BRU
Bamboo & Rattan Update
INBAR
Sharing the latest news and activities from the bamboo and rattan sectors

BAMBOO SKYLINES: CITIES OF THE FUTURE?

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Cover Image
Bamboo structure along a riverbank in Guilin, China. Credit: llLab.

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B R U

EDITORIAL

Welcome to the fourth issue of the* Bamboo and Rattan Update *for 2024, which details bamboo's contribution to sustainable cities and communities.

As countries develop over time, there is a general trend of people moving from the countryside into cities. Many factors drive this process, from efficient agricultural practices requiring fewer on-farm workers, superior job opportunities and better healthcare and educational services to closer proximity to entertainment, shopping, cuisine and music locales. As standards of living continue to rise, most experts do not expect rural-urban migration to stop anytime soon, and over half the global population now resides in an urban environment.

Sustainable Development Goal (SDG) 11 of the United Nations (UN) 2030 Agenda for Sustainable Development aims to "Make cities and human settlements inclusive, safe, resilient and sustainable." Recognizing the rapid pace of urbanization, this goal emphasizes the need to manage cities in ways that ensure equitable access to housing, transportation and other basic services. Key targets of SDG 11 include upgrading slums, reducing urban sprawl and improving public transportation to accommodate growing populations while minimizing negative environmental impacts.

One critical aspect of this endeavor is disaster risk reduction and resilience. Climate change is worsening, and natural disasters are occurring with increasing frequency and intensity. Cities must be ready to withstand these events to ensure residents are safe and also can recover when they inevitably take place. This process involves building new, strengthened infrastructure, strategic urban planning going forward and preserving elements from cultural and natural heritages. Specific indicators include more efficient waste management, enhanced air quality monitoring and sustainable energy solutions to make our cities healthier and more vibrant.

Such a massive undertaking requires close coordination between a range of international actors from the public and private sectors and community organizations. Governments, businesses and civil society must work together to implement innovative policies and technologies. Especially challenging issues remain in financing sustainable development initiatives, especially in low-income countries. Despite this, if the world can make meaningful progress toward achieving this goal, we would reap multiple benefits, from improved quality of life for all urban residents and more robust climate change mitigation to securing green economic growth that carefully considers our environment.

Bamboo has a critical and ever-expanding role to play in this endeavor. As a versatile plant resource that is fast-growing, renewable and sequesters carbon, it can be used as an environmentally friendly building material for a range of structures, from houses and bridges to scaffolding. Selecting bamboo over emissions-intensive materials like concrete and steel can avoid greenhouse gas emissions from the construction sector. Given its lightweight, durable and flexible nature, it is ideal for resilient, disaster-proof structures capable of withstanding earthquakes, floods and typhoons. Other benefits include improving air quality, providing shade, reducing city temperatures and fostering community living spaces.

The first article of BRU 5-4 features a profile with llLab., a design studio founded in Stuttgart, Germany and based in Shanghai and Porto. The studio is at the forefront of architecture, design, art and urbanism. The interview highlights their Bamboo Cloud Exhibition hosted in New York City, and discusses the design philosophy behind the incredible structure as well as some of the challenges involved with transporting and assembling a complex piece of bamboo architecture.

Could bamboo be the cornerstone of an entire town? For Anji County, China, the answer is a resounding yes. Home to abundant bamboo resources, the area exemplifies how bamboo can power sustainable urban development by integrating craftsmanship and cultural heritage with environmental conservation. Grand public bamboo structures in the area create aesthetically pleasing and comfortable public spaces, while also generating income for the tourism industry, which is an important sector of the local economy.

Construction can particularly benefit from increased application of bamboo-based materials. Bamboo composite materials are showcased in the last article as sustainable, low-carbon solutions for the modern construction industry. These materials are ideal for walling, flooring and outdoor structures, with myriad environmental advantages. More research and innovation can help us truly unlock their potential and facilitate a green transition for global construction.

From the bustling streets of New York City to the peri-urban lands of Anji, we are witnessing more people tap into the potential of bamboo for sustainable cities and communities. In architecture and design, bamboo is heralded as a traditional material being unlocked by modern technologies and innovation, leading to the formation of breathtaking structures. To truly allow bamboo to contribute to the achievement of SDG 11, the plant resource needs deeper integration with not only artistic endeavors but also with every-day building projects. With bamboo in mind, the future, and our cities, can be green.

THE EDITORS

BAMBOO CLOUDS TAKE OVER THE CITY

The bamboo exhibition nestled within the streets of New York City. Credit: llLab.

llLab. is a design studio originally founded in Stuttgart, Germany, where its founders, Luis Ricardo and Hanxiao Liu, first met. The studio is now based in Shanghai, China, and Porto, Portugal. With a design philosophy that transcends specific fields, llLab. seeks visionary approaches to uncover unexpected solutions. Bamboo emerged as the most suitable material for one of their nature-focused projects, and this discovery has inspired the studio to continue experimenting with bamboo ever since. What follows is an in-depth conversation with the studio, exploring their acclaimed projects in Guilin and New York City.

Your earlier project Bamboo Bamboo, Canopy and Pavilions in Yangshuo, Guilin, China generated a lot of buzz online. Could you talk a little about the process behind creating it?

When we first started thinking about using bamboo as the main material, we didn't have very much knowledge about it. We started from learning about the basics of the materials, trying to understand how different species of bamboo behave, and then collaborated with local craftsmen to pursue the shapes that can be created to get the most comfortable porosity for the most beautiful lighting and shadows. It is almost impossible to fully describe the whole experience, but the learning process about bamboo truly helped us in creating the space [in Yangshuo] with it.

What was your reaction when the organizers of NYC x Design invited llLab. to design a bamboo project at the Gansevoort Plaza Meatpacking District in New York City?

We were quite nervous actually when we received the invitation from NYC x Design. After we completed our project in Guilin, China, we received two different invitations from Saudi Arabia to bring our design there. However, we had to refuse due to lack of knowledge in safely transporting it. Considering the bamboo material, we needed to invent an entirely new system for construction, weaving and assembly, so we were quite panicked at first. Then, it grew into a strong momentum for our design and production processes.

How did you arrive at your design for the stunning Bamboo Cloud exhibition? What inspired the theme "Open To The Sky"?

The "Open To The Sky" theme was a coincidence and I think partially a common inspiration between the organizer and ourselves. When the organizer found us and invited us, we were already talking about the theme. We realized that it was a perfect match, especially taking place during the pandemic period. And given such an opportunity, we worked quite hard on the optimization of the porosity, creating an almost invisible structural system, to provide the purest intersecting natural light and most beautiful shadows for people.

