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Conference Report

Outcomes of the Fifth International Conference on Bioscience and Biotechnology, 2024 (ICBB-2024): Planetary Health—A Local Discourse

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Abstract: The Fifth International Conference on Bioscience and Biotechnology, 2024 (ICBB-2024), held in Godawari, Nepal, from 21 to 24 April 2024, aimed to address planetary health challenges within the local context of Nepal while fostering global dialogue. Bringing together 240 participants from 10 countries, including 20 international invited speakers, the conference sought to explore the intersections of human health, environmental sustainability, and societal well-being. Jointly organized by the Research Institute for Bioscience and Biotechnology (RIBB), the University of Nepal Development Board (UoN-DB), Vrije Universiteit Amsterdam (VUA), and the Himalayan Environment Research Institute (HERI) and co-organized by Phutung Research Institute (PRI), Kathmandu Research Institute for Biological Sciences (KRIBS), Engage Nepal with Science (ENwS), and Kathmandu Center for Research and Education (KCRE), the conference represented a collaboration of 15 institutions and companies. With attendees from diverse backgrounds—academia, research institutes, private companies, NGOs, and government organizations—the conference featured a robust program of keynotes, workshops, panel discussions, focus group discussions, and oral and poster presentations. Thematic focuses included sessions on Air and Water, Climate Change, Ecology, Evolutionary and Environmental Sciences, and Global Health. A major highlight was the recognition of Nepal's rich biodiversity and its vulnerability to the impacts of climate change. The event drew inspiration from the European Planetary Health Hub, convening and exploring sustainable, locally relevant solutions to global planetary health issues. Outcomes of the conference included new research collaborations, an enhanced focus on interdisciplinary approaches to biodiversity conservation, and a deeper understanding of how indigenous knowledge can play a crucial role in environmental sustainability. Additionally, ICBB-2024 set a precedent for eco-friendly conferencing practices by emphasizing sustainability throughout the event. In conclusion, ICBB-2024 succeeded in fostering meaningful dialogue and collaboration, inspiring both local and

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global actions to address pressing planetary health challenges. The event underscored the importance of integrating science, policy, and traditional knowledge in the pursuit of sustainable solutions for planetary health.

Keywords: planetary health; transdisciplinary research; biodiversity loss; climate change

1. Introduction

Glacier by Yuyutsu Sharma

A hope that someday I shall sprout
like a tree on the edge of a remote hillside.
A hope that someday a Queen-of-the-Night
shall bloom in my chest and draw out all the smoke
I have inhaled in these malignant cities.
A hope that someday a newborn brook shall cleanse
and wash away the bacteria of greed within me.
A hope that someday a Buddha meditating in the niche of a cairn
beside the city's garbage heap shall rise, shake his limbs,
and walk away toward the village of eternity to take another birth,
to save me from the shame of becoming a glacier.
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The Fifth International Conference on Bioscience and Biotechnology, 2024 (ICBB-2024), held in Godawari, Lalitpur, Nepal, from 21 to 24 April 2024, brought together a diverse assembly of minds, ideas, and actions to confront the pressing challenges of planetary health. Organized by the Research Institute for Bioscience and Biotechnology (RIBB), this biennial conference continued its tradition of fostering interdisciplinary collaboration and knowledge exchange in bioscience and biotechnology [1]. The theme of the conference program (see Supplementary Material) for this year, "Planetary Health–A Local Discourse", ICBB-2024, provided a platform to delve into the complex relationship between human health, environmental sustainability, and societal well-being, emphasizing local perspectives with global implications.

Inspired by the previous Planetary Health meetings at ARTIS (Amsterdam, the Netherlands) [2,3], which established a robust transdisciplinary network for addressing planetary health challenges, RIBB aimed to replicate this impactful approach in Nepal. The profound impact and collaborative spirit observed at the conference organized by Prof. Remco Kort motivated our effort to address local planetary health issues. Nepal's distinctive status as a biodiversity hotspot and its vulnerability to environmental degradation, despite minimal greenhouse gas emissions, underscored the importance of this discourse [4]. The threats to human health, food security, and livelihoods (World Bank, 2023) highlighted the need for such an initiative in Nepal [5].

