Nacional de Ferrocarriles S.A (Enafer). On September 22, 1999, the Ministry of Transportation and Communications (MTC) granted a 30-year concession to Ferrocarril Transandino S.A (Fetransa) for the south and southeastern rails. In this deal, 689 km of rails and materials of the southern line (from Matarani, Arequipa to Cusco) and 111 km of the southeastern rail line (from Cusco to Machupicchu) were transferred.

Fetransa administers both rail lines, but PeruRail S.A. operates them. They are distinct private entities, but they belong to the same association: Sea Containers Ltd. (or its subsidiary, Orient-Express Hotels Ltd. in PeruRail's case) and Peruval Corp S.A. Orient-Express is a significant economic player in the region. It is also owner of the Sanctuary Lodge that is located at the entrance of Machupicchu Inca Citadel and at the Monasterio Hotel in Cusco – two high-class hotels.²⁴



This train travels parallel to the Urubamba River

There are advantages to entering Machupicchu Historic Sanctuary by rail, the main reason being that it helps control visitors, allows for understanding the characteristics of the area, and facilitates the opportunity to provide adequate and appropriate information to tourists. It also makes it harder for illegal settlements to form since it prevents land settlements along the route and acts as an obstacle to potential illegal resource users.

To the south, one can reach Mollepata via vehicle and from there, hike or travel via mule across the Incachiriasca Gap to reach the protected area, next to Salkantay Peak, three days later. This route is becoming a well-known tourism trip.

Conservation and Research

The most researched part of Machupicchu Historic Sanctuary is along the Inca Trail. The Wiñay Wayna Research Station, established in 1985, despite its limitations, has become a base for biological research where approximately 20 research projects on flora, fauna, and ecology have been conducted. Below are some of the research publications on the Sanctuary.

GALIANO, W. & NÚÑEZ, P. Estudios Comparativos de la Diversidad Florística del Santuario Histórico de Machupicchu y el Sector Alto del Parque Nacional del Manu. Curso sobre estimación de la Biodiversidad. Smithsonian Institution. Cusco, Perú. 1992.

GALIANO, W. & NÚÑEZ, P. Evaluación Rápida de la Flora en la Carretera de Acceso entre Aguas Calientes y la Ciudadela del Santuario Histórico de Machupicchu.

MONTEAGUDO, M. A. Evaluación de la Diversidad Arbórea en Tres Bosques Representativos del Santuario Histórico de Machupicchu. Tesis para Biólogo. FCB UNSAAC. Cusco, Perú. 1997.

PEYTON, B. Spectacled Bear Habitat Use in the Historical Sanctuary of Machupicchu and Adjacent Areas. Master's Thesis. University of Montana, USA. 1984.

POZO, G. S. Tasas de Deforestación en el Santuario Histórico de Machupicchu. Tesis para Biólogo. FCB UNSAAC. Cusco, Perú. 1997.

PYHALA, M. Is carrying capacity a useful tool for tourism management? The case of Machupicchu. A dissertation submitted to the School of Development Studies of the University of East Anglia. September 1999.

TUPAYACHI, A. Impacto Ambiental sobre la Diversidad Arbórea del Santuario Histórico de Machupicchu. Informe I. UNSAAC. Cusco, Perú. 1995.

TUPAYACHI, A. & GALIANO, W. Flora del Santuario Histórico de Machupicchu: Wiñay Wayna. Biota. Lima, Perú. 1988.

Threats

Current threats to Machupicchu Historic Sanctuary include:

- Carrying capacity exceeded along the Inca Trail
- Hydroelectric center and energy transmission lines
- Solid waste
- Burns and forest fires
- Agriculture and grazing
- Landslides
- Extraction of rocks (for crafts) and sand
- Uncontrolled hunting
- Exotic species' introduction
- Incomplete physical survey and legal land tenure

- Lack of institutional coordination
- Machupicchu Pueblo – Machupicchu Inca Village Highway

Currently, the most worrisome environmental problems include impacts from “traditional” agriculture that uses damaging techniques like slash and burn; fertilizers and chemicals used by migratory agriculturalists that are expanding the agricultural frontier; presence of various domesticated animals within the Sanctuary that lead to greater deforestation and less natural vegetation; periodic forest fires that cause irreversible damages to wildlife and can lead to additional problems like erosion and unbalanced hydrological regimes; poor management of the Sanctuary’s intensive use zone that includes the access routes, rail line, Aguas Calientes-Puente Ruinas-Ciudadela highway, over capacity on the Inca Trail; slumming of Aguas Calientes; garbage accumulation; and lack of knowledge regarding the protected area.²⁵

In the middle of all these threats to Machupicchu Historic Sanctuary, there are also conflicts that make management more difficult. Examples of existing conflicts include PeruRail’s monopoly of train service; conflicts between tourism operators and cargo carriers; the growing conflict surrounding the construction of the Sta. Teresa - Hydroelectric Center Machupicchu road; conflicts regarding distribution of fees collected to enter the Sanctuary and archeological complexes; conflicts related to the physical and legal land titling; institutional conflicts regarding the Sanctuary’s management; conflicts regarding co-management of the concession of the Hiram Bingham highway; and interinstitutional conflicts related to solid waste management.²⁶

Carrying capacity along the Inca Trail

The Inca Trail is one of the Sanctuary’s main tourist attractions. Between 1984 and 1997, there was an 800% increase in the number of tourists from 6,300 to 50,000, respectively. The following table details the yearly visitors to the traditional Inca Trail.

Visitors to the traditional Inca Trail

YEAR	CITIZENS	FOREIGNORS	TOTAL
1984	666	5597	6263
1985	1398	5652	7050
1986	8879	8174	17053
1987	6304	8834	15138
1988	8318	10685	19003
1989	7437	7153	14590
1990	3487	4453	7940
1991	2236	4172	6408
1992	4341	5572	9913
1993	6336	8504	14840
1994	8834	14515	23349
1995	10105	19390	29495
1996	14687	30475	45162
1997	15687	34260	49947

TOTAL	98715	167436	266151
--------------	-------	--------	--------

Source INC²⁷

The Inca Trail is one area within the Sanctuary with environmental problems, mostly due to overuse of the trail. For example, there are areas along the trail that have been reforested with the introduced, non-native eucalyptus (*Eucaliptos globulus*), and there are pasture areas full of cattle. Use of mules along the trail to transport cargo in the lower areas is causing trail erosion. Drainage between Sayacmarca and Phuyupatamarca, Chaqui Cocha zone, causes erosion and deterioration of the landscape. Also, there is an excessive number of buildings in Pacaymayo that create a negative visual appearance and alter the landscape. Also, wooden latrines are located close to the Phuyupatamarca complex.

There is also a lot of garbage produced in camping areas. Non-degradable solid waste (such as plastic bottles, plastic bags, tinfoil, and cellophane) are dumped along the trail's outskirts and, while not readily visible, nonetheless contaminate the environment.



Group of cargo haulers after a long hike

Another result of the trail's overuse is the installation of antennas for radio communication, which also impacts the visual aesthetics of the area. Certain structures, like in Wiñay Wayna (biological station, control station, hostel, etc) and those in other places such as Q'oriwayrachina, Pacaymayo, and Wiñay Wayna for INC and INRENA vigilance staff, damage the forest.

Tourism in general generates additional impacts. People remove rocks from the original Inca Trail to keep as souvenirs. There is serious erosion threat in certain sectors that are not cobbled. In addition, many side trails have been formed and are full of garbage and human feces. Many cargo carriers go overweight with the cargo, and this also adds to serious erosion along the trail.²⁸

Cargo carriers generate certain difficulties for the Sanctuary and contribute to problems generated by tourism agencies working within the protected area. First of all, the requirement that tourists bring cargo carriers increases the number of people in the Sanctuary. Also,

considering that between 40 and 50% of the permits issued to walk the Inca Trail are used by the cargo haulers, they must constitute a significant amount of pressure on the protected area. While the cargo haulers are the responsibility of the tourism agency that hires them, some haulers do not comply with the established norms and generate serious impacts to the trails used. Haulers contribute to garbage generation, excrement along the trails and camps, vegetation destruction, and rock removal.

Hydroelectric center and energy transmission lines

Another serious problem within the Sanctuary is the Machupicchu Hydroelectric Center. This center was built in 1959; it has been reconstructed several times after it suffered damages from Aobamba River and Urubamba River Dam floodings. The center – which is an important structure because it provides much of the energy available to southern Peru – impacts the protected area by creating negative visual effects (towers, energy transmission lines, houses, and other installations) and by its associated activities (disorganization because of the flow of personnel, contamination, forest fire risk, pressure on the natural resources due to hunting and extraction). The relationship between the hydroelectric center's access routes and use of the Sanctuary is direct and undeniable, especially when it comes to spreading tourism and its orientation towards critical habitats for different species, such as the torrent duck (*Merganetta armata*), which can be affected by changes in water level in the Urubamba River.²⁹

There is an underground tunnel that cuts through the mountain at the altitude of km 107 of the Cusco Quillabamba rail line that brings water to Aobamba River for hydroelectrical purposes. Some experts argue that this underground tunnel affects the geological stability of the mountain, which is right next to the ancient Machupicchu village.

The company, Generadora de Energía Machupicchu S. A. (EGEMSA). EGEMSA, is responsible for managing the hydroelectric center and for generating electricity. Electrosur Company transports and distributes the energy, thereby creating additional impacts. EGEMSA has a series of projects in the Machupicchu Historic Sanctuary. It maintains access roads to its installations which have both direct and indirect impacts on the environment. For example, when the road bordering Aobamba River was affected by avalanches several years ago, company built bridges to correct the problem, thereby clearing more natural land. These roads facilitate tourism while also facilitating access for colonists and migratory farmers.

Also, the company conducts avalanche prevention work, which modifies the environment. The company hopes to control Salkantay Lagoon, which is an Upper Andean Lagoon at the foot of the snow-capped peak. According to reports from the area's administrators, even though the company has just finished studies and corresponding permits, they are requesting work bids. They want to drain the lagoon, which they say is part of their prevention work. However, draining the lagoon will impact birds, fish, and aquatic



A dam at from the hydroelectric plant

vegetation. The actual work needed to carry out the drainage will generate additional impacts, for example, there will be additional workers, heavy machinery, and vehicles in the area that will produce waste, among others.