How was Bamboo Cloud received by the public in New York?

There was a great and unexpectedly active reception from the public. From the time that we started our on-site installation construction, we already received many people coming to ask questions and wishing to talk about our work. We even had a couple who knew us online and also worked with bamboo art who came to see our installation process.

We had a strong feeling about the public reaction — that people are very curious about meeting new things in the shared city space, and that people also had very little knowledge about this exotic material. The contrast in space and in materiality is very important, we believe, for a new level of understanding of nature.

Can you share a moment (or a few) when the team successfully overcame an obstacle in the design process?

Almost every single step was an obstacle! It was so difficult that when we eventually arrived at where we were and for it to look so simple and effortless, it already represented a great step forward for our team in the process of learning about bamboo.

One example is that there was such a lack of understanding about the material from other parties involved in the transportation and construction that to implement the test installation, packaging, transportation and the live installation at the Meatpacking District, we needed to create a tutorial in order to carefully guide the completion of almost every single step.

Bamboo Cloud uses a novel assembly method. What are some of its advantages?

This assembly method helps us learn how to break the inherent force in the bamboo material and recover the integrity of it, while maintaining a consistent appearance and minimal reinforcement in the installation. Materials used are consistent and clean, and the structure used in the installation was almost invisible; therefore, the shadows are clean and light.

We are now able to transport even larger-scale design works to sites located far away from where they are created. The human space provided under the work can be optimally arranged, with ideas of portability and sustainability in mind.

What considerations must be taken when using original bamboo and engineered bamboo?

Considering what the materials really are, original bamboo is a naturally grown material, with its own natural biological composition. Engineered bamboo is a decomposed and evenly recombined and strengthened version of this. Engineered bamboo is a stronger and denser bamboo

Members of the public enjoying the communal space under exquisite bamboo structures (top). Credit: llLab.

Bamboo Clouds nestled in New York City's Meatpacking District (bottom). Credit: llLab.

material that has a more consistent distribution to withstand pressure, with the elasticity being well kept in the direction of the material.

This matter is closely related to the applied scale. If original and engineered bamboo are undergoing mixed force transitions, some weak points may be more vulnerable, as the original bamboo may become the inconsistent part of the whole, creating a weakness in stress concentration.

How did you decide to use interlocking joints and waves as part of the structural design?

It was a learning process in the development of the design. While we were working on the assembly method and connecting structure, we found out that making the truss with a conventional understanding was actually opposing the strength of the bamboo material; therefore, we completely reconsidered the composition and approached the truss system using bamboo as the origin. To maximize the function of the bamboo material and to maintain its unique elasticity, we tried to avoid having any "broken point" that stops the transmission of forces in the material, so no sharp corners were made in the structure.

The force in the structure is very smoothly and flexibly transferred through the material members, showing that it is a truss that is truly suitable for bamboo.

Do you see sustainable bamboo buildings as a new trend in construction going forward? What role do you expect llLab. to play in designing buildings of the future?

It seems that the trend is coming to the bamboo construction. However, it is still widely considered a material that is similar to wood. The special properties of bamboo are still ignored in many processes.

We hope to explore, challenge and discover the unseen parts of the bamboo material, so we can pursue our next step with true bamboo materiality. For example, in summer 2024, we experimented with integrating curving bamboo structures at a retail site in Shanghai for our Bamboo Bamboo | Turn Turn exhibition. After we better understand the full spectrum of bamboo, we hope to implement exciting and innovative solutions at building scale, tapping into its true power as a non-wood material.

Is there anything else you'd like to add?

After our experiment with bamboo, we realized that there is a huge gap in the making and application of this material. It seems that it is either used to make art or small objects in exotic cultures, or as just "another kind of wood" at the building scale. It is our honor seeing the globe starting to test how bamboo can be used in different ways after our bamboo project in Guilin, China.

Now that we have experienced our first case in transporting nature, we hope it encourages more learning about bamboo and stimulates further challenges ahead.

LUIS RICARDO, HANXIAO LIU

Luis Ricardo and Hanxiao Liu are the co-founders of llLab., a design studio based in Shanghai and Porto.

ANJI: FROM BAMBOO TOWNSHIP TO SUSTAINABLE CITY

The scenic landscape of Zhujing Bamboo Culture Neighborhood. Credit: Zhujing.

One corner of Zhejiang Province holds 1.8% of China's bamboo resources — and is responsible for 10% of its total national production value, while offering a sustainable lifestyle to its 600,000 residents.

Anji County is located in Zhejiang Province, China, and is well known for its abundant bamboo resources. In recent years, Anji has achieved a synergistic development of its economy and environment by actively promoting bamboo-based industries and bamboo forest protection initiatives. In 2012, Anji won the UN Habitat Award, becoming a world-renowned model of sustainable communities.

Jingwu Village: A village with bamboo as its livelihood

Jingwu Village is located in the northeastern part of Anji County, where over 1000 hectares of bamboo are planted. It is a well-known village in Anji that specializes in bamboo and uses it as a development foundation. In Jingwu, bamboo covers the mountains and fields, not only as a common sight but also as a key source of sustainable livelihoods for the villagers: Most farmers in the village rely on bamboo for their livelihoods, with wisdom passed down from generation to generation.

The data shows that bamboo weaving, a traditional intangible cultural heritage, has generated CNY 8 million for Jingwu in recent years, accounting for more than 30% of the village's total economic income. Luo's Workshop is one of the dozens of workshops in Jingwu that engage in bamboo weaving, founded by Mr. Luo Siqing, a skilled craftsman, and specializes in producing high-end handicrafts such as bamboo bags, bamboo flower vases and bamboo tea sets with exquisite craftsmanship and durable quality.

As woven bamboo products are gaining popularity among consumers at home and abroad, more and more young people are returning to their hometowns to engage in the woven bamboo industry. Under the guidance of the inheritor of Luo's Workshop, Mr. Luo Cheng, the workshop has gradually expanded its production scale and built a complete "bamboo-product" industrial chain. Mr. Luo is also trying to tap into the online market to further boost the influence of Jingwu's woven bamboo products. "Currently, about 40 villagers work in the workshop, and every step from bamboo harvesting to product weaving and shipping is completed in Jingwu," Mr. Luo told us.