United Nations Secretary-General António Guterres, during his visit to Nepal in October 2023, also acknowledged Nepal's commendable efforts in climate action and emphasized the critical need for international support to assist Nepal in safeguarding both its future and the global environment. Unlike some developed countries, Nepal has not yet surrendered to environmental deterioration and still has the opportunity to reverse the damage. It stands as a reservoir of natural diversity and unique ethnic communities that harbor a wealth of traditional knowledge and dietary practices, which are yet to be fully explored through scientific research. While possessing immense potential, Nepal

generally lags behind in technological advancements, making international collaboration and support crucial.

The aforementioned elements collectively provided a solid foundation for organizing ICBB-2024, centered around the theme of planetary health: to address the urgent planetary health challenges highlighted by global discussions and the specific vulnerabilities of Nepal. The conference was organized with the aim of fostering collective action and developing local solutions grounded in the principles of equity, resilience, and sustainability. The conference emphasized the importance of integrating indigenous knowledge and traditional practices in promoting planetary health. Integrating the session, 'Unlocking the secrets of fermentation: an expedition into nourishing and sustainable culinary frontiers', into our initiative allowed us to deepen our understanding of both international and local fermentation practices. The presentation included a diverse range of international fermented foods, which complemented our demonstration of local alcohol fermentation processes. This integration not only enriches our exploration of global fermentation techniques but also highlights the value of local traditions, fostering a comprehensive appreciation of fermentation's role in sustainable and nutritious culinary practices. Indigenous communities, with their deep-rooted connection to land and resources, provide invaluable insights into sustainable living and ecosystem management [6,7]. By incorporating these perspectives into scientific research and policymaking, ICBB-2024 aimed to amplify marginalized voices and foster a more inclusive approach to planetary health [8]. The conference objectives included facilitating interdisciplinary discussions, promoting collaboration among local and international stakeholders, and raising awareness to inspire action on critical planetary health challenges.

The conference convened scientists, researchers, policymakers, and community leaders from 10 countries to engage in meaningful dialogue and collaborative efforts toward a sustainable future. With a diverse program featuring keynote addresses, invited speaker sessions, poster presentations, workshops, and networking opportunities, ICBB-2024 provided a comprehensive platform for learning and collaboration. The importance of hosting a local discourse in Nepal was emphasized, highlighting the relevance of addressing planetary health challenges in this unique setting and providing a strong foundation for the conference.

The theme of ICBB-2024, "Planetary Health", guided the conference's design and execution, highlighting the interconnectedness between planetary health and the well-being of all living organisms. Recognizing that every action, no matter how small, can have a profound impact on the environment and planetary health, the organizing committee meticulously designed the conference to align with its mission of promoting planetary health awareness and appreciation. Efforts were made to minimize environmental footprint by reducing plastic usage, opting for eco-friendly conference materials, avoiding disposable items and flex materials, and aiming to set a new departure for sustainable, planet-friendly conferencing. The conference venue within the Kathmandu Valley was chosen to enhance the connection with nature, and the agenda featured Nepal's rich food diversity, promoting sustainable dietary choices. ICBB-2024 provided an invaluable opportunity for students to present research, interact with international experts, and forge future connections. The conference also served as a critical platform for discussing local planetary health issues, fostering opportunities for research, policymaking, and awareness. By facilitating dialogue and knowledge exchange, ICBB-2024 aimed to catalyze progress towards a healthier, more sustainable future for Nepal and beyond. Here, we present the key takeaways, insights, and outcomes from the workshops, panel discussions, focused group discussions, graduate student sessions, and scientific sessions, such as Air and Water, Climate Change, Ecology, Evolutionary and Environmental Sciences, and Global Health.

