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INBAR

Bamboo and Rattan Update

Volume 2 | Issue 4

Sharing the latest news and activities from the bamboo and rattan sector

BUILDING THE FUTURE WITH BAMBOO

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Cover Image
The Gallery Bridge restroom, a bamboo structure created by ATA Studio in Nanjing, China.
Credit: Timeraw Studio.

Editorial Team
Liu Kewei (Guest Editor)
Wu Junqi
Charlotte King
Leticia Robles (Art Editor)

Contributors
Mateo Gutierrez, Kent Harries, Li Zhu, Liu Kewei, Yang Jun

To Submit
www.inbar.int/bru-magazine/
bru-magazine@inbar.int

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About INBAR
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B R U

EDITORIAL

Welcome to the sixth issue of* Bamboo and Rattan Update*: a magazine that aims to bring together diverse voices for nature-based solutions around the world.

In Issue 1 of this year's *BRU* volume, we looked at traditional bamboo construction: how bamboo poles (referred to in this issue as 'round bamboo') remain a relevant and important building material in countries around the world.

This issue looks ahead, to the future of bamboo construction. How can bamboo be part of the expanding range of low-carbon, biobased construction materials? And what are the obstacles to doing this?

There is certainly a growing demand for bamboo. In October 2020, Ursula von der Leyen, President of the European Commission, called for "a construction industry that uses natural materials such as wood or bamboo" as part of her editorial introducing the new European Green Deal. And in November this year, the venue for the UN climate conference in Scotland featured bamboo flooring and bamboo housing materials.

In this issue, Professor **Kent Harries** introduces one of the most important contributions to round bamboo construction in recent years. His article, 'Updated: ISO 22156' (page 4), describes the content of the new international standard, ISO 22156:2021. As Harries notes, standards are a vital way to build trust in bamboo construction as a safe, durable option. But the standard itself is only the start of the process: "For ISSO 22156 to be as useful as possible, designers must use it, criticise it, supplement it and ultimately help to make it better."

Round bamboo is not the only type of bamboo construction material. The other contributions in this issue focus on an engineered bamboo: durable, strong and made to standardised lengths and sizes. How can plybamboo, glulam bamboo and other materials compete with steel, cement and PVC in the modern construction sector?

One important area to understand is bamboo's fire resistance. As Dr. **Mateo Gutierrez** explains in 'Burning Questions' (page 6), a lack of research about bamboo's fire performance has prevented it from being used in buildings of more than two storeys. This may be about to change. New work conducted by the University of Queensland and elsewhere is improving what we know about bamboo in fire conditions, and how to handle risks.

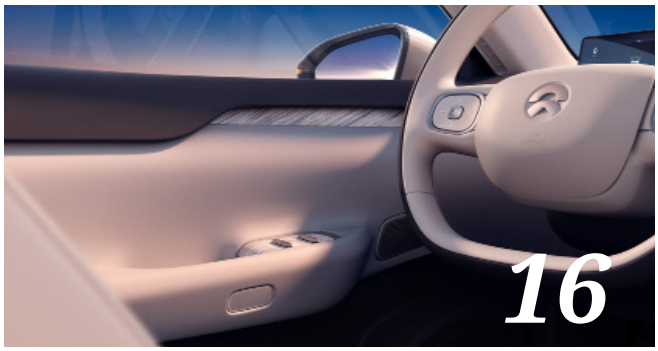
A lot of research is being done into engineered bamboo, and perhaps nowhere more so than China. As Professor **Yang Jun** and Ms. **Liu Kewei** show in their article, Chinese researchers account for more than half of all recently published work on bamboo construction. In 'Raising the Roof' (page 9), Yang and Liu

summarise a recent survey which collates experts' advice on the way forward for China's bamboo construction sector. In 'Bamboo 2.0' (page 12), meanwhile, the lead architect of ATA Studio, Mr. **Li Zhu,** introduces his company's experience using bamboo glulam to build several eye-catching structures in China.

As usual, this issue also includes a round-up of the latest international news—from rattan car interiors to bamboo air conditioning systems (**Internode**, page 16)—as well as INBAR's work over the last few months (**INBAR Spotlight**, page 19). We review a new book on the Philippines' bamboo sector (**In Review**, page 23) and summarise some of the key recent and upcoming events in 2021 and 2022 (**Events**, also page 23).

Finally: thank you for reading *BRU*. INBAR established this magazine in September 2020, and with every issue that passes, nature-based solutions are only becoming a more critical part of the global conversation about climate change, COVID-19 and sustainable development. Happy new year, and see you in 2022.

THE EDITORS



> ***The revised standard is important… The availability of standards leads to broader acceptance in the design community. Such acceptance, coupled with advocacy, can lead to broader social recognition of a previously marginalised vernacular construction material and methods.***
>
> ***- 'Updated: ISO 22156', Page 4+***

> ***With the Chinese nation's goal of achieving peak carbon and carbon neutrality, bamboo glulam will have more and more applications in the architectural field.***
>
> ***- 'Bamboo 2.0', Page 12+***

UPDATED: ISO 22156

The updated standard for bamboo structural design makes a critical contribution to building with round bamboo.

In June 2021, the International Organization for Standardization (ISO) published ISO 22156:2021 Bamboo Structures – Bamboo Culms - Structural Design. This standard significantly revises and replaces the 2004 version, which was a slim 15 pages and provided mostly high-level guidance.

The revised standard is important for several reasons. The development of formal standards for bamboo construction serves technical, social and economic objectives. First and foremost, construction standards ensure safety in the built environment and are essential for the recognition of bamboo by the engineering community. The availability of standards leads to broader acceptance in the design community. Such acceptance, coupled with advocacy, can lead to broader social recognition of a previously marginalised vernacular construction material and methods.

In BRU *Volume 2 Issue 1, structural engineering firm Ramboll described their work building earthquake-resilient houses with round bamboo. Credit: Ramboll UK.*

Building on old standards

The 2004 edition of the standard, ISO 22156:2004 – Bamboo – Structural Design, was groundbreaking: it was the first international attempt to develop a design standard for full-culm round bamboo. It was adopted by national standards organisations in Ecuador, Jamaica, the Netherlands, the Philippines and Viet Nam, and integrated into the National Building Code of India.

While critical for establishing a basis for promoting and normalising bamboo construction, the first edition was an 'intent-signifying' document; no specific design guidance was provided. One could not design a structure using ISO 22156:2004; one could only ensure that their design met the intent of the document. Efforts to revise ISO 22156 began in earnest in 2016, by a special Working Group under the auspices of ISO Technical Committee (TC) 165, which deals with timber structures. While bamboo is obviously not 'timber', TC 165 had the needed expertise to focus on the issues of building structures, and to understand the loads and environments in which bamboo buildings must operate.

