The Ruka Mapuche: clues for a sustainable architecture in southern Chile?

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ABSTRACT: Due to its adaption to climate and the use of local materials, indigenous architecture can provide clues of how to improve the sustainability of contemporary architecture. In Chile the most well known surviving indigenous architecture is the Mapuche *ruka*. For centuries the *ruka* has formed an important part of the cultural identity of the Mapuche people. However there exists little relationship between the *ruka* and contemporary construction. Research by the authors has shown that the *ruka's* internal environmental comfort is compromised by the use of open hearths for space heating with no chimney. However the materials used in their construction are 100% natural, locally sourced and biodegradable. This paper presents examples of contemporary architecture inspired by *rukas* and questions how the use of local materials and the concept of temporality, fundamental to the Mapuche world vision, might provide valuable clues for a new sustainable architecture for rural southern central Chile.

1 INTRODUCTION

1.1 *Vernacular and Indigenous Architecture*

The study of vernacular and indigenous architecture has changed over the centuries. In 19th century Europe vernacular architecture was studied in the search for a national style and identity. At the same time the study of oriental and southern hemisphere indigenous architecture was purely anthropological (Arboleda 2006). In 1968 the Museum of Modern Art (MOMA) New York hosted the exhibition "Architecture without Architects" (Rudofsky 1968). The exhibition and the accompanying catalogue presented large scale photographs of vernacular and indigenous architecture focusing principally on their aesthetic qualities aiming to raise their value to that of fine art. A year later publications such as "Shelter and Society" (Oliver 1969) and "House Form and Culture" (Rapoport 1969) changed this focus, concentrating instead on cultural and social aspects. Since the 1990s the performance of these constructions has been studied in the hope of providing clues for a new sustainable low energy architecture (Cook 1996, Huang & Lui 2010, Foruzanmehr & Vellinga 2011). Indigenous architecture is now appreciated for its bioclimatic concepts and environmental principals. It is no longer studied as an historical document but rather as a potential model for sustainable development (Heal et al. 2006). However the sustainability of vernacular and indigenous architecture has been idealized (Arboleda 2006) and it is therefore necessary to obtain empirical measurements of its performance in use to allow the application of its advantages and the avoidance of its drawbacks.

1.2 *Indigenous architecture in Chile.*

Continental Chile stretches over approximately 4,300km from latitude 17.5° to 56° south, with a maximum width of 350km at its widest point. This thin sliver of geography has been inhabited since 12,800BC (UNESCO 2004) by a rich mix of indigenous tribes including the Chinchorros, Aymaras, Diaguitas, Atacameños, Kollas, Mapuches, Tehuelches, Alakalufes and Yaganes. Each of these tribes developed its own architectural expression; however the architecture of these original inhabitants receives little recognition in modern day Chile. Wainsberg (1978) in his book "*En torno a la historia de la arquitectura Chilena*" begins the history of Chilean architecture with the colonial architecture of the Spanish conquistadores, whilst Gross (1978) in "*Arquitectura en Chile*" dedicates only 6 pages to indigenous architecture. At the same time not only has indigenous architecture been ignored by contemporary Chilean society but in the context of supposed "development" the indigenous population has been rehoused in western style social housing which bears no correlation to their own culture. Today this situation has to some extent been rectified by the publication by the Chilean Ministry of Public Works of three design guides for public projects relating to the

two largest ethnics groups, the Mapuche and the Aymara, and the indigenous population of Easter Island the Rapa Nui (MOP 2003). These guides are however generally only consulted for projects specifically designed for the indigenous population and have little impact on contemporary architecture. According to the latest census 11% of the Chilean population identify themselves as pertaining to an indigenous tribe, of which 84% are Mapuche and 6% Aymara (INE 2013).

2 THE MAPUCHE RUKA

Of the surviving examples of indigenous architecture in Chile, that of the Mapuche (People of the Earth *mapu*-earth, *che*-people) is perhaps the most well known and it is the house or *ruka* that is the most representative architectural element of the Mapuche world. It symbolizes the *nag mapu*, the domestication of the natural environment, the most important space for the meeting and participation of the *lof* or community (MOP 2003). In the Mapuche world vision there exists the intrinsic concept of *Az Mapu*, or how things must be done to maintain equilibrium between man and the earth. This concept leads to clear rules and guidelines for every aspect of daily life including the location, orientation and design of the *ruka*. The circular form is a recurring element in Mapuche architecture. It represents the ovary, man's first habitat; the ruka, man's home; the *guillatuwe*, the Mapuche sacred space; and the cosmos. The concept of temporality is ever present in the Mapuche world vision. All is governed by the cyclic changing; day to night; life to death; and the rotation of the seasons. This temporal nature can be clearly seen in the materials and construction of the *ruka* and daily Mapuche life which promotes the notion of "treading lightly" a concept also advocated by current sustainability theory.

