Uros hand made reed floating islands

A proved ancient technique
Today a closed cycle in practice to learn from
Tomorrow an innovative development

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Because of global warming, rising sea levels and the running out of fossil fuels, it is important to look for sustainable adaptable solutions. Therefore special attention should be given to the potential of floating reeds in construction.
This paper is about a closed cycle example in practice, to learn from. It tells the history of a millenary South American civilization named Uros.
It gives an overview of sustainable daily practices of the Uros - who live on floating organic hand made islands on the cold waters of Lake Titicaca at 3810 m above sea level in Puno, Peru - and their potential for future innovative developments.
The objective of this paper is to highlight the importance of researching the *Totora* plant's floating properties, which will give us insights into its possible diverse applications as a floating material of construction.
This study bridges science with traditional knowledge, an inspiring lesson for developing innovative ideas.

Location: Puno- Peru

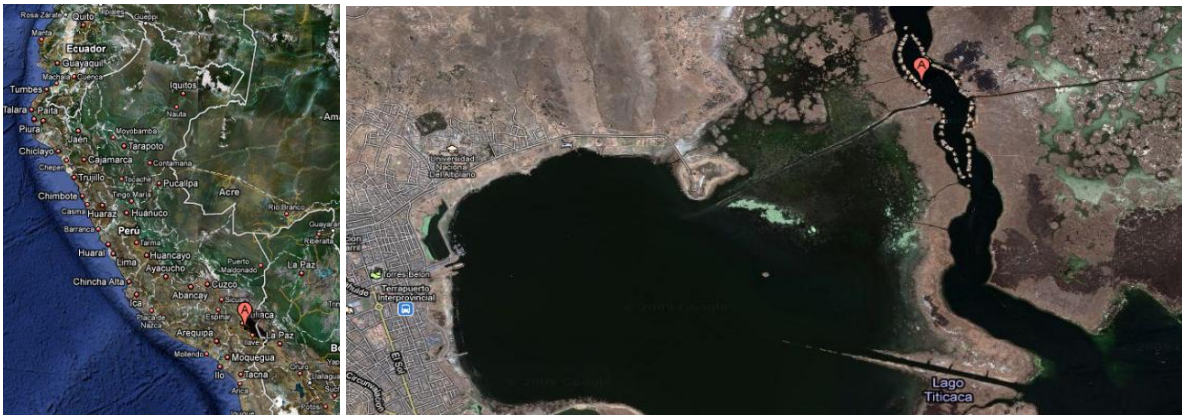

Figure 1 : *Islands located at five kilometers east from Puno port at 3810m above sea level*
Source: Google earth

The Totora plant

This paper is about the Totora plant that grows in Titicaca Lake. Its scientific name is Schoenoplectus californicus ssp. tatora.

Totora is an aquatic plant which grows in humid places, wetlands, along rivers and lakes.

This plant has a long stem (400 cm long approximately) and its stem section has a circular shape (d =1.5 cm aprox).

From outside the stem looks like an impermeable green layer, when it is still humid.

Once it is dried, the exterior layer becomes harder and breakable. Its color gradually turns from green - yellow till brown.

The insides stem looks similar as a white sponge due to its porosity. It is in these small holes where air is contained.

It's inside texture is soft with delicate soft humid fibers.

Uros Inhabitants

Uros are pre-Incan people that nowadays live on 46 (in Oct 2009) floating man-made islets on the Titicaca Lake in Puno, Peru.

The number of islands can vary depending on couples forming new families, then new islands are made or existing islands might be joined to form one bigger island.

Around 2,000 descendants of the Uros were counted in the 1997 census, although only a few hundred still live on and maintain the islands; most have moved to mainland in Puno and surroundings.

The Uros community does not speak the Uro language anymore.

Currently they speak Quechua and Aymara dialects. The majority also speaks Spanish, which is the official language in Peru.

