Fresco: intangible heritage as a key to unlocking the links between the conservation of biological and cultural diversity in Alamos

Daan Hoekstra
Visual artist and independent researcher, Fondo Estatal para la Cultura y las Artes de Sonora, Mexico

ABSTRACT

Alamos, Sonora, Mexico contains world-class heritage and is on the tentative list for World Heritage status. The colonial architecture in the town centre has been declared a National Historic Monument and a unique eco-system of incomparable biodiversity and is protected under UNESCO's network of biosphere reserves. Local indigenous groups keep alive a wealth of information about practical and medicinal uses of plant species.

External forces threaten the natural, cultural and intangible heritage of the region.

The UNESCO guidelines for identifying and clarifying bio-cultural diversity call for *multiple regimes of credibility* and an interdisciplinary,holistic approach. This paper explores links between biological and cultural diversity seen through the lens of the global intangible tradition called fresco painting. An artist's perspective identifies previously unnoticed connections as well as economic alternatives to destructive land-use patterns, resulting in concrete proposals for the conservation of natural, cultural and intangible heritage in Alamos.

Fresco is an ideal model for explaining how an intangible tradition expresses itself and positively impacts on bio-cultural diversity at global, regional and local levels. The model answers UNESCO's call for frameworks and methodologies for recognising and describing the interdependence of nature and culture, and leads to an understanding of the quantitative value of diversity.

Introduction

New technologies and economic patterns often have a destructive impact on biological and cultural diversity and lead to the loss of traditional knowledge. The study of bio-cultural diversity - one of the most promising new fields that has emerged in an attempt to address these tragic losses - recognises that biological, cultural and linguistic diversity are *inextricably linked*,[1] that diversity is threatened by common forces, and that common conservation strategies ought to be explored.[2]

If new technologies erode traditional cultures, the re-introduction of an ancient technology could have a healing effect.

This paper explores these issues in relation to a small Mexican town. Alamos, Sonora, contains world-class cultural, natural and intangible heritage - unique for such a small place. Its colonial architecture has been declared a National Historic Monument and Alamos is on the tentative list for World Heritage status. The environs contain incomparable bio-diversity within an unusual eco-system where the Sonoran desert meets the Sierra Madre and the more humid rainforests to the south. The area's Tropical Deciduous Forest is protected under UNESCO's network of biosphere reserves. The outlying region is inhabited by the Mayo and Guarijio Indians, keepers of a wealth of information about the practical uses of local plants.

The heritage of the region has been eroded by globalisation and modernisation. Development, population growth, deforestation and a new wave of mining activity threaten bio-diversity. A desert could replace what is now a seasonal tropical rainforest.

Hundreds of colonial buildings in the historic centre are registered monuments but they are endangered due to a lack of awareness about proper methods and materials for conservation. Historic homes are remodelled with little sensitivity to authenticity. The most damaging practice is an overuse of Portland cement in old adobe and masonry buildings, a practice condemned by conservation authorities worldwide. The vinyl paint currently used is also inappropriate and prevents walls from breathing.

Intangible heritage - which refers not to artistic products, but rather to the knowledge, values and practices that bring them into existence [3] - will be key to the process of preservation. It can be argued that modern technologies, lifestyles, cultures and economies are unsustainable because of their distance from nature, while pre-modern traditions were sustainable because of their proximity to it.

What would happen if an age-old intangible tradition were re-injected into the present-day situation in Alamos? Could the technology be useful in the modern world? When considering the possibilities it is hard to ignore the amazing knowledge of plant diversity that is still guarded by local indigenous cultures. This will later prove essential. For now, we will address the intangible heritage called fresco painting.

Fresco is a technique used for painting murals. Pigments ground in water are painted on to walls finished with fresh lime plaster. The moist wall absorbs the pigments. When the wall dries, the pigments are chemically sealed inside the wall. The materials used in fresco painting are simple - lime, water, sand and pigments.

In the rush to protect intangible heritage worldwide, fresco painting as a practice - a traditional craft relying on knowledge passed down from generation to generation, and based on a knowledge of nature - has largely been forgotten. [4] A fresco as a product is cultural heritage. Fresco as practice, process and traditional craft is intangible heritage. This paper will address the intangible aspect, how it helps to define links between biological and cultural diversity in Alamos and the conservation strategies it brings into focus.

The development of lime technology and fresco painting worldwide

The development of fresco depended upon the birth of lime technology - a milestone in history. Lime is made by heating limestone to form calcium oxide, which is then slaked with water to form calcium hydroxide, used as plaster. When the plaster sets it releases water and absorbs carbon dioxide to return to its original state - limestone.