2. Workshops

2.1. Workshop I, Transboundary Air Pollution in the Northern and the Southern Side of the Himalayas

The (Asia-Pacific Network for Global Change Research) APN-funded workshop on "Transboundary air pollution in the Northern and the Southern side of the Himalayas" brought together 30 leading experts from around the world. Guests from different countries, including China, the United Kingdom, the Netherlands, Hong Kong, and India, along with local participants from Nepal, participated in the workshop to discuss transboundary air pollution issues in South Asia. The event featured presentations from prominent researchers from China, India, and Nepal, covering topics such as particulate pollution in South Asia, transboundary pollution transport over the Himalayas and Tibetan Plateau (HTP), impacts of air pollution in the cryosphere and water resources, and the spatiotemporal characteristics of atmospheric aerosols over Indo Gangetic Plains (IGP) to the HTP. Prof. Shichang Kang inaugurated the workshop with an opening speech about the wider glance of atmospheric pollution and cryospheric change (APCC) over the HTP. After Dr. Lekhendra Tripathee gave a brief presentation on the APN funding, results on atmospheric aerosols from South Asia were presented. In addition, Dr. Pengfei Chen, Dr. Kirpa Ram, and Dr. Hemraj Bhattarai presented several issues and characteristics of air pollution. The round table discussions were held after the scientific presentations dividing the participants into three groups focusing on "Atmospheric Science", "Atmospheric Pollution and Cryosphere", and "Atmosphere and Water". Key problems identified during the discussion included the long-range transport of atmospheric pollution to remote and pristine areas of HTP. Some of the future directions were identified from the workshops, such as the need for the identification of new air pollutants (BC, As, Hg, MPs in the air) before they become worse, setting up a new standard for South Asia as emissions and implications are quite different from developed nations. In order to achieve this, an interdisciplinary approach is needed involving various specialists, including chemists, engineers, agriculture scientists, geologists, and environmentalists.

2.2. Workshop II, Mercury Matters: A Workshop on the Multifaceted Impact of Pollution

The workshop "Mercury Matters: A workshop on the multifaceted impact of pollution" brought together 30 leading experts from around the world, including guests from England, Scotland, the Netherlands, China, Hong Kong, and India, along with local participants from Nepal, to discuss the multifaceted impact of mercury pollution. The event featured presentations from prominent researchers from China and Nepal, covering topics such as transboundary mercury transport over the Himalayas, mercury in the cryosphere, the importance of mercury studies in aquatic environments, and the spatiotemporal characteristics of atmospheric particulate-bound mercury. After the completion of several presentations, roundtable discussions were conducted. These discussions divided participants into two groups focusing on "Mercury in the cryosphere and water" and "Atmospheric mercury pollution". Key problems identified during the discussion included the long-range transport of mercury to remote and pristine glaciers and rivers, which are the source of water for a significant population living downstream, the negative impacts on freshwater bodies and aquatic life, and the insufficient understanding of natural mercury sources compared to anthropogenic emissions.

The workshop concluded successfully, highlighting critical aspects of mercury pollution and fostering collaborative discussions among experts. The key takeaways emphasized the need for more focused research on natural sources of mercury, understanding mercury dynamics in the context of climate change, and enhancing monitoring and modeling efforts to address mercury pollution comprehensively. Participants recommended encouraging

more research on natural mercury sources, establishing local, regional, and global collaborations, increasing the number of monitoring stations to gather more data, and developing advanced models to predict and forecast changes in mercury emissions. The event underscored the importance of continued international cooperation and innovative research to tackle the complex challenges posed by mercury pollution. The collaborative efforts and shared knowledge from this workshop will be instrumental in addressing the multifaceted impacts of mercury pollution globally.

2.3. Workshop III, Climate Change at School Level—Young Scientists, Young Changemakers

During the first day of the conference, 30 students from eight different schools based in the Kathmandu Valley were selected to present 10 posters that highlighted their efforts in studying climate change in their area and their climate action initiatives. The participating schools were Mount View English Boarding School (Balkot), N. K. Singh Memorial English Preparatory High School (Baneshwor), Shree Basuki Secondary School (Lakuri Bhanjyang), Sungabha English School (Thaiba), Galaxy Public School (Gyaneshwor), Bright Future Secondary School (Naikap), Adarsha Kanya Niketan High School (Mangal Bazar), and Reliance Co. Ed (Kapan).

