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**MODEL MANAGEMENT OF HABITABILITY IN PROTECTED WILD AREAS (ASP)<sup>[1]</sup> CASE STUDY  
TORRES DEL PAINE NATIONAL PARK (PNTP), PATAGONIA CHILE.  
Villanueva, Laura. <sup>(1)</sup>, Cuchi, Albert <sup>(2)</sup>**

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**Abstract:** Tourism in the Chilean Patagonia has grown rapidly since the last decade, promoted to a large extent by state actions and encouraged by private companies with the aim of turning this region into a pole of attraction for tourism, by encouraging the productive development of the country. This tourism is based on the geographic values of this extreme territory and on one of the most fragile natural environments of the country. These foci of interest are mostly located within the Magallanes Region located within the National System of Protected Wild Areas belonging to 58.9% of the total area of the region, with Torres del Paine National Park receiving the largest number of visitors doubling their income over the last decade over an area of 181,229 ha. This "invasion of nature tourism" has so far demanded services that cover the needs of visitors, which have been resolved unsustainably and with little management measures of the impacts that these facilities can cause in the Protected Wild Areas, generating a risk to the conservation, therefore the most important objectives in the creation of a National Park. Today they have been designed to open to medium-term tourism development with the arguments to decentralize the flow of activities in Torres del Paine Park. In general they are places of great extensions where the time to travel them entails the temporary permanence within them which implies to inhabit them by times limited. There are currently no management plans with a Sustainability approach for these wilderness areas of the region that can solve the habitability management within them through a methodology of material flows. On this enormous territory is where it is proposed to approach the subject, studying the metabolic flows that the habitability implies in Torres del Paine as well as the material flows that are given to satisfy it, then formulate a proposal that can be adapted to the rest of the Wild Areas Protected and with the limitations that this implies of its relation with the environment, which is a challenge that is extrapolable to another scale if we consider that for sustainability, the whole planet is but a great natural park in which we must inhabit.

**Keywords:** Habitability; Protected Wild Areas; Sustainable Architecture; Material Flows; Satisfaction of needs.

## 1. Introduction

National parks are attributed on one hand as being places recognised for their extraordinary resources, generally characterised by exceptional natural conditions. On the other hand the social protection of these places is given through a configuration of parks implying the acknowledgement of the risk of deterioration due to human activity. So far, the intrinsic activity that visitors carry out in this national park is mainly based on recognising the natural landscape and the temporary stay in the area. These activities are delimited by a trail that has always been accessible to the people.

Because landscapes require the active participation of their observers. The lived landscape is a vital experience, where the senses feel, creative talent is set in motion and knowledge is enriched with knowledge. But all this requires integration into the landscape and rhythms. (Garbizu 2016)

It is implied that social interaction should not allow the deterioration of the park and its natural quality, therefore the activities will be constrained to that condition. As a result, the relationship with the environment will be limited to focus on the real necessities of the visitors' habitability without the need to carry other out productive or consumerist activities. This is shown in the region of Magallanes, Fig 2, and in the PNTP by the challenge that in the last ten years the number of tourists has doubled. Nevertheless, the aim is to preserve the national parks through education so tourism management and

its impact is not seen as an objective by the Corporación Nacional Forestal<sup>1</sup> (CONAF) *National Forest Corporation* which does not have the resources to manage it properly. This directly affects the way in which touristic activities are held in the circuits proposed in the PNTP and how these actions are reflected in the infrastructure analysis. Many of these are collaborations and tend towards sustainable habitability that is not yet present in the park. This leads to thinking of different solutions that would allow freedom in economical, legal and political aspects.

Everybody sees tourism in good light as well as a model of growth, employment and foreign exchange with an innocuous effect with the natural environment that has been exploited throughout history. The social collective, authorities, communication media, citizenship and business entourage perceive touristic activity as good for itself, often used as ecotourism to reaffirm a perception of environmental innocuousness. Therefore the region projects and owns its future in a natural environment with the intention of creating better opportunities for this type of tourism which wants to be more involved with opportunities in the special strategies of the Patagonia territory (Inostroza 2008)

If the consumption of tourism is the natural territory, the natural resources are infinite and so the strategies to manipulate and manage the interventions in the park. These interventions are focused in