Learning to work with lime was one of humanity's most sophisticated technological developments during the Stone Age. Relying upon their knowledge of nature, people learned to process stone, make it malleable, shape it according to their wishes and make it return to stone. Thus lime technology had a religious significance in some early cultures because it was associated with the act of creation.[5] The process was perfected during the Neolithic period around 12,000 BC.[6] The high temperatures needed to burn lime signalled the beginning of pyro-technology, a prerequisite of metallurgy.

On a worldwide level, the use of lime has a number of

The Importance of Lime in the Conservation of:
Natural Heritage: Lime is produced at lower temperatures than cement, requiring less energy, and resulting in 20% less CO2 output. It can be produced locally, lowering transportation energy costs. Cement production, on the other hand, requires high-tech, centralised facilities. Unlike cement, lime putty absorbs CO2 during the curing process, offsetting the amount released during production. High-calcium lime absorbs nearly its own weight in CO2. Unlike cement, lime mortar can be recycled. Unlike cement-bonded bricks, those using lime mortars can be recycled. Millions of bricks are fired annually using an enormous amount of energy. Most of these bricks will be laid with cement and will never be recycled. Salvage yards can supply used bricks only if they were laid with lime mortar, which is easily removed.
Intangible Heritage: Lime production is one of the earliest technologies discovered by humanity, so it is simple and accessible to the poor. Knowledge of the production of lime and the use of lime in traditional building is intangible heritage in itself.
Cultural Heritage: Lime is strong, flexible, and permeable. Lime plasters are porous and absorb moisture. Lime plaster works like a wick, absorbing the moisture from the structure and allowing it to evaporate. When used with a breathable paint, this can reduce moisture problems in a building. Cement is impervious - it doesn't absorb water. Once water finds its way into a cement building, it doesn't find its way out. Compared with brittle Portland cement, lime mortar moves with the structure and prevents masonry from cracking. Some lime advocates say that lime is self-healing, by filling hairline cracks through capillary action. Restoration architects and conservators of monuments the world over have discovered the dangers cement poses to old buildings, and now specify the use of lime mortar and plaster. Restorers try to use the original material, if possible, and lime plaster and mortar was used worldwide prior to the mid 19th century.

Table 1
The Importance of Lime in the Conservation of

advantages for the conservation of biological and cultural diversity.

By the time the first frescos were painted in Crete around 1500 BC, lime technology had spread around the world. The art of fresco followed quickly. Some of the earliest instances are:

- 1500 BC Knossos, Crete
- 1200 BC Thebes, Egypt
- 470 BC Ancient Greece
- 100 BC Manchuria
- 100 AD Pompeii, Italy
- 400 AD Pyongyang, Korea
- 500 AD Ajanta, India
- 500 AD Russia, Ukraine, the Balkans
- 675 AD Japan

Fresco in Mexico

Mural painting was widespread throughout pre-Columbian Mexico, most notably among the Maya. Many Mayan frescos are still in existence today – which is amazing since most are found in hot, humid tropical regions. One of the oldest, in Bonampak Chiapas, dates from 800 AD. Researchers have long known that a brilliant blue produced by the Maya was made with indigo. Until recently, it was not understood why the blue did not fade in the same way indigo dye in blue jeans fades. Recent research indicates that Maya Blue was made by heating indigo with a white clay called palygorskite. [7] The indigo molecules lodged themselves inside the tube-like clay molecules to make the blue more resistant to acid, alkali, sunlight and humidity. [8]

Researchers at the University of Texas, El Paso have imitated Mayan technology to create a line of pigments that surpass modern pigments in being light and chemical resistant. In their production and use they are less toxic and more ecologically sound than existing commercial pigments. [9]

Just as they did in their pigments, the Maya employed the combination of organic and inorganic chemistry in their lime technology. The Mayan approach was more advanced than its Old World counterpart. For example, statutes during the Roman Empire insisted that lime for construction be slaked for three years prior to use - a rule of thumb still used by restorers and fresco painters today. The Maya slaked lime with a liquid obtained from the bark of a tree. The sugars in the mucilage accelerated the slaking process so the lime was ready to use in two weeks. The result is an especially hard and durable plaster. [10]

Fresco as a key to unlocking the links between the conservation of biological and cultural diversity in Alamos

Lime and pigment technology in Alamos employed innovations pioneered by the Maya. The plaster technology was probably carried to Alamos by Spanish settlers who picked up the knowledge in central or southern Mexico. Seri pigment technology may have existed prior to the conquest.