During the 2-h poster session, primary and secondary school students confidently presented their citizen science projects in front of renowned Planetary Health experts from all around the world. During their outstanding presentations, all the schools agreed that Nepal is one of the most vulnerable countries to climate change and that immediate national action had to be taken to protect their very important and varied ecosystems, which are exceptionally rich in biodiversity and freshwater resources. The main findings displayed by the students were that during the last few years, plastic had become a major waste component in their schools and their streets. Plastic is non-biodegradable and does not decompose, and it has become one of the most pressing environmental issues of our time. Students also studied air pollution using microscopes and using lichens as bioindicators to measure the air quality in their locality. Remarkably, some of the students had also been talking to older members of their families and their communities to understand the changes in weather patterns and biodiversity that have already been happening during the last 40–50 years and to assess how much they knew about climate change.

As a result of their observations, students presented the initiatives undertaken to address pressing issues and their future action plans to further reach their communities to continue empowering in environmental education and spreading environmental awareness. Some of the initiatives and future plans discussed included tree plantation programs to preserve local biodiversity, joining national and international programs to tackle invasive species, plastic-free initiatives, reusing plastic to give it a new life through art and other creative approaches, litter picking events, talks to local businesses to reduce the use of plastic bags and encourage the use of sustainable transportation, and last but not least, reduce consumerism. Some students collaborating with schools from other parts of the world to tackle the climate crisis also emphasized the importance of international cooperation to combat the biggest challenge of our time.

3. Kathmandu Center for Research and Education (KCRE) Graduate Student Sessions

3.1. Graduate Student Session I

The graduate student session was one of the parallel sessions in the conference, which was chaired by Dr. Alba Abad from the Wellcome Centre for Cell Biology, University of Edinburgh, UK, and moderated by Rojlina Manandhar from the Research Institute for Bioscience and Biotechnology, Nepal. The session covered the research topics from the

graduate students on different aspects of planetary health issues, i.e., the effect of climate change on the growth of indigenous rice variety, immune responses in HIV patients, use of Raman technology in the detection of *E. coli* in drinking water, reusing industrial waste as a bacterial growth medium, and detection of antimicrobial resistant genes from poultry farms. The objectives of the graduate session were as follows:

(i) to bring together students from different colleges, universities, and research institutes and share their research outcomes at an international conference;
(ii) to hone the communication skills of students on the scientific platforms;
(iii) to encourage and motivate students by recognizing their work with the best research awards.

The graduate talks were judged on the basis of the content of research work, presentation visuals, relation to planetary health, and ability to effectively answer the questions asked. All of the research works were very informative and competitive. Padma Shrestha from the Centre for Health and Disease Studies Nepal (CHDS-Nepal) won the graduate talk competition for her presentation "Molecular detection of *tet* A gene among *Staphylococcus aureus* isolated from litter and soil of poultry farms of Kathmandu Valley". Her research topic addressed a major public health concern over the use of antibiotics as a feed in poultry and the impact of tetracycline-resistant genes among *Staphylococcus aureus* to humans as serious public health threats. The winner was awarded a "Farming kit", which perfectly matched the theme of the conference. The graduate session helped researchers to talk about their work and created an opportunity for discussion and collaboration with different institutes.

3.2. Graduate Student Session II

Another parallel session was chaired and co-chaired by Dr. Qianggong Zhang from the Institute of Tibetan Plateau Research and Pengfei Chen from the Northwest Institute of Eco-Environment and Resources, while Mr. Gaurav Adhikari from the Research Institute of Bioscience and Biotechnology moderated the session. The session saw speakers who won the KCRE Excellent Student Thesis Award from the Kathmandu Center for Research and Education, funded by the Chinese Academy of Sciences.

The first speaker, Mr. Bimal Kumar Raut from Central Department of Chemistry, presented his work on potential natural inhibitors of human pancreatic alpha-amylase (HPA), an enzyme important in Type 2 diabetes. Quercetin was identified as a promising candidate using in silico methods, and molecular dynamic simulations and DFT analysis helped confirm its stability and high reactivity. A comparable inhibition to a standard drug was observed in initial tests, which warranted further validation of the effectiveness.

Another speaker from the Central Department of Biotechnology, Ms. Sujata Pokhrel, talked about her in silico study on the potential of Phi 6, a bacteriophage for its potential to combat *Pseudomonas syringae* strains. With protein–protein docking (HADDOCK), Phi 6's spike protein interaction with type IV pilin proteins on *Pseudomonas* was predicted along with binding affinity. The speaker drew a conclusion with the findings supporting the initial hypothesis and added that future wet lab experiments could validate Phi 6's broad spectrum potential for plant disease.