Figure 2**:** *Totora islands, next to each other on Titicaca Lake.*

Source: Wikipedia

The Uros use bundled dried totora reeds to build boats and their own floating land where they live. They also make Totora handicrafts for selling them to tourists.

The purpose of the island settlements was originally defensive. The Uros mention that it was safer to live on the water in order to avoid invaders: first the Incas and later on the Spanish invaders.

Figure 3: *Uros hand made reed floating island*

© R. Torres

Uros sustainable daily practices

The Uros fish carachi and trout . They also cultivate fish farms, for their own consumption and for offering them to the tourists in the floating restaurants.

Figure 4: *Fish farm, Uros set the nets during the afternoon and fish is collected the next morning.*
© R. Torres

Totora mini floating farms:

Some islands have their own animal's farms, where they grow animals such as pigs and cuyes (guinea pigs) and some birds such as chickens and ducks.

Figure 5: *Guinea pigs small farm* *Local birds*
© R.Torres

Totora small greenhouses

The Uros use the totora reed as primary bed base, which is covered with a layer of soil (2 cm deep). Then it is ready for cultivation of small plants. Uros cultivate herbs, such as chamomile tea, mint and other flavoring herbs.

In order to protect the plants against rain and hail, totora coverage is placed around it.

Figure 6: *Small greenhouses* E*ating totora*

© R. Torres

Totora is also present in Uros diet and medicine

The indigenous people use totora roots in their meals. They make flour out of it, which is used to prepare soups, cakes, cookies and fresh drinks.

According to local farmers, totora reeds are important for cattle feed forage. The animals produce more tasteful meat and milk.

Another advantage is that totora contains iodine, which helps in the health of Uros teeth, even though the Uros hardly use dental paste.

The ashes form the totora is used as antiseptic. This helps for a faster healing of wounds.

Source: Manejo sustentable de la totora. Consorcio Andino para la conservación, investigación, el desarrollo y la promoción de la totora. COANDIT

ENERGY – WATER – MATERIALS

Energy:

The Uros are open to modern technology; some houses have solar panels to run appliances such as televisions, radios and for recharging mobile phones.



Figure 7: *Solar panels* *Energy saving lamps* *Cooking place*

© R. Torres

Cooking: The cooking area is outside. The Uros usually use stones or bricks to avoid direct contact with the reeds.

Totora is highly flammable; therefore they constantly spread water around during cooking. As cooking fuel they burn totora.

They cook in ceramic cooking pots that they trade or buy with surrounding communities.

Indirect energy (Transport):

Uros transport is by boat, these boats are made of totora or wood. For example for going to school, kids go rowing.

Only few boats use gasoline, engines are used only if it is really necessary.

They also have an original way of selling-delivering groceries. A kiosk boat visits the islands every morning, there people can buy bread, butter and the tourists can buy coffee, cookies, chips, etc.


Figure 8: *Girls going to school* *The kiosk boat*

© R. Torres

Water:

Drinking water

According to the Uros themselves, they have always drunk water directly from the lake but due to some contamination upstream, they now have to boil it before consumption.

One island has an elevated water tank that works with a pump and a filter.

Regarding toilets, this issue is not yet well resolved.

For going to the wc, people go to an adjacent island by boat, usually this toilet island is located at 30 m away approximately.

Over these toilets they add totora ashes, which have alkaline properties.

Materials

For building an island:

The dense roots that the plants develop and interweave form a natural layer called Kile.

The Uros cut these roots which grow 1 to 2 m deep in the water.

They go with their boats and cut the root in pieces of 3 m by 10 m.

They then anchor the collected totora blocks with nylon ropes attached to wooden sticks to fix them to the bottom of the lake.

The reeds at the bottom of the islands rot fairly quickly, so new reeds are added to the top constantly. This is especially important in the rainy season when the reeds rot faster.

With appropriate maintenance the islands can last up till thirty years.