Categoría	Nombre	Chilenos	Extranjeros	TOTAL	Superficie Há
MN	Cueva del Milodón	72.408	29.409	101.817	189
MN	Los Pingüinos	6.947	21.970	28.917	97
PN	Bernardo O'higgins	15.704	12.612	28.316	3.525.901
PN	Cabo de Hornos	1.011	6.532	7.543	63.090
PN	Pali Aike	1.154	782	1.936	63.093
PN	<b>Torres del Paine</b>	<b>87.328</b>	<b>110.175</b>	<b>197.503</b>	<b>181.229</b>
PN	Yendegaia	0	0	0	150.612
PN	D'agostinni	0	0	0	1.460.000
RN	Alcalufes	324	689	1.013	2.313.875
RN	Laguna Parrillar	7.227	313	7.540	18.814
RN	Magallanes	7.328	1.030	8.358	13.500
SUBTOTAL REGIONAL		<b>199.431</b>	<b>183.512</b>	<b>382.943</b>	<b>7.790.400</b>

**Fig.1** Tourists arrival in 2014 to the different ASPs of the Chilean Magallanes and Antarctica. Source: own elaboration based on the CONAF statistics. MN: National Monument, PN: National Park, RN: Natural Reserve [3]. Villanueva L.

technical possibilities to satisfy the visitor's necessities through a model of sustainable habitability.

The documents regarding regulations in the National Parks in Chile only provide partial data for the research since none of them solve the architectural or habitability model for a National Park. This lack of regulations needs to focus in a model of habitability

for Torres del Paine, to motivate and justify this research project. It is necessary to analyse how visitor's inhabit the infrastructures and how the material flows and other necessities function in the park to be able to have an approach to a management model of sustainable habitability that can be adapted into the design and construction guidelines of this conservation sites in the region of Magallanes.

## 2. Delimitation of the scope of study (Background)

The Magallanes region is located in the far south of the south American continent and it conforms part of the Patagonia Fig 2. and it is extended 41° between parallel south which includes the Andes and part of the trans Andean territory. It reaches to the Atlantic ocean and ends in Cabo de Hornos, covering a surface of 700.000km<sup>2</sup> Fig 2. This last region of the Chilean Patagonia is one of the most extended in the country and it covers 13.203.400ha, corresponding to 58% to SNASPE<sup>2</sup>. This percentage includes six national Parks, three Natural Reserves and three Natural Monuments in 52% of the total SNASPE territory that is managed by CONAF<sup>1</sup> (National Forestal Corporation. *Corporación Nacional Forestal*,2008).

<sup>1</sup> Autonomous institution that belongs to the State of Chile. It depends on the Chile Ministry of Agriculture and it is in charge of managing the forests' politics, incentivate de region's development, fight forest fire and manage the conserved wild areas of the national parks and national reserves.

<sup>2</sup> The natural wealth of Chile is protected within the National System of Protected Wild Areas of the State, created and administered by CONAF. It is defined as a national park to a generally extensive area, where there are diverse environments unique or representative of the natural biological diversity of the country, not significantly altered by human activity. It is an area of capable of self-perpetuation and in which species of flora and fauna or formations geological, are of special educational, scientific or recreational interest. It is called a National Reserve to the area whose natural resources need to be conserved and used with special care, the susceptibility of these to be degraded or their importance in safeguarding the welfare of the community. The Natural Monument is a generally reduced area, characterized by the presence of native species of flora and fauna or by the existence of relevant geological sites from the natural landscape, cultural or scientific point of view.

This high number of territory emphasizes the ecological importance of the region and functions as a reservoir of fragmented ecosystems of international relevance (Jax & Rozzi, 2004).

The region of Magallanes occupies one of the most important water reserves in South America (Rivera et al. 2002) and it is also one of the most important unexplored territories that include hundreds of islands that correspond to more than 48.000km of the coastline in the region Fig. 2.

This research delimits the importance of its geography and aims to understand the new ASPs of the region. In the study case of the PNPT and the Yendegaia National Park, Agostini and Cabo de Hornos have recently been approved to exploit tourism in this region with insufficient infrastructure for long stays of park rangers and visitors. In 2017, the Sustainable Tourism Management was presented for the Cabo de Hornos Biosphere Reserve which was held by the university of Magallanes (UMAG) the Omora Foundation<sup>3</sup> and the North Texas University. This Plan intends the realization of the management plans for this Park between 2017 and 2019.

Moreover, the PNPT is one of the major resources that generate tourism market in the region of Magallanes and Fig. 1 shows the influx of annual tourists in the different ASPs. This Plan was created in 1975 and covers an area of 227.298 ha, where the closest community, Puerto Natales locates to 150 km. and the capital city Puerto Arenas to 400 km. Fig. 1. The PNPT is located at 50°45' - 51°20' in the south latitude and 72°31' - 73°22' in the west latitude. According to the temperature records, the region presents low temperatures with very little variations between summer and winter. The daily temperature is relatively constant during the seasons, with minimum variations that do not exceed 12°C. July is the coldest month, presenting low temperatures of 2.5°C and reaching the highest to no more than 8°C. During the summer, the lowest temperature can reach 3°C and the highest can reach to 15°C. in January (CONAF, 2007). Spring and summer belong to the windy season, with the windiest months in November where the speed of winds can burst up to 100km/h. (Soto et al., 1994).