Visual impact of the transmission lines

According to park guards, in 2001 during a monitoring visit to the area, EGEMSA had drained 12 meters of the lagoon. The protected area staff arrived just as the company had removed their operators and they found a large amount of garbage and empty shotgun cartridges. Many times, EGEMSA carries out their operations without any coordination with INRENA or INC, going against protected area management policies. The company has not provided its work plan and apparently there is no Environmental Adjustment Program (PAMA), even though it is required by the Ministry of Energy and Mines.

According to people who know the zone, years ago the Salkantay's glaciers reached the lagoon, but sadly, this is no longer the case. Both global warming and local lagoon management are affecting these snow packs, which are receding upslope. Sanctuary park guards added that trout (*Oncorhynchus mikiis*) will be very affected by the lagoon's destruction. There was a time when locals commercially fished for trout and it negatively impacted the lagoon; but because of this INRENA stopped the extraction.

Solid waste

“The forest hides everything” best describes the prevailing, insidious pattern in the Sanctuary. For years, camouflage provided by vegetative coverage hid irresponsible use that threatened to turn this beautiful heritage site, which is the most visited site in the country, into a giant garbage dump. A range of studies conducted by INRENA since 1982, including studies on tree diversity and detailed inventories using test plots and transects, support this fear. During their studies, researchers found large amounts of solid waste in inaccessible forests that had previously been considered “pristine.” These studies have determined that the most affected areas include the Inca Trail, the rail line, Vilcanota River, the urban and rural communities, the Aguas Calientes road, and the road to the archeological city.

Today, solid waste generated by tourism along the Inca Trail and the ancient city as well as the waste coming from Aguas Calientes and other small settlements is closely managed. All of the garbage is removed from the zone by train and taken to an authorized landfill. While this

measure has significantly helped to improve the solid waste problem, there are still serious deficiencies that need attention.

INC staff in Wiñay Wayna said that garbage pollution is one of the main problems. Because of the sheer numbers of tourists, it has been impossible to clean all of the garbage. Tourism operators are obliged to remove garbage, but they do not do it. Waste control is found along km 106, but that is not efficient since the tour operators use two other routes to finish the Inca Trail hike. Tourists use the traditional trail to visit the ancient city of Machupicchu, where everything is kept clean. While the tourists are in Machupicchu, the pack haulers use the other trail to complete the trip (they do not go to the ancient town), which takes them directly to the rail line. This trail sees more garbage and contamination because the pack haulers throw it along the trail to lighten their load even though they are supposed to dump it at the train to be hauled away. Tourists do not use this route. Usually the garbage is dumped at night since the pack haulers are trying to make it back to the train quickly.³⁰

Solid waste pollution affects the environment, tourism, and health. The Vilcanota (Urubamba) River is actually one of Peru's Ten Most Contaminated Rivers.³¹ Various tourists agencies located in the watershed, especially those that offer canoe trips, have decided to cancel those packages from their offerings since the water is so contaminated and there are excessive amounts of garbage on the river's edges.

Another major source of contamination is the Huatany River and its micro-watersheds located near Cusco. On average, 60 tons of garbage is dumped there on a daily basis. During the rainy season, this garbage flows to the Vilcanota-Urubamba River via the Huambutio mouth. Communities settled along Vilcanota (Urubamba) River dump their wastewater and garbage on the banks. All of this waste arrives in the Sanctuary via Urubamba River. There is also a certain level of contamination from plastic bottles, tinfoil, cellophane, glass pop bottles, and aluminum cans thrown by visitors of the ancient city and Inca Trail. Empty plastic bottles and bags with food residuals attract insects and bacteria, which also threaten fauna in areas of the lowland Amazon forest.³²

The district of Machupicchu produces 5 tons of solid waste every day, generated in the urban center of Machupicchu Pueblo (Aguas Calientes): 3 tons collected by the municipality in the ancient village of Machupicchu, 1 ton collected by INC, and 1 ton collected by INRENA along the Inca Trail. Previously, this waste was disposed of in informal dumps located near Machupicchu Pueblo (Aguas Calientes), along the train lines, and even in the creeks of the neighboring district, Ollantaytambo.

In an effort to reestablish the Sanctuary's sanitary and environmental conditions, and thereby complying with the Master Plan, a system has been implemented on a test basis to remove



Bags of trash ready to be transported by train outside of the Sanctuary

solid waste generated in the Sanctuary. Garbage is collected and kept in sealed bags to be later transported by train to Pachar (Ollantaytambo District). The PeruRail company provides this transportation as per their agreement with the Sanctuary. In return, in July 2003, this company was exonerated from paying for the train's right-of-way. After reaching Pachar, the waste is transported via dump truck to the Haquira landfill, located in Corca district in Cusco Province, thanks to INRENA's subsidy.

Lack of implementation of institutional mechanisms to cover public service expenses in Machupicchu District threatens the sustainability of any solid waste and wastewater management solutions in the Sanctuary. Without an agreement between the municipalities of Urubamba and Machupicchu regarding final garbage deposition in Yuncacha Huayco, there is a risk that garbage will be deposited into informal dumps along creeks in the districts of Machupicchu or Ollantaytambo.³³

Puente Ruinas has accumulated the most garbage in the Sanctuary; garbage along the Inca Trail is better controlled. Agencies carry garbage from Wiñay Wayna to km 106 (along the train line) in Choquesuisui. INRENA completes garbage control forms in each campground, so the tourism agency's garbage is weighed and that weight should correspond to subsequent weighings in other campgrounds.

In 2004's first semester, 724 tons of solid waste were generated in Machupicchu Historic Sanctuary, of which 93% (667 tons) was generated in the town of Machupicchu (Aguas Calientes) and stored along km 112 – Puente Ruinas; 6% (41 tons) was generated along the Inca Trail, and is now stored at km 107; and only 1% (6 tons) was generated along km 82, 88, and 122.

Solid Waste Generation by Sector in Machupicchu Historic Sanctuary, 2004

Generación de Residuos Sólidos por Sectores en el SHM 2004 (Toneladas)

SECTOR	ENERO	FEBRERO	MARZO	ABRIL	MAYO	JUNIO	TOTAL
KM. 112	113.20	108.84	101.72	105.13	121.91	126.00	676.79
KM. 107	7.05	2.81	5.87	8.31	9.09	8.27	41.40
KM. 122	0.04	0.08	0.12	1.05	0.09	0.27	1.64
KM. 82	0.02	0.07	0.23	0.75	0.73	0.73	2.54
KM. 88	0.20	0.39	0.41	0.18	0.21	0.46	1.85
TOTAL	120.51	112.20	108.35	115.42	132.02	135.73	724.22

Data INRENA – Cusco

Transportation flow of solid waste in Machupicchu Historic Sanctuary

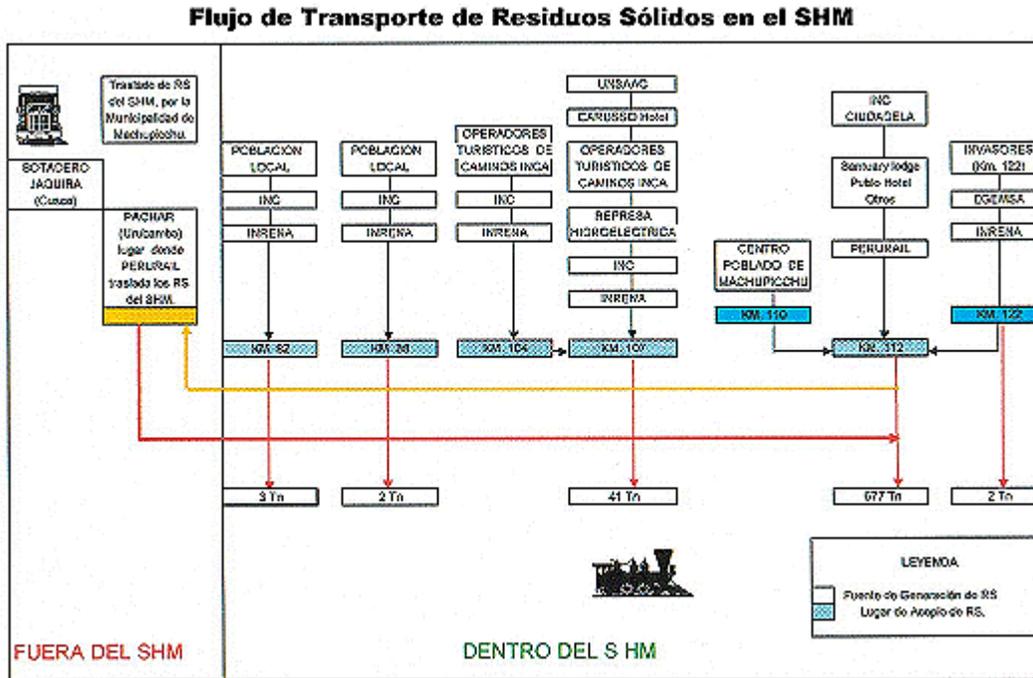


Diagram: INRENA – Cusco

The train is another source of garbage pollution. First, garbage is collected when the train and the stations are cleaned. Second, passengers toss garbage out of the windows and pollute along the train’s route. The restrooms are also a source of contamination as their contents are dumped directly out of the train. This dumping is not only a source of contamination, but also a public health problem.

Burns and forest fires

Peyton’s studies on the spectacled bear (1979-1983) provide the first reference of the Sanctuary’s forest fires and burns. They reveal that 57% of the Sanctuary has been subject to forestry exploitation, forest fires, and intense agriculture. Most of the forest fires have been caused by negligence, accident, or intent.