An early version of the *ruka* was the *ruka encolihuada*. This consisted of a conical structure constructed around a central vertical pole (Coña 2002). Today the *ruka* is an oval or rectangular enclosed space, traditionally without interior subdivisions. In general the enclosure has only one entrance which must face east towards the rising sun and the first energy of the day. The word for door in Mapundungún, the language of the Mapuche, is *wülngin* which simultaneously means "where the man enters and exits" and "where the sun enters". The only other openings are triangular apertures below the ridge beam orientated east and west, "these holes of the house allow the smoke to escape and provide roosts for the chickens" (Coña 2002). In most of central and southern Chile the prevailing winds are from the south and from the north in winter. Therefore the orientation of the door and openings provides protection from these winds. Coña (2002) claims that historically there was no need to close the door opening as robberies were unheard of and that closing doors were only introduced with the arrival of the Spanish.

The focus of the *ruka* is the open hearth, a place for gathering, conversation, work, cooking and the only source of heat within the dwelling. There is no chimney and the smoke rises, exiting via the previously described roof openings. The smoke and soot impregnates both the timber and the thatch, playing a fundamental role in the preservation of the construction materials.

2.1 *Variations in Mapuche architecture.*

Each branch of the Mapuche people has developed its own variations of the *ruka*. The form and materials adapt depending on the materials locally available and the climate in which the *ruka* is situated (Fig. 1).

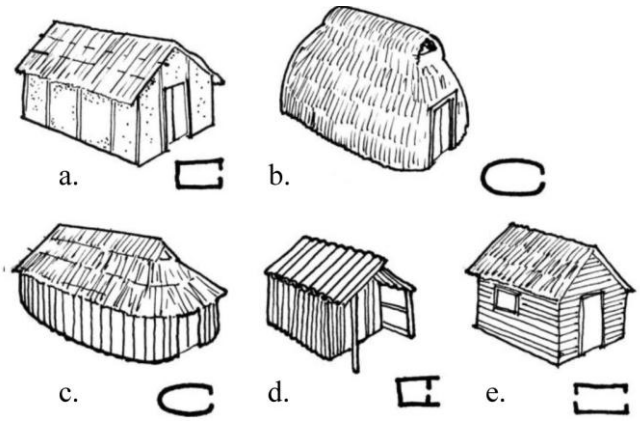

Figure 1. The rukas of the different branches of the Mapuche people. a) Picunche, b) Lafkenche, c) Nagche, d) Pehuenche, e)Williche. *Source:* Diagram by C. Whitman

The Picunche (People of the North) build rectangular or oval dwellings with thatched roofs and introduce thermal mass in the walls in the form of wattle and daub (*quincha*) in order to control the high diurnal thermal oscillation and high daytime temperatures. The Lafkenche (People of the Sea) use the reeds that grow in coastal wetlands for thatching both roof and walls, whereas the Nagche (People of the Plains) and Williche (People of the South) use thatch only for the roof and make use of more abundant timber for the walls, with the Nagche favouring vertical posts and boards and the Williche horizontal. The *ruka* of the Pehuenche (People of the Pehuen, the fruit of the Araucaria tree *Araucaria araucana*) is the most different with its walls and roof of hollowed logs or *wampos*. This massive construction resists the snow loads imposed by its location in the foothills of the Andes.

Whilst there exists to this day the tradition of constructing traditional *rukas*, currently it is extremely rare to find a continually inhabited *ruka*. In general the *rukas* are now reserved for special

events, for family meeting and for offering tourist accommodation.

2.2 *Materials and construction*

In keeping with the Mapuche concept of temporality all types of *ruka* are ephemeral, made of only natural, biodegradable materials with little elaboration.

The construction of a *ruka* takes place as a *mingaco* or communal task in which the owner invites the rest of the community to take part. Following the completion of the main structure the owner offers the workers a meal with meat, bread and *mudai* or *chicha* an alcoholic drink made from fermented wheat, corn, apples or pine nuts. Again following the completion of the thatching another meal is offered. It is said that the time allowed between the completion of the structure and thatching is governed more by the time required in order to prepare sufficient meat and *chicha*, rather than that required by the thatching work (Coña 2002). The primary structure is formed by tree trunks. Forked trunks or *taras* form vertical posts supporting horizontal beams culminating in the ridge beam or *kuikuipani* (Coña 2002) (Fig. 2).