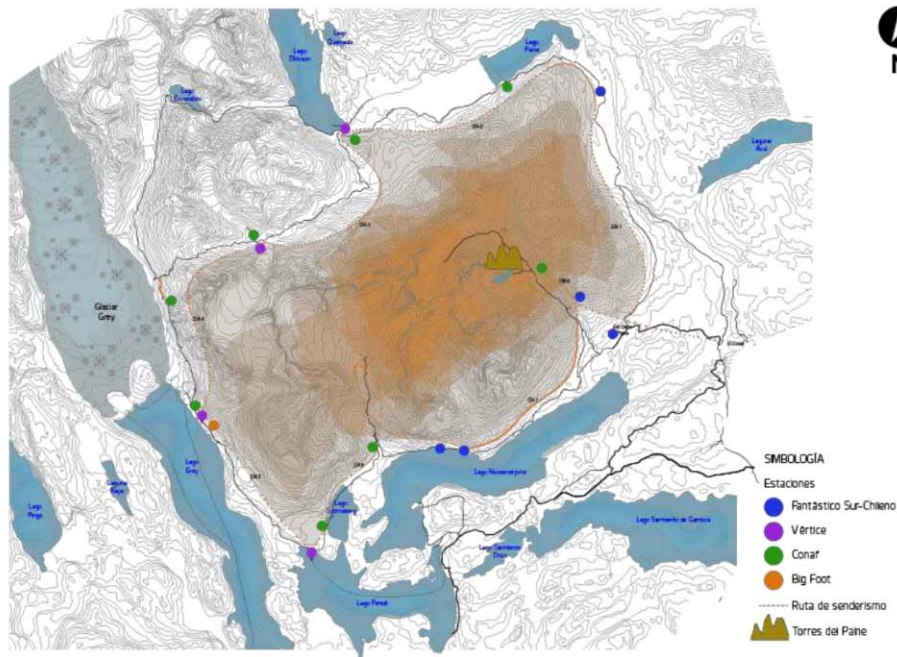
The Paine Mountain Circuit is the most important one in the PNPT since it surrounds the entire mountain massif with an extension of 93.2 km. and it takes from 8 to 10 days to make the entire trail. The "W" trail is the busiest one since it goes through the main landmarks of the park in its 76,1 kilometre extension. It carries this name because seen in the map, the path forms a "W" in the territory. This trail crosses the Gray Glacier in the west side of the Paine massif and takes from four to five days, depending on the weather conditions and how long the visitor plans to stay in each place. This circuit is located within the Zone of Primitive Use<sup>4</sup> next to the eighteen sets of infrastructure that function according to the visitor's necessities and its permanence in each place. Mostly this infrastructure belongs to shelters and camping areas Fig. 3



**Fig. 2** Satellite image of the Patagonia. It can be appreciated the ice south fields, the Strait of Magallanes, Tierra del Fuego island and the Parque Nacional Torres del Paine.

<sup>3</sup> The Omora Foundation, is a research centre for the Biosphere Reserve Cabo de Hornos that belongs to the University of Magallanes, in the region of Magallanes, Chile.

<sup>4</sup> The zones of primitive use are natural areas that have had a minimum of human intervention. It contains unique ecosystems of scientific value that could adapt to moderate public use. There are no roads or other use of motorized vehicles. The aim is to preserve the natural environment and at the same time to facilitate scientific, environmental education and recreation studies.



**Fig. 3** Location of the Mountain Circuit inside the PNPT and the 18 infrastructure stations, Own elaboration.

## 2.1. Habitability regulations in a natural environment

Habitability is determined by the relationship and adequacy between man and his environment and refers to how each of the territorial scales is evaluated according to his ability to meet human needs. (Jirón 2004).