An examination of the plant species in the Alamos area that have been used for pigment production, plaster production, binders and varnishes sheds further light on the relationship between the conservation of both biological and cultural diversity. An artist's perspective

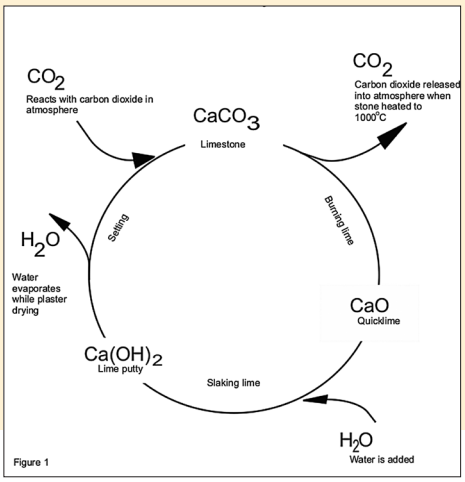

Figure 1
The Lime Cycle, drawing by the author.

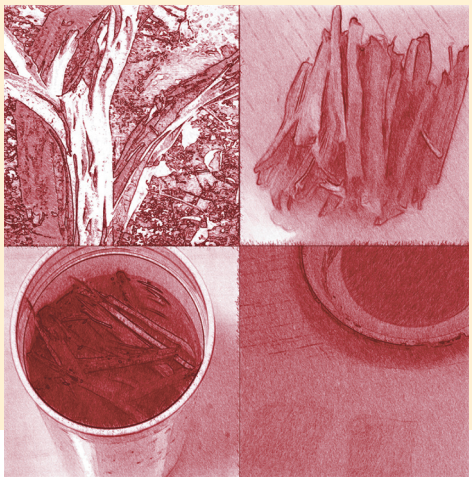

Figure 2
Making dye from *Haematoxylum brasiletto,* artwork by the author.

Product=	Organic +	Inorganic
Maya Blue pigment	Indigo (*Indigofera suffructosa*)	Palygorskite (*a white clay*)
Mayan lime plaster	Holol[a] tzin (*Heliocarpus donnell*)[b]	Lime and sand
Seri Blue pigment, Sonora[c]	Guayacan (*Guaiacum coulteri*)	Montmorillionite (closely related to Palygorskite)
Alamos Traditions[d]		
Paint:	Samo (*Heliocarpus attenuatus*), as binder	Sata (Iron oxide, a natural red earth)
Plaster:	Samo (*Heliocarpus attenuatus*)	Lime and sand

a. Kerpel, Diana Magalona, 'La cal y los mayas' in *La Pintura Mural Prehispánica en México; Boletín Informativo*: Año III, Numeros 6-7, Julio-Diciembre 1997, UNAM, Mexico, DF: p.7.
b. Bolles, David, *Combined Dictionary-Concordance of the Yucatecan Mayan Language*, FAMSI.
c. Haude, Mary Elizabeth, 'Identification and Classification of Colorants Used during Mexico's Early Colonial Period' in *The Book and Paper Group Annual*, Volume 16, 1997, American Institute for Conservation.
d. Current oral traditions in Alamos all agree on the use of *samo* and *sata*. The Latin name for *samo* is from Yetman, David, *The Guarijios of Sonora*, 2002, University of New Mexico Press, p. 227.

Table 2
Mesoamerican Innovations in Paint and Plaster Technology, and how they came to Alamos: © 2009 Daan Hoekstra

steeped in the intangible tradition of fresco painting acts as an aid to recognising links between nature and culture, resulting in concrete proposals for conservation strategies.

Some Alamos plant species and their relation to the conservation of biological and cultural diversity

Alamos is rich in plants that are used as dyes. The potential for the sustainable development of colourants as an economic alternative to the present destructive patterns of land use should not be underestimated. The international demand for dyes is about 800,000 tons per year, valued at £2.5 billion. [11]

Red Pigments

The Guarijio used 'brasil' wood (*Haematoxylum brasiletto*) to make a dye for coloring palm for making baskets.[12]

'Brasil' is a legume, which is important for maintaining healthy soil. It may be ecologically desirable to explore the commercial value of growing this for its dye and medicinal properties as an alternative to the over-harvesting of it for firewood.