ISO 22156:2021 applies to "the design of bamboo structures whose primary load bearing structure is made of round bamboo or shear panel systems in which the framing members are made from round bamboo." It can be used for one- and two-storey residential, small commercial or institutional and light industrial buildings which are below 7 metres in height.

The standard addresses fundamental requirements of designing with round bamboo. The standard explicitly addresses the tendency for bamboo to split longitudinally; different 'service classes' based on anticipated equilibrium moisture content; as well as issues associated with maintenance, inspection and the ability to replace structural members. All of these requirements are understandably different from timber standards, but critical for the overall safety and durability of bamboo construction.

ISO 22516 is a model code and is intended to be supplemented by National Annexes that may

The standard should pave the way for more constructions like the 'Heart of School', part of Green School in Bali, Indonesia. Credit: INBAR.

prescribe limits on species, dimension, grading practice, and allowable stresses. Much of the utility of ISO 22156 stems from its adoption of established standards from the timber industry, particularly for determining member, joint and assemblage load-bearing capacities. ISO 22156 is also made more widely applicable through direct reference to ISO 19624, which defines clear grading approaches for bamboo poles.

Work in progress

Developing a standard is an early step in the broader acceptance and adoption of bamboo as a construction material. Advocacy, in the form of encouraging and facilitating the adoption of ISO 22156 into National Building Codes, is the critical next stage. This, and improved outreach and training targeted to engineers, architects and artisans, will help to establish bamboo on an equal footing with other construction materials. But it will take time.

The next revision of ISO 22156 need not take 17 years. ISO 22156 remains very much a living document. Its gaps can serve as a 'research needs' document and new research will feed future revisions. Engagement with the bamboo community is paramount to this effort: for ISO 22156 to be as useful as possible, designers must use it, criticise it, supplement it and ultimately help to make it better.

More 'hands-on' information is on the way. A guide for designing bamboo structures using ISO 22156:2021 is being prepared and is expected to be published in 2022. This guide, which is being published by the Institute of Structural Engineers, or 'IStructE', with the support of INBAR and Philippines-based foundation Base Bahay, provides commentary on the provisions of ISO 22156 and includes design examples. The electronic version will be available for free worldwide. Plans are also underway to translate the guide into Spanish.

KENT A. HARRIES

Kent Harries, PhD, FASCE, FACI, FIIFC, PEng, is a Professor of Structural Engineering and Mechanics at the University of Pittsburgh, USA. He was the project leader for the ISO 22156 revision, and is a member of the INBAR Bamboo Construction Task Force.

BURNING QUESTIONS

New research is breaking down one of the biggest obstacles to building with bamboo.

In recent years, bamboo products have attracted significant interest within the building industry as highly renewable, sustainable and environmentally friendly materials. However, the carbohydrate molecules that make bamboo so desirable as a low-carbon material—bamboo captures and stores carbon dioxide as carbohydrates—also make it a flammable and combustible one.

As with other biobased materials, bamboo's main components, such as cellulose and hemicellulose, react to heat and undergo a chemical decomposition; these release pyrolysis gases that lead to flaming combustion. Because of this, the design of any bamboo structure requires a fire-safety strategy to guarantee the safety of occupants and the long-term life of the property.

A number of institutions and research groups worldwide have started to investigate the fire performance of round and engineered bamboo, and how its use in the built environment would affect fire safety. These include the University of Edinburgh, ARUP, the Shanghai Research Institute of Building Sciences, and the University of Queensland, which have already published several studies to understand the performance of bamboo in areas such as flammability, fire growth, heat transfer, structural integrity, and fire dynamics.

"The few building codes that allow for bamboo use around the world... do not address fire safety requirements." Credit: Genevieve Worrell.

Despite this work, the few building codes that allow for bamboo materials around the world still restrict its use to no more than two storeys. Moreover, those codes do not address fire safety requirements, and focus instead on the structural design of bamboo buildings. This approach assumes that residential single- and two-storey houses do not need to provide structural adequacy during a fire to provide life safety. However, to build more complex and taller bamboo buildings, more research is required to ensure their safety when exposed to a fire.

Learning from timber

Like bamboo, timber is another common construction material that is combustible in nature. In recent years, the rapid growth of high-rise timber buildings due to the increasingly widespread use of mass timber has pushed industry and academia to deal with many unresolved gaps when it comes to fire safety of structures supported by load-bearing combustible materials. Recent research and testing have helped understand the fire performance of timber systems such as cross-laminated timber (CLT) and glued laminated timber (glulam).

Bamboo has the potential to be used in similar applications to timber. However, although bamboo has a similar physical and mechanical behaviour to timber—sharing as it does many of their constitutive compounds—they do have different behaviours in fire.

To take one example: since bamboo has slightly higher thermal conductivity than timber, the heat travels faster through the solid, heating a larger portion of the cross-section, meaning current heat

transfer models proposed for timber elements would not describe bamboo's thermal behaviour.