Currently the publications issued by state and regional agencies, as well as from different independent organizations on design and construction regulations in ASP are very broad when taking criteria to develop projects of habitability in National Parks, focusing more than anything in the conservation of the biodiversity. At the national level; The Chilean General Urban Planning and Construction Ordinance (OGUC) defines protected areas as "areas of protection of natural resources" and repeats the responsibility for the Territorial Planning Instruments, (OGUC 2008). However, there are more specific documents such as the Management Plans of the ASP, which are mainly referred to as management tools, which is based on a planning process and includes technical, normative and guiding aspects to ensure the conservation of a protected area, through the ordering of the use of its space, (Nuñez 2008). The Chilean Law 19,300 on general bases of the Environment, explain the criteria for conservation in protected areas, however, it does not refer to guidelines on habitability in the design of tourist facilities as administrative within the Parks. On the other hand, the Technical Manual 23 of CONAF, Method for Planning Protected Areas Management (Nuñez 2010) presents criteria for the classification of zones within protected areas, which are based on landscape units, species of flora and fauna, water resources, and other aspects relevant to the conservation of biodiversity, so that the management plans focus on the regulation and use of the different zones that could exist within a protected park.

In the year 2011, Chile's National Tourism Service (SERNATUR)<sup>5</sup> and the Federation of Tourism Companies (FEDETUR)<sup>6</sup> jointly produced a document titled Chile for sustainable tourism, Manual of good practices, (SERNATUR 2011), which promotes sustainable tourism with the aim of ranking the country as one of the most attractive destinations for both local and international markets. Focussing mainly on holiday accommodation and travel facilities, the study discusses issues such as the management of water, energy, waste and the territory itself, as well as involving the local community in the development of the project.

<sup>5</sup> El Servicio Nacional de Chile or the National Tourism Service is a public organisation responsible for the promotion and development of tourism in Chile.

<sup>6</sup> Federación de Empresas de Turismo de Chile or the Federation of Tourism Companies is a trade union which collaborates with other trade associations as well as with both public and private tourism companies.



Fig 4. Vista hacia las Torres del Paine desde mirador; dic.2015, PNTP, Autor

The "Manual for the formulation of plans for public use in the Protected Wild Areas of the State", CONAF 2014; suggests that public bodies such as the municipality, the SERNATUR, the Chambers of Tourism, as well as other similar non-governmental organizations for environmental protection collaborate on the project. Other publications have also provided detailed information on the impact of tourism in Patagonia. One such paper titled "Tourism in Patagonia: a threat to the ecological integrity of the environment" (Inostroza 2008) makes a comparative analysis between tourism



Fig. 5 Modelo de Sistema de Manejo Turístico. Esquema utilizada por CEQUA para el proyecto *Sistema de Manejo Turístico para Áreas Protegidas de Chile* (Villanueva 2015)

development in the region and the natural environment. By means of a dialectical approach to landscape ecology, the study reveals that in Magellan there are relevant ecological areas outside the state's protected zones which require prompt action with regard to conservation due to their growing potential as popular tourist destinations.

Furthermore, keeping in mind the process of material flows, which is instrumental in developing a sustainable model, Fentanes. K., and Cuchi. A., analyze and attempt to implement the process of material flows in the field of architecture in order to understand the habitability of a particular place. Fentanes (2004) concludes that the demand for a closed-loop material flow in order to ensure sustainability extends the scope of architecture to managing these cycles on a global level as well as to a better understanding of how the scarcity of existing resources in a specific terrain determines the architecture of the place. Likewise, in his essay **Perception of territory from the analysis of material flows**, Albert Cuchi discusses material flows as an effective tool for sustainability by highlighting the importance of its form and how it reinforces the essential role of the territory as the main factor of sustainability. In Chile, no references where the study of material flows has been applied so as to develop a suitable model of habitability in a National Park have been found.

On the other hand, the Center for Quaternary Studies (CEQUA)<sup>7</sup> has just completed a study known as the Tourism Management System for Protected Areas of Chile, (CEQUA 2016), which will improve the management of public use, conservation of the biodiversity and the quality of the experience of the visitors in favor of sustainable tourism. It uses as a study site the mountain circuits of Torres del Paine National Park. In this study two variants intervened, one defined by the fixed ecological load and the other by the physical load of the infrastructure of the park, the latter being an area of interest for my investigation, on which I worked for the duration of my Master's thesis. During this period, data related to PNTP's environmental load capacity related to infrastructure and obtained through the CEQUA foundation was analyzed. Subsequently, the data was collected and verified with the help of a field trip to the park in December 2015 and October 2016, which consisted of visiting all the stations built on a trekking circuit that surrounds the Torres del Paine Fig. 5

So far the data I have gathered after having interviewed the park rangers and administrators of private stations with the objective of obtaining information on the supply system, data on energy consumption and waste management, is an account of the human activities of the visitors, the conditions of

<sup>7</sup> The CEQUA is the first scientific research centre in the Magallanes region with in studies conducted in the fields of ecology, territorial studies and climate change.

habitability, satisfaction of needs as well as the means by which they are satisfied. It is observed that regulations for sustainable habitability in the park are not followed, thereby giving rise to the freedom to opt for different infrastructure solutions, which in most cases respond to economic, legal and political necessities.