Because yearly forest fires were such a common occurrence, INRENA and other agencies implemented strict control in 1981. Wild fires create irreversible damages, especially when they occur in the forests and destroy ancient trees that serve as seed banks. Another problem is when species like Colombian pines, that only have a few individuals of the opposite sex, are destroyed: this could lead to extinction. Systematic forest fires provoke loss of biological diversity when they destroy stability and equilibrium of fragile ecosystems, and when they interrupt food chains of birds, rodents, insects, and other animals.



The Machupicchu wildfires start in the agricultural areas outside of the Sanctuary, travel into the pastureland, and then extend into the forests. Traditional techniques are much to blame for this situation—fields that are left fallow for crop rotations often convert into pastures. The result is loss of forestry species and quick invasion by secondary species. Wildfires have most often occurred in the zones of Pacaymayo, Chachabamba, Yanacocha towards Aobamba, Torontoy, Pampacahua, and Cedrobamba. Wildfires have also been relatively frequent at Phuyupatamarca and Pacaymayo, along the Inca Trail, usually due to accidents and negligence.³⁴

A tree burned by a previous forest fire along the Aobamba River



This photo shows Andean pastures that recently burned



Vegetation being burned for farming purposes

Agriculture and grazing

Domesticated animals are a problem in Hayllabamba, in the Cusichaca sub-watershed, especially equine species—horses, donkeys, and mules—that are used to transport tourists from the Llullucha Opening to Yuncachimpa. There are also sheep and pigs in the zone (approximately 200 in total).

Vegetation growth is stunted, especially small trees and native bushes. There are approximately 400 to 500 head of cattle and sheep in the Palcay zone, in the upper parts of Huayllabamba and Pampacahuana and on the slopes of Salkantay.³⁵ In total, within the Sanctuary, it is estimated that there are between 700-800 head of cattle, 150-300 horses (and donkeys or mules), and 300-500 sheep.

Unsustainable livestock practices and unproductive use of Sanctuary pastures bring about ecosystem degradation and loss of natural resources. The large cattle population and its use of the land cause damage and destruction. Generally, cattle graze in inappropriate places, like in the forest, in areas with protected flora species, and on steeply sloped pastures. Erosion is a consequence of surpassed cattle-carrying capacity, use of inappropriate pastures, overgrazing, and pasture burning.³⁶

Cattle in the Sanctuary mostly graze on natural pastures and native species. They are not restricted and therefore can cause erosion in sloped areas and compact soil in humid, flat areas. Burning and overgrazing outside of the Sanctuary also facilitate erosion since vegetative coverage is reduced and topsoil lost. Pastures located in the jungle brow area are mostly molasses grass (*Milinis minutiflora*), which is an invasive plant and highly susceptible to burns. To farmers, it is considered a weed and they burn it to eradicate it.³⁷

Farming plots are a constant within the Sanctuary.³⁸ Around human settlements and in areas with isolated homes, there is farming. Soils are disrupted in the upper pasture areas, native vegetation is cut and burned—especially in relic forests—and tropical forest of the Aobamba zone is destroyed.



Domesticated animals in the lower part of the protected area

Fields are usually located in inappropriate places (on steep slopes, on forested slopes, etc.). In some cases, the crops are inappropriate because they are introduced species. There is also intensive agriculture in some parts, with excessive amounts of agrichemicals. Many farmers want to increase their fields.³⁹



Land preparation for agricultural purposes in the upper portion of the Sanctuary



A farm plot in the Aobamba Sector

There are farm plots within the Sanctuary and in the adjoining buffer zone. INRENA has established regulations and notifications to stop agriculture from expanding into the Sanctuary, but despite park guard efforts and because on-the-ground implementation is easier said than done, it is very difficult to actually stop agricultural expansion.

The locals believe that INRENA ordinances and crop and livestock limitations are designed to force them to leave the Sanctuary. Therefore, enforcement of these regulations has generated tensions between the farmers and INRENA.

An associated effect is firewood extraction, which is done on a subsistence level.⁴⁰ Farmers and livestock owners seek firewood from within the Sanctuary to meet their energy needs. Several years ago, there was systematic, commercial extraction, however Sanctuary authorities stopped it. Today, commercial extraction is rare and difficult to detect in the case that it occurs. There is a large firewood demand in Machupicchu Pueblo (Aguas Calientes) due to large consumption in fire burning stoves and grills. There are over 70 restaurants, 90% of which offer pizza cooked in a wood oven. Previously, this firewood came from the Sanctuary, but today it is brought from Cusco and other places.

Landslides

Throughout the Sanctuary, one can observe evidence of landslides of diverse magnitudes. Of course nature has a lot to do with the landslides, especially when it comes to the typical avalanches seen during heavy rains, but the human factor plays an important role in causing landslides in some zones. Certain activities like agriculture and grazing are the root causes of some landslides. In order to farm, large areas are deforested, especially areas on slopes, leaving the land exposed to erosion. Cattle compact soil and consume grasses and other vegetation in high areas, and the livestock owners tend to deforest the tropical forests in the lower areas, also creating erosion.

Intentional burns and fires are also factors leading to landslides. While fires are not an issue within the Sanctuary anymore thanks to INRENA's control and the awareness campaigns conducted to stop them, damage caused by past wildfires still affects efforts to prevent landslides. Many zones were burned and have yet to recover, especially on steep slopes. Only sparse and small vegetation has managed to gain hold, but it is not enough to retain the soil under the extreme rain conditions and the earth is easily washed away, making landslides common. This situation is easily seen in the Aobamba River Zone, where it is primarily tropical vegetation growing on the slope.



Landslides in the Aobamba River Sector and in the Cusichaca River Sector

Once there has been a landslide, it is extremely difficult, if not impossible, to restore the land. When the topsoil has been eroded, removed, and slid off, only rocky land remains that is very difficult to plant or reforest. Once the bedrock is exposed, landslides continue along the borders unless there is sufficient, strong vegetation to retain the soil and stop the landslide from growing.

Landslides not only cause loss of soil, but also generate sedimentation in the rivers, thereby affecting water quality and ichthyologic wildlife. When there is a large landslide and the debris dams creeks and rivers, natural disasters can result, as has been the case over the last few years in the zone.

Landslides are the most serious threat facing the Sanctuary. While the other concerns, such as tourism, garbage, livestock activity, management problems, etc. can be managed and have solutions, nothing can be done to recuperate the land lost in a landslide.

Extraction of rock (for crafts) and sand

In Machupicchu District there is a small quarry where rocks are extracted for use in local crafts. This extraction is small-scale and does not constitute a serious threat for the Sanctuary, but there is a certain level of conflict between extractors. Local Machupicchu craftsmen complain that craftsmen and businessmen from other areas extract large quantities of material. This quarry is located at km 101 along the rail line in Cedrobamba. Sixty families from Aguas Calientes and the nearby towns extract rock from the quarry, as do craftsmen from Cusco with whom they have conflicts. Currently, this activity is very restricted because INRENA maintains strict control over it.⁴¹

Illegal hunting



Deer for local consumption

Hunting is prohibited in the Sanctuary, but it is still a threat to targeted species, especially deer. There is no sport hunting in the Sanctuary, but there is occasional subsistence hunting by local residents. In the past, pumas and foxes were hunted because they threatened livestock.

A zone vulnerable to illegal hunting, especially hunting of Andean deer (*Hippocamelus antisensis*), is in the southeast where hunters enter the area via Limatambo and head

towards Salkantay. Other critical areas are found in the mountains along the Sanctuary's northeastern border towards Piscaccucho, Chillca, and Ollantaytambo.⁴²

Introduction of exotic plants

Exotic species introduced into the Sanctuary generate a visual impact because they modify natural landscapes and alter the soils, especially in the cases of the eucalyptus, pastures, and crops. Their impacts on the fauna are unknown, although it is assumed that they cause fauna to move away since they change the habitat and many times eliminate natural feed sources.

There are several exotic floral species in the Sanctuary, including the following: *Abutilon pictum*, *Achyranthes herbstii*, *Antirrhinum majus*, *Canna indica*, *Catharanthus roseus*, *Cobaea scandens*, *Crocasmia aura*, *Coleus blumei*, *Cupressus macrocarpa*, *Dahlia pinnata*, *Dianthus plumarius*, *Eucaliptus globulus*, *Euphorbia plucherrima*, *Gladiolus communis*, *Hedychium coronarium*, *Helianthus annuus*, *Heteropogon melanocarpum*, *Hibiscus rosa-sinensis*, *Hydrangea macrophylla*, *Impatiens balsamina*, *Leucanthemum vulgare*, *Melinis minutiflora*, *Musa cavendishi*, *Musa sapientum*, *Myosotis arvensis*, *Pennisetum clandestinum*, *Pelargonium peltatum*, *Pelargonium zonale*, *Spartium junceum*, *Sorghum bicolor*, *Symphytum officinale*, *Rheum raponticum*, *Ricinus communis*, *Ruta chalapensis*, *Salvia leucantha*, *Tagetes patula*, *Tritonia crocosmaeflora*, *Yucca gloriosa*, *Zantedeschia aethiopica*, *Zephyranthes carinata*.⁴³

Incomplete physical survey and legal land tenure

Legalization of natural protected areas guarantees the existence of these areas because they are considered part of the National Heritage and of the public domain, and therefore can no longer be sold to individual landowners. Of course, certain limitations apply when it comes to those

with property claims and actual acquired property rights before the protected area was established, but regardless of the situation, all inholdings are to be managed in harmony with the objective of the protected area. Inhabitants of the rural sector of the Sanctuary are mostly landholders as a result of the agrarian reform.⁴⁴

Machupicchu's Conservation and Management Strategy, approved in the Sanctuary's master plan, is named to resolve the physical and legal land tenure problems within the Sanctuary. Among the expected results, by 2008 the land planning and improvements program should have been conducted and complete and the Sanctuary should be physically and legally indemnified.⁴⁵ Six years have passed since that master plan was approved, and there are still no noticeable results. Instead, there are two major conflicts: 1) conflicts in the special use zone, both in the urban and rural areas, and 2) conflicts related to increasing the size of the Sanctuary's buffer zone.