Studying bamboo's fire resistance

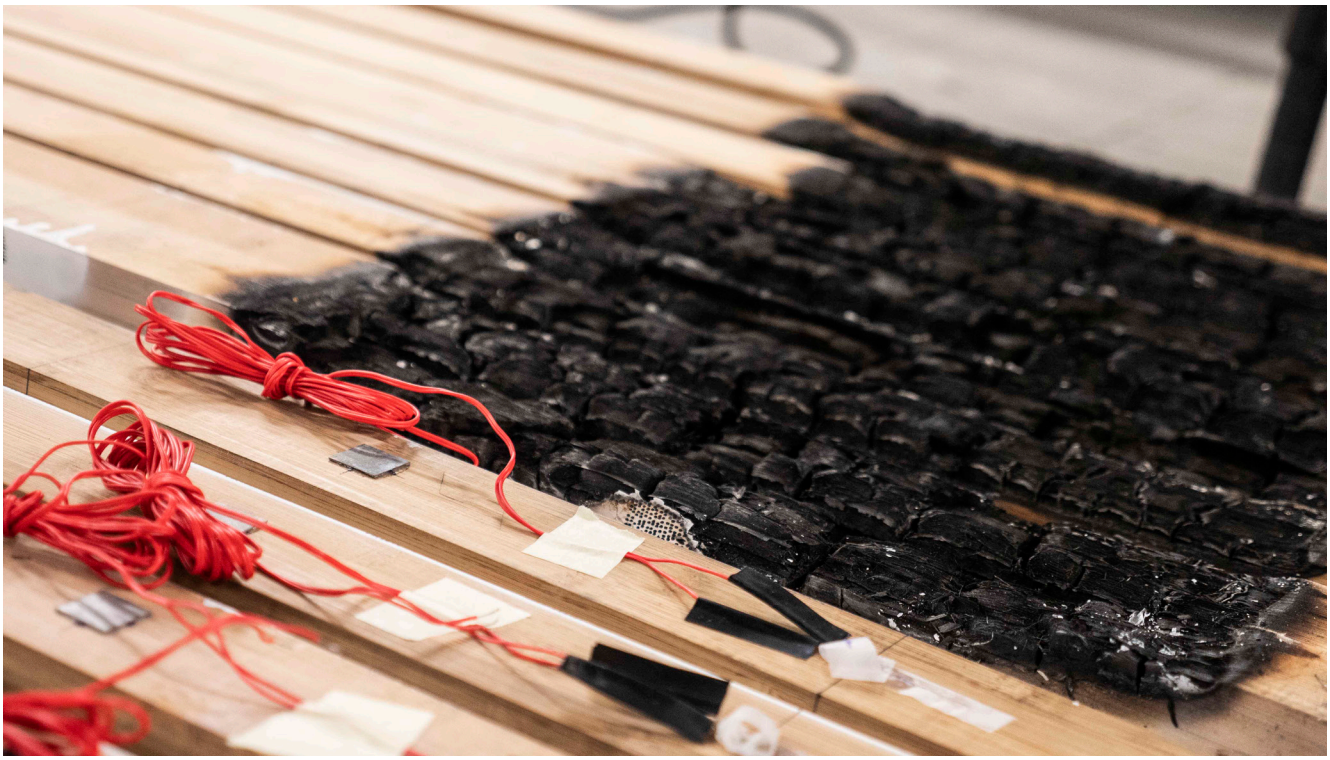
If bamboo is ever going to be considered for mid- and high-rise buildings, understanding its fire performance, and developing adequate building regulations, are critical aspects for its safe use in the built environment.

To address some of those knowledge gaps, in recent years researchers from the University of Queensland in Australia have published several studies aiming to understand the fire performance of both round and engineered bamboo construction materials.

Researchers first investigated some of the basic thermal properties required to describe the behaviour of bamboo. They observed that bamboo's thermal conductivity has a steady behaviour up to approximately 225°C. After that temperature, the values of the thermal conductivity drop as bamboo starts to decompose. Interestingly, flammability test results suggest that laminated bamboo has better 'ignition properties', meaning that it requires more energy to ignite than other traditional timber species used in the built environment. Researchers also performed several mechanical tests on bamboo to understand its reduction in strength and stiffness at elevated temperatures. The results suggest that bamboo can lose up to 70% of its compressive strength at 100°C. They also found that for temperatures above 250°C, the strength and stiffness of bamboo is gone.

By combining these findings with newly developed models, the researchers were able to create a number of design tools. These tools define how the presence of bamboo might affect the size of the fire, and predict internal temperatures during heating.

During a fire experiment, laminated bamboo beams are loaded and burned simultaneously. Credit: Genevieve Worrell.



The results of these experiments can help designers and engineers create performance-based designs for fire-safe bamboo buildings. Credit: Genevieve Worrell.

Of particular importance, by quantifying bamboo's strength reduction at elevated temperatures, the researchers were also able to propose constitutive stress-strain models, which, combined with the heat transfer models, allow engineers and designers to obtain the load-bearing capacity of laminated bamboo elements when exposed to fire. These data and modelling techniques can provide performance-based designs for fire-safe bamboo buildings.

Future research

There is still a long way to go before bamboo's fire performance is fully understood, and there are many areas where further research is needed. Aspects such as structural fire performance, compartment fires (a fire in a room or 'compartment' within a building) in buildings lined with bamboo, or in buildings where bamboo is the primary load-bearing material, reliable heat transfer models, and fire protection methods for round and engineered bamboo, must be addressed before bamboo can be used in mid- and high-rise structures.

Bamboo's combustible nature does not mean we cannot use it safely in building applications. After all, humans live together with many other flammable materials that are as or more combustible than bamboo: from cars and other machines operated by fuels that require way less energy to ignite, to plastics, furniture, clothes, and many other combustible elements that represent some hazard in the built environment. If the correct fire safety measurements have been taken, these materials do not represent a significant risk in people's daily lives.

The doors to understanding bamboo's fundamental fire properties have been already opened. Exciting opportunities are waiting to be fully explored, which will enable the creation of more and more fire-safe bamboo structures in the built environment.

MATEO GUTIERREZ GONZALEZ

Mateo Gutierrez has a PhD in structural and fire safety engineering from the University of Queensland. He is a Technical Development Manager at Cusp, producers of the first commercially certified plantation hardwood cross-laminated timber in the world.

MINISERIES: BAMBOO CONSTRUCTION IN CHINA

China boasts almost seven million hectares of bamboo, and the largest bamboo sector in the world. The following miniseries explores various aspects of China's bamboo construction sector. 'Raising the Roof' summarises expert opinions on the construction sector in China, and how it can be developed. In 'Bamboo 2.0', a leading bamboo architecture studio shows what this 'bamboo future' might look like in practice, with photographs of their most eye-catching bamboo structures.

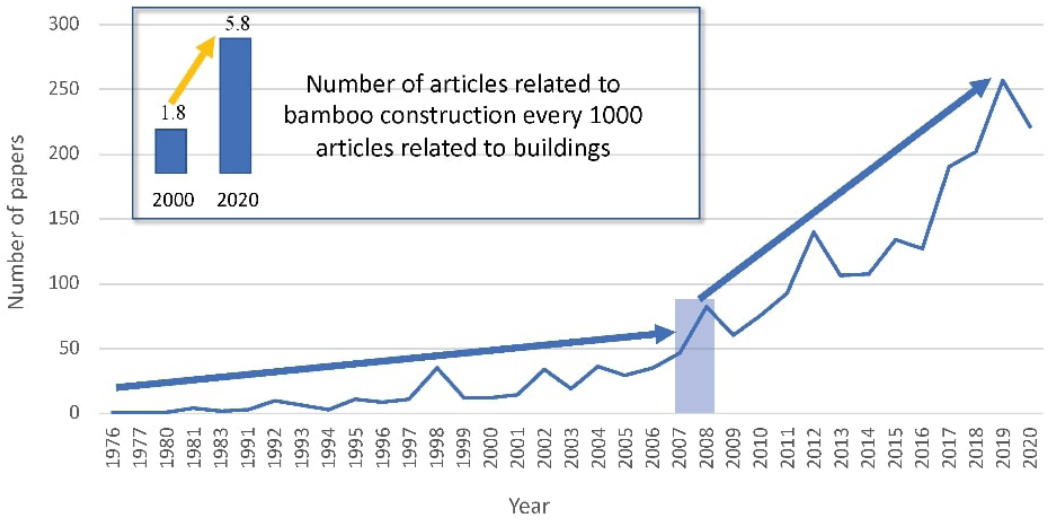
RAISING THE ROOF

A new survey has collated experts' advice on the way forward for China's bamboo construction sector.