Blue Pigments

Guayacan (*Guaiacum coulteri*) is native to the Guarijio territory near Alamos. [13] At the time of the conquest, a blue colour was made by the Aztecs with guayacan flowers. [14]

Indigo (*Indigofera suffructosa*) is native to Alamos and grows wild on the outskirts of the town. The Mayo and Guarijio used indigo to dye fabrics.

Manufacturing synthetic indigo results in significant

pollution and is currently a global problem. Environmental organisations and the public are calling for an alternative. [15]

Indigo production makes good sense for Alamos. It is another legume and improves the soil. It is perennial, self-propagating and can be harvested without killing the plant. The potential income could compete with that from destructive cattle ranching which is practiced there at present. Gathering and processing leaves could reinvigorate the existing indigenous craft practices and encourage better stewardship of the land.

Yellow Pigments

Children in Alamos colour Easter eggs with pionilla (*Erythrina flabelliformis*) and Mayo weavers boil the bark to make a yellow dye. [16]

In Alamos, the fruit of sanjuanico (*Jacquinia macrocarpa pungens*) was used to make soap. Throughout the region, the flowers were strung to make necklaces - by the Seri, Yaqui and Mayo people. The flowers can be dried and stored for decades. When rehydrated with water they look as if they are freshly-picked. [17]

One of the last Mayo weavers, Doña Maria Soledad Moroyoqui, boils the flowers of sanjuanico to make a yellow fabric dye. [18]

Gums, resins and binders

Tree resins are economically important because of their extensive use in perfumes, incense, medicines and the food industry. For the artist, resins are especially important as binders, paint mediums and varnishes.

Mexico is a major supplier of resin. In 1994, it produced 36,731 tons, including 22,000 tons of gum rosin and 4,000 tons of turpentine. [19] Sustainable development of resins offers promising possibilities for alternatives to the present destructive uses of land.

Samo (*Heliocarpus attenuates*) is a common small tree in the Alamos area. The mucilage was used in the preparation of lime plaster and as a binder for paint. The combination of the organic samo with inorganic lime and pigments resembles the paint and plaster technology of the ancient Maya, known for its durability. The Maya used a tree they called *holol*.[20] *Holol* refers to a variety of species, one of which is *Heliocarpus donnell*.[21]

To prepare the mucilage, the Guarijio soak strips of bark in water. The mixture is sometimes boiled. The water is then mixed with sand and lime to make plaster, or with lime/and or pigments to make paint. [22]

Samo will be essential to any future effort to restore Alamos' colonial architecture. Very few authentic paint and plaster surfaces remain because almost all of them have been ruined by the use of vinyl paint and plaster containing Portland cement.

The Mayo soak the wood of vinorama (*Acacia farnesiana*) in water to make a blue dye.[23] The Aztecs used *Acacia farnesiana* gum as a paint binder[24] which suggests that it could be a suitable substitute for gum arabic - an African gum from *Acacia senegal* and *Acacia seyal*. First used as a binder in inks and cosmetics, gum arabic now has a multitude of industrial uses. It is completely edible and is used in processed foods as a glue, thickener, binder, extender and to give texture. It is also the binder most commonly used in watercolour paint.

Honey that comes from mesquite flowers (*Prosopis glandulosa*) is prized for its flavour. The seedpods are an important source of animal fodder and are used to make a variety of foods.[25] Mesquite performs an important ecological role throughout Mexico by providing a fixative for the nitrogen that helps enrich the soil in arid regions. This attracts plant species which enjoy the richer soil and they in turn support various species of animals. [26]

Mesquite is widespread in the Alamos region and is an important source of firewood and lumber. Unfortunately, using the wood for lumber, furniture, firewood and charcoal is causing deforestation. Academics are advocating more sustainable uses for mesquite - in the production of honey, food, fodder and medicines. [27]

Another possibility for sustainable use involves producing mesquite gum which is very similar to gum arabic. World demand for gum arabic is about 45,000

tons per year. In 2003, Mexico imported 7,000 tons of gum arabic at a cost of nearly four million dollars. [28] The availability and price of gum arabic on the world market varies greatly because there are frequent scarcities due to the political situation in Africa, especially in the Sudan. It makes good economic sense for Mexico to pursue a domestic alternative.