As an important contribution to the elaboration of a broad conceptual framework that requires incorporating the habitability in ASP, beyond what we currently find in them and management plans, this research intends to carry out a study of the current habitability conditions in the PNTP will be carried out through the collection of current material and documents on the infrastructure of the park, where we will find different typologies of socially accepted habitability, which we believe are recognized by the regulations or the responsibility for environmental impact assessment instruments. Recently the situation in Torres del Paine National Park is being modified due to the studies that the Cequa Foundation carried out in the park since 2014 and that they have been approaching to define an environmental load capacity as well as the capacity of infrastructure load, being the latter the reason for an investigation that from 15/02/16 Conaf placed a restriction of 80 people to the Massif Paine due to the wastewater systems and camps were far exceeded. That number was arbitrary and not part of the results of the project.

### **3. Objectives**

The objective of this thesis is to define a Habitat Management Model for the Protected Wild Areas of the Chilean Patagonia, a PNTP<sup>8</sup> case study, with the in situ analysis of the activities and needs of the visitors in Torres del Paine National Park, to through a study of the needs that this habitability implies and of the material flows necessary to satisfy them, carrying out a critical analysis of the existing habitability and its impact on the environment, where the basic purpose is to achieve a balance between the ecosystem of Patagonia Chilean and human activities; analyzing alternative strategies and finally proposing actions that can be considered as a whole as a model applicable to other natural parks in a Chilean Patagonia, which are rapidly beginning to be exploited driven by the local tourism economy and the country. Thus, in Chile, resolving habitability management within ASP through a material flow methodology is relatively new.

### **4. Methodology**

The methodology was organized in such a way as to obtain relevant information so as to analyze the processes generated in the PNTP. FIG. It shows the structure of the research, based on these concepts, the objectives, aspects to be evaluated and the methodology which were proposed. The study was based on research obtained from field work in the PNTP in order to obtain quantitative and qualitative data through interviews with public and private entities involved in the park as well as visitors.

- Theory - Norms

Information was collected and updated from legislative texts of the regional tourism sector, ASP management plans of the Magallanes region as well as general regulations that also affect them.

- Spatial structure of the Patagonian natural environment of the PNTP

Necessary information corresponding to the field of study on the spatial structure of the Patagonian natural environment and the spaces constructed within the Mountain Circuit of the PNTP was obtained. It is also important to understand the formation of this park in order to study the infrastructure such as cattle ranches<sup>9</sup> built in the park before the creation of additional models, and not the least, to study the history of mountaineering in the sector, since the first ascents to its summits attracted the attention of many visitors keen on exploring places little known to them, thus originating in one of the first trails around Massif Paine. In other words, making a study of the patrimonial subject of the PNTP which has a great significant value compared to others of the region and the country would be essential.

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<sup>8</sup> The previous study was based on an estimate of the Protected Wild Areas, which served as a management model in the mountain circuits of the PNTP.

<sup>9</sup> Livestock productive unit in the southern pampas. For reasons of productivity, given the low yield of the land, each room occupies a lot of ground. It is estimated that, at present, economic sustainability requires an extension of at least 3,000 hectares. Historically, stays organized by business groups followed an industrial model, and were much larger (up to 200,000 ha). The estancias were the only settlements in the pampa; and great distances made communications difficult. Benavides, J.

- Metabolic Flows and Material Flows

Schemes and tables were developed to identify activities, needs and metabolic flows. A study was carried out on the material flows of each of the stations recording energy resources and waste management between Conaf, private concessions and Est. Co Paine.<sup>10</sup>

- Critique of alternatives and proposal of habitability management model PNTP

Currently under study, the guidelines will be structured to define a Habitat Management Model for PNTP as a hypothesis, which can then be checked during the last stage of the investigation.

- Model of Habitability Management in ASP of Magallanes.

This next step consists of replicating this Habitability Model in the management of the next interventions in the national parks of the region. To this end, the necessary information will be collected corresponding with the study of the spatial structure of the Yendegaia National Park, the Cabo de Hornos National Park and the D'agostinni National Park.

- Check the model.

The results of this work, beyond the aspects related to the case study, try to raise awareness of the methodological aspects of the realization of this study, keeping in mind its applicability to other cases, in other ASPs of the Chilean Patagonia.