Bamboo has been a traditional building material in southern China for millennia. However, by the 1980s, rapid economic growth drove 'modern' preferences towards concrete, masonry and steel construction, and research on bamboo stagnated.

It is only recently, with national commitments to carbon neutrality and environmental sustainability, that interest in bamboo has rebounded. The Chinese Academy of Engineering believes the construction sector will become much more environmentally friendly by 2035, in order to realise "the development vision of green and low-carbon sustainability" put forward by China's leadership. The bamboo construction sector can be an important part of this national vision, with its low-carbon and high-performance modern structures.

In 2018, a national consulting project, 'Research on Development Strategies and Key Technologies for the Bamboo Construction Sector in China towards 2035', was set up by the Chinese Academy of Engineering. The project, which was led by Tsinghua University and co-implemented by INBAR, Shandong Jianzhu University and the Chinese University of Hong Kong, aimed to assess China's use of bamboo construction, and how to expand the sector further. The final report, published in 2021, included suggestions to the Chinese government for their further actions.



Trends analysis of global academic articles related to bamboo construction. Credit: Yang Jun and Liu Kewei.

Construction of a two-storey building with glued laminated bamboo in China. Bamboo has been a traditional choice of housing material in China for millennia, but new constructions are expanding its applications and durability. Credit: Ganzhou Sentai Bamboo & Wood Co., Ltd.

Growing global interest

According to the project's literature analysis, the number of international peer-viewed papers about bamboo construction has been increasing steadily since the 1970s, indicating that a large number of research and technological innovations are being undertaken. For every thousand papers related to buildings, the number related to bamboo construction increased from 1.8 in 2000 to 5.8 in 2020. In particular, the number of published papers on this theme increased significantly around 2008, because of the expanded range of innovative applications for engineered bamboo in constructions.

In recent years, China has taken the lead in this research: between 2009 and 2020, Chinese researchers were behind more than half of all internationally published literature on the subject. This is the direct result of increased research investment in this field since 2008. In 2020, the National Natural Science Foundation of China alone launched 15 projects, and continues to increase funding for bamboo construction-related initiatives year on year. The Foundation's major research interests focus on bamboo modification, fibre-reinforced bamboo materials, engineered bamboo components and structures, and bamboo-wood or bamboo-steel hybrid structures.

Collecting expert opinions

Following on from the literature review, the report authors designed a questionnaire for 42 Chinese and 8 international scientific researchers, architects, engineers, entrepreneurs and policy makers, to find out more about the perceived advantages and drawbacks of bamboo construction in China.

In general, the experts agreed that bamboo's biggest advantage as a construction material is its natural regeneration, which is much faster than that of wood. (Bamboo poles mature within three to five years; most types of construction timber

require several decades.) The second advantage is that China is a major bamboo resources country, and bamboo is a highly suitable local material to replace wood.

In terms of disadvantages, most experts identified bamboo building materials' lack of durability and fire resistance as areas which urgently needed improvement. More than half of the experts were also concerned about the reliability of bamboo structure joints, and just under 50% were concerned about the environmental impact of adhesives used to make engineered bamboo materials.

Regarding the 'image' and promotion of bamboo buildings, 84% of the experts believed that a lack of technical standards is the key issue preventing the further uptake of bamboo housing. They also mentioned: the higher cost of bamboo construction products; the difficulties of current materials to pass required fire approval tests; and the inferior quality and quantity of demonstration housing.

The way forward

Based on expert opinions, the report identified several key targets for the development of the bamboo construction sector in China by 2035.

Firstly, more research is needed to develop bamboo construction products which are durable, fire resistant, and require little energy to produce. In particular, the development of new, biobased adhesives for engineered bamboo should be thoroughly studied. In addition, innovative bamboo products should be developed to promote the plant's application in multi-storey and high-rise buildings, and buildings with a long lifespan.

Secondly, China needs to establish a complete system for bamboo construction standards. Technical standards are of great significance to ensure the quality and safety of construction, while promoting the application of advanced technologies and enhancing the core competitiveness of the country and enterprises. However, at present, no standard system has been established in the field of bamboo construction in China. Support is needed to help researchers transform their work into standards and specifications as soon as possible, and to design a bamboo building construction standard system.

Research should be carried out to solve key issues related to designing and building bamboo structures, and improve their ability to resist earthquakes, typhoons, fire and other disasters. In addition, more research into hybrid bamboo composites, such as bamboo-wood, bamboo-steel, bamboo-concrete and fibre-reinforced bamboo, can drive the development of the bamboo construction industry.

Finally, China should promote demonstration bamboo construction projects for a variety of sizes and scenarios, including temporary shelters, residential buildings, public buildings and bridges. Complex structural forms such as multi-storey, durable and large structures can demonstrate various new technologies, and test the usability and advantage of technical standards. In addition, demonstration projects can help to promote market application and increase public confidence in the use of new materials.

Providing support

The government can support the development of China's construction sector in a number of ways. Firstly, the government can create the enabling conditions needed for bamboo construction enterprises to expand their scale, and enhance their competitiveness against alternatives, such as cement, steel and concrete. The government can also establish national key laboratories or engineering centres, and set up national scientific research funds and international cooperation projects focusing on bamboo construction. Finally, central support is needed to spur the design of national technical standards, and to promote bamboo construction demonstration projects for public infrastructure.

YANG JUN AND LIU KEWEI

Yang Jun is a Professor of Civil Engineering at Tsinghua University, China. Liu Kewei is the Coordinator of INBAR's Global Bamboo Construction Programme and Bamboo Construction Task Force. Professor Yang and Ms. Liu are two of the main researchers of this project.

BAMBOO 2.0

The head of ATA Studio introduces some of China's most inspiring structures, made with engineered bamboo board.

China is the largest producer and processor of bamboo in the world. Bamboo-made furniture, utensils and other products, including building materials, have been popular since ancient Chinese times.

Despite this, there remain a number of obstacles to building with bamboo in China. Several of these are related to issues with using round bamboo.

Obstacles to growth

As all bamboo architects know, round bamboo experiences issues such as cracking and buckling under pressure and certain weather conditions. This is particularly problematic in China, which spans five climate zones, as it means bamboo has very different mechanical properties based on where it is used. Nowadays, new preservation techniques have improved bamboo's weather resistance, and certain methods of construction—such as bundling together several bamboo poles with hemp rope to form a structural component, and then combining these to form a more complex structure—can overcome concerns about breaks. However, this kind of construction technology, which relies heavily on handwork, requires experienced craftsmen, and cannot use standardised technical measures, which limits its applications for large-scale construction.