Dr. Yolanda L. Lopez-Franco, from the Centro de Investigacion en Alimentacion y Desarrollo A.C. in Hermosillo, Sonora, was part of a team that investigated the potential of mesquite gum. The team found that the chemical characteristics, emulsifying properties and molecular structure of the gum made from *Prosopis glandulosa* would make it a suitable alternative to gum arabic. [29]

Developing mesquite gum production in Sonora would have a positive environmental impact in the same way that the production of gum arabic does in Africa. There, production of gum arabic from *Acacia senegal* has effects such as

reducing desertification due to the control of the erosion and enrichment of soil nutrients, providing local populations with an additional source of income, awakening rural populations to a sustainable use of natural resources. [30]

Burseraceae, a member of the torchwood family, is known for its aromatic resins. The Guarijio collect the resin of *torote copal (Bursera stenophylla)* to burn as incense in churches, to freshen the air in their homes and to use in teas as a remedy for the common cold. [31]

The word *copal* comes from the Nahuatl *copalli* and copal varnish enjoys a long and important history as an artist's material. In pre-Columbian times copal was used primarily in religious rituals. [32]

The Mayo used *torote colorado* (*Bursera simaruba*) for making a light brown dye for weaving. [33] The resin of *torote colorado* is also burnt as incense in churches in Guatemala, [34] and was one of the prime sources of ritual copal used by the pre-Columbian Maya. [35] *Bursera simaruba* has been employed commercially to make turpentine, glue and varnish, and it has been suggested that its resin could be used as another substitute for gum arabic.[36]

The Mayo used *Bursera microphylla* to make textile dyes. [37] The Seri used elephant tree resin to seal cracks in boats and pottery. [38]

Specific conservation strategies - the interplay of global, regional and local articulation

A globally recognised intangible tradition (fresco) leads to the recognition of global, regional and/or local

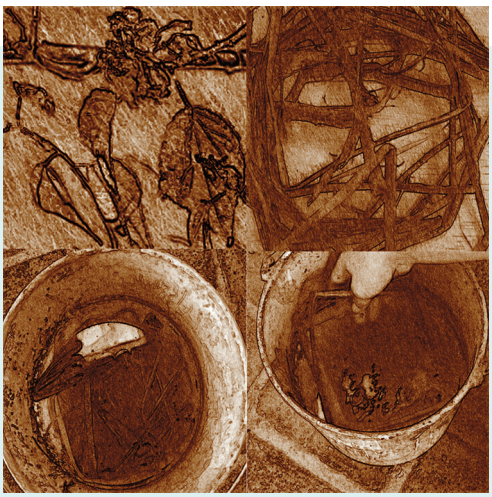

Figure 3
Making dye from *Erythrina flabelliformis,* artwork by the author.

Figure 4
Extracting mucilage from *Heliocarpus attenuates,* artwork by the author.

Proposal Local conservation of natural, cultural and/ or intangible heritage.	Recognition How was the opportunity recognised?	Confirmation What other information supports the proposal?	Synergy Happy coincidence.
1. Explore the cultivation of *Haematoxylum brasiletto* and the commercial potential of its extract as an artist's pigment. Conservation focus: NH	**Local:** The Mayo used *Haematoxylum brasiletto* to make a red dye.[a]	**Global:** *Haematoxylum brasiletto* is used worldwide as a pigment.	**Regional:** Long history of medicinal use among indigenous groups. Global: Recent scientific research verifies the therapeutic value of the extract.
2. Explore the viability of Seri Blue pigment as a source of income, if it can be produced without harming the *Guaiacum coulteri* trees. Conservation foci: NH, IH, CH	**Regional:** The Seri Indians produced a blue pigment from *Guaiacum coulteri*, by combining organic and inorganic chemistry.	**Global:** A global market exists for *Guaiacum coulteri* products for use in medicines, food, liquor and perfumes.	**Global:** Endangered status and the overuse of wood bring attention to the need for sustainable options.
3. Promote the local and regional use of *Heliocarpus attenuatus* in the conservation of cultural heritage, as a plaster additive and paint binder. Conservation foci: NH, IH, CH	**Local:** *Heliocarpus attenuatus* was traditionally used as a plaster additive and paint binder in Alamos.	**Regional:** The Maya used a similar heliocarpus species as a lime additive to enhance the slaking process.	**Global:** Mayan plaster and paint technology is currently a hot topic in academia, so any practical use of materials will broaden the range of current knowledge.
4. Promote gathering and small-scale cultivation of *Indigofera suffructosa*, as well as sustainable indigo dye production. Conservation foci: NH, IH, CH	**Local:** The Mayo and Guarijio made indigo dyes. Indigo grows wild locally.	**Global:** Indigo is an important commodity.	**Global:** The ecological value of naturally-sourced indigo is recognised and the market is increasing.
5. Promote the collection and sale of mesquite gum. Conservation focus: NH	**Local:** The Mayo use mesquite gum to make a brown color.[b]	**Global:** An international market exists for vegetable gums for use in the food, cosmetic and art industries.	**Regional:** Mesquite is a legume and improves soil health.
6. Promote local copal resin production from *Bursera simaruba, Bursera microphylla, and Bursera stenophylla.* Conservation foci: NH, IH, CH	**Local:** The Guarijio collect copal resin to burn as incense in churches. Global: Copal resin is prized as an artist's material.	**Regional:** The origin of the word copal is from the Nahuatl *copalli*. The best copal for some uses is reputed to come from Mexico.	**Global:** A world market exists for its use as incense, an artist's material and for ritual use.
7. Promote the collection of *acacia farnesiana* gum as a substitute for gum arabic. Conservation focus: NH, IH, CH	**Regional:** The Aztecs used the gum as a binder.	**Global:** A world market exists for gum arabic	**Local:** The species is one of the first to prosper in cleared areas, making it ideal for forest restoration.
8. Promote the use of locally produced lime, for the reasons listed in figure 2. Conservation foci: NH, IH, CH	**Local/global:** Contrary to worldwide conservation standards, lime plaster is currently not being used locally in the restoration of colonial architecture.	**Global:** Lime is promoted worldwide for its beneficial role in the conservation of natural and cultural heritage.	**Local:** Lime was once produced locally, and is considered the best in the state.
9. Investigate *Bursera simaruba* as a possible source of turpentine and varnish. Conservation focus: NH	**Local:** The local name is similar to that of other resin producing species.	**Regional:** *Gumbo limbo* is used to produce turpentine, glue and varnish.	**Global:** There is a worldwide market for natural solvents and varnishes.