Ms. Amita Twayana, from Amrit Campus's Botany department, presented her recent work on the Cymbidium orchid genus in Nepal. In her work, she identified 10 distinct Cymbidium species, unlike previously thought 16 species, by examining herbarium specimens and reviewing existing information. Features like flower structure and color, along with pseudobulb characteristics, were crucial for differentiation and recommended further genetic analysis can help solidify these classifications and explore Western Nepal for a more complete understanding of the distributions.

The final speaker from the Central Department of Hydrology and Meteorology, Ms. Smriti Adhikari, spoke about her investigation on the role of weather in a 2022 aircraft accident over Nepal's challenging terrain. By analyzing weather data using weather research and forecasting modeling, she talked about her findings of high humidity, cloud water mixing ratio, and updraft winds, indicating the potential for icing and turbulence and suggesting an unfavorable environment for the flight. She concludes the necessity of comprehensive weather analysis in investigating aviation accidents in challenging Nepal's airspace. Ms. Sujata Pokhrel won the best speaker award in this session for her in silico work on the potential of Phi 6 as a potential bio-control agent for plant pathogens.

4. Panel Discussion on Planetary Health

In this panel discussion, chaired by Prof. Remco Kort (Vrije Universiteit (VU) Amsterdam, the Netherlands), the impacts of anthropogenic disruptions on Nepal's environment were examined, and viable pathways for sustainable intervention were explored. Panelists included Dr. Poorna Kanta Adhikary (the University of Nepal Development Board (UoN-DB), Kathmandu, Nepal), who specializes in eco-centric development and community resilience; Dr. Anup Subedee (Kirtipur Hospital, Kirtipur, Nepal), a public health expert with extensive experience in pollution-related health dynamics; and Prof. Chhatra Mani Sharma (Central Department of Environmental Science, Tribhuvan University (TU), Kritipur, Nepal), an environmental scientist, whose research focuses on ecosystem preservation and the integration of interdisciplinary methodologies.

4.1. What Are the Impacts of Human Disruptions in Nepal?

All respondents noted significant impacts of human disruptions in Nepal. Poorna Kanta Adhikary (PKA) highlighted ecosystem destruction leading to pollution, global warming, and natural disasters affecting human health and livelihoods. He also mentioned the negative impacts of unplanned road construction and melting glaciers. Anup Subedee (AS) observed the effects of unplanned construction, deforestation, and severe air pollution, along with the spread of diseases like dengue to new areas. Chhatra Sharma (CS) emphasized pollution's broad impact on human health and ecosystems, affecting water, air, and soil.

4.2. What Are Important Mitigating Strategies?

PKA suggested a comprehensive approach involving a green economy, green work, and various forms of education, including formal, informal, non-formal, and TVTET (technical and vocational education and training) alongside social and economic programs to implement green work. AS recommended a societal shift away from materialistic consumerism towards community-oriented living, changes in financial systems, and better support for marginalized populations. CS emphasized changing people's habits to stop polluting and degrading environments, believing that nature can heal itself if harmful activities cease, with technical solutions as supplementary measures.

4.3. How Would You Describe the Relationship with Nature in Nepal

PKA discussed the example of green road construction using local labor and sustainable practices, which was later abandoned in favor of damaging heavy machinery. He advocates for better road planning, green technology, and fair wages to restore a healthier relationship with nature. CS noted that individual efforts to clean up the environment, such as the Bagmati River, often fail without coordinated efforts from all sectors.

4.4. Do You Think There Is a Role for Indigenous Knowledge in Academic Curricula?

PKA strongly supports integrating indigenous knowledge into education, citing personal experiences where traditional bioengineering methods were effective for environmental

management. CS agreed, noting that indigenous knowledge is valuable for solving local environmental problems and should be incorporated into academic research and education.

4.5. What Opportunities Do You See for Interdisciplinary or Transdisciplinary Approaches?

PKA stressed the importance of breaking down disciplinary silos and using transdisciplinary approaches, sharing his experience with integrated training programs that combined various fields. He believes that understanding and applying indigenous practices can bridge silos and enhance scientific approaches. CS mentioned the growing popularity of transdisciplinary approaches in academic research in Nepal, citing examples of river catchment restoration projects that involve collaboration between environmental and social scientists.