Material properties aside, there are other issues impacting round bamboo construction in China. In terms of design, Chinese architectural engineers have few specifications and corresponding computational software for the design of original bamboo structures. As such, it is difficult to form effective graph papers to guide the construction of the site workers. These situations have hindered

The bamboo glulam structure in No. 4 Yard, Lixiang Village is a space shared by villagers and tourists. Credit: Timeraw Studio.

the large-scale promotion of round bamboo building materials in design and construction processes: the current application of round bamboo in China is mostly concentrated in the field of small-scale buildings and outdoor structures.

Glulam bamboo

It is because of these difficulties that ATA Studio started to experiment with outdoor glued bamboo board, or 'glulam'. In an early project, 'Nanjing Qixia Mountain Scenic Area Tourist Station' (pictured on page 14), the studio used bamboo glulam boards on the decorative panels of the building's facade, which made the building harmonise with the surrounding temples.

Bamboo glulam has several advantages over round bamboo. It is weather resistant, has excellent performance in resisting ultraviolet rays and temperature differences, and is available in various sizes. In addition, the mechanical properties of the material are close to those of glued wood, and—like glued wood— can be combined with steel plates and bolts to form a structure. All of these properties mean structural engineers have a corresponding standard basis for calculations. Finally, the construction methods of factory prefabrication and on-site assembly of bamboo glulam have created favourable conditions for its large-scale application.

ATA Studio has explored the application of bamboo glulam in a variety of site conditions. For example, in the 'Gallery Bridge Restroom' project (pictured on the front cover), the owner requested that the building be created quickly and avoid damage to the forest and topography during construction. Because its excellent texture eliminates the need for interior redecoration, the designed bamboo glulam frame system saved time and investment, and satisfied these requirements well.

In another rural project, 'No. 4 Yard, Lixiang

Village' (pictured on page 13), the Studio used small bamboo glulam structural components to create a large indoor space under relatively limited construction conditions, using simple construction equipment.

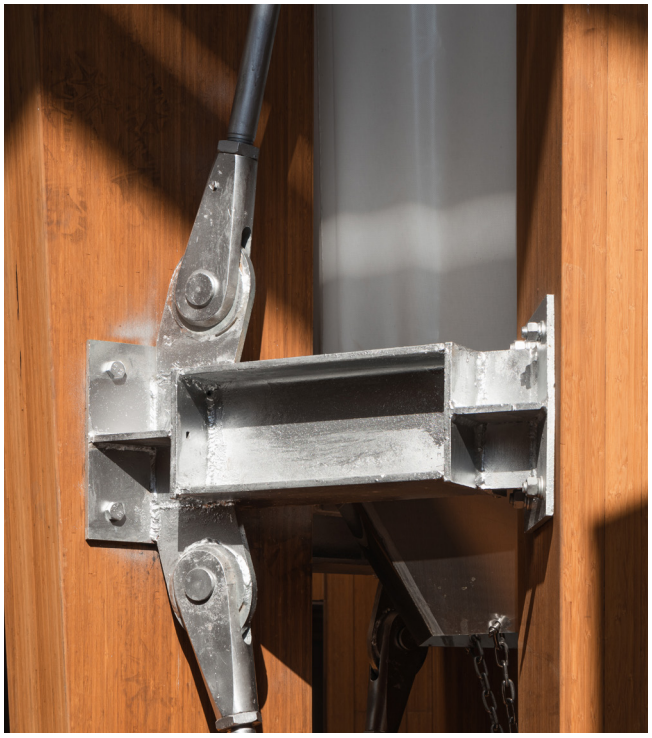
In harmony with nature, bamboo glulam also has its own unique advantages, even in places where the natural environment has been destroyed. In the 'Tangshan Mine Camp Visitor Centre' project (pictured on page 15), an abandoned mine pit was used to build a tourist service centre. Bamboo glulam plays a key role in this project: seven umbrella-shaped structures of different sizes support the roof of the whole building, the largest one being 19 metres in diameter. The building's unique form gives people the feeling of insects passing through, and leaves a strong impression of the surrounding damaged rock wall.

ATA Studio believes that bamboo glulam is an environmentally friendly and low-carbon construction method, and a modern inheritance of traditional Chinese wooden culture. It explores a new rural construction method that can meet the functional needs of today without destroying the characteristics of rural culture. Predictably, with the Chinese nation's goal of achieving peak carbon by 2030 and carbon neutrality by 2060, bamboo glulam will have more and more applications in the architectural field due to its excellent carbon fixation, stable material characteristics and attractive texture.

LI ZHU

Li Zhu is the lead architect at ATA Studio in China. He is interested in building types which combine industrialisation with natural and local elements, and experiments with the balance between architectural technology, function and space in design.

Nanjing Qixia Mountain Scenic Area Tourist Station. As an earlier project by ATA Studios, the bamboo here is mainly decorative, not structural. Credit: Timeraw Studio.



Details from the bamboo glulam structure Tangshan Pit Camp Tourist Center, which is situated in an old mining site. The largest bamboo 'mushroom' roof has a diameter of 19 metres. Credit: Timeraw Studio.

Collating the latest international news and activities around bamboo and rattan sector development.

AREP's adiabatic cooling system. Credit: Olivier Dauce.

Bamboo cooling solution for urban areas

French firm AREP has developed a low-tech cooling system which could replace air conditioning in urban areas. The system, which uses "the natural freshness of water" to cool the surrounding air, is made with bamboo, and could be used "in cooling down outdoor spaces such as public squares, sunny pedestrian streets, and large structures like train stations" according to a profile in *DesignBoom*.

The system (pictured above) relies on the principle of 'adiabatic cooling'. Water flows through a hyperboloid structure made of bamboo; as it evaporates, the water 'absorbs' energy from the heat of the ambient air, thus generating a cooling effect.

AREP has already installed a prototype in Hanoi. Using the system led to a temperature drop by 6°C in the surrounding area. According to an interview with *DesignBoom*, the team believes the device could be even more efficient in drier climates, such as the Mediterranean basin or in the Gulf.

Source: DesignBoom, 5 December.

New rattan car material developed

According to *Automotive Daily*, Germany company Out for Space has developed "the next green car material" using rattan. The material, which is called 'Karuun' (pictured on page 17), uses rattan trimmed into square-section rods that are glued into panels or pressed into blocks. This basic material can then be processed in a number of different ways, creating everything from thin, transluscent slices (Karuun Stripe), to sheets that can be pressed into 3D shapes, such as spheres, in much the same way as sheet metal or vacuum-formed plastic (Karuun 3D).