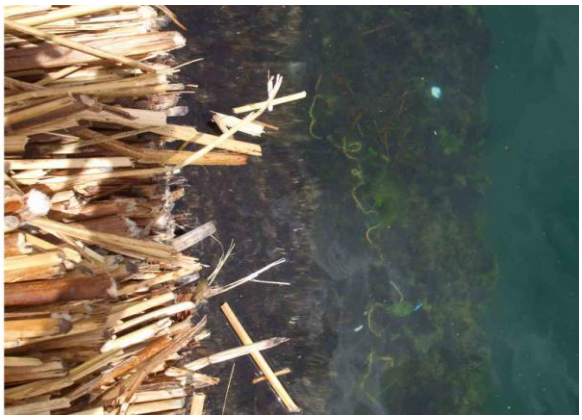

Figure 9: *Construction process maquete* *Top view of an island edge (1.5 -2m. deep)*

© R. Torres

How does it float?

After 1.5 to 2 years of growing the totora roots are ready to leave the ground naturally and start to float due to the gasses expelled by the roots.

It is in this moment that the Uros go to the Totorales area to cut the roots in pieces for making new islands.

Maintenance

During the dry season this process of maintenance is carried out once per month and during the rainy season it happens once per week.

After 30 to 40 years the island decays and the Uros abandon it to make a new one.

In the abandoned island new totora plants start to grow, then these old islands turns into new totorales again.

For building houses

The Uros use bamboo or wood for the structure of the house, over these they attach kesanas (totora walls).

During the rain, the stems-kesanas increase naturally their volume when they are in contact with the water, in this way the space between the stems become smaller.

Using only one layer kesana the house is not very well protected against rain water but with 2 layers kesanas the water impermeability improves and also the material's thermal properties.

For building a reed boat

Building a boat lasts approximately one month when working daily with five men.

The process includes cutting, drying the totora for one month and final selection.

The best totora for making boats is the totora of 8 months old to 1 year.

In the past the entire boat was made of totora stems but this construction lasted one year at most.

Nowadays the Uros community takes advantage of empty plastic bottles of soft drinks of 2 to 3 lt, mainly left behind by the tourists during their visits.

The core of the boat is made of 1200 bottles, 600 in each side. (This amount is for a big boat) .The amount of resources varies according to the boat's size.

Only the last layer is entirely made of totora stems.

Figure 10: *Technique compressing totora by hand.* *Tree roots as building tools*

© R. Torres

Natural building tools

They use natural tools such as root from trees:

Le ena, for shaping the totora with hits

Carabato tool used for compressing the totora stems.

The technique consists of compressing the boat gradually, until 3 times.

This adjustment is to compact the reeds in order to avoid water infiltration.

With this new technique combined with reused bottles and totora stems, the boats last longer but start to decay after two years.

Waste: Small amount of waste is collected by a municipal boat.

Mostly leftovers from the tourists, such as plastics bags or packages from cookies

Cleaning water properties

This emergent aquatic plant is used for water quality treatment in Bolivia and Peru.

It is used to remove phosphorus and nitrogen from effluents before they are discharged to natural drainage systems.

These plants can absorb nitrate, phosphate, heavy metals such as manganese, and other chemical compounds. They are generally used to provide secondary treatment of effluents, in small lagoons filled with *totora.*

Source: www.oas.org/usde/publications/Unit/oea59e/ch22.htm#TopOfPage

Other uses:

Furnitures in general such as chairs, mirror frames, beds, etc.

Diverse handicrafts such as baskets, toys, etc.

Sensation of well being

According to Uros words," We overall highly respect Pacha Mama (mother earth), who gives us all for living. Living in this harmony makes us feel happy".
Going beyond Uros words and after living the Totora experience, I can see the reed has many potentialities in the field of sustainable modern architecture integrated with the landscape:

Phenomenology: "Trust your senses"
When your senses communicate to you about the surroundings:

Smell: Explore the totora and perceive a fresh soft fragrance.
See: Delight your eyes with the diversity of colors and tones that the reed offers along the year, from green-yellow -brown colors.
Observing different arrangements of totora, generating curious forms; it was pleasant to see these in contrast with the blue sky during a sunny day and the starry sky at night.
Listen: The language of the reeds, which somehow responds to your every step.
Walking on totora has a cracking floor feeling and experience a soft sinking sensation. It goes down about 1" depending on the density of the ground below you.
Touch: The textures of the material inside and outside the plant invite you to play, to explore and to create with them.