5. Focus Group Discussions

5.1. Planetary Health Discussions and Exploring International and Local Initiatives

The focus group discussion for the Fifth International Conference on Bioscience and Biotechnology with the theme of Planetary Health aimed to develop small and scalable project ideas aligned with planetary health principles. Emphasizing local initiatives in Nepal, the session was designed to build on the outcomes from the previous meeting in Amsterdam. The discussion was structured into break-out groups focusing on identifying needs or gaps and formulating projects in research, education, policy engagement, or movement building. This summary covers the key points from four focus areas: three research topics and one educational initiative.

5.1.1. Gaps in the Use of Pesticides and Fertilizers in Kavre, Nepal

Problem identification: Excessive use of pesticides and fertilizers in Kavre, Nepal, despite the availability of organic alternatives.

Proposed solutions:

1. Comparative analysis: Conduct a comparative study on the effects of chemical and organic fertilizers regarding productivity and time;
2. Awareness and education: Educate farmers on the benefits and usage of K organic fertilizers;
3. Policy review: Assess and suggest improvements in existing implementation policies to promote organic farming practices.

Project steps:

- Gather data on current pesticide and fertilizer use from farmers;
- Analyze the economic and environmental impacts of chemical versus organic fertilizers;
- Develop educational programs and materials for farmers;
- Engage with policymakers to support the transition to organic farming.

5.1.2. Why Is Chure Drying? Delving into the Causes of Drought in the Chure Region of Nepal

Problem identification: Communities in the Chure region face severe drought, erratic rain, and flooding, impacting agriculture and daily life.

Proposed solutions:

1. Water management techniques: Implement indigenous and environmentally friendly water management techniques;
2. Community-led projects: Develop community-driven projects for rainwater harvesting, irrigation canals, and groundwater management;
3. Vegetation rehabilitation: Rehabilitate dry riverbanks with fruit trees and vegetables to improve local food security.

Project steps:

- Engage local communities to design and implement water management solutions;
- Construct rainwater harvesting ponds and underground water canals;
- Plant fruit trees and vegetables along riverbanks to prevent soil erosion and provide sustainable produce;
- Monitor and record the effectiveness of these interventions through community feedback and scientific data.

5.1.3. Development of a Novel-Defined Culture Medium from Nepal's Natural Resources

Problem identification: The cost and accessibility of cultivation media for bacterial cultivation in laboratories in Nepal are challenges due to high import taxes and limited financial support.

Proposed solutions:

1. Government support: Advocate for governmental assistance in purchasing cultivation media to reduce costs;
2. Bulk purchase and preparation: Buy individual components in bulk and prepare the cultivation media locally;
3. International support: Seek backing from international organizations to fund and supply the necessary materials;
4. Local sourcing: Utilize locally available resources to create the culture medium, reducing dependency on imports.

Project steps:

- Conduct research to identify suitable local resources for the culture medium;
- Write and publish a research paper detailing the components and preparation methods;
- Lobby for policy changes to reduce import taxes and encourage local production.

5.1.4. Introduction of Planetary Health to School Education Programs

Target Group: Children aged 13–14 years in Nepal.

Program Structure:

1. Curriculum Integration: Integrate planetary health themes into existing social science courses;
2. Student Engagement: Allow students to select themes and propose ideas based on their interests;
3. Mentorship and Evaluation: Provide support through theme leaders and previous participants, with assessments through final presentations.

Project Steps:

- Start the program in one government school as a pilot;
- Conduct focus group discussions with students before and after the program to gauge interest and effectiveness;
- Expand the program to other schools in the municipality based on the pilot's success;
- Train mentors from previous cohorts to sustain the program.

5.1.5. Conclusion

The focus group discussion successfully identified critical issues and proposed innovative, scalable solutions for planetary health in Nepal. The collaborative approach, engaging local communities, leveraging indigenous knowledge, and integrating education, highlights the potential for impactful local initiatives that can be scaled.