Out of Space believes there are several advantages to using rattan in car interiors. As well as being fast-growing, rattan's natural vascular structure means that "it is easy to infuse dyes and other treatments through the material using only a small amount of energy." In addition, rattan "depends on biodiversity to survive, and thrives in tropical forests", meaning that sustainably sourced and managed rattan can help protect the areas in which it grows.

With more and more manufacturers increasingly turning towards sustainable materials for car interiors as a replacement for traditional wood, metal and plastic, rattan could be an increasingly important part of design in the automotive sector.

Source: Automotive Daily, 7 December.

China pitches regional bamboo carbon trading schemes

In December, China's central government released guidelines urging local authorities to establish pilot trading markets for bamboo-backed carbon offsets, according to an article in *Carbon Pulse*.

Local governments should explore and develop a carbon sink industry for bamboo to drive innovation in carbon sink mechanisms, said a notice co-signed by 10 central government agencies, including the National Forestry and Grassland Administration and the National Development and Reform Commission, but not the Ministry of Ecology and Environment, which runs China's carbon markets.

That might indicate the forestry administration would ultimately be in charge of any bamboo schemes, observers told *Carbon Pulse*.

The move is the latest government push to develop offset markets, which have gained increasing attention after President Xi Jinping announced China's 2060 carbon neutral target last year. A number of provinces have launched their own forestry-based offset programmes.

China published its first methodology for bamboo sinks in December 2012, and a first bamboo project was registered under the national China offset programme in 2015. However, the national programme was put on hold in March 2017 and has yet to be revived, leaving new bamboo and all other offset types unable to seek crediting via the central government scheme.

Credit: CarbonPulse, 8 December.

Communities in Uganda use bamboo to hold back worsening floods

By slowing floodwater and stabilising riverbanks, bamboo walls could protect farmers in Uganda from climate change-worsened floods, and earn them extra income, according to an article published in *Thomson Reuters*.

Floods impact about 50,000 people in Uganda each year. For several years, community leaders and farmers' groups have been encouraging farmers to plant bamboo and indigenous trees along the riverbanks in the flood-prone Kasese district. Bamboo is a particularly useful flood defence: the grown plants act as a barrier to slow the water pouring from swollen rivers, while bamboo's extensive root system stabilises the soil and catches silt, helping keep the riverbanks

New rattan-based product 'Karuun' could have a variety of applications in car interiors and beyond. Credit: Karuun.

from collapsing. Community leader Mr. Charles Nyamutare described bamboo as "one of the most important interventions we are using to control flooding", and estimates that communities in his area have planted about 1.2 million bamboo plants so far, stretching 40 kilometres along the Sebwe River and 10 kilometres along the Mubuku River.

Bamboo offers an additional, economic benefit. According to one farmer interviewed for the article: "When my bamboo has matured enough, I plan to sell some of it for building materials so that I earn an extra income." According to Mr. Nyamutare, from a single mother plant, a farmer can make more than UGX 250,000 [USD 70] a year selling bamboo for use in construction and as charcoal.

The national government is also supporting bamboo as a flood defence. In August, the Ministry of Water and Environment announced a UGX 30-billion [USD 8400] project to restore and protect the district's main river, the Nyamwamba. The project involves planting bamboo along the river's banks, as well as carrying out spot cleaning of the waterway and putting in place flood forecasting and early warning systems.

Source: Thomson Reuters, 22 November.

Australia-Indonesia bamboo initiative

One highlight of the UN's climate conference held in Scotland this November was a summary of the 'KANOPPI-2' project: an initiative supported by the Australian Centre for International Agricultural Research's Forestry Research Program, which aims to build up bamboo's potential as a source of income for rural communities in Indonesia.

In the session 'Women Saving the Planet: Gender Equality in the Fight for Climate Change', KANOPPI-2 project coordinator Ms. Desy Ekawati shared the main lessons from the project, and explained how rural Indonesian women have used bamboo as a tool to help adapt to climate change.

The KANOPPI-2 project teaches the practices of sustainable bamboo forestry and agroforestry management to farmers, and has established a women's group to prepare bamboo seedlings for provincial-level planting projects.

One group that benefitted from this work is a sub-tribe on the island of Flores. The small group, consisting of just five families, owns 15 hectares of communal bamboo and has been involved in sustainable management activities through the project. According to Ms. Ekawati, in 2018, this group earned about IDR 100 (USD 7000) selling bamboo.

"Before the utilisation of bamboo as an industrial material, [the families] only used bamboo for domestic and social-culture purposes, but now they can sell their bamboo to the local industry," she said. This provides "not only value for the economy, but [also] with the community, we have also reinvented the environmental services and sustainability of bamboo."

Source: Mirage, 25 November.

Dominican Republic bamboo seminar

On 16 November the Dominican Republic held its first international bamboo seminar. The event, 'Generating Alliances for Economic Reactivation and Sustainable Development through Bamboo', was hosted by the Pedro Henríquez Ureña National University, with support from INBAR, the Ministry of Environment and Natural Resources, the Special Fund for Agricultural Development and other institutes and funds.

The aim of the seminar was to generate alliances in order to spur the development of the Dominican Republic's bamboo sector. During the training, His Excellency Mr. Orlando Jorge Mera, the Dominican Republic's Minister of Environment and Natural Resources, said that bamboo can make an important contribution to the country's Environment Strategy 2021-2025, and told attendees that his Ministry had formally recommended that the Dominican Republic join INBAR.

Other speakers discussed ongoing bamboo initiatives in the country, including a project to industrialise the sector, ongoing research at the University, and a workshop producing bamboo furniture.

INBAR currently has 11 Member States in the Latin American and Caribbean region and hopes to receive the Dominican Republic into the network next year.

Source: Acento, 12 December.

INBAR SPOTLIGHT

INBAR commissions research, conducts project work and raises awareness about bamboo and rattan across its 48 Member States.

Representatives from INBAR's Member States gather to watch the raising of Pakistan's flag outside INBAR Headquarters. Credit: INBAR.

Welcoming INBAR's 48th Member State

On 10 November, INBAR hosted a flag-raising ceremony for its newest Member State: the Islamic Republic of Pakistan. Pakistan officially joined INBAR on 1 July 2021, becoming INBAR's 48th Member State and 16th in the Asia-Pacific region.

Speaking at the flag-raising ceremony (pictured), His Excellency Mr. Moin ul Haque, Ambassador of the Islamic Republic of Pakistan to China, said of bamboo: "It is difficult to imagine any other crop with such diverse uses for humankind. Bamboo is employed as a food item, an important construction material, for making musical instruments, paper and pulp, and many other uses… Bamboo's wider application across many industries is helping to protect precious timber resources from depletion."