Territorial conflicts in the Sanctuary's urban area: The main urban zone within the Sanctuary is defined as the space occupied by Machupicchu Pueblo (Aguas Calientes), in which there is constant unregulated occupation and lack of integral vision, considering that this is a national natural protected area and that it is a high risk zone when it comes to natural disasters. The Sanctuary's special use zones (urban and rural) lack planning instruments. Lack of precise urban limits and lack of growth zone limits (for Machupicchu Pueblo), in addition to unregulated urban development, problems defining urban and rural property rights within the Sanctuary, and lack of clarity regarding the titled properties are all sources of conflict related to the Sanctuary's physical and legal indemnification.

The majority of Machupicchu Pueblo (Aguas Calientes) residents lack land titles or cadastre plans that would offer proof and provide judicial security of the properties they hold and develop (homes, hotels, restaurants, among others). Several conflicts result as a product of this situation and lack of resolution.

Territorial conflicts in the Sanctuary's rural area: There are groups of rural farmers in the Sanctuary. Their activities are concentrated between Q'orihuayrachina and Huayllabamba. Problems related to private and communal property rights in the Sanctuary date back to the beginning of the agrarian reform of 1969.

Ex-plantation owners of lands that are now part of the Sanctuary have begun judicial proceedings to define their legal situation instead of accepting the laws passed during the agrarian reform. Some of the plantations in this situation include Q'unte and Santa Rita de Q'unte. Both the organized farmers groups and ex-plantation owners are demanding that the process for the physical survey and legal land tenure in the rural sector of the Sanctuary be clarified.

The main legal battle is coming from the Zavaleta family, who were owners of a plantation that covered almost the entire left margin of the Urubamba River and who were expropriated during the 1970s agrarian reform. The Peruvian State did not include the expropriation in the public registries, and the ex-owners claim that they were not compensated at all. The fact that this property transaction was not even included in the public registries forms the basis of their case. Apparently, the State has finally included the transaction in the public registries. INRENA

authorities think that once this legal complaint with the Zavaleta family is resolved, the next legal problem will be with the communities settled within the Sanctuary.

Another territorial conflict stems from the plan to increase the Sanctuary's buffer zone. One of the expected results from implementing Machupicchu's Master Plan for 2008 is increasing the buffer zone by more than 18,000 hectares. There are also proposals to declare complementary local protected areas (municipal, communal, or private) in the Urubamba watershed. These proposals are sources of new conflicts. Not only are local residents concerned about these proposals, but the municipal leaders are as well. They confirm that there is no integrated vision of the Sanctuary or its borders and there is no defined policies dedicated to the Sanctuary's territorial planning.⁴⁶

The conflict with past owners is complicated and has gotten into the courts; each side has their own version of the story. For example, Roxana Abril Núñez, descendant of one of the ex-owners mentions, "it is known that Machupicchu is located within my great grandfather's property. The government condemned part of the property--the archeological portion--claiming that the historical monuments were State property, but they failed to compensate the private property owner. Therefore, the State should pay a just price for the land. In 1944, my grandfather sold part of the property (known as Kente and Santa Rita) to the Zavaleta family. The fifth clause expressly states that the Machupicchu, Huaynapicchu, Puyupatamarca, Sayacmarca, and Wiñay Wayna archeological groups were excluded from the sale since they were, at that time, being expropriated by the State. Therefore, the Zavaleta family has no right to claim property rights over these archeological sites. The rights actually belong to the descendants, like me, of the original owner, José Emilio Abrill Vizcarra. The Zavaleta family only owns Kente and Santa Rita de Kente, approximately 11,000 hectares. However, the Zavaletas have surprised public and international opinion by claiming to own Machupicchu."⁴⁷

According to a Zavaleta family member, "The State is not recognizing our property, and because of this, other problems have arisen. For example, we cannot develop projects, we are not paid for use of roads through our property, or for access to Machupicchu. We are only harassed and that is why we are suing. Machupicchu was purchased in 1944 and our position is that we still own it since we were never paid compensation or fair market value for the land. Of the 22,000 hectares, 2,000 were given to rural farmers. This group of beneficiaries has seen a demographic explosion and they are invading lands, taking advantage of the opportunity created by the State itself. These people demand property rights [and] basic services, among other things. This has created a social problem. In 1981, a supreme decree was issued creating a conservation unit. Later, the state recognized that they had made a mistake and had to clarify that the area was not to be included in the agrarian reform, and they repealed the agrarian reform decrees leaving the property and those who "received" the property in the reform in legal limbo. We have been suing the state for over 30 years, since 1974. We want justice. We want to be justly compensated, and obviously we would like to keep some of our property to develop some projects that we have not been able to develop thus far because of the mess."⁴⁸

Lack of institutional coordination

Machupicchu's Management Unit (UGM) was created on June 8, 1999 (published on July 9, 1999) by Supreme Decree 023-99-AG. The Committee of Directors governs the organization; it

was originally created by INRENA's head and the national director of the National Institute of Culture (INC). As of May 2001, Cusco's Regional Governmental president and the vice minister of tourism have joined the committee of directors.

The UGM also has a technical staff that depends on the committee of directors and is responsible for implementing and supervising the activities outlined in Machupicchu's Master Plan, 1998-2008.

UGM's principal objective is to guarantee that the archeological monuments, cultural values, natural environment, and landscape are used for scientific purposes, tourism, and recreation. UGM staff work to create new coordinating entities to manage the Sanctuary's natural resources. Even though the legal framework backing management of the Sanctuary's cultural and natural resources is in place, politics of interinstitutional management develop very slowly.

Perceptions of each institution (UGM, INRENA, and INC) and of its role, functions, and spheres of influence are at the base of the Sanctuary's management conflicts. There is confusion about which functions each institution is supposed to assume.⁴⁹

“The management unit has not changed much unfortunately, because it lacks legal backing that would give it the necessary authority. Its first confrontations have been with the District of Machupicchu who is the least willing to accept regulations and modifications to the current state of the Sanctuary. The municipal governments have been irresponsibly granting permission to people to occupy the area. The Regional Government supports the district mayor because of political and economic reasons and because of their mutually supportive relationship, inappropriate concessions that do not contribute to the Sanctuary's protection are granted. Add to that the municipality's 10% of the income from the Village of Inca de Machupicchu that is used to further urbanize the town of Aguas Calientes. In addition, the current government has been handling all of this trying to satisfy groups that are most politically aligned or those that could be useful at some future date, like the Regional Government.”⁵⁰

Machupicchu Pueblo – Machupicchu Inca Village Highway

There are actually several ways to access the Sanctuary, all of which facilitate migration and access to the natural resources and generate related problems because of illegal uses that could significantly and permanently damage the Sanctuary. As soon as access increases, pressure on important areas will also increase as will the difficulty and cost of control. In general, local people and authorities support building more access roads around the Sanctuary, mostly to improve the road from the town of Machupicchu to Santa Teresa. If this happens, more people will move to the zone expecting to benefit from the Sanctuary's tourism, thereby generating additional impacts on the area.

Most motorized vehicles travel the road between Aguas Calientes and the ancient village. Tourists visiting the ruins also use this route. Minibuses constantly drive the route moving tourists to and from the ruins. The traffic creates noise and dust that impact nearby fauna and vegetation. In addition, the buses' weight and constant use of the road generate vibrations that pressure geologic formations on which the road is built. This could be creating a landslide risk. Both the road and the presence of buses generate visual impacts all the way to the ruins.

Transporting tourists and using the access routes is seen as a viable business for several interested sectors. For example, the Urubamba Mayor wants to provide a bus to each district within the province in order to take tourists to the ancient village. There are already 22 buses in operation along the route, so if the Mayor implements his plan and provides a bus to each district, the road will be unsustainable. INRENA and the tourism sector oppose the project for their own reasons.

Future threats

Highway Construction: Santa Teresa to Machupicchu's Hydroelectric Center

As was previously mentioned, Machupicchu's Hydroelectric Center is within the Sanctuary and it generates energy for the city of Cusco and the southern Andean region. Santa Teresa is located in the Sanctuary's western buffer zone. In 1998, the town was flooded and all 6,000 inhabitants were affected. In addition, the main access route, the Cusco-Quillabamba Train Line, between the town and the rest of the region was destroyed.

Since then, the people have had serious problems getting to and from other parts of the region. They have to walk 12 km along a path between Santa Teresa and Machupicchu Historic Sanctuary. Towards Quillabamba, there is another path, but it is 75 km and in terrible shape. People from Quillabamba use a road from Málaga to Cusco which is also in poor condition but needed frequently to transport people and products to Cusco's market.

For more than 40 years, La Convención province (which neighbors the Sanctuary) has been interested and pushing for a road to connect with Cusco as an alternate to the train. Institutions in charge of protecting the Sanctuary (UGM, INRENA, INC, MINCETUR, and CONAM) have expressed their opposition to the project. Machupicchu's Master Plan, approved by Chief Resolution Number 085-98-INRENA-J, explicitly prohibits highway building that would provide direct access to the Sanctuary. In addition, the Sanctuary must comply with the terms of the UNESCO Convention of 1972. Highway projects to provide direct access to the Sanctuary will undoubtedly increase visitors, business people, and settlers, which will of course multiply the Sanctuary's already existing problems.

Stakeholders such as the Regional Government of Cusco (which is also part of the Sanctuary's Management Committee of Directors) are politicizing the situation, supporting the road to help the "forgotten people" in the region. They are not even considering Cusco's Regional Strategic Plan, which was created in a participatory manner, and does not mention this highway project. The Regional Government supports the highway construction project, putting it above other state sectors. The Machupicchu people have not yet defined their position.

Most of the stakeholders related to the project favor building the road, except for INC, INRENA, EGEMSA, and PeruRail, who defend the alternative that supports the Sanctuary's conservation. The alternative they support is improvements to the rail line and extending it to the Collpani Chico sector.⁵¹

Recommended Solutions

Carrying capacity along the Inca Trail

According to the Master Plan, Machupicchu Historic Sanctuary's capacity to generate great wealth through tourism should be efficiently developed with local inhabitants, who have traditionally been shut out, and contribute to regional and national progress. The local population should be encouraged to participate in tourism activities under fair terms and proportions related to their contributions.