Key: NH= Natural heritage: sustainable use of forest products, alternatives to destructive land use patterns and alternatives to wasteful industrial practices, IH= Intangible Heritage: preservation of traditional knowledge and crafts. CH= Cultural Heritage: proper methods and materials for restoration.

Notes:
a. Ayala, Oscar S. , Flores, C. Elpidio, Germán, José Luis, Rios, Lombardo, 1987, *Génesis y Desarrollo de La Cultura Mayo de Sonora*, ITSON, p. 23.
b. Ibid.

Table 3
Specific Conservation Strategies:

bio-cultural links, which are confirmed by global, regional and/or local examples, and are aided by fortuitous circumstances acting on a local, regional and/or international level, and have led to concrete proposals for local action focussing on the conservation of natural, cultural and/or intangible heritage.

Practical steps towards implementation

An experimental project aimed at establishing a permanent centre for the teaching of fresco painting techniques in Alamos began in 2007, with minimal funding from the Programme for Municipal Cultural Development. The project has made modest advances such as the construction of a lime pit, the development of introductory workshops in fresco technique and the construction of a practice mural. The main benefits to date have been a gradual increase in public awareness about the advantages of lime plaster in the conservation of both cultural and natural heritage. The programme also serves as an introduction to historic paints and pigments.

In the realm of conservation of cultural heritage, the most positive development has been the current project to restore Alamos' centuries-old church. Expert conservators from central Mexico are training a group of local craftspeople in the art of restoration. Local workers are learning about the advantages of lime, the dangers Portland cement poses for old buildings, general restoration skills and the ethics, procedures and philosophy of the profession. [39]

Conclusion

An investigation into bio-cultural diversity is a journey into a web with multiple levels of linkages. For example, links between tangible and intangible heritage, eloquently established by Mounir Bouchenaki, [40] can help clarify the links between biological and cultural diversity. Intangible practices and processes often rely upon knowledge of bio-diversity, resulting in diverse tangible products. Natural and intangible heritage are the deeper sources of tangible cultural heritage and the sources of its deeper meanings.

Intangible heritage could be seen as the intermediary between nature and culture that unites a knowledge of natural processes with the production of artifacts. If one aspires to having unified strategies for protecting both nature and culture, knowledge of natural processes

works in both directions. One could then speak of the primacy of intangible heritage and the need to protect it first as a prerequisite to environmental conservation and the safeguarding of artifacts. The urgency could not be clearer. As Bouchenaki noted, intangible heritage is the most fragile element in the web of interconnections, requiring the most delicate intervention.