## 5. Results

### 5.1 Field study

The 18 stations around the mountain circuit were visited and comparative tables were developed in order to have a complete view of the infrastructure within each park, such as maximum capacity, Fig. 6 services, energy, water, supply and waste Fig. 6, administered by CONAF, partly a private collaboration and although in some, as in the sector of Gray Glacier Fig. 3 share the place 4 of them. From 2014 to 2016 the number of visitors exceeded the maximum capacity in each of the stations. It is observed that the historical capacity does not surpass the declared limits but that all the historical maximums are equal to the declared maximum. It is inferred that all stations use firewood as an energy source at least for some of their needs, such as heating, cooking and hot water. For the production of electricity all the stations use diesel or benzine with generators.

	ESTACIONES CIRCUITO DE MONTAÑA PNTP	personal fijo de trabajador roles	MODELO HABITABILIDAD turística/capacidad máxima x día					máx.histórico al 2015				SERVICIOS					
			REFUGIO n°personas	CAMPAMENTO n°personas	n° tiendas	CABAÑAS n° personas	DOMOS n° personas	TOTAL máx. personas por día (noche)	CAMPAMENTO n° personas en una noche	n° tiendas	REFUGIO n°personas	diferencia	TOTAL personas por día (noche)	L°.duchas	WC	Lo:lavatorios	Lp:lavaplatos
privados	R. TORRE CENTRAL	18	60	0	0	0	0	60	0	0	60	0	60	12	15	11	4
privados	R. TORRE NORTE	0	60	0	0	0	0	60	0	0	60	0	60	8	8	7	0
privados	C. LAS TORRES	2	0	600	300	0	0	600	500	250	0	-100	500	12	8	8	4
privados	SERÓN	3	0	100	50	0	8	108	0	0	0	-108	0	3	3	3	2
estatal	COIRÓN	2	0	2	1	0	0	2	2	1	0	-2	0	2	2wcs* 2wc	2	1
estatal	DICKSON	2	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1
concesión	DICKSON	4	27	400	200	0	0	427	300	150	27	-100	327	6	6	4	3
estatal	PERROS	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
concesión	PERROS	1	0	240	120	0	0	240	0	0	0	-240	0	2	2	0	3
estatal	PASO	2	0	30	50	0	0	30	320	160	0	290	320	1	2	1	3
concesión	GREY	17	60	400	200	0	0	460	414	207	60	14	474	18	21	23	5
estatal	GREY	2	0	0	0	0	0	0	0	0	0	0	0	3	3	3	1
privados	GREY	8	12	0	0	0	0	12	0	0	12	0	12	1	1	1	1
concesión	PAINE GRANDE	30	100	400	200	0	0	500	420	220	100	20	520	31	31	22	4
estatal	PAINE GRANDE	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
estatal	ITALIANO	2	0	80	100	0	0	80	600	300	0	520	600	1	4wcs* 7wc	1	1
privados	FRANCÉS	7	32	200	100	0	24	256	104	52	32	-120	136	13	13	18	1
privados	LOS CUERNOS	15	35	200	100	16	12	263	300	150	35	72	335	14	18	14	4
privados	CHILENO	9	32	120	60	0	0	152	800	400	32	680	832	12	12	10	2
estatal	BASE TORRES	2	0	100	100	0	0	100	260	130	0	160	260	1	5	1	1

\* Baños secos

Fig. 6 Table summarizing the infrastructure and activities of habitability in each Station. Master Thesis (Villanueva 2015)

<sup>10</sup> The Cerro Paine ranch is the only private property within the Torres del Paine National Park belonging to the Kusanovic family from Croatia since 1979.



Of the 18 stations that use firewood, 7 of them, belonging to Conaf use firewood collected from the surrounding area. Regarding the use of alternative energies, the Conaf stations that have the installation of photovoltaic cells to load communication equipment but until 2016 they did not work.

When comparing the levels of hygiene in each campsite according to the current regulations<sup>11</sup> of the Ministry of Health for public spaces, which is very general; we found that in most cases the requirements were not be met. This indicates that there must be two toilets for every 6 camping sites, if we consider each camping site as the space to install a tent for two people, we find that one would need 1 toilet for every 6 visitors in the stations.

The septic tanks in 7 stations collapsed due to the large number of visitors or there is no way to transport the sludge that accumulates due to the insulation of the place, flow of visitors and form of storage. For example, in camp dogs two years ago they excavated an absorption well (pit), in Dickson camp a second well / pit. In Italian camp there are 14 toilets of which 10 were closed, 4 of them are dry tops that reached their maximum. The Chileno and Cuernos stations have biofilter treatment plants based on earthworms, and then infiltrate the land. All stations with camps occupy infiltration fields (fish bones or absorption wells). However, it is concluded that the current health regulations are not specific to installations in protected wild areas, so the water toilet system would not be the solution for these types of places. Therefore there is no efficient use of water. On the other hand there is no priority of use of renewable energies by the administration of the Park. Otherwise the waste management is deficient.