Relying on its rich bamboo resources, Jingwu has gradually formed some small-scale local bamboo processing industries, which have been developed without destroying the natural environment. For example, Youjing Crafts Factory, which is adjacent to Luo's Bamboo Art, has a number of small production lines, mainly processing bamboo chopsticks, bamboo tubes and other daily-use products. In talking to villagers, we learned that the factory's production lines provide employment at home for about 40 residents, most of whom are women, elderly and persons with a disability who have been left behind in the village. "At our factory, each employee earns about 3,000 yuan per month, which significantly improves their lives," the head of the factory shared.

Natural heritage conservation for sustainable community development

The movie *"Crouching Tiger, Hidden Dragon"* directed by Ang Lee was filmed in Anji's Big Bamboo Sea. This expansive, verdant bamboo forest, with its cascading bamboo waves and serene and beautiful natural scenery, became the stage for martial arts warriors to showcase their skills in the movie, and shaped classic scenes in the film with a unique Chinese aesthetic. The film's blockbuster success made the Big Bamboo Sea known to global audiences, greatly promoting the development of local cultural tourism.

The high-altitude glass bridge is a popular tourist attraction in the Big Bamboo Sea. Credit: Big Bamboo Sea in China.

Construction workers in Zhujing building a large bamboo building. Credit: Hainan Daily, Zhujing.

"The Big Bamboo Sea has brought tangible and substantial benefits to local villagers, helping them embark on the path to common prosperity," Li Hong, head of the scenic area, told us. "The bamboo forests here need to be regularly harvested and replanted to maintain the scenery. This task is prioritized to be undertaken by local villagers," he added. Most job opportunities in the area are open to local residents, such as managing parking lots, serving as tour guides and operating souvenir shops. Currently, more than 30 managers in the scenic area are from Anji. This not only increases the income of more than 100 villagers nearby, but also enables them to directly participate in the daily operation and management of the scenic area, thereby enhancing the sense of belonging of local residents and stimulating community vitality.

The increasing number of tourists has accelerated the economic development of surrounding villages. Many villagers have converted their idle houses into homestays or farm-to-table restaurants to accommodate visitors from around the world. At the same time, local agricultural products such as bamboo shoots, bamboo wine and bamboo toys are sold to tourists, further promoting the development of the community economy. "According to the latest statistics, there are now more than 4000 homestay rooms near the Big Bamboo Sea, and there are about 200 farmhouse restaurants. The retail value of specialty agricultural products now exceeds CNY 20 million," Li Hong introduced. Through this multi-stakeholder participation and a mutually beneficial approach, the Big Bamboo Sea not only preserves Anji's rich ecological resources but also achieves the synergistic development of culture and tourism, achieving a win-win situation between social and economic benefits.

Empowering public spaces in communities

Anji's rich bamboo resources not only provide the raw materials for traditional handicrafts, but they also form scenic landscapes that purify the mind and body. Bamboo is innovatively utilized in the construction of public buildings, showcasing a unique ecological architectural style and becoming a part of beautiful scenery in the community. One Anji-based bamboo design and construction company, Zhujing, has always been committed to the application of bamboo resources in modern architecture, opening up a whole new world for bamboo in the fields of architecture, spatial design and cultural creativity.

The Chairman of Zhujing Company, Cai Wei, explains: "Bamboo regenerates quickly and has a strong carbon absorption ability, which aligns with the current sustainable development concept. At the same time, bamboo has excellent tensile strength, compressive strength and flexibility. Coupled with its cultural importance in the East, it has great market potential. This is why Zhujing is dedicated to this material and continuously expanding its application prospects." Through collaboration with research institutions and independent studies, Zhujing has successfully mastered the core technologies for the preservation of original bamboo, as well as mold and insect prevention. The company has been granted nearly 20 authorized patents, including an invention patent for "Antiseptic and Mold-proof Treatment Technology for Original Bamboo," which addresses anti-mold treatment, and a utility model patent for "Support Base for Original Bamboo," designed to enhance the support structure of bamboo building. After eight years of strengthening the Anji market, Zhujing has successfully completed over 40 bamboo structures in Anji, significantly contributing to the establishment of Anji's reputation as a national hub for showcasing bamboo architecture.

"Because bamboo architecture is beautiful in shape, has a strong visual impact and leaves a lasting impression, it is suitable for application in public and commercial spaces." Cai shared. One good example of this is the Zhujing Bamboo Culture Neighborhood, which acts as a community public space created by the company. This is enabled by integrating the local bamboo-related plantation, manufacturing and leisure and tourism industries. The bamboo on the mountain in the village is bought by Zhujing at a favorable price, and then processed and built into the street area. The street attracts tourists by means of bamboo cultural tourism and the sale of bamboo cultural products. In addition,

Founder Luo Siqing working on bamboo weaving. Credit: Frida Liu.

local villagers can also come here to relax in their spare time. It represents a communal public space that has been built and is now governed by the villagers, with benefits accessible to all.

A new material for young designers

In recent years, as the world has deepened its interest in sustainable development, bamboo, as an environmentally friendly building material, has become increasingly valued. To realize the creativity of young designers and combine it with Anji's rich bamboo resources, the Anji government has teamed up with INBAR, China Bamboo Industry Association (CBIA) and other important organizations to hold regular bamboo architecture design competitions for colleges and universities in order to encourage young architects to use bamboo for innovative design. They also hope that this will provide more ecological awareness for the construction of sustainable communities in the future.

The "Wind Riding Paragliding Club | Spiral Bamboo Pavilion" project designed by the Southeast University (SEU) team won first prize at the Third National Bamboo Design and Construction Competition. This project effectively connects landscapes, line of sight and specific usage scenarios at different elevations through the simple yet dynamic form of a spiral, leveraging the site's topography. Bamboo's excellent bending performance and tensile strength make this spiral form feasible. Inside the pavilion, one can gaze up at the lightweight roof woven from raw bamboo, gentle curves outlining a unique contour. Windows positioned facing different directions frame views of the mountains, lakes, sky and paragliding, creating a rich spatial experience characterized by the interplay of light and shadows and constantly changing perspectives.