He also expressed his hope that bamboo and rattan could become key tools in Pakistan's sustainable development, as part of initiatives such as the country's 'Ten Billion Tree Tsunami' project.

Pakistan has a long relationship with INBAR, and was an Observer at the organisation's formal establishment back in 1997. In her speech, Professor Jiang Zehui, the Co-Chair of INBAR's Board of Trustees, told participants that she had met with His Excellency Mr. Imran Khan, Prime Minister of Pakistan, in 2019, and that His Excellency Mr. Moin ul Haque had subsequently visited INBAR Headquarters in 2020. Another delegation of spouses and staff from the Embassy, led by His Excellency Mr. Moin's wife Mrs. Farah Moin, visited in January 2021.

Developing bamboo and rattan standards in Africa

Between 2 to 5 November 2021, experts from the INBAR Task Force on Sustainable Bamboo Management met in Accra, Ghana to work on a range of bamboo standards. The meeting was held alongside a capacity-building workshop for representatives of 11 countries, on how to create standards for bamboo products.

Both activities were part of the South-South and Triangular Cooperation initiative, which is run by China and the International Fund for Agricultural Development as part of the Inter-Africa Smallholder Farmers Livelihood Development Programme. The Programme aims to support the development of the bamboo sector across Africa, through sharing knowledge and building expertise in a range of areas.

At the meeting, 17 Task Force experts from Cameroon, Ethiopia, Ghana, India, Kenya, the Netherlands, Nigeria, Sierra Leone and Zambia worked on a number of voluntary guideline standards, including step-by-step guides on the use of bamboo for landscape restoration and criteria for certifying bamboo plantations. Once released, these standards are expected to support the development of the bamboo sector in countries which lack standard guidance for setting up and managing bamboo resources.

The capacity-building workshop, which was held alongside this meeting, introduced trainees to existing technical guidelines, and provided advice on how to develop or adapt bamboo standards to national circumstances. The workshop included representatives from 11 countries, and was hosted with the African Organisation for Standardisation and supported by the Ghana Standards Authority.

Bamboo at the UN climate conference: an "available, scalable and natural" solution

INBAR promoted bamboo's role as a carbon sink, a source of biomass energy and a low-carbon construction material at the UN's annual climate conference in November.

The climate conference, known as the 26th Conference of the Parties (COP 26), was held in Glasgow, Scotland. Throughout the two-week event, INBAR highlighted bamboo's potential as a sustainable, low-carbon construction material, which can replace more emissions-intensive products including cement, steel and PVC. INBAR hosted a booth which featured an eye-catching bamboo–timber gridshell structure, designed by a team from Edinburgh Napier University, and coorganised a side event on biobased building materials with the International Union of Architects.

As well as bamboo construction, INBAR also attended several events to promote bamboo's role as a source of renewable energy, a carbon sink, and a low-carbon product which can help countries meet their carbon neutrality targets.

In an official statement released during COP 26, INBAR Director General Mr. Ali Mchumo described bamboo as "an available, scalable and natural" resource, and "a common climate solution for many developing countries in the tropics and subtropics."

New trade figures for bamboo and rattan

INBAR's most recent trade report, released in October, breaks down the latest data on international trade of bamboo and rattan products.

According to the report, which uses data from the UN Comrade database, in 2019, exports of bamboo and rattan commodities reached USD 3.4 billion. Of this, China is the largest exporter for bamboo products (exporting USD 2 billion, or 67% of the global total), and Indonesia for rattan products (USD 137 million, or 38%). The USA and Europe are also becoming bigger players in international bamboo and rattan trade.

The report shows a large jump in trade volume between 2017 and 2018. This is due to new trading codes, or Harmonized Commodity Description and Coding Systems (HS) codes, which became effective in 2018. Whereas historically, many bamboo and rattan products have been misclassified as 'timber' products, due to the lack of appropriate codes, the newly expanded range of HS codes provides a wide choice of descriptions for Customs to use, including bamboo charcoal, bamboo pulp and paper-based articles, bamboo flooring panels, and rattan basketwork and furniture.

According to Dr. Wu Junqi, a trade specialist at INBAR, "A better understanding of bamboo and rattan trade is critical to raising awareness about these plants, and providing appropriate support to developing products. This latest report is great news for the visibility of bamboo and rattan goods, and the growth of the sector."

The China Bamboo Cultural Festival 2021

The 11th China Bamboo Cultural Festival was held

in Yibin, a city in Sichuan province, China between 19 to 20 October.

Yibin has been dubbed the 'bamboo city of China', on account of its extensive bamboo forests and well-developed bamboo industry. The 2021 Cultural Festival, which was co-hosted by INBAR, the National Forestry and Grassland Administration of China, and the government of Sichuan, provided a valuable platform to display bamboo crafts in Yibin, and to discuss the contribution of bamboo to sustainable development in China more generally.

The Festival was attended by hundreds of people in person, including a delegation from INBAR with representatives from eight current and prospective Member States. A large number of online viewers also took part in virtual events, tours, and related bamboo e-commerce activities. As well as a summit and product exhibition on the first day, participants at the physical event attended a field trip to several key bamboo sites in Yibin, including the International Bamboo Products Trading Centre, Yibin Paper Industry, and the south Sichuan 'bamboo sea'.

INBAR webinars in 2021

20 December marked the end of INBAR's final webinar in 2021. During 2021, INBAR has held 22 online webinars, five training programmes—longer, multi-day periods of study on a certain topic—and two virtual study tours, during which participants were able to 'visit' bamboo-producing areas. Each live session attracted hundreds of participants, and thousands more visitors have viewed the webinar recordings.

Originally started in 2020 in response to COVID-19 travel restrictions, INBAR's e-learning programme has become a major pillar of outreach and knowledge transfer work. Topics in 2021 have included: innovative rattan applications; creating policy roadmaps for bamboo sector development; bamboo's growth in Europe; bamboo's role in landscape restoration and urban 'greening'; bamboo textiles; and various types of assistance and training for bamboo entrepreneurs.

In addition to its one-off webinars, INBAR also arranged longer online courses. These included multi-day series on bamboo construction, sustainable management of tropical bamboo, the basics of bamboo weaving, and a two-part virtual study tour of Anji, a bamboo-producing area of China. All participants for INBAR series received exclusive access to webinar recordings, and a certificate upon completion of the course.

INBAR Regional Offices also led more tailored courses, such as: ' Bamboo: a nature-based solution for restoration in the Amazonian region', 'Bamboo opportunities for agribusiness and forestry in Uganda', and 'Investment opportunities for commercial forestry in Kenya'.