## 5.2 Material flows

The study has analyzed the material cycles by monitoring consumption of each station within the PNTF Fig. 8, water being the only resource to form a part of a closed-loop cycle although not in a sustainable way as the treatment systems are not adequate, **while the others outsource the ecological footprint to and from a local economic system, Puerto Natales**. The current condition of the PNTF responds to the immediate solutions, sustained with the support of external resources of private companies that, at best, cause pollution outside the park and, at worst, inside, which has only been bearable as the inflow (of what- water or tourists?) to the PNTF remained low until 2013 as well as during winter seasons. Subsequently, the level of water pollution rose to such an extent that a crisis ensued, resulting in the temporary closure of the park. So far, the results show that the way in which the satisfaction of needs are accounted for and solved, correlates to an economic model that determines or defines the habitability and with it a model that although, on the one hand tries to be sustainable, the process is not applied from the origin, so the material cycles remain open-looped.

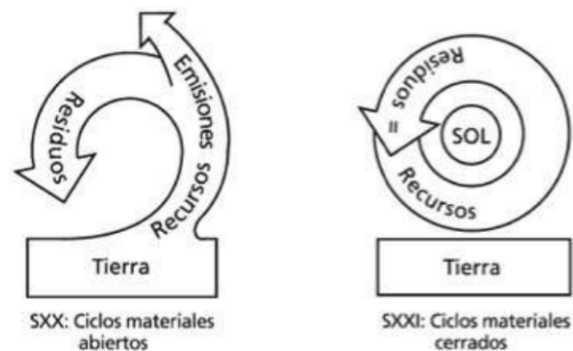


Fig. 7 Cycle of Materials.. (G.Wadel 2010)

Addressing this situation is even more difficult in the context of the characteristics of Torres del Paine, as it exceeds the limits of a traditional analysis environment and at the same time recognizes conservation and seeks sustainable habitation.

This model, through its flows should close the cycle of materials. This suggests that a model of habitability management in the current context that is Torres del Paine and to approach sustainability, is the closure of two cycles, some within the park, so far carried out by the water cycle and the other outsourcing the footprint outside of it, but seeking a supply of local resources and reducing waste generated by visitors.

<sup>11</sup> Regulation (article 15 clause 301)

ESTACIONES CIRCUITO DE MONTAÑA PNT	ENERGÍA						AGUA			AGUAS RESIDUALES		RESIDUOS		ABASTECIMIENTO	
	LEÑA		GAS		DIESEL		captación	almacena (lt.)	Consumo día (L)	TIPO	capacidad (L)	separa	cantidad día (m3)	medio	frecuencia
	Fuente	Consumo día (m3)	Consumo día (L)	k CO2 diario	Consumo día (L)	k CO2 diario									
R. TORRE CENTRAL			400				Arroyo		5520	3 fosa		si		camioneta	
R. TORRE NORTE	compra	0.198	67	600	40	104.4	Arroyo	1200	6560	1 fosa	45000	si	1.3	camioneta	diario
C. LAS TORRES			133				Arroyo		16000	2 fosas		si		camioneta	
SERÓN	compra	0.033	7.5	11.84	1.3	3	Arroyo a 100mt	4000	1500	fosa	2500	SI	0.3	camioneta/caballo	semanal
COIRÓN	recogida	0,09	5.76	8.88	7.33	17.45	arroyo	no	320	fosa	1500	si	10	camioneta	cada 10 días
DICKSON	recoge	0,11	5.77	8.89	7.33	17.45	lago	no	160	fosa	1500	SI	12	camioneta/balseo	semanal
DICKSON	compra	0.06	17.28	26.64	7.8	18.56	lago	2000	6720	fosa	3000	NO	0.2	camioneta/balseo	semanal
PERROS	recogida	0,11	2.88	4.44	7.33	17.45	río	no	160	fosa	1500	SI	8	porteo	según rol
PERROS	recoge	0.06	17.28	1.48	4	9.52	río	no	6480	fosa	3000	NO	0.16	caballo	mensual
PASO	recoge	0,11	0	0	7.33	17.45	arroyo	no	4160	poso	0	SI	12	porteo	semanal
GREY	compra	0.22	100.8	155.4	60	142.8	lago	10000	22160	fosa	10000	SI	1.2	lancha	semanal
GREY	compra/recoge	0,088	2.88	4.44	7.33	17.45	lago	1000	160	fosa	1500	SI	10	lancha	mensual
GREY	compra	0.055	4	5.92	25	59.5	lago	2000	960	planta	0	SI	0.1	lancha	cada 10 días
PAINE GRANDE	compra	0.25	129.6	199.8	65	154.7	lago	30000	26400	fosa	10000	SI	1.8	catamarán	semanal
PAINE GRANDE	compra	0,088	5.76	8.88	7.33	17.45	arroyo	2000	160	fosa	1500	NO	10	catamarán	mensual
ITALIANO	recogida	0,088	0	0	7.34	17.45	arroyo	1000	6560	fosa	5000	SI	24	porteo	quincenal
FRANCÉS	compra	0.033	27	41	20	47.6	arroyo	no	9520	planta	40000	SI	1.1	bote/caballo	semanal
LOS CUERNOS	compra	0.7	90	139	20	47.6	arroyo	no	11440	planta	30000	SI	1.3	bote/caballo	semanal
CHILENO	compra	0.16	60	91	20	47.6	arroyo	no	6880	planta	14000	SI	1.1	caballo	semanal
BASE TORRES	recoge	0,11	0	0	7.33	17.45	arroyo	500	6560	fosa	1500	SI	24	porteo	semanal