For Peng Sixiang, a member of the Spiral Bamboo Pavilion design team, this was his first serious experience working with bamboo

The Spiral Bamboo Pavilion seamlessly blends into the tranquil bamboo forest. Credit: Frida Liu.

materials. "Bamboo is an unconventional material for architecture students, but I can see the feasibility of using raw bamboo for temporary structures and public space buildings. We may explore these directions in the future," he shared. Considering the durability of the structure, the team added a metal roof on top of the bamboo roof to ensure waterproofing and extend the building's lifespan. This also served to visually fuse modern architecture with traditional materials. "This was the second time that Southeast University has participated in the bamboo architecture design competition. The competition provides a platform for universities to experiment and explore frontier technologies and sustainable building-related knowledge," said Wang Yifan, an associate professor who served as a mentor for the SEU team. In her opinion, this competition provides an opportunity for students to integrate conceptual design with practical implementation, laying a foundation for the younger generation to build sustainable communities.

We can see the important role that bamboo has played in facilitating Anji's transformation from a bamboo township to a bamboo-based sustainable city. This process is inseparable from achieving a balance between humankind and nature, utilizing bamboo while promoting a joint participation model with shared benefits among the community. We look forward to the Anji experience being replicated elsewhere, benefiting more residents and the environment.

SOPHIE ON, FRIDA LIU
Sophie On is a sustainable development specialist employed by consultancy agency yehyehyeh, one of China's most influential sustainable fashion organizations. Frida Liu is the sustainable development content editor of the Wall Street Journal Chinese Edition.

BAMBOO COMPOSITES FOR MODERN CONSTRUCTION

Walls of bamboo composite material. Credit: Feng Pengfei.

Bamboo composites are making waves in the construction sector as a new type of green, low-carbon and renewable material.

In recent years, driven by the low-carbon economy and sustainable development, there has been increasing research into and development of bamboo composite materials around the world. With features like renewability, high strength, lightweight properties and easy processing, bamboo composites are increasingly being used in construction, furniture, automotive and packaging industries. These composites are ideal for integration with sustainable development initiatives. But there is still not enough awareness about the untapped potential of this resource.

What are bamboo composite materials?

Bamboo composites are versatile engineered materials, capable of being made into different forms suitable for different construction types. This variety offers innovative solutions for expanding material choices and advancing sustainable development in the building industry.

Bamboo fiber-reinforced composite materials are created by combining bamboo fibers with a polymer matrix. Techniques such as spinning and spraying are used to effectively integrate the bamboo fibers with the polymer matrix. These composite materials exhibit excellent mechanical properties and weather resistance, making them suitable for use in beams and columns.

Bamboo-wood composite materials refer to composite boards or squares made by blending bamboo and wood. These types of materials balance the flexibility of bamboo with the stability of wood, overcoming drawbacks like deformation and cracking. In construction, bamboo-wood composite materials are a popular choice for flooring and wall panels.

Bamboo-plastic composites are made by merging bamboo and plastic through processes such as hot pressing and extrusion. This composite offers the natural texture and appearance of bamboo alongside the water and corrosion resistance of plastics. It is commonly used in outdoor elements like doors, windows and balconies.

Applications in construction

As a new type of building material with lightweight, high strength, and environmental friendliness, bamboo composite materials are highly promising for widespread application in wall structures.

First, bamboo composite materials can be used as the primary load-bearing components in wall structures due to the high strength and rigidity. Compared with traditional brick-concrete structures, the use of bamboo composite materials can reduce the weight of the overall structure and improve the seismic performance of the building. Second, bamboo composite materials, as bamboo inherently offers excellent thermal insulation properties. Moreover, the filler materials used in bamboo composites can be selected for insulating capacity, such as polystyrene foam boards. Thoughtful design and material selection can enable bamboo composite materials to reduce heat transfer, enhance insulation and lower energy consumption in walls structures. Third, bamboo composite materials bring charm and beauty with its natural texture. Using bamboo composite materials in buildings not only meets functional requirements but also creates a warm and inviting aesthetic.

However, obstacles still remain for integrating bamboo materials in construction projects. Bamboo's sensitivity to moisture necessitates moisture-resistant and anti-corrosion treatments to maintain stability. Manufacturing and processing technologies of bamboo composite materials also need upgrading to boost their performance and lifespan.

Applications in floor decorations

Bamboo composite materials have been widely used in floor decorations, with great potential for further incorporation owing to their myriad beneficial properties.

Since they are light, bamboo composite materials can reduce the overall floor weight since they are less dense and lighter than traditional flooring materials, facilitating ease of transportation and installation while reducing the load. Bamboo can also mute floor vibrations and noise to create a cozy living environment. These floors are combined with a polymer resin to increase the strength and wear resistance, and have high water resistance, making them suitable for high-traffic areas like commercial centers or office buildings. Aside from its structural qualities, environmentally speaking, bamboo is a renewable resource capable of rapid growth on marginal and degraded soils. In fact, while some timber crops take decades before they can be harvested, bamboo can be harvested in just three to five years. Meanwhile, floors made with bamboo composite materials use environmentally friendly adhesives.

With all its natural benefits, bamboo composite materials are natural selections for flooring. As the world looks for sustainable solutions to global problems, bamboo will play an increasingly larger role in the construction sector as a floor decoration.

Environmental advantages

Bamboo composite materials are more environmentally friendly than traditional building materials, requiring less energy and producing no harmful emissions during manufacturing, aligning with sustainable development goals.

Bamboo composite materials are also renewable and recyclable, with bamboo's rapid growth ensuring an abundant and consistent supply. They can be reused throughout their life cycle, optimizing resource use in construction and reducing pressures on other natural resources. They are also effective at thermal insulation, leading to a reduction in energy consumption, while also absorbing jarring noises.

In addition, bamboo composite materials help protect the environment by sequestering carbon dioxide during growth, reducing greenhouse gases. Since the construction sector is responsible for 40% of global carbon emissions, the application of bamboo composite materials for structures can not only conserve non-renewable resources but also contribute to lowering emissions.

Given the bevy of good qualities, bamboo is well suited as a pro-environment building material, with broad applications in the sector.

Four challenges to consider

As an emerging building material, bamboo composite materials are being increasingly used in construction. However, new challenges have emerged as use of the material becomes increasingly mainstream.

Durability — Although bamboo itself has natural resistance to corrosion and insect damage, bamboo composite materials still face environmental challenges over longer periods of time from factors such as UV radiation, humidity and temperature fluctuations. These factors can lead to a deterioration in performance and even result in problems like cracking and warping.

Mechanical properties — Despite their excellent mechanical properties, such as high strength and light weight, bamboo composite materials may have limitations in other aspects. For instance, bamboo fibers have weaker directional strength, susceptibility to cracking or stretching and inadequate compressive strength for some structural applications.