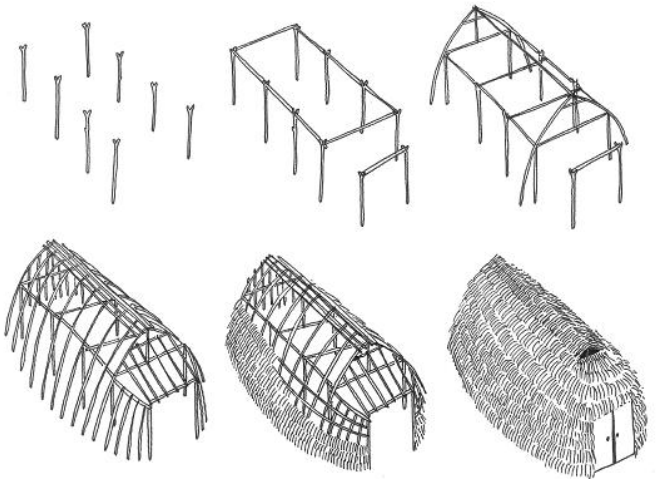

Figure 2. Construction sequence of a Lafkenche ruka. Source: Diagram by C. Whitman

In all but the Pehuenche ruka this primary structure supports a secondary structure of thinner trunks and branches which is in turn thatched with ratonera grass (Hierochloe utriculata), sedge (Schoenoplectus californicus) or tree suckers. "The most traditional houses are covered with a thick layer of thatch which constitutes a stupendous protection against the rains and an unbeatable thermal insulation" (Aldunate de Solar 1996). The thatch is placed starting at the bottom, working upwards so that the second row overlaps and covers most of the first. Two men, one inside, the other outside, pass a needle of the Chilean bamboo colihue (Chusquea culeou) threaded with the stem of a creeper voqui (Voqui blanco Campsidium, voqui pilfuco Berberidopsis corallina, voqui negro Muehlenbeckia hastulata) between the thatch so that the *voqui* passes above and below two horizontal bars that compress the thatch (Coña 2002).

In the case of the Pehuenche *ruka*, instead of thatch, straight, hollowed logs are used in the form of large roofing tiles, alternately convex and concave, forming both the horizontal and vertical enclosure of the *ruka*. When well-constructed these canoes or *wampos* prevent the ingress of rain, and if gaps do occur these are filled by smaller timbers or colihue (*Chusquea culeou*) a local bamboo. A solid bracket is carved into the bases of the roof *wampos* to provide a mechanical connection with the horizontal roof beams. In the past the *ruka* was sometimes lined with *quila* (*Chusquea quila)* (Whitman & Turnbull 2014) another local bamboo which has been shown to have thermal insulating properties (Petit-Breuilh et al 2013). However to date the authors have found no evidence of this practice in the current construction of Pehuenche *rukas*.

The floors of the *rukas* are bare compacted earth with no additional finish. This provides sufficient thermal mass to mitigate high summer diurnal thermal oscillations (Whitman & Turnbull 2014).

In both the Lafkenche and Pehuenche *rukas* the materials used are dictated by those locally available. The reeds for thatching grow in the coastal lakes and wetlands, the timber for the *wampos* in the temperate rainforests of the Andean foothills. These materials are therefore not only low carbon in there production but also require little energy and carbon emissions in there transportation to site. This intimacy between production and use promotes a consciousness of the natural environment not found in contemporary society. For example, those Mapuche interviewed for this paper stated concern over the problems of crop run-off which they say is changing the variety of reeds found in wetlands and how non-native trees such as pine and eucalyptus are depleting groundwater reserves.

2.3 *Environmental comfort in the Mapuche ruka*

A study by the authors (Whitman & Turnbull 2014) of post occupancy evaluation and environmental comfort in *rukas* Lafkenche and Pehuenche found that winter dry bulb temperatures and relative humidity rarely achieved the hygrothermal comfort zone as defined by Givoni (1998). However measurement of black globe temperatures around the open hearth showed that comfortable temperatures were achieved. This need to gather around the open fire was identified by the users as a positive aspect, uniting the family group and promoting conversation. Natural daylighting in the Lafkenche ruka was also focused around the space occupied by the open hearth further increasing its importance.

The main problem identified by the study was the poor air quality with high levels of ultra fine parti-

cles whilst the open hearth was lit. The study concluded that whilst the use of local low carbon materials was exemplary, the indoor environmental comfort was compromised by the open hearth which was the only means of achieving thermal comfort.