First, the maximum number of visitors per attraction must be determined. That is, the carrying capacity of each of the Sanctuary's sites must be determined. Then, tourism diversification within the Sanctuary can be promoted to reduce the pressure on the Inca Trail and the ancient ruins. Visitor flow along existing routes needs to be adjusted to coincide with the carrying capacity of each site and the number of allowed visitors per site per day must be established. Tourism potential in the Cusichaca Watershed, from Wayllabamba to Salkantay, in the Aobamba Watershed, along the Inca Trail, and additional locations in the buffer zone should be evaluated in order to decongest other areas in the Sanctuary.

Settlements near the Inca Trail, Q'oriwayrachina, Wayllabamba, Pampacahuana, Chillca, Piscacucho, and Miskay in the buffer zone, are the most traditional and the inhabitants have the most experience with tourists. The sector of San Antonio de Torontoy has archeological sites and the train passes by, but there is not much contact with tourists. In Intihuatana-Hidroeléctrica-Aobamba, there are archeological sites and native forests, but very little tourism. These areas should be promoted as complementary tourism options.



Tourists at the Machupicchu ruins

The Inca Trail on the valley floor, which runs parallel to the Urubamba River from Q'oriwayrachina to Wiñay Wayna and then to Machupicchu, has tourism potential, though it is currently not used very often. It costs \$25 to take this trail compared to \$50 for the traditional Inca Trail, which is probably why the tourist companies do not promote it. They prefer to charge more for a longer, more costly trip on the traditional Inca Trail. As long as they make money, tourism companies will take any tourist, whether out of shape, elderly, or lacking the necessary physical capacity to complete the trail, without any warning about the physical challenges.

The valley floor Inca Trail is affected by the presence of electrical towers, which may prohibit it from becoming a premier tourism attraction. But, nonetheless, it is an easier trail without extreme slopes and is ideal for older visitors, school visits, and others.

Montane forests and interesting tropical vegetation as well as the occasional animal (like tinamous, squirrels, curassows, etc) are seen along the trail as well as beautiful and historically valuable archeological complexes.

Inca trails should be used in a way that is safe for both the visitor and the protected area, that does not pass the carrying capacities of the routes or attractions, and that does not saturate the area with visitors. The Inca Trail going to Machupicchu must be used according to the Public Use and Recreation Plan and the Inca Trail Management Plan. Any installation or work completed along the Inca Trail should blend in with the landscape and follow the approved site plan.⁵²

Ecological restoration should be a priority in sites along the trail that have been impacted. Maintenance of the trail is based on ecological and cultural considerations to defend its natural and cultural value. Some places with erosion problems or that present erosion risks should be corrected first.

In order to decongest the Inca Trail, the number and flow of visitors must be regulated and additional options must be offered. Complementary studies should be completed in order to determine whether or not closing certain portions of the Inca Trail would help its restoration, or if the existing vegetation would require such a measure.

Bathroom installations should meet the landscape's characteristics and visitors' needs, and there should be an appropriate waste disposal system to avoid contamination. The baggage haulers do not have adequate installations to sleep in and many times just sleep anywhere they want. Therefore, installations for haulers should be built and norms respected so they can rest appropriately.

Guides and tourism staff should be trained in aspects of conservation and security. They should be obliged to take pre- and post-exams to evaluate such training. Inappropriate behavior should be severely punished.

The Sanctuary's Recreation and Tourism Plan should consider the design and regulation of visitors' flow, adequate itineraries, transportation, and carrying capacity. The carrying capacity is defined as the level of public use that an area can tolerate without damaging resources or diminishing the tourists' experience.⁵³

In the ancient city of Machupicchu, there are projections of 800,000 tourists per year with between 1,600 to 2,000, even up to 3,000, tourists per day. On average, there are actually 300 to 400 tourists during any average day and between 1,500 and 2,000 during high season (July to September). Due to environmental deterioration, it is advised that the archeological group cannot support more than 917 visitors per day and no more than 385 visitors at any one time.⁵⁴



The view of Machupicchu from the start of the Inca trail

When considering comfort and visitor satisfaction, distribution and concentration of visitor groups should be taken into account. Visitor flows should be carefully managed to minimize environmental impacts and to ensure visitor satisfaction. In order to maintain sustainable use and

determine carrying capacity, evaluations should be done using interviews, opinions, visitors' likes and dislikes, and environmental monitoring.



Camping sites allowed in Wiñay Wayna

More information should be provided to visitors about the area's management and rules and regulations. In addition, different forms of information should be available, such as botanic gardens, interpretation centers, onsite museums, and ecological and archeological guides.

A study on the Inca Trail is urgently needed that would help shed light on the actual situation and inform the formation of user regulations and indicate the amount of park guards needed in order to meet the Sanctuary's conservation and management goals.

Adequate rules need to be established. "Before, in order to offer tourism services, the business had to meet many requirements, but now it is easier. They only need municipal licenses to exist, which is rather informal. Before, to open a hotel, there were many requirements. Not now. There is not even information about how many hotels or rooms there are. The occupancy of the hotels is unknown because it is no longer regulated. We only have a registry of those who voluntarily register. This is the case with tourism agencies as well, we think that there are at least 600 agencies in Cusco, but we only have accredited half that number."⁵⁵

Hydroelectric center and energy transmission lines

Sanctuary's authorities must make the companies operating the generation plant and distributing the energy minimize their negative impacts on the landscape, biodiversity, and cultural heritage in the Sanctuary. The Environmental Adjustment Program (PAMA) should be carried out and reviewed by INRENA before it is authorized. In addition, an ecological restoration plan should be created for areas affected by the hydroelectric plant and its operations, including the watershed. The hydroelectric plant and its operations should make sure to have their Environmental Adjust Programs (PAMAS) up to date, as required by the Ministry of Energy and Mines.

Maintenance operations should be compatible with conservation of the Sanctuary's environment and culture. They should be stricter in implementing their wastewater and solid waste treatments in order to increase hygiene and environmental conservation. A Health, Security, and Environmental Plan should be established for the hydroelectric plant staffers and contractors with strict rules regarding environmental care and biological diversity conservation. This plan should be revised by INRENA before being approved by the Ministry of Energy and Mines. Cutting vegetation along the transmission lines should be done following ecological considerations in order to minimize negative impacts and restore affected areas. Water retention done by the plant should be done while monitoring the Urubamba River to ensure that the river's flow is ecologically sufficient, meaning that it should be in good enough state to maintain the habitat of the torrent duck (*Merganetta armata*) and other local species.⁵⁶

An efficient alternative, which would improve the Sanctuary’s environment, would be to remove and abandon the hydroelectric installations and build a new plant outside of the protected area. There is rumor of a new hydroelectric plant in the Huilcar zone, outside of the Sanctuary, but this project is long-term and is not certain because of the costs.

Solid Waste

Solid waste should be eliminated from the Inca Trail and surrounding areas completely and removing it from Machupicchu Historic Sanctuary should continue as it has been. Garbage should not be dumped along the route and garbage cans should not even be provided, rather the saying “Whatever enters, leaves” should apply. A strict system of controls and fines should be implemented to assure compliance with this rule.

In the cities of Urubamba, Ollantaytambo, and Machupicchu Pueblo, environmental problems related to garbage disposal are increasing because local governmental authorities lack human resources and the inhabitants lack environmental awareness. Since tourism activities have been identified as one of the main sources of waste production, the institutions and operators making money from this activity (the municipalities, INC, INRENA, and private companies) should be the ones to resolve the conflict and political institutions, like the National Environmental Council (CONAM), Machupicchu’s Management Unit (UGM) and the General Health Office (DIGESA), should support this work.

The National Institute of Culture (responsible for archeological sites) is responsible for maintaining the Inca Trail. Despite garbage management activities currently underway, such as weighing the cargo and recollection posts that obligate operators to take garbage out, some garbage still remains on the circuit. This waste is left by visitors, haulers, and guides and includes plastic pop bottles, candy and chocolate wrappers, and bags. INC staff removes it. Yet, INC should not be responsible for picking up waste in the Sanctuary since its mission and status are different than that. Other strategies should be developed in which local populations are involved in managing the garbage. Garbage management could be a source of employment for locals.



Visual impact from a garbage can in an inappropriate location

Train passengers have been seen throwing garbage out the windows. Using garbage cans within the trains should be promoted. At the same time, screens should be installed on the windows so they cannot throw anything out.

Permanent and participatory clean-up mechanisms should be implemented along the Urubamba River, especially in the portion crossing the Sanctuary. Educational campaigns should be carried

out to encourage people to stop throwing garbage into the river. These activities should be coordinated with municipal authorities and health authorities, especially in the upper Urubamba waters from where the contamination flows into the Sanctuary.

Burns and forest fires

Rigorous security measures should continue to prohibit burns and involuntary forest fires. In recent years, there have been no serious fires, and control actions and awareness should continue with the same intensity.

Deforestation should not be permitted in the forests or on steep vegetation because of the threats to the environment, landscape, and local inhabitants. This should be strictly implemented in Aguas Calientes, which is seriously threatened by natural disasters, as well as Aobamba Watershed. Because of landslide risks, vegetative coverage is needed to protect the lives and wellbeing of the inhabitants.

Agriculture and grazing

Sustainable work must be done with the communities so that agricultural and grazing activities neither expand nor increase. One idea is for INRENA to use funds generated from tourism to implement sustainable activity projects and programs with locals.

Agroforestry should be promoted following the Sanctuary's rules and restrictions using appropriate species at each ecological floor, focusing on those that protect the environment while also benefiting the local communities in some way. INRENA promotes a reforestation program with local workforce. This program should be increased and expanded in more sectors within the Sanctuary.

INRENA's monitoring and control activities should be continued in order to prevent burns and forest fires. Erosion control measures and management of the cobbled trails should be included, emphasizing soil and water conservation techniques on slopes. Training should be provided as well.

There should be a yearly, detailed animal census to know precisely how many animals live within the Sanctuary, including cows, horses, donkeys, sheep, etc. This information will help implement control measures and develop corresponding alternatives. Replacing cattle and horses with llamas and alpacas is one of INRENA's initiatives that ought to continue.