Fire resistance — Since bamboo is inherently flammable, bamboo composite materials require improved fire resistance for construction uses. This is one active vein of research into the material, namely, improving fire resistance via the addition of flame retardants. More research is necessary to validate results and ensure bamboo composite materials reach safety regulations.

Sustainability — Despite bamboo's inherently sustainability, from its full biodegradability, renewability and low-carbon nature, the production of bamboo composite materials may involve chemical treatments and energy consumption that are less sustainable. Therefore, more attention should be paid to creating green production processes, such as in developing environmentally sound adhesives.

Vision for the future

Bamboo composite materials have good prospects for application in the construction sector. More research can also facilitate their entry and ensure the materials are meeting sustainability benchmarks. Future studies should focus on deepening our understanding of these types of composite materials, addressing both their advantages and shortcomings, driving technological innovation, enhancing their sustainable aspects, and promoting their broader adoption across the industry.

MAO LINHAI, SU LIJUN, ZHAO LEI
Mao Linhai is the general manager, Su Lijun is the Chairman, and Zhao Lei is the Deputy General manager of Zhonglin Green Carbon (Beijing)Technologies Co., Ltd.

Outdoor floor of bamboo composite material. Credit: Feng Pengfei.

Collating the latest international news and activities around bamboo and rattan sectors development

Bamboo as a Substitute for Plastic: China-Europe-Africa Forum on Bamboo Technological Innovation and Green Industry Cooperation held in Brussels on 17 October 2024.

New rattan initiative in Indonesia safeguarding environment and boosting economy

Kiranamulya "Kirana" Budi Arthanti, a 16-year-old student from Indonesia, helped a school project blossom into a major conservation initiative known as the Rattan for Life Project. Inspired by a visit to a rattan furniture factory, she used funding from a photo exhibition to plant 1400 rattan seedlings in the Meratus Mountains of South Kalimantan. Her project gained further momentum when she won the International Baccalaureate's Global Youth Action Fund competition, receiving a USD 3000 grant. With this additional financial support, Kirana expanded her efforts by purchasing and planting an another 6000 rattan seedlings alongside local environmental activists, villagers and officials.

The project not only promotes environmental conservation but also aims to improve the local economy by generating sustainable income sources through rattan cultivation, which is an important non-timber forest product. Kirana's initiative has received widespread recognition from local leaders and environmental stewards who view it as a model for sustainable development and youth-led action. By merging conservation with community empowerment, Kirana hopes to inspire others to protect Indonesia's natural resources and contribute to building sustainable livelihoods.

Source: The Jakarta Post, 23 August

Empowering locals in Zambia with furniture and handicraft training

A recent bamboo training initiative in Vizimumba, a village in Zambia's Eastern Province, has empowered the local community by teaching them skills to produce furniture and handicrafts with bamboo. This effort, led by INBAR in conjunction with local partners, seeks to address economic challenges and environmental degradation. By creating a sustainable value chain for bamboo,

the program helps participants diversify income streams, reduces dependency on traditional farming practices and also contributes to mitigating deforestation. Trainees, particularly women, have gained a newfound sense of financial independence, improving their quality of life and fostering community resilience.

Through the training, artisans learned how to blend traditional techniques with modern innovations to create high-value bamboo products. This sustainable model bolsters economic opportunities and is in alignment with conservation goals, as bamboo is a renewable resource that is also capable of sequestering a large amount of carbon. The program's success highlights the potential of targeted capacity building and sustainable resource use to transform rural livelihoods while advancing environmental stewardship.

Source: CIFOR-ICRAF Forest News, 9 September

Bamboo delivering low-cost sustainable solutions to Liberia's sanitation challenges

In Liberia, sanitation issues such as open defecation continue to stymie development efforts, contributing to health risks like waterborne diseases and malnutrition. To tackle this, innovative efforts are enabling greater access to proper sanitation equipment through the USAID-funded Countywide Sanitation Activity (CWSA). Launched in 2022, this five-year initiative emphasizes a market-based approach to deliver affordable and sustainable toilet solutions, including bamboo-framed toilets and the low-cost "safe toilet" (SATO) pans. These products are designed to improve durability and accessibility for rural communities, targeting areas like Lofa, Nimba and Grand Bassa counties.

The program also spearheads behavior-change initiatives and local capacity building to ensure long-term impact. Community members, such as those in Baila, have embraced these solutions, supported by training for local sales agents and partnerships with businesses to enhance availability and awareness. This model addresses immediate sanitation needs while driving economic growth via entrepreneur empowerment and sustainable supply chain creation for sanitation products.

CWSA has two ambitious goals: 1) Providing access to sanitation for 1.4 million people and 2) supporting 300 businesses by 2027. Success stories, such as highlighting particularly vulnerable members in the community benefiting from improved toilet facilities, can help demonstrate the transformative potential of integrating innovative design, affordability and community engagement. These efforts ultimately showcase the vital role of collaboration in advancing public health and quality of life across Liberia.

Source: Population Services International (PSI), 3 October

China-Europe-Africa Forum platforms bamboo innovation, industry cooperation and plastic substitution