Fresco painting practices and processes are a global intangible tradition with a number of unique regional and local manifestations - an ideal example of *unity in diversity*. Bio-cultural researchers speak of the *moral imperative* to resist homogenisation and uniformity, and instead strive towards *unity in diversity* as our best hope for a sustainable future. [41]

Change and modernisation erode cultural, natural and intangible heritage around the world. The same drivers lead to disintegration wherever it may be. If reintegration and healing are to occur, logically they should be driven by common catalysts as well.

Fresco is an ideal model for explaining how a resilient global intangible tradition re-articulates itself and impacts positively on bio-cultural diversity at global, regional and local levels. The model answers UNESCO's call for frameworks and methodologies for recognising and describing the interdependence of biological and cultural diversity. [42]

Acknowledgements

The author would like to thank Ted Glattke for his helpful editorial suggestions. This research was made possible by generous support from the Fondo Estatal para la Cultura y las Artes de Sonora, the government of the State of Sonora, Mexico, the Instituto Sonorense de Cultura; and CONACULTA.

Figure 5
Fresco technique workshop in Alamos. Artwork by Elena Valdes. Photo by the author.

Figure 6
Practice mural in for project *Muralismo al Fresco*. Photo by the author.

NOTES

1. *Declaration of Belem*, 1988, Belem. This document, a result of The First International Congress of Ethno-biology, recognises the stewardship role of indigenous people and its importance for the preservation of biological and cultural diversity. www.ethnobiology.net/_common/docs/DeclarationofBelem.doc
2. Maffi, Luisa, 2005, 'Linguistic, Cultural and Biological Diversity' in *Annual Review of Anthropology* 34: p.600. http://www.csinrcid.ca/downloads/maffi_linguistic_cultural_biological_diversity.pdf
3. Bouchenaki, Mounir, 2003, *The Interdependency of the Tangible and Intangible Cultural Heritage*, keynote address for the ICOMOS 14th General Assembly and Scientific Symposium.
4. Fresco qualifies as intangible heritage as defined in the *UNESCO Convention for the Safeguarding of Intangible Heritage*, 2003. http://unesdoc.unesco.org/images/0013/001325/132540e.pdf
5. Vásquez de Agredos Pascual, Ma Luisa, 2004, 'Las Bases de Preparación de la Pintura Mural Maya: el Papel de las Recetas Técnicas en el Marco de la Conservación y de la Creencia' in *Actas XV Congreso de Conservación y Restauraci_n de Bienes Culturales, Murcia*: p.488. http://www.cervantesvirtual.com/servlet/SirveObras/89142843210170586521457/024298_0034.pdf
6. Kingery, W. David, Vandiver, Pamela B. and Prickett, Martha, 1988, 'The Beginnings of Pyrotechnology, Part II: Production and Use of Lime and Gypsum Plaster in the Pre-Pottery Neolithic near East' in *Journal of Field Archaeology* 15, No. 2, Summer 1988: pp.219-244.
7. Polette, Lori, Ugarte, Norma, Yacaman, Jose Miguel, and Chianelli, Russell, 2000, 'Decoding the Chemical Complexity of a Remarkable Ancient Paint' in *Scientific American Discovering Archaeology*, July /August 2000: pp.46-53.
8. Ibid.
9. Mayan Pigments, Inc., http://www.mayanpigments.com [consulted 28 April, 2009].
10. Kerpel, Diana Magalona, 1997, 'La cal y los mayas' in *La Pintura Mural Prehispánica en México; Boletín Informativo*: Año III, Nūmeros 6-7, UNAM, México DF, Julio-Diciembre 1997: pp.5-8. It is interesting to note that the fresco tradition of the Indian subcontinent also combined lime with vegetal matter, according to Annet Both, a fresco practitioner in Holland.
11. Report from the State of the United Kingdom forming part of the IENICA Project, Prepared by: ACTIN, Pira House, Randalls Road, Leatherhead, Surrey, 158. See also the National Non-Food Crops Centre website, http://www.nnfcc.co.uk/metadot/index.pl?id=2165;isa=Category;op=show [consulted June 2, 2009].
12. Ayala, Oscar S., Flores, C. Elpidio, Germán, José Luis and Rios, Lombardo, 1987, *Génesis y Desarrollo de La Cultura Mayo de Sonora*, ITSON: p. 23.
13. Yetman, David, 2002, *The Guarijios of Sonora*, University of New Mexico Press: pp.229-30
14. Haude, Mary Elizabeth, 1997, 'Identification and Classification of Colorants Used during Mexico's Early Colonial Period' in *The Book and Paper Group Annual*, 16, American Institute for Conservation. http://cool.conservation-us.org/coolaic/sg/bpg/annual/v16/bp16-05.html
15. SPINDIGO Project http://www.spindigo.net/SUMMARY.htm [consulted May 26, 2009]
16. Yetman, David and Van Devender, Thomas R., 2002, *Mayo ethnobotany: land, history, and traditional knowledge in northwest Mexico*, University of California Press: p.201. Also noted in *Génesis y Desarrollo*: p.23.
17. Felger, Richard Stephen, Johnson, Matthew Brian and Wilson, Michael Francis, 2001, *The Trees of Sonora, Mexico*, Oxford University Press: p. 323.
18. Interview with Doña Moroyoqui, Masiaca, Sonora, July 2008.
19. FAO document, FRA 2000, *Non-Wood Forest Products Study for Mexico, Cuba and South America*, Rome, October 1999. Food Resources Assessment Program Working Paper 11, 33. http://www.fao.org/docrep/006/ac769e/ac769e00.HTM