Kenya bamboo study tour

From 28 November to 2 December 2021, in collaboration with the Kenya Forestry Research Institute (KEFRI), INBAR organised an in-country bamboo study tour in Kenya. The tour gathered about 35 delegates from 13 countries to learn about the development of the country's bamboo sector.

On the tour, participants learned from researchers and entrepreneurs about various aspects of Kenya's bamboo sector reform. Speakers included Dr. Joshua Cheboiwo, Chief Executive Officer of the Kenya Forestry Research Institute, as well as representatives from GreenPot Enterprises, which has established bamboo nurseries and plantations, and Ecopole, which is making power transmission poles using bamboo.

The study tour was conducted as part of the Inter-Africa Bamboo Smallholder Farmers Livelihood Development Programme, which aims to transfer knowledge, skills and technologies about bamboo sector development across Africa.

New bamboo project in World Heritage site

A new three-year pilot activity to promote bamboo for carbon neutrality has been launched in Chishui, China.

China is a country with some of the world's most abundant bamboo resources. In Chishui, which is part of the famous Danxia China World Heritage site, locals have used bamboo for centuries, and their bamboo weaving skills are particularly well-known within China.

Since 2018, the United Nations Educational,

Scientific and Cultural Organization has worked with INBAR and Chishui Natural World Heritage Management Bureau to promote bamboo weaving as a sustainable source of income in Chishui. The new project, which was launched in December 2021, aims to build on this work, creating a model for sustainable livelihoods which can contribute to China's new carbon neutrality targets and be exported to other parts of China.

The first month-long workshop (pictured) began on 1 December 2021, and consisted of training from Ms. Yang Changqin, a living heritage bearer of Chishui bamboo weaving. Over the course of the month, Ms. Yang taught 25 women how to weave high-value bamboo products for sale. Future workshops will cover other aspects of building a successful business, passing on principles of creative design, digital marketing, and organisational management.

The project will also conduct research to quantify the carbon benefits of bamboo weaving activities, as a way to help ascertain the craft's contribution to China's goal of reaching carbon neutrality by 2060.

A new agreement with UNIDO

On 28 October, INBAR and the United Nations Industrial Development Organization (UNIDO) signed an agreement committing to increased cooperation on developing the global bamboo and rattan sectors.

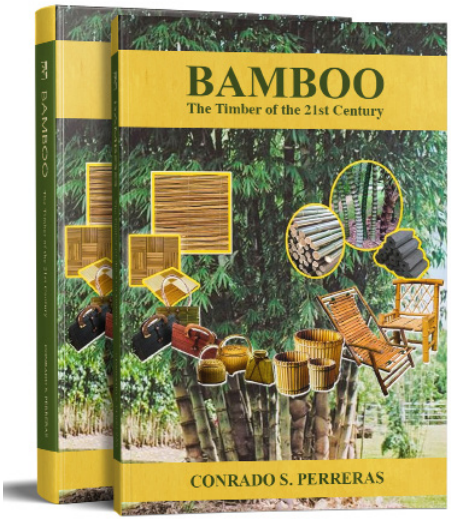
UNIDO is the specialised agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalisation and environmental sustainability. It has 170 Member States. Speaking at the signing ceremony, Mr. Li Yong, Director General of UNIDO, said: "INBAR and UNIDO share many common aspirations", including "working with individuals on the ground to improve their livelihoods and strengthen sustainable models of economic growth."

In particular, the agreement makes reference to: promoting agribusiness and rural entrepreneurship; improving standards and certification for bamboo and rattan products; building robust value chains for bamboo and rattan products; and promoting exchange of best practices and technologies across UNIDO and INBAR's networks.

Speaking on behalf of the INBAR Board of Trustees, Co-Chair Professor Jiang Zehui said that the agreement was a real example of "win-win cooperation to advance our vision and mission and contribute to achieving the United Nations Sustainable Development Goals, and is particularly significant for industrial transformation of the world's bamboo and rattan sector."

Trainees in Chishui learn how to create woven bottle coverings as part of the INBAR–UNESCO project. Credit: INBAR.

IN REVIEW



Bamboo: The Timber of the 21st Century

Bamboo: The Timber of the 21st Century analyses the development of the Philippines' bamboo sector since the signing of Executive Order (EO) 879: a Presidential decree that announced the need to develop the bamboo sector, and included directives such as the need to procure 25% of all school desks and chairs from bamboo.

EO 879 was signed in 2010, but as the book shows, the bamboo sector has yet to reach its full potential. In fact, exports of bamboo products declined between 2005 and 2015, and the engineered bamboo products sector remains underdeveloped.

A key issue, the author notes, is a "grossly inadequate" supply of bamboo. Although bamboo covers between 39,000 and 53,000 hectares of land, much of this is unmanaged or grown on homesteads. In fact, "There is hardly a company in the Philippines producing bamboo products that has its own bamboo plantation of the desired species." Instead, companies must use whatever species is available, even if this means using low-quality stock.

A key recommendation of the book, then, is for the government to prioritise planting commercial bamboo species. With 125,000 hectares of bamboo, the author suggests, the Philippines would be able to fulfil the directives laid out EO 879, and develop a strong bamboo sector.

Despite the obstacles, the Philippines' bamboo sector has big potential, and the last decade has seen a lot of new momentum. With its many species—the book counts 70 known species, including several commercially important varieties—and a long history of creating products with bamboo, the Philippines could yet become a major exporter of bamboo furniture, handicrafts and engineered bamboo products. This new volume suggests how.

Conrado S. Perreras. (2021) *Bamboo: The Timber of the 21st Century*. BambooPhil: The Philippines.

EVENTS AND MEETINGS

19-20 October

The 11th China Bamboo Culture Festival

Yibin, China

28 October

INBAR-UNIDO Agreement Signing Ceremony

Virtual event

1-12 November

The UN Climate Conference (UNFCCC COP 26)

Glasgow, Scotland

10 November

Flag-raising Ceremony for the Islamic Republic of Pakistan's Accession to INBAR

Beijing, China

23-25 February

Africa Bamboo and Rattan Congress

Yaoundé, Cameroon

25 April-8 May 2022

UN Biodiversity Conference (CBD COP 15): Part 2

Kunming, China

Credit: BAM•BU BICYCLES.

Bamboo may not be a common material in Europe, but one man is looking to change that. In October, travel journalist Sergi Unanue completed his tour of continental Europe using a bamboo bicycle. Mr. Unanue covered more than 7000 km in 142 days, beginning from Punta de Tarifa in Spain and ending in the Norway's North Cape, in an effort to raise awareness about climate change. Sergi's bicycle was provided by Bambu Bicycles, a bamboo bicycle frame company based in Portugal. Sergi reported no major issues with his bamboo bicycle throughout the journey.

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