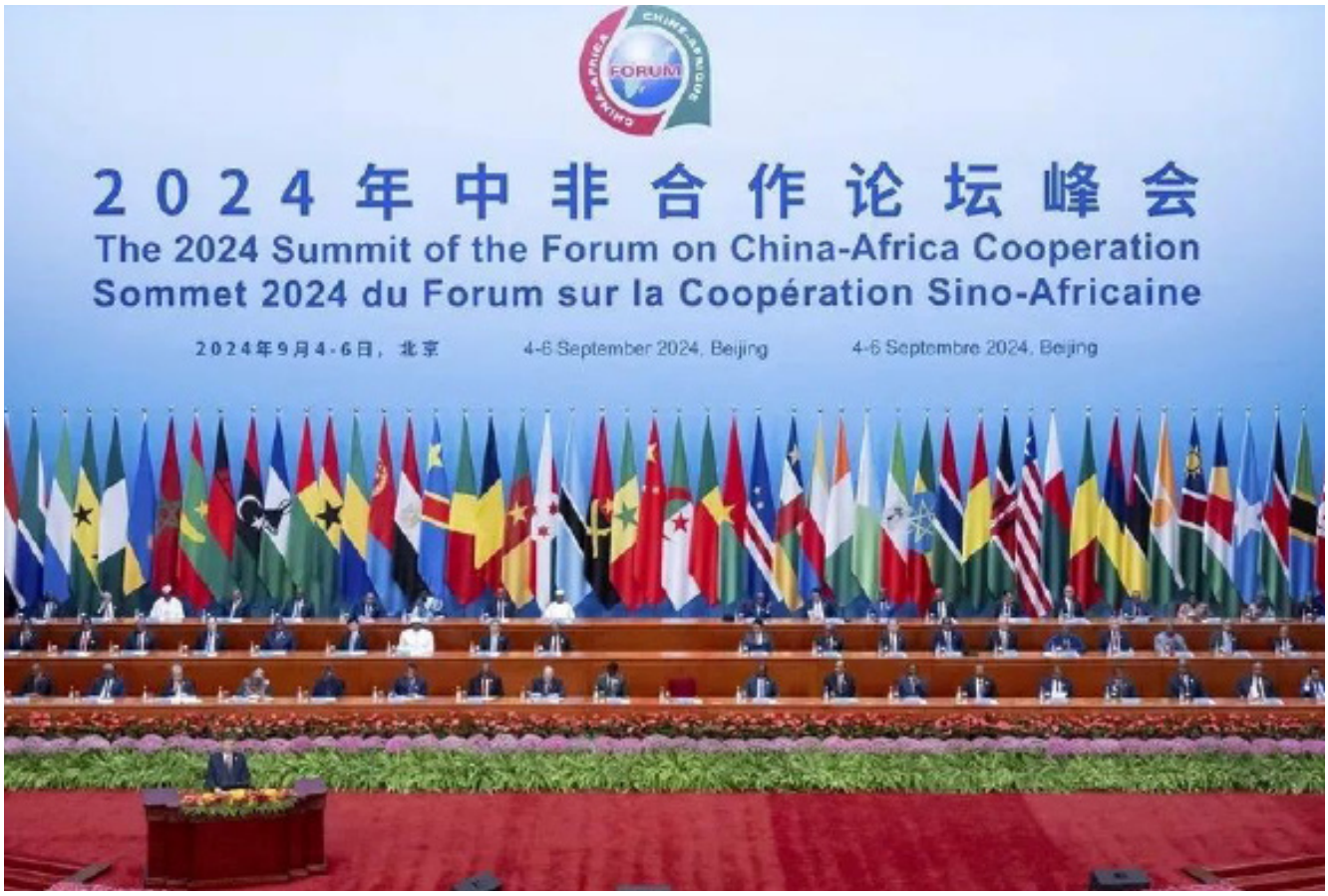
The China-Europe-Africa Forum on Bamboo Technological Innovation and Green Industry Cooperation was recently held at the China Cultural Center in Brussels, focusing on bamboo as a sustainable alternative to plastics. The event opened with cultural activities, including tea art demonstrations and bamboo calligraphy, fostering an engaging atmosphere for discussions on sustainability.

Key speakers from INBAR, China and other international organizations shared strategies for leveraging bamboo in low-carbon development and poverty reduction. Discussions included China's "Three-Year Action Plan" for the Bamboo as a Substitute for Plastic Initiative, the Cradle-to-Cradle sustainable design approach, and more.

Afterward, a panel session discussed bamboo's applications in industries like architecture and fashion, also mentioning some challenges for implementation. The forum called for strengthened global partnerships between actors in China, the EU and Africa to advance bamboo-based innovations, sustainable policy frameworks and transboundary climate solutions.

Source: Food and Agriculture Organization News, 17 October

INBAR commissions research, conducts project work and raises awareness about bamboo and rattan across its 51 Member States.



On 5 September 2024, Chinese President Xi Jinping attended the opening ceremony of the FOCAC Beijing Summit and delivered a keynote speech at the Great Hall of the People in Beijing. Credit: Xinhua News Agency reporter Zhai Jianlan.

INBAR strengthens partnership with Cameroon, promotes crafts sector

On 27 August 2024, Cameroon's Ministry of Small and Medium-sized Enterprises, Social Economy and Handicrafts (MINPMEESA) and INBAR's Central Africa Regional Office (CARO) formalized their partnership at an important ceremony in Mbalmayo, signing a Memorandum of Understanding and delivering equipment to the Special Craft Village of Mbalmayo. The objectives of this ceremony were twofold: To formalize the strategic cooperation between MINPMEESA and INBAR and to improve the working conditions of artisans specializing in bamboo and rattan crafts in Mbalmayo.

The ceremony, held under the patronage of H.E. Paul Biya, President of the Republic of Cameroon, was marked by the presence of Ministers H.E. Achille Bassilekin III of MINPMEESA and H.E. Hele Pierre, Ministry of Environment, Nature Protection and Sustainable Development, as well as senior government officials. After the ceremony concluded, as part of The Restoration Initiative project, René Kaam, Director of INBAR CARO, handed over 50 pieces of important equipment to the artisans of the Special Craft Village of Mbalmayo, including drills, grinders and gas tools.

Bamboo highlighted at 2024 FOCAC Beijing Summit

From 4 to 6 September 2024, the Beijing Summit and the Ninth Ministerial Conference of the Forum on China-Africa Cooperation (FOCAC) was held in Beijing, where the Forum on China-Africa Cooperation Beijing Action Plan (2025-2027) was passed.

According to this plan, the key measures to support Africa by the Chinese side in the next three years include advancing the development of a China-Africa Juncao Cooperation Center and a China-Africa Bamboo Center. It also points out that China and Africa will continue to enhance cooperation with international organizations like INBAR and work with the African side to promote cooperation for implementing the Bamboo as a Substitute for Plastic Initiative.

Group of Latin America and Caribbean Countries in China visits INBAR's CIFTIS exhibit

On 13 September 2024, INBAR's Pavilion at the 2024 China International Fair for Trade in Services (CIFTIS) was visited by diplomats and dignitaries. Led by H.E Mr. Fernando Lugris, Ambassador of Uruguay to China and Dean of the Group of Latin American and Caribbean countries (GRULAC) in China, 15 diplomats of GRULAC visited the INBAR Pavilion.

Prof. Jiang Zehui, Co-Chair of the INBAR Board of Trustees, attended and delivered a welcome speech, noting that two previous dialogues and exchange activities have been held in recent years. Lugris spoke next, expressing that Latin American and the Caribbean countries place great importance on environmental protection and sustainable development. The CIFTIS visit showcased the achievements of bamboo's industrial development and ultimately helped spread bamboo and rattan knowledge.