Fig. 8 Table summarizing source and consumption of energy, water, wastewater, waste and supply. Master Thesis (Villanueva 2015)

## 6. Conclusions

### What is the model of habitability management in a national park with the characteristic conditions of Patagonia?

We can conclude that Torres del Paine National Park, which exceeds the limits of a traditional environment of analysis and at the same time recognizes conservation, requires a model of sustainable habitability as such, which should close the material cycles and at the same time, through appropriate management of the use of foreign (local) resources, can reduce the impact of material flows with the objective of meeting the basic human needs, maintaining the quality of the environment, both inside and outside the park. Fig.7

The above supports us so far in proposing a Habitability Management Model in the current conservation context of the Torres del Paine Park, it would be the closing of the material cycles, some within the park, until now carried out by the water cycle and the others outsourcing the footprint outside of it, but seeking a supply of local resources and reducing waste generated by visitors. In order to establish this Habitability Management Model, it will be necessary to determine the effects of foreign materials on the PNTP it will be possible to determine the materials necessary for the habitability of the visitors and the capacity of the mountain circuit to support a new architectural intervention, bringing with it a need to satisfy food, fuel for cooking, thermal conditioning, sanitary system, water supply, hygiene, waste management, communications and transport that together affect the biodiversity of the park. Fig. 9

Finally, it is concluded that in order to achieve a suitable habitability model, in a natural environment of high environmental value, through the principles of sustainability, it is necessary, first, to manage visitors. "It is not the buildings that consume energy, those who must want to change is the human group that occupies them". (Cuchi. A.)<sup>12</sup>

<sup>12</sup> Based on notes taken during the Master's programme MAEMA 2015, UPC.

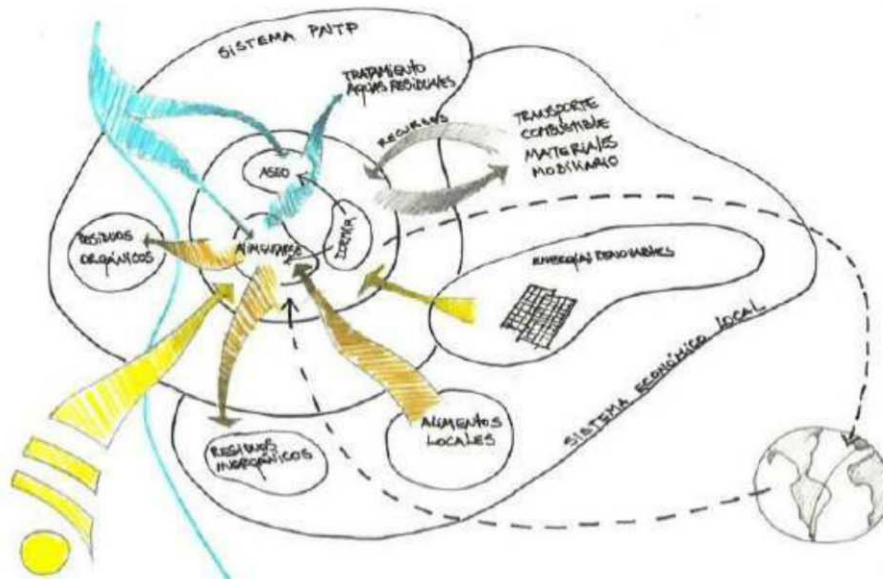


Fig. 9 Current Habitability Model of PNTP

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