Let nature and ancient wisdom inspire us!
All these give a sensorial experience that makes you feel relaxed.
For that reason, we architects should not forget to incorporate these aspects in our projects; looking for the balance between **people** – **water** – **green**, especially in these day of sea level rising.
Exploring this natural floating reed might give us answers to solve many environmental problems.

Innovation inspired by nature:

"Wisdom is widespread, not only in indigenous peoples but also in the species.

The Biomimicry emulate natural models. Adapt and evolve, use life-friendly materials and processes, engage in symbiotic relationships, and enhance the bio-sphere. By following the principles life uses, you can create products and processes that are well adapted to life on earth.

By studying the shapes of nature's strategies and how they are built, biomimicry can help you minimize the amount your company spends on materials while maximizing the effectiveness of your products patterns and forms to achieve their desired functions"

Source: 1997 Janine M. Benyus

Vision

Bio Architecture

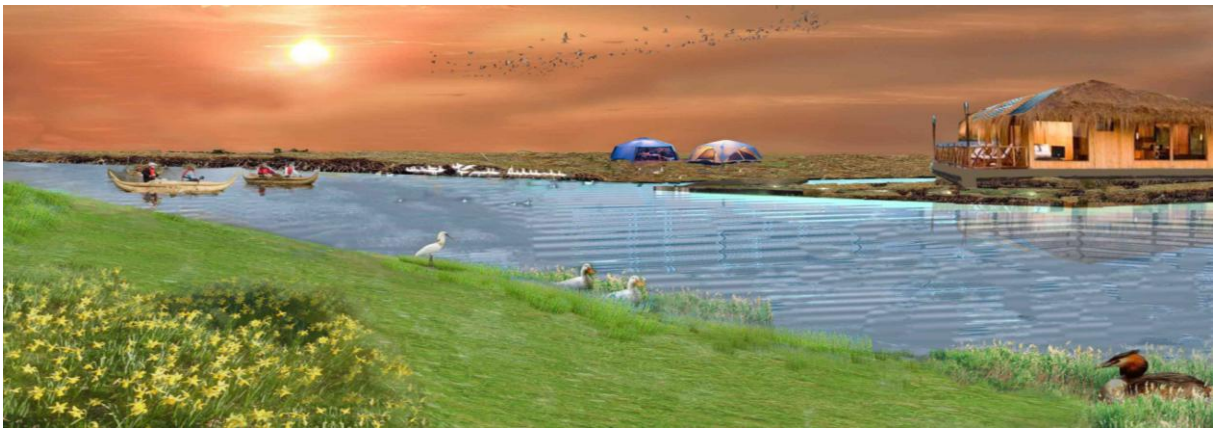

***Figure 11**: Art work © R. Torres*

Researching floating natural reed Totora might open opportunities for new green innovative solutions in diverse contemporary uses:

Floating new lands,

Floating campings,

Reed houses, restaurants with solar panels.

Floating gardens

Reed boats

***Figure 12**: Art work © R. Torres*

Productive landscapes

Not only attractive landscape to see but also productive landscapes

Producing energy: Reed as biomass fields?

Producing food: Reed floating farms and green houses

Producing materials of construction

Education and Recreational landscapes

***Figure 13**: Art work © R. Torres*

Provide a special experience for extensive recreation : Outdoor floating events:

Floating spas, yoga lessons, playgrounds, etc

Floating festivals, parties, etc

Floating art exhibitions.

Workshops, etc.

Conclusion: Exploration of the Totora plant's floating properties is needed, to improve its performance in terms of durability and its resistance against microorganisms and fire.

The results will give us insights for its possible diverse applications as a floating material of construction.