5.2. Initiatives in Nepal's Higher Education Sector Addressing Planetary Health Concerns

This session provided a platform for a focus group discussion that centered around initiatives within Nepal's Higher Education Institutes (HEIs) sector concerning planetary health issues. The primary goal was to assess existing initiatives within Nepal, explore noteworthy efforts from global institutions, and identify opportunities for collaboration among policymakers, academia, and communities to tackle planetary health issues effectively.

With an assembly of 18 participants, the discussion commenced with individuals sharing personal insights on their experience of education relating to planetary health. The discussion revealed a gap in formal education pertaining to planetary health within Nepali universities. Findings from research on the missions of the existing universities in Nepal discussed during the discussion showed that only one university, Far Western University, explicitly incorporated sustainability in its mission statement, while others lacked distinct commitments to integrating planetary health concerns into their educational and research objectives.

The discussion was followed by smaller groups delving deeper into three areas: (a) the best practices of Nepal's HEIs in relation to planetary health; (b) international initiatives deserving of emulation; and (c) collaborative strategies involving academia, policymakers, and communities.

Group 1 highlighted commendable initiatives within Nepal, which included examples such as Tribhuvan University's decentralized campuses aiming to reduce carbon footprints, the partnership between the Department of Environment Science and the Public Service Commission to hire environment scientists for local governments, and an engineering college in Bhaktapur collaborating with the municipality on indigenous waste management practices, fostering a unique HEI municipality alliance.

Group 2 discussed exemplary initiatives undertaken by higher education institutions outside Nepal in the field of planetary health that could serve as models for Nepal's institutions to learn and contextualize. These initiatives include establishing research institutes within universities to focus on innovative interdisciplinary research addressing environmental challenges, promoting sustainable fashion practices to combat fast fashion trends, adopting bookless education to reduce paper consumption, and establishing student syndicates to empower students in sustainability initiatives.

On the other hand, Group 3 emphasized the importance of collaboration among Nepal's policymakers, academia, and communities to translate planetary health concerns into effective policies and actions. Strategies highlighted by the group include forming a consortium of universities dedicated to planetary health, bridging the gap between research and policy, and incorporating indigenous wisdom into public discussions.

The group discussions not only highlighted the innovative endeavors within Nepal's HEIs but also underscored the requisite for broader collaborations and a more comprehensive approach to addressing planetary health challenges on local and global scales. The discourse served as a stepping stone toward fostering synergistic efforts among stakeholders to push sustainable solutions to planetary health concerns.

Moving forward, the group discussion concluded that it is crucial for Nepal's higher education institutions to fully embrace their role in educating and equipping students to address planetary health challenges. This includes offering courses on planetary health, collaborating with stakeholders to understand local ecological issues, and contributing to global solutions. By implementing these initiatives and fostering collaboration, Nepal's institutions can play a significant role in promoting sustainability and environmental stewardship.

5.3. Cultivating Research-Ecosystem in Developing Countries: Bringing the Brains Back

In the globalized world, on the one hand, economies compete to attract the best human resources for their efficient functioning and further development. On the other hand, humans have been migrating in search of better career opportunities and quality of life. Freedom of movement and pursuing one's career is arguably a fundamental human right and a precondition for human progress. These facts have strong implications for the development of emerging economies (low- and middle-income countries, LMICs), which, while inefficient in developing human capital (HC) for themselves, also face massive migration of youth and of the very little HC that they could have retained.

This situation is most clearly visible in the nascent research ecosystem in LMICs like Nepal, despite some promising cases of returning HC, some of whom have started their own non-governmental research institutes [9]. However, a lack of resources, extreme red-tapism instead of government support [9], and a pessimistic outlook [10] have stunted progress. This focused group discussion aimed to identify the subtleties of this complex subject matter and identify strategies for research institutes operating in LMICs to move forward by bringing more researchers back and retaining them. In a two-hour-long workshop, thirty-three young scientists identified a few prevalent opinions or ideas relevant to the four topics, discussed their implications in randomly formed focused groups of three–four participants and the plenary sessions, and rated those opinions from 0 (lowest) to 10 (highest), as summarized in Table 1.

Table 1. Summary of Opinions and Ratings from Focused Group Discussion on Researcher Retention in LMICs.