Alpacas breeding at the base of Salkantay Mountain

An organized and normalized system is needed to manage the livestock within the Sanctuary. Sanctions are needed for ranchers who do not follow established norms or fees for Sanctuary pasture use. Such a system will need to be legitimized by a Ministerial Resolution, Directorial Resolution, or Chief Resolution (INRENA), that would allow park guards to take actions against ranchers not following the rules. Such a regulation explicitly needs a list of infractions and fee amounts. The protected area's administration must strictly implement zoning and territorial planning within the Sanctuary in order to prevent users from transgressing and breaking the norms.

The Sanctuary is part of the national heritage. The resource users benefit from the Sanctuary's resources, but at the cost of the area's integrity. Because of this, a compensation mechanism and/or complementary financing is needed, therefore a fee system for using pastures within the Sanctuary could be considered, especially in the special use zone with livestock. Pay scales and fees are needed depending on the number of cattle present per rancher in the Sanctuary. These do not have to be significant amounts, but they should correspond to the income and local economy.

Uncontrolled hunting

While this activity is not occurring within the protected area itself, park guards should implement sanctions strictly when they encounter hunters, like contracted workers in the hydroelectric center or staff with tourism agencies. Awareness campaigns should be conducted with residents and other stakeholders in nearby areas.

Introduction of exotic plants

Eventually, introduced plants should be eradicated, especially eucalyptus and “retama,” as well as herbaceous invasive plants, especially molasses grass.

Removal campaigns of introduced species should be promoted. INRENA could promote such campaigns using Sanctuary-generated funds similar in nature to the reforestation campaigns they conduct using native species. It should be noted that control and eradication of introduced species is a potential source of employment for local residents.

Incomplete physical survey and legal land tenure

Existence of judicial processes in which property rights are being disputed are evidence that the Sanctuary’s legal situation has yet to be defined and this must be considered when defining any other future strategy.⁵⁷

Measures should be taken to resolve the situation of occupied lands as soon as possible, basing the resolution on legally established norms and corresponding administrative procedures.

A physical-legal land planning strategy is needed for the Sanctuary’s property in order to define the rights and legal situation of the settled inhabitants and to deal with the claims of the ex-owners. A study is needed to document the number of settlers per sector and how they came into possession of the land, taking into account the property regime present during the agrarian reform, and finalize once and for all their possession claims (either by providing titles or condemning the properties and compensating the land holders). In addition, current laws must be implemented to impede any new settlements into the zone.⁵⁸

Voluntary and legal relocation of local inhabitants is a management option that is perfectly legitimate, and one that certain inhabitants also prefer. In order to be successful, this policy must offer relocated populations economic conditions and living standards superior to what they enjoy in the Sanctuary. It should be stressed that this policy should only apply to inhabitants that voluntarily want to be relocated and it should be done without pressure or violence.⁵⁹ Nonetheless, it is unclear how the local people will react to this relocation policy; some young adults have manifested their decision to stay in the zone.⁶⁰

Increasing the Sanctuary’s borders

The Sanctuary’s orographic conditions are extremely important for the area’s biodiversity, which, as was previously mentioned, is threatened by a series of environmental impacts that reduce fauna and flora populations, and their habitats. As a result, biodiversity conservation is concentrated in the Sanctuary’s inaccessible areas or even areas outside of the borders. This is one of the reasons why the borders should be increased and the Sanctuary should be enlarged.

The size of the Sanctuary (32,592 hectares) is small, and that fact alone makes managing and protecting plant and animal species difficult. The 8,900 hectares of cloud forest (or brow forest) is not enough to maintain viable populations of species such as *Podocarpus*, *Cedrela*, *Nectandra*, *Ocotea*, *Styloceras*, *Ficus*, and *Polylepis*, especially if these areas have been previously burned.

There are many reasons favoring the Sanctuary's enlargement:

Many pristine forests or in a good state of conservation are outside of the Sanctuary's borders. Neighboring forests are generally found on the slopes, which would be ideal for including them as protected forests.

Most tree ferns grow outside of the Sanctuary's limits, for example in Cedropata and Aobamba. On the northeastern border, in a neighboring micro-watershed, four orchid species are found along the altitudinal gradient--*Masdevalia amabilis*, *M. davisii*, *M. veitchiana*, *M. sp. Nova* (a recently discovered species)--whose conservation status is not guaranteed by the Sanctuary.

Most of the spectacled bear (*Tremarctos ornatus*) populations are also outside of the Sanctuary's borders. There is an adequate remnant forest that serves as an important biological corridor between the eastern and central mountain ranges for the spectacled bear's conservation and population recovery

Well-conserved forests are more and more scarce because of human pressures, and the remnants lack sufficient connections needed to maintain biological and ecological interactions. This does not guarantee the stability and viability of plants and animals with small populations in inaccessible places.⁶¹

The Sanctuary's borders were not designed properly according to watershed management concepts. Instead of considering the *divortium aquarum* of the watersheds as the divider, in this case the rivers mark the borders (Cusichaca in the east and Aobamba in the west), which do not define the watersheds. This is very problematic when there is a human population within the watershed, because it is impossible to separate the population's influence on the environment so that it does not affect both sides of the river.⁶²

Lack of institutional coordination

Coordination must be improved and a common vision needs to be developed among all the institutions responsible for managing the Sanctuary, especially INRENA and INC, since this problem is one of the biggest for the Sanctuary.⁶³

The members of the Management Committee do not assume an active role in order to have a larger political influence. This institution needs to be strengthened and the member institutions need to offer more help to the Management Committee in order to strengthen it.⁶⁴

“Because there are many heads involved, there is no authority. It does not help that each one of these institutions is working in favor of its own interests. It is obvious that the institutions put more efforts in implementing other actions (as is the case with the local and Regional Governments, for example) and most of the time, these actions do not follow parameters that the protected area needs.”⁶⁵

Direct and deliberate coordination is needed between INRENA, INC, the Ministry of Industry and Tourism, and Cusco's Regional Government, where actions are shared, common policies are

developed, there is joint training, and coordination is close and permanent, in order to strengthen the Management Unit so that it can implement true conservation policies and management.

Access routes, highways, and other infrastructure

“The Sanctuary was created to be accessed on foot. Later, mule packs were introduced and trails built for them. Finally cars, trucks, buses, and helicopters were available to access the Sanctuary. But, in return, there are no spectacled bears, cock-on-the-rocks, and the flora has been affected. We would like to put in a less offensive cable car, but we cannot ignore the fact that the problems will continue—the buses and other travel options will continue to access the Sanctuary.”⁶⁶

Machupicchu’s connection with the region’s highway network does not benefit public use of the Sanctuary, yet it represents a significant change that increases negative environmental impacts. New highways with direct access to Machupicchu Historic Sanctuary must not be built, regardless of their location or length.⁶⁷

Without considering whether or not there is a need for new access for visitors, it should be recognized that uncontrolled access routes can create problems related to illegal uses, which are capable in some cases of causing significant and permanent damages to the Sanctuary. It is simple: the cheaper and easier the access, the more pressure on the sites of interest and the more difficult the labor and cost of control.

A fundamental aspect in managing a protected area is related to controlling access, both the routes and points of access as well as the transportation mode. Flow of visitors and resource users must be controlled to meet management objectives and to avoid illegal entries as much as possible.

A large number of vehicles within the Sanctuary should be prohibited. Those vehicles operating within the protected area should follow rules and regulations and be strictly monitored. The situation in which authorities cannot control the flow of visitors, where they cannot stop people from entering conservation areas, and when they cannot guarantee security, must be avoided. The sustained public use of the protected area must be guaranteed.⁶⁸ Protection and management personnel can carry out their functions without 4x4 vehicles; for example, they can walk.

Plus, the rugged topography and pronounced slopes that receive frequent rains are not suitable for highway construction. An evaluation should be conducted on the impacts caused by the use and maintenance of the existing highway: Aguas Calientes-Puente Ruinas-Ciudadela. A PAMA should be initiated for the buses along the Aguas Calientes-Puente Ruinas-Ciudadela highway. It should define the operation conditions and desirable characteristics: maximum weight and size, motor type, fuel type, etc. Neither new highways within the Sanctuary nor access highways should be built.⁶⁹

Operation of all public service infrastructures within the Sanctuary, including the access routes and internal routes, should meet its conservation goals. Design, construction, and use of any public infrastructure within the Sanctuary must be done according to the zoning plans and objectives, and they must be adjusted according to environmental impact studies.⁷⁰

Any infrastructure work within the Sanctuary is required to present an Environmental Impact Study. A competent authority then evaluates these studies. If approved, the process moves on to public consultation. Existing routes and transportation modes should have environmental evaluations, and if necessary, adjustment or mitigation plans.



A bus stop at the Machupicchu ruins

Environmental impacts on the natural protected area caused by the train should be minimized. Train service must be clean and quiet, as should any maintenance done and machinery used. The train's environmental impact should be evaluated, and corrective measures applied if necessary. Maintenance and new additions should be conducted under strict ecological considerations and with absolute care near archeological sites.

Since passengers are obligated to take the train, they should receive more information about their trip to Machupicchu while on the train.

The Sanctuary's authority should provide materials to the train operators to distribute to the passengers and tell them about the Sanctuary.⁷¹

Regarding the highway to Santa Teresa, despite the urgent need to resolve this social problem for the local people, it must be noted that building new roads within the Sanctuary or new access roads to it is explicitly prohibited in the management plan. Most likely, because resolving Santa Teresa's isolation is seen as an urgent issue, other options may not have been considered that do not require connecting the road with the train inside of the Sanctuary. In addition, building the road in a zone that has already seen significant deterioration, like where the hydroelectric plant and Aobamba are located, could seriously increase the deterioration.⁷²

La Convención is another urgent problem since its people have been isolated ever since the flood. An evaluation is needed of alternative projects that would allow this community to develop and have easier access with the outside world without having to go into the Sanctuary to get it.