3 CONTEMPORARY RURAL DWELLINGS IN SOUTHERN CENTRAL CHILE.

Today the majority of residential construction in rural southern and central Chile is of platform framed timber construction, with either timber or corrugated galvanised steel cladding (Whitman & Fernández 2010). These constructions, in particular those clad in corrugated steel have a high visual impact on the rural landscape. In addition this construction solution lacks the thermal mass necessary for high summer temperatures and in many cases sufficient thermal insulation for winter. Those dwellings built prior to the introduction in 2007 of the Chilean Residential Thermal Building Regulations are rarely insulated. Those constructed since 2007 must comply with a maximum thermal conductivity ranging from 1.9W/m^{2}K and 0.6 W/m^{2}K depending on latitude and altitude (MINVU 2006). Although Chile was the first Latin American country to introduce thermal building regulations, the requirements of the regulations have been criticized for their inadequacy and relative weakness at both a national and international level (Caldera Sánchez 2012). This lack of sufficient insulation leads to high heating demands and low levels of hygrothermal comfort.

4 CONTEMPORARY ARCHITECTURE INSPIRED BY THE MAPUCHE RUKA.

4.1 *Cultural centre, Trawüpeyüm, Curarrehue.*

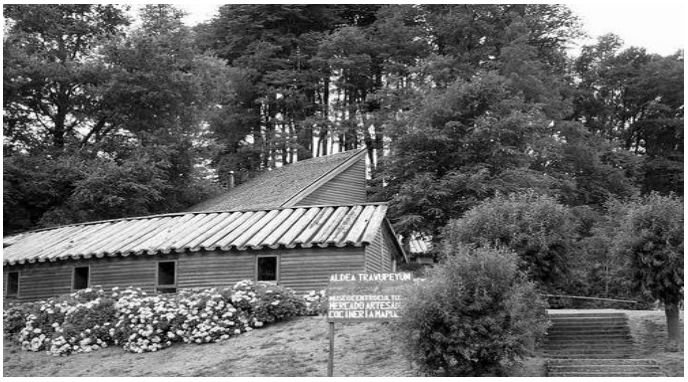

Figure 4. Cultural centre, Trawüpeyüm, Curarrehue. Source: Huencho (2007)

The Trawüpeyüm Cultural Centre in Curarrehue (Fig. 4) is situated 35km east of Lago Villarica, in the Araucanía Region. The project was the result of collaboration between the local Pehuenche community and the Chilean government. Through public participation the community identified key cultural elements for inclusion in the architectural design (MOP 2003). The architect Eliseo Huencho is himself Mapuche (although not Pehuenche) which helped gain the trust of the community (Huencho 2007). One of the most emblematic features of the project is the curved plan form of the building which opens towards the rising sun. This plan form responds not only to the orientation of the ruka but also to the Mapuche sacred space or Guillatuwe, which in the case of the Pehuenche is a circular open space delimited by constructions of branches, trees and shrubs, opening also towards the east. Another key architectural element reflecting the Pehuenche culture is the strategic placing of an open hearth as a place for meeting and conversation. The open hearth has a hood and chimney thereby reducing internal air contamination. Externally timber canoes or wampos are used as the termination on the sloping roof. This is perhaps the clearest connection with the Pehuenche ruka and the element that the community fought most to retain in the project despite opposition from the authorities. Whilst the building is clearly modern in its design, these elements proposed by the community help give the cultural centre a clearly Pehuenche identity.

4.2 *Casas-Ruca, Social Housing, Huechuraba*

This social housing development of 25 dwellings to the north of the Chilean capital, Santiago de Chile, was designed by the Chilean architect Cristián Undurraga. Again public participation with the Mapuche community was used to help identify the key elements they wished to see included in the project, although one member of the community claims that they did not fully understand the proposals until the project was on site (La Tercera 2012). The most important requisite of the community was the orientation of the dwellings, facing east towards the rising sun (Undurraga 2013). It is however unfortunate that the site was not better chosen, as being on a west facing slopes of hill this orientation is not the ideal solution (Fig. 5).

Figure 5. Eastern façades, casas-ruca, Huechuraba. Source: Underaraga (2013)

In order to soften the reinforced brick construction typical to Santiago social housing projects, and to integrate Mapuche elements, an impregnated pine trunk provides the diagonal bracing required to resist seismic loading and provides a strong architectural element on both the east and west façades. Behind this bracing element there is a screen of *colihue* bamboo covering both wall and windows. Whilst both the timber trunk and the *colihue* are elements found in the traditional architecture of the *ruka* neither are local to Santiago. In addition the linguistic style used for their application appears more oriental than Mapuche.