20. Kerpel, p.7.
21. Vásquez de Agredos Pascual, Ma. Luisa, 2004, 'Las Bases de Preparación de la Pintura Mural Maya: el Papel de las Recetas Técnicas en el Marco de la Conservación y de la Creencia', *Actas XV Congreso de Conservación y Restauración de Bienes Culturales, Murcia*, pp. 481-482, identifies *holol* as Heliocarpus spp. Staines Cicero, Leticia, de la Fuente, Beatriz, *La Pintura Mural Prehispánica en México: Estudios*, 1998, UNAM Instituto de Investigaciones Estéticas, p 65, lists *Heliocarpus spp* as one of the trees classified as *holol*. Flores, Jose Salvador, Sosa, Victoria, McDonald, Andrew, 1985, *Etnoflora Yucatanense*, UADY, p.582 contends *Heliocarpus Donnell-Smithii* and *Heliocarpus glanduliferus* are *holol*.
22. *Guarijios of Sonora*, op cit: p.227.
23. *Mayo Ethnobotany*, op cit: p.192.
24. Martinez-Cortez, F., 1970, *Pegamentos, gomas y resinas en el Mexico prehispanico*, Mexico City: Resistol, S.A..
25. López-Franco, Yolanda L.,Goycoolea, Francisco M., Valdez, Miguel A., March 2006, 'Goma de mezquite: una alternativa de uso industrial' in *INCI* 31: 3: pp.183-189. http://www.scielo.org.ve/img/revistas/inci/v31n3/body/art7.html
26. Ibid.
27. Ibid.
28. Ibid.
29. Ibid.
30. Institute of Biometeorology, CDM: a tool for development. The Keita case. http://www.cc.ibimet.cnr.it/cdm.php (consulted 1 May, 2009)
31. *Guarijios of Sonora*, op cit: p.188.
32. Stross, Brian, 1997, 'Mesoamerican Copal Resins' in *U-Mut* Maya 6: pp.177-186. http://www.utexas.edu/courses/stross/papers/copal.htm
33. *Génesis y Desarrollo*, p.23.
34. Navarrete-Tindall, Nadia and Nuñez, Mario A. Orellana, *Species Descriptions: Bursera simaruba*, USDA Forest Service leaflet.
35. Stross, op cit.
36. Navarrete-Tindall and Orellana Núñez, op cit.
37. *Génesis y Desarrollo*, p. 23. Numerous sources list *Bursera microphylla* as *torote colorado*, while *torote colorado* was identified as *Bursera simaruba* by Yetman, according to Guarajio usage.
38. *Trees of Sonora*, op cit: p.181.
39. The Parroquia de la Purísima Concepción de Álamos is currently being restored by Straulino Restauracion. The author is a member of the restoration team.
40. Bouchenaki, Mounir, op cit.
41. In 'Linguistic, Cultural and Biological Diversity' in the *Annual Review of Anthropology* 34 (2005) pp.599-617, Luisa Maffi, a pioneer of bio-cultural diversity studies, discusses the question of *diversity and unity* in relation to the work of Harmon, D. and Wollock, J..
42. *Links Between Biological and Cultural Diversity: report of the international workshop*, organised by UNESCO with support from the Christensen Fund, UNESCO, Paris 2008: p. 23. This report calls for the integration of strategies to conserve cultural and natural diversity - a biocultural approach. http://unesdoc.unesco.org/images/0015/001592/159255e.pdf