Environmental education campaigns

Without the people's support, any environmental conservation policy will be perceived as an imposition or as a deliberate manipulation affecting the people. Instead, reevaluating and applying traditional knowledge about the environment is recommended.

Teachers in the zone need training, especially in the rural area. The Ministry of Education should formally recognize this training and make it part of their requirements to receive their teaching certificate. In addition, environmental education campaigns should be implemented to the population in general in which the importance of the Sanctuary and conservation strategies are emphasized.⁷³

Communication between involved institutions and local people must be improved. Flow of information should be clear and efficient. The campaign should be conducted using all means of communication, including radio, flyers, workshops, discussion and analysis, and training programs.

Conclusions

Machupicchu Historic Sanctuary is a very important protected area for Peru. On the one hand, the Sanctuary harbors important biodiversity, well-conserved forests, and impressive landscapes. On the other hand, it is home to spectacular archeological complexes and has extraordinary landscape values that have made it internationally renowned.

Nonetheless, a series of threats endanger its integrity as a natural protected area. Too much tourism along the Inca Trail has created environmental problems. Its maximum capacity is 500 people per day, and 99% of those use the Inca Trail, generating a concentration of tourists. There are reports of corruption and bad management of the Inca Trail.



Bridge over the Aobamba River

The hydroelectric plant is another threat. Although it provides energy to southern Peru, it creates negative visual impacts in the Sanctuary. There are power lines, towers, homes, and other infrastructures and permanent and temporary workers that all add to the mix. They carry out their operations without conducting any pertinent coordination with INRENA and thereby contradict the protected area's management policies.

Solid waste is another problem, but one that has been addressed. The waste generated by tourists along the Inca Trail and in the ancient city is strictly managed, as is waste from Aguas Calientes and other towns. All of the garbage is shipped out via train and sent to an authorized landfill. Despite these measures that have helped get the situation under control, there are still certain problems related to solid waste management.

Vegetation burns and forest fires are not an imminent threat, but ones that seem to spontaneously occur when people are negligent or not careful. However, grazing and agriculture do represent a serious threat to the protected area. Estimations of the number of animals (approximately 700 or 800 cattle, 150 to 300 horses, and 300 to 500 sheep) suggest that grazing is unsustainable and the Sanctuary's pastures cannot support that many animals. As a result, ecosystems and natural resources degrade.

Expansion of agricultural fields is continual in the Sanctuary. Crops are usually planted in inappropriate places and sometimes the crops themselves are inappropriate. There are certain areas with intensely managed crops and use of agrochemicals. Many farmers want to and expect to increase their cultivated areas.

Throughout the Sanctuary, landslides are present. While this is a natural occurrence, especially the avalanches caused by hard rains, the human factor plays an important role in their origins. And, once a landslide occurs, restoring the affected area is almost impossible.

Another problem in the reserve is the incomplete physical and legal land tenure. There are several aspects to this problem, including urban problems within Aucas Calientes where there is a lot of unregulated occupation and people lack property titles and even land cadastres. There are problems with rural farmers whose lands are not recognized. Ex-plantation owners are fighting for their property rights that were affected by the agrarian reform.

Yet another problem is institutional. The various institutions involved are not clear on their functions or how to cooperate. While there is a legal structure for managing the Sanctuary's cultural and natural resources, interinstitutional cooperation is slow.



Returning by the Aobamba River

Finally, existing and future roads are problems. The road leading to Machupicchu's ancient city, which is the preferred tourist route, is a threat to the slope's stability, as well as its flora and fauna. Extending a road to Santa Teresa seriously threatens the Sanctuary's integrity by providing direct access, which would bring more visitors, business people, and immigrants, which in turn would aggravate all the other existing problems.

Confronting these problems and difficulties requires many actions. The carrying capacity of each attraction should be determined and the maximum number of visitors established. Once completed, tourism could be diversified and additional attractions offered to relieve pressure from the Inca Trail and the ancient city. Tourism flow must be carefully managed in order to avoid negative environmental impacts and to ensure visitor satisfaction.

The companies operating the electric plant and distributing electricity must be forced to minimize their negative impacts on landscape values, biological diversity, and the Sanctuary's

cultural heritage. Reducing their impacts should be done in coordination with the area's administration.

There should be no solid waste along the Inca trail, and the removal program should continue. Additional strategies that involve local inhabitants to manage the Sanctuary's garbage should be developed since trash management is a source of work for locals.

Agricultural and livestock activities need to be sustainable. These activities should not expand or increase, and sustainable projects and programs should be carried out with the people. An annual census is needed to know the precise number of domesticated animals within the reserve. An organized and regulated system, which should include fees and sanctions, is needed to manage livestock within the Sanctuary. The administration needs to strictly enforce zoning and the Sanctuary's territorial plans, and not allow users to fall back on their agreements.

Resolving the property conflict should be a priority, using existing legal norms and corresponding administrative procedures. Physical and legal land tenure and planning strategy is needed for the Sanctuary's property in order to define the rights and legal situation of the inhabitants and claims of ex-plantation owners.

Coordination and creating a common vision must be improved, especially between INRENA and INC, so that they can implement coherent and viable policies that will help manage the Sanctuary. Collaboration needs to improve between INRENA, INC, the Ministry of Industry and Tourism, and the Cusco Regional Government. There should be shared actions, common policies, joint trainings, close and permanent coordination, and a better organized Management Unit in order to truly implement conservation and unified management policies in favor of the Sanctuary.

Road building within and outside of the Sanctuary, providing direct access, must be stopped regardless of the location or length of the proposed road. Impacts caused by the existing train should be minimized.

Finally, environmental education campaigns are needed to help make the locals aware of the Sanctuary's importance and its conservation strategies. Communication between involved institutions and local people must improve and the flow of information should be clear and efficient.

All of these measures should help to address Machupicchu's numerous problems and help conserve this incredible area.



Relict vegetation that is only on one side of the mountains

References

ALFARO, C.G. Lineamientos Ambientales Básicos para la Prevención de Incendios Forestales en Machupicchu. Cusco-Perú. Tesis para el grado de Magíster en CGA.UASB. Sucre, Bolivia. 1997.

BOWMAN, I. Los Andes del Sur del Perú. Edit. Universo. Lima, Perú. 1980.

CENTRO BARTOLOMÉ DE LAS CASAS/CONSORCIO DE INVESTIGACIÓN ECONÓMICA Y SOCIAL. Evaluación Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco. Cusco, Octubre del 2003.

CENTRO DE DATOS PARA LA CONSERVACIÓN de la Universidad Nacional Agraria La Molina CDC-UNALM, para el Programa Machupicchu/PROFONANPE. Biodiversidad del Santuario Histórico de Machupicchu: Estado Actual del Conocimiento. Primera Edición 2002.

CENTRO DE ESTUDIOS REGIONALES AGRARIOS BARTOLOMÉ DE LAS CASAS Y PACIFIC S.A. Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Cusco, Septiembre del 2001.

CHEPSTON-LUSTY, A. Tracing 4 000Years of Enviromental History in the Cusco Area, Peru, from the Pollen Record. Mountain Research and Development. (1 8) 2: 159-172. MS and UNU. 1998.

FJELDSA, J. & N. KRABBE Birds of the High Andes. Zoological Museum, University of Copenhagen and Apollo Books. Viborg, Denmark. 1 990.

FORERO C., LEÓN T. Geographical Patterns of Neoendemic and Older Relict Species of Andean Forest Birds: The Significance of Ecologically Stable Areas. In Biodiversity and Conservation of Neotropical Montane Forest. Edited by S. Churchill. 89-102. NYBG. 1993

FRANCO, J., J . HURTADO et al, Herpetofauna Preliminar del Santuario Histórico de Machupicchu. Mimeogr. 8 PP. 1997.

GALIANO, W. & DE OLARTE, J. Conservación de Recursos Fitogenéticos y Análisis de una Microcuenca Hidrográfica en el Valle Sagrado: Calca-Urubamba. Inf. N° 5, CI -UNSAAC. Cusco, Perú, 1995.

GALIANO, W. Decálogo Normativo para la Conservación, Desarrollo y Manejo del Santuario Histórico de Machupicchu. Opciones: 3:4-7, Inandes. Cusco, Perú. 1995.

GALIANO, W. Tasas de Deforestación sobre la Diversidad Arbórea del Santuario Histórico de Machupicchu. Informe Proyecto Multidisciplinario UNSAAC. Cusco, Perú. 1997.

GALIANO, W. Flora del Sur del Perú: Dicotyledoneae. GTZ- UNSAAC. Cusco, Perú.

- GALIANO, W. Situación Ecológico-Ambiental del Santuario Histórico de Machupicchu: Una Aproximación. Programa Machupicchu. Cusco. Febrero 2000.
- GAMARRA, J. Esbozo del Plan Maestro del Santuario Histórico de Machupicchu. Tesis para optar al título profesional de Biólogo. FCB. UNSAAC, 1986.
- HAMILTON, L. S. Una Campaña por los Bosques Nublados: Ecosistemas Únicos y Valiosos en Peligro. UICN. 1995.
- HERRERA, F. Machupicchu: Apuntes sobre la Flora de la Quebrada. Estudios sobre la Flora del Departamento del Cusco. 2: 178-189. Edit. Rozas. Cusco, Perú. 1993.
- IGEMMET, Geología del Cuadrángulo de la Carta Geológica Nacional, correspondiente a las hojas 27 – r, Urubamba y 27 - s Calca. IGEMMET. Lima, Perú.
- KALAFOTOVICH, C. Compendio de Geología de Machupicchu. En Machupicchu: Devenir Histórico Cultural. :23-38. Edit. E. Chevarría. Cusco, Perú. 1992.
- MILLER, K. Planificación de Parques Nacionales para el Ecodesarrollo en Latinoamérica. FEPMA. España. 1990.
- MINISTERIO DE AGRICULTURA Inventario y Evaluación de los Recursos Naturales Altoandinos del Perú: Departamento de Cusco (Reconocimiento). Lima, Perú, 1985.
- NUÑEZ, P. Listado de la Flora y Fitogeografía del Santuario Histórico de Machupicchu. Seminario Curricular.FCB-UNSAAC. Cusco, Perú. 1992.
- OCHOA, J. Macrobiodiversidad del Área Protegida de Machupicchu. Cuadro 1 pp. 1997.
- PLENGUE, M. & PULIDO, V. Lista de Aves del Santuario Histórico de Machupicchu. Boletín del Instituto Forestal y de Fauna Silvestre. Lima, Perú. 1985.
- PONCE, F., SOLANO, P., SUÁREZ DE FREITAS, G. Plan Maestro del Santuario Histórico de Machupicchu 1998-2008. Instituto Nacional de Recursos Naturales INRENA - Instituto Nacional de Cultura INC.
- REYNEL, C. Agroforestería Tradicional en los Andes del Perú. Proyecto FAO-Holanda/INFOR. 1987.
- RICALDE, D. Diagnóstico de la Problemática del Santuario Histórico de Machupicchu. Seminario Curricular. FCB-UNSAAC. 1984.
- TUPAYACHI, A. Tasas de Deforestación y Diversidad Arbórea del Santuario Histórico de Machupicchu. Proyecto Multidisciplinario UNSAAC. Cusco, Perú. 1994.