Bamboo recognized at key trilateral forum in Brussels

On 17 October 2024, the Chinese Mission to the EU and INBAR jointly held the forum Bamboo as a Substitute for Plastic: China-EU-Africa Forum on Bamboo Technological Innovation and Green Industry Cooperation in Brussels, Belgium. The event was jointly co-hosted by ICBR, the Europe-Asia Center and the China Cultural Center in Brussels.

Diplomats from Latin American and Caribbean countries visited the INBAR Pavilion at the 2024 CIFTIS.

Hosted in Costa Rica, The V Latin American and Caribbean Bamboo Symposium celebrated bamboo, strengthened technical skills and fostered exchange of best practices for global participants.

Speakers at the forum included Prof. Jiang Zehui, Co-Chair of the INBAR Board of Trustees, and H.E. Cai Run, Chinese Ambassador to the EU, among other dignitaries. At the event, bamboo was heralded as an "effective entry point" for trilateral cooperation between China, the EU and Africa. Afterward, an exhibition was held showcasing the diverse uses of bamboo, particularly for replacing many plastic products.

Bamboo as a Substitute for Plastic at UNFCCC COP29

Strategically responding to plastic pollution has recently become a hot topic in the field of global environmental governance. In November 2022, China and INBAR jointly launched the BASP Initiative to deepen global cooperation on plastic substitution and leverage bamboo's unique attributes in replacing plastic products. This can help us create a planet that is greener and cleaner for future generations.

On 18 November 2024, INBAR and the National Forestry and Grassland Administration (NFGA) of China held a joint side event on "Harnessing Climate Action to Reduce Plastic Pollution: Bamboo as a Substitute for Plastic Initiative" at China Pavilion of the 29th Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC COP 29). Leadership from INBAR and NFGA delivered presentations showcasing the potential of bamboo for replacing plastic products, highlighting the importance of integrating the BASP Initiative into both international and national strategic planning frameworks.

Driving sustainability with bamboo: The V Latin American and Caribbean Bamboo Symposium

Latin America and the Caribbean is globally recognized for its biological and cultural wealth. Bamboo has been at the intersection of humans and the environment for thousands of years in the region. From its use by the Las Vegas culture in Ecuador as the primary material for building homes and temples to its presence in ancient civilizations such as Caral in Peru, Calima in Colombia, and Talamanca and Boquete in Panama, bamboo has played an essential role in the cultural, economic and environmental development of the region.

The national flag of the Oriental Republic of Uruguay is hoisted above INBAR Headquarters.

Celebrating that history, from 19 to 23 November 2024, the V Latin American and Caribbean Bamboo Symposium was held at the National University of Costa Rica (UNA). Co-organized by UNA, INBAR, the Colombian Bamboo Society and the International Network of Universities and Research Centers for Bamboo (RIUCI-Bamboo), along with other local stakeholders, this landmark event took place under the theme "From its Roots: Diversity and Uses." The symposium brought together over 150 participants from 18 countries in Latin America and the Caribbean, Europe and Africa to share knowledge about the advancements, current uses and potential of bamboo in the region, ultimately highlighting the resource's versatility and benefits in generating income and combating climate change.

Putting the missing pieces into the puzzle: Bamboo as a key non-plastic substitute

The fifth session of the Intergovernmental Negotiating Committee (INC-5) to develop an international legally binding instrument on plastic pollution, including in the marine environment (ILBI), was held from 25 November to 1 December in Busan, Republic of Korea. INBAR participated the INC-5 session, submitting a written statement and observing the negotiations.

INBAR invites all nations, civil society organizations and international bodies to join the Bamboo as a Substitute for Plastic Initiative, launched by INBAR and China in 2022. This initiative is crystalizing efforts and actions with stakeholders to mitigate plastic pollution and effect positive changes for people and planet. Moving forward, life cycle assessments of bamboo applications could help build the evidence-based foundation for generating more buy-in to the project, a circular economy approach can boost resource efficacy in bamboo value chains and other measures like standards, preferential trade policies and non-tariff-related measures can all help facilitate a just transition to a more environmentally sustainable world.

Flag-Raising Ceremony for the Oriental Republic of Uruguay

On 28 November 2024, INBAR celebrated the accession of the Oriental Republic of Uruguay into the INBAR family. Delegates from INBAR, the Embassy of Uruguay in China, the Ministry of Livestock, Agriculture and Fisheries of Uruguay, the Embassy of Nepal in China, and the NFGA of China were invited to take part in a Flag-Raising Ceremony held at INBAR Headquarters in Beijing, China.

Mr. Carlos Faroppa, Director General of the Forestry Department of the Ministry of Livestock, Agriculture and Fisheries of Uruguay, spoke at the ceremony. He mentioned that this moment represents a new commitment from Uruguay and China, highlighting INBAR as an example of collective efforts contributing to global sustainability. In Uruguay, the forestry sector impacts many people, with the country witnessing significance growth in recent years. At the same time, as a deforestation-free country, Uruguay has a long tradition of caring for its national resources. Uruguay is now ready to harness bamboo as an emergent resource with great potential for sustainable development, social inclusion, environmental conservation and job creation.

INBAR ANNUAL INTERNATIONAL PHOTO COMPETITION

First place in the category Bamboo and Rattan as Plastic Alternatives: "Making coiled lacquerware with bamboo." Credit: Myat Zaw Hein, Myanmar.