4.3 *Ruka Melilef*

Figure 6. Ruka Melilef, Melipeuco. Source: Photo by authors

Ruka Melilef is situated a few kilometres outside the village of Melipeuco in the valley of River Allipén, in the Araucanía Region of Southern Chile. It is a bed and breakfast and the home of a Pewenche couple who spent 20 years in France living in political exile during the Chilean military dictatorship. On their return to Chile they decided to build their home drawing on important aspects of their indigenous architecture whilst integrating features to provide improved comfort for themselves and their guests. This decision was met with dismay by the parents of the husband who were ashamed that their son wished to build a *ruka*. They saw this choice to value their indigenous heritage as a retrogressive step. However the couple's time in France had heightened their appreciation of the importance of their cultural identity and they were convinced of their decision. The location of the house was decided on through consultation with the local *machi* (holy man). As with all *rukas* the front door faces east, with the main axis of the house running east-west. The main structure is of locally forested timber which was felled at a time specified by the *machi*, according to the phase of the moon, between the autumn equinox and the winter solstice, when the sap is low to ensure the longevity of the timbers. The walls are of locally collected stone and timber and internal finishes are of *colihue*, a local bamboo. Drawing on the knowledge the couple had gained during there time in France, the walls are insulated with expanded polystyrene and the windows are double glazed in timber frames. The roof is clad with *coigüe* (Nothofagus dombeyi) shingles but however is not insulated. Heating is provided by a wood burning stove situated centrally in the living room, a modern interpretation to the open hearth; this mains the importance of the hearth as the heart of the *ruka* whilst avoiding the poor air quality arising from open fires. In a second building connected to the house, a large space for is provided for larger gatherings. This space is organized around a huge open fire which in this case is provided with a fire-hood and chimney. Guest rooms are located on the ground floor, whilst the second floor is the couples private space and bedroom, an open space, without subdivision, beneath the eaves, in many ways similar to the interior of the traditional *ruka*.

As part of a research project studying sustainable construction in the area where Ruka Melilef is located, dry-bulb temperatures and relative humidity were measured during summer and winter months (Whitman et al. 2013). The results showed that in general both dry bulb temperature and relative humidity readings during winter months fall within the comfort zone. This clearly illustrates the advantages of insulating the walls and double glazing the windows. The main problem identified by both the measurements and the owners is the overheating of the second floor during summer. This could be reduced by insulating the roof and the introduction of a ventilated roof space.

5 DISCUSSION

Of the three examples, Ruka Melilef remains the most faithful to the concepts of Mapuche architecture. The location was chosen with the aid of a *machi*, the orientation is with the door facing east, the fire remains the focal point of the house, the second floor is an open communal space and nearly all the materials are locally sourced with the exception of the polystyrene insulation. It is interesting to note that, with the introduction of glazed windows not present in the traditional *ruka*, the orientation is ideal for passive solar gain with the main axis running east-west. The least successful application of indigenous concepts is that of the social housing in Santiago. Due to poor site selection the orientation of the dwellings looses its meaning and the materials appear overlaid like wallpaper to an architecture that has little in common with that of the Mapuche. In order to successfully apply lessons from indigenous architecture it is necessary to understand the underlying concepts behind the choice of materials or special design, rather than pick and choose elements as if from a samples pallet or replicate formal compositions indiscriminately.

6 CONCLUSIONS

The Mapuche notion of temporality and the equilibrium between man and the earth is a fundamental concept that can inform contemporary architecture as we strive for an architecture with lower environmental impacts. The materials used in the construction of traditional *rukas* are not only low carbon but also local. They require little transportation and therefore reduce the associated emissions and energy use. This proximity closes the gap between production and use, and promotes a greater awareness of the environment.

Currently the use of open hearths within the dwellings compromises indoor environmental comfort and requires levels of ventilation which negates the possible insulation value of the thatch and solid timber constructions. However the replacement of the open hearth with an enclosed timber stove, as in the case of Ruka Melilef, or with a hood and chimney, as in the case of Trawüpeyüm, allows the retention of the importance of the hearth as the focal point, a place for gathering and conversation, whilst minimizing its negative impacts.

Both the examples of Ruka Melilef and Trawüpeyüm show the possibilities of integrating Mapuche concepts in contemporary construction. Yet the concepts of temporality and equilibrium offer lessons that are wider reaching and provide a valuable clue to the development of a sustainable architecture for not just central, southern Chile but for the whole world.

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NOTE

This paper was made possible by funding FONDART of the Consejo Nacional de la Cultura y las Artes of Chile.