VALENCIA, G. & LAMASE, G. Estado Actual del Conocimiento de la Lepidoptero fauna (Rhopalocera) del Santuario Histórico de Machupicchu: una Prospección. *Jornadas de ciencias Biológicas*, mimeog. 5 pp. 1989.

VARGAS, C. Flora del Santuario Histórico de Machupicchu. En *Machupicchu: Devenir Histórico Cultural*. :23-38. Edit. E. Chevarria. Cusco, 1 992.

WALKER, B. & RICALDE, D. Aves de Machupicchu y Alrededores. *Boletín de Lima*. 58: 69-79. Lima, Perú. 1988.

YOUNG, K. Biogeographical Paradigms Useful for the Study of Tropical Montane Forest and their Biota. In *Biodiversity and Conservation of Neotropical Forest*. Edited by S. Churchill et al. 79- 88. NYBG. 1993.

Notes

- ¹ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 5-6.
- ² Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 141.
- ³ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pagina 137 – 139.
- ⁴ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 155.
- ⁵ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 163.
- ⁶ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 173.
- ⁷ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 131 – 136.
- ⁸ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 221-222.
- ⁹ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 226.
- ¹⁰ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 213.
- ¹¹ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 227-229.
- ¹² Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 220.
- ¹³ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 226.
- ¹⁴ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 6
- ¹⁵ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 8.
- ¹⁶ Article No. 23 of the Protected Areas Law # 26834 states that independently of the category assigned, each area should be zoned according to its requirements and objectives. This includes: Strict Protection Zone, Wildlife Zone, Recreation and Tourism Zone, Direct Use Zone, Special Use Zone, Recoperation Zone, and Historical cultural Zone. Article 60 of the Supreme Decree # 038-2001 regulating the protected area establishes norms for zoning.
- ¹⁷ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 42.
- ¹⁸ Interview with Engineer Jorge Pacheco del Castillo, chief of the Sanctuary's Management Unit in the office of the UGM in Cusco, July 8, 2004.
- ¹⁹ Social and Institutional Evaluation of the Risks in Vilcanota – Cusco Valley. *Evaluacion Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco*. Centro de Estudios Regionales Agrarios Bartolomé de las Casas/Consortio de Investigación Económica y Social, Cusco, Octubre del 2003. Págs. 55-59.
- ²⁰ Estimate based on information collected in the field and data from the "Participative Diagnostic of Machupicchu Historic Sanctuary's Rural Sector," elaborated by Centro de Estudios Regionales Agrarios Bartolomé de las Casas and Pacific S.A. Cusco, September 2001.
- ²¹ Interview with Machupicchu (Aguas Calientes) District Mayor, Mr.. Oscar Valencia Auca on July 18, 2004 in his office in Machupicchu.

- ²² Participatory Diagnostic of the Sanctuary's Rural Sector: Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Págs. 54 – 55.
- ²³ Afterwards, the route was increased to Chaullay, and later in February 1978, it was planned to extend to La Convención province in order to facilitate transportation of coffee and fruit from the valley. However, because of the massive damages incurred by the flood between the Hydroelectrical Center of Machupicchu (km 122) and Santa Teresa in 1998, the train service to Quillabamba (km 172) was suspended.
- ²⁴ Evaluación Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco. Centro Bartolomé de las Casas/Consortio de Investigación Económica y Social, Cusco, Octubre del 2003. Pag. 62.
- ²⁵ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 232.
- ²⁶ Evaluación Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco. Centro de Estudios Regionales Agrarios Bartolomé de las Casas/Consortio de Investigación Económica y Social, Cusco, Octubre del 2003. Pag. 30.
- ²⁷ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 233.
- ²⁸ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 234.
- ²⁹ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 65.
- ³⁰ Interview with INC staff in Wiñaywayna, July 17, 2004. The people interviewed included: Baltasar Medrano Panoca, Jorge Paz Pinelo, Ramiro Cortez Robles, Eustaquio Ayala Huamán, Carine Farfán Zúñiga, Eladio Dávalos Mayhua, José Domingo Linares Salazar, and Eduardo Bayona Rivera.
- ³¹ 45% of the rural population tosses solid waste directly in the river, contaminating communities down river; 15% throw their garbage in random dumps, generating visual impact. Diagnóstico Participativo CBC/Pacific. Pag. 206.
- ³² Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 238.
- ³³ Evaluación Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco. Centro de Estudios Regionales Agrarios Bartolomé de las Casas/Consortio de Investigación Económica y Social, Cusco, Octubre del 2003. Págs. 114-116.
- ³⁴ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 244.
- ³⁵ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 247.
- ³⁶ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 184.
- ³⁷ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 74.
- ³⁸ Spread of agricultural areas has destroyed approximately 10,000 hectares, which is about 30% of the Sanctuary.
- ³⁹ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 212.
- ⁴⁰ According to the surveys taken in Diagnóstico Participativo del Sector Rural del SHMP, 86% of the population uses firewood to satisfy their energy needs. Pag. 206.
- ⁴¹ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 129.
- ⁴² Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 247.
- ⁴³ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 249.
- ⁴⁴ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 110.
- ⁴⁵ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Págs. 23-24.
- ⁴⁶ Evaluación Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco. Centro de Estudios Regionales Agrarios Bartolomé de las Casas/Consortio de Investigación Económica y Social, Cusco, Octubre del 2003. Págs. 90 – 92.
- ⁴⁷ Interview with Roxana Abrill Nuñez; direct descendant of Mr. José Emilio Abrill Vizcarra, ancient landowner of Machupicchu. Interview conducted in Cusco, July 9, 2004 in the Inca Museum.
- ⁴⁸ Interview with José Enrique Zavaleta, legal representative of Mr. Julio Carlos Zavaleta Zavaleta, previous owner of part of the land that is now Machupicchu Historic Sanctuary. Interviewed conducted July 7, 2004 in Cusco, at Mr. Julio Zavaleta's home.
- ⁴⁹ Evaluación Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco. Centro de Estudios Regionales Agrarios Bartolomé de las Casas/Consortio de Investigación Económica y Social, Cusco, Octubre del 2003. Págs. 100 – 101.

- ⁵⁰ Interview with Dr. Jorge Flores Ochoa, head professor of the Anthropology department in the University of San Antonio de Abad in Cusco. Interview conducted July 8, 2004 in the Anthropology Department of UNSAC.
- ⁵¹ Evaluación Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco. Centro de Estudios Regionales Agrarios Bartolomé de las Casas/Consortio de Investigación Económica y Social, Cusco, Octubre del 2003. Págs. 75-76.
- ⁵² Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 72.
- ⁵³ For more information about the Inca Trail's carrying capacity and the Sanctuary, see: Is carrying capacity a useful tool for tourism management? The case of Machupicchu, by Minna Pyhala. A dissertation submitted to the School of Development Studies of the University of East Anglia. September 1999.
- ⁵⁴ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 235.
- ⁵⁵ Interview with Architect Abel Ortiz de Cevallos; Regional Director of Outside Business and Tourism of Cusco, DIRCETUR Cusco. July 7, 2004.
- ⁵⁶ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 74.
- ⁵⁷ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 214.
- ⁵⁸ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. xiii.
- ⁵⁹ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. xv.
- ⁶⁰ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 129.
- ⁶¹ Galiano Sánchez W. Situación Ecológico-Ambiental del Santuario Histórico de Machupicchu: Una Aproximación. Programa Machupicchu. Cusco. Febrero 2000. Págs. 73-74.
- ⁶² Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 138.
- ⁶³ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. viii.
- ⁶⁴ Evaluación Social e Institucional y Análisis de Riesgos en el Valle del Vilcanota – Cusco. Centro de Estudios Regionales Agrarios Bartolomé de las Casas/Consortio de Investigación Económica y Social, Cusco, Octubre del 2003. Pag. 106.
- ⁶⁵ Interview with Alberto Delgado Araoz, Executive Director of Instituto Machupicchu. Conducted July 6, 2004 in the IMAPI offices in Cusco.
- ⁶⁶ Interview with Architect Abel Ortiz de Cevallos; Regional Director of Outside Business and Tourism of Cusco, DIRCETUR Cusco. July 7, 2004.
- ⁶⁷ Plan Maestro del Santuario Histórico de Machupicchu. Págs. 66-67.
- ⁶⁸ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 65.
- ⁶⁹ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu. Pag. 70.
- ⁷⁰ Machupicchu's Master Plan: Plan Maestro del Santuario Histórico de Machupicchu.
- ⁷¹ Plan Maestro del Santuario Histórico de Machupicchu. Págs. 68-69.
- ⁷² Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. 28.
- ⁷³ Diagnóstico Participativo del Sector Rural del Santuario Histórico de Machupicchu. Centro de Estudios Regionales Agrarios Bartolomé de las Casas y Pacific S.A. Cusco, Septiembre del 2001. Pag. x.

Written by: Diego Shoobridge

Collaborators: Julio Torres Calderón Zárate and Miguel Morán Morán

Date published: September 2004

Translated by: Amanda Vanega