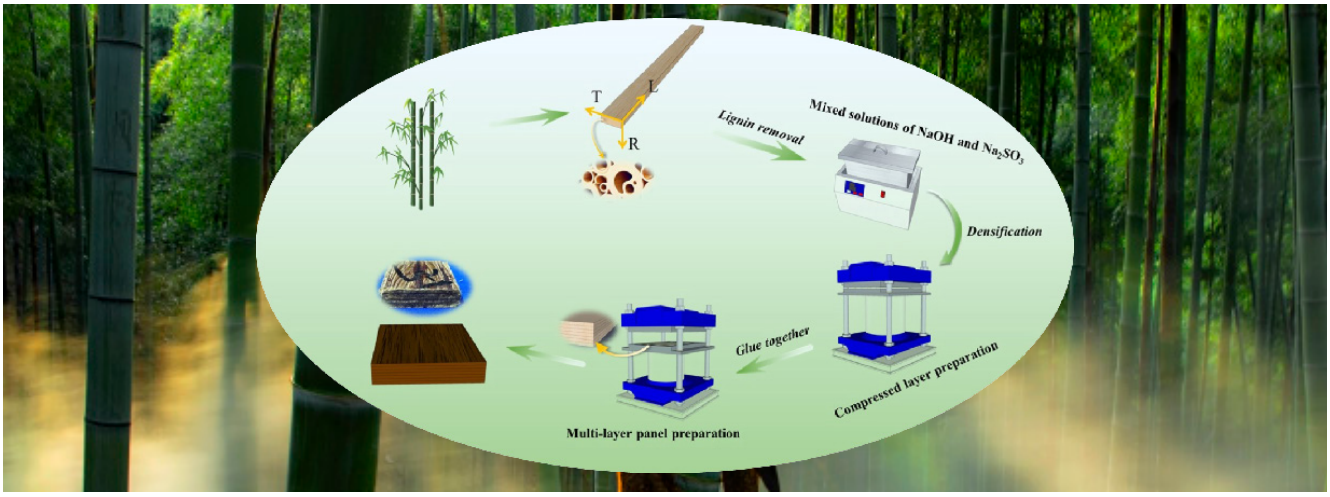
This year's photo competition highlighted outstanding creativity from the participants, with over 200 entries from around the world showcasing the beauty and versatility of bamboo and rattan.

INBAR remains dedicated to promoting these remarkable plants for sustainable development, with photo competition participants playing a key role in this mission. Their photographs offer a glimpse into how bamboo and rattan are intricately woven into our daily lives. A distinguished panel of photographers selected the top images in this year's three categories: Bamboo and rattan as plastic alternatives; Industrial or craft innovations related to bamboo and rattan as substitutes for plastic; and Community impacts of bamboo and rattan.

Discover the stories behind these photos and also the second and third places in each category at www.inbar.int/announcing-the-winners-of-the-2024-international-bamboo-and-rattan-photo-competition/

First place in the category Industrial or Craft Innovations Related to Bamboo and Rattan as Substitutes for Plastic: "Intrecci liberi." Credit: Iacopo Bertolini, Italy.

First place in the category Community Impacts of Bamboo and Rattan: "Planting bamboo." Credit: Aung Kyaw Zaw, Myanmar.



Schematic diagram illustrating the preparation process of composite-modified glued bamboo.

Augmenting bamboo strength and thermal stability for green construction

In recent years, more attention has been paid to the fire retardant capability of modern wood structures, in particular focusing on how the high thermal conductivity of metal fasteners may accelerate charring of the adjacent wood and compromise the fire resistance of joints. In the context of global climate change and energy shortage, bamboo, as a sustainable material, has great potential in structural applications. Studies have shown that the mechanical properties of bamboo can be strengthened via physical and chemical modifications, such as by removing lignin and hemicellulose while retaining the original fiber direction and hierarchical structure, and then subjecting the material to hot pressing.

High-strength biomaterials like bamboo show immense potential as alternatives to metal fasteners; however, their performance and reliability in extreme high temperature environments are still question marks in the research landscape. To this end, Chinese researchers have developed an environmentally friendly, high-performance composite bamboo plywood, providing an alternative to metal fasteners for sustainable construction, and also demonstrating a high-value application of bamboo as a green and safe building material.

A recent study investigated the mechanical properties of the composite bamboo plywood. It found that the modified composite materials significantly improved the "modulus of elasticity, bending and tensile strengths of bamboo" while delivering "a slight improvement in compressive strength." In comparison to natural bamboo, after performing the optimal alkaline treatments, researchers observed improvements in the modulus of elasticity by 180%, bending strength by 220% and tensile strength by 170%. The lengthened alkaline treatment procedure also led to improvement in ductility, indicating that the material maintains its strength while being capable of a certain degree of deformation. Through thermal stability analysis, it was discovered that the limiting oxygen index of the composite bamboo plywood was positively correlated with the modification time, indicating that the modification treatment improved the fire resistance of bamboo and made bamboo less likely to burn in the air.

Cone calorimetry was used to test the combustibility of the composite bamboo plywood. The results showed that compared with untreated bamboo, the treated bamboo had superior flame retardant properties and thermal stability. The composite bamboo exhibited improved mechanical properties, including reduced voids, higher glass transition temperature and maintained cell well integrity, resulting in good interfacial interaction and stress transfer

Summary of article published by Qian, J., Yue, K., Liu,. S., Lu, D., Wu, P., and Li, Q. in *Journal of Cleaner Production*, Volume 451, 20 April 2024.

EVENTS

6–12 October
International Bamboo Exchange Experience Tour (Central American and Caribbean countries)
Panama, Costa Rica, Cuba, Dominican Republic

17 October
International Day for the Eradication of Poverty

17 October
Bamboo as a Substitute for Plastic: China-EU-Africa Forum on Bamboo Technological Innovation and Green Industry Cooperation
Brussels, Belgium

21 October - 1 November
16th meeting of the Conference of the Parties (COP16) to the Convention on Biological Diversity
Cali, Valle Del Cauca, Colombia

24 October
Webinar on Bamboo Policy Integration Across Continents: Lessons from Latin America, China, India and Africa
Online

24 October
United Nations Day

31 October
World Cities Day

6 November
INBAR Establishment Day

11 - 22 November
29th Conference of the Parties (COP29) to the UN Framework Convention on Climate Change
Baku, Azerbaijan

19 - 23 November
5th Latin American and Caribbean Bamboo Symposium
Heredia, Costa Rica

13 - 27 November
2024 International Online Seminar – Bamboo in Africa: Pathways to Sustainable Construction and Development
Online

25 November - 1 December
The fifth session of the Intergovernmental Negotiating Committee on Plastic Pollution (INC-5)
Busan, Republic of Korea

28 Nov 2024
Flag-Raising Ceremony for the Oriental Republic of Uruguay
Beijing, China

1 - 6 December
60th Session of the International Tropical Timber Council and Sessions of the Associated Committees
Yokohama, Japan

11 December
World Soil Day

11 December
International Mountain Day

2 - 13 December
16th session of the Conference of the Parties (COP16) of the UN Convention to Combat Desertification (UNCCD)
Saudi Arabia

11 - 13 December
The Second International Young Scientist Forum – Bamboo Resources in a Changing Climate
Online & China

For more information, please see INBAR's event page: https://www.inbar.int/events/.

Delegates from the Forestry Commission of Guyana, EU Delegation of Guyana, Expertise France and INBAR's Latin America and the Caribbean Office visited the Allpa Bambu Bamboo Transformation Center in Pichincha, Ecuador.

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