Topic	Opinion (Average Rating 0–10)
Mobility of Young People	Mobility of young people should be discouraged by law to curb brain drain (0.7)
	Mobility may be allowed if the individual obtains funding from an international agency (4.4)
	Investing in better local higher education will help curb brain drain (9)
	Government should invest in mobility despite brain drain (9.4)
	A competitive R&D ecosystem will result in brain gain (8.9)
What could make the brain come back?	Family, home, nature, culture, satisfaction of giving back (6.9)
	Exploring traditional knowledge (5.2)
	The problems in LMICs and their solutions (6.6)
	Low living costs (3.6)
	Low operational costs (e.g., wages, rents, etc.) for entrepreneurs and innovators (5.6)
Setting up a stage for an attractive R&D ecosystem.	Supportive legal framework with recognition and subsidies for R&D (9.4)
	Funding agencies encompassing private (for-profit, non-profit, industries) research institutes (8.8)
	Investment in shared/public R&D infrastructure (9.0)
	Enhanced collaboration between the developed economies and LMICs (8.9)
	Enhanced collaboration between the LMICs (8.5)
	The LMIC R&D-ecosystem is not productive enough yet to warrant an investment or set up the stage (5.3)

Table 1. *Cont.*

Topic	Opinion (Average Rating 0–10)
Effect of discovery research in brain gain and local development.	Discovery research in a country does not impact brain gain (5.7)
	Prioritize immediate developmental needs, not discovery (6.5)
	LMICs should rather focus on implementation and applications of the latest discoveries and inventions (7.5)
	LMICs must also invest in discovery to curb or reverse brain drain (7.3)
	There must be sufficient funding and space for all kinds of research curiosities, including discovery (8.2)

6. Summary of Thematic Session on Air and Water

Aligning strongly with the theme of the conference, the session dedicated to Air and Water was important in the overarching discussion on "Planetary Health". The health of the air and water systems of the planet are key aspects of planetary health, and as such, the session was kept in the discussion. There were six presentations in the session, including the keynote session. Major discussions focused on contaminants in both air and water and the transport of said contaminants in the resources. Proper and regular monitoring of natural systems is an important part of ensuring planetary health. For widespread and equitable monitoring, lower-cost and portable systems for surveillance are important. Novel optics-based devices could play an important role in widespread monitoring, regardless of the socio-economic conditions of the citizens in different parts of the world. Contaminants such as mercury, microplastics, black and brown carbon, bacteria, etc., in air and water were discussed in the session. Primarily, climate change-induced melting of glaciers has released the legacy-stored mercury into our water systems. Changes in our climate may have also contributed to the degradation of macro plastics that we use, which may have been transported aerially to the water systems, which then presents in the form of microplastics in our rivers. Black and brown carbon particles from biomass burnings, fossil fuel combustions, etc., are also transported into the clouds, which transport them to our water systems during rainfall, causing transboundary pollution in the process. While these discussions were not exhaustive in any way, they are an important part of the conversation surrounding planetary health to make it more inclusive and complete.

7. Summary of Thematic Session on Climate Change

The Himalayas and the Tibetan Plateau, often referred to as the Third Pole, serve as critical resources for billions of people across Asia. This vast region not only houses the largest reserves of freshwater outside the polar areas but also plays a crucial role in regulating the climate. However, its sensitivity to climate change has become increasingly apparent, with observable impacts occurring at an accelerated pace. Rising temperatures have resulted in rapid glacial melt, which initially increases water availability but poses long-term risks such as decreased river flows and increased vulnerability to natural disasters like floods and landslides. As glaciers recede, they threaten the livelihoods of communities dependent on glacial meltwater for agriculture, drinking water, and hydropower generation. Additionally, the changing climate affects biodiversity, leading to shifts in species distribution as ecosystems struggle to adapt to new conditions. This loss of biodiversity can disrupt food chains and compromise the resilience of ecosystems, further exacerbating ecological fragility. As this is a major issue in today's changing world, climate change was given importance as a separate session in the ICBB-2024. The session was chaired by Prof.

Shichang Kang, who is a climate and glacier change expert from the Chinese Academy of Sciences and moderated by Prof. Chhatra Mani Sharma from Tribhuvan University, Kirtipur, Nepal. Several important presentations were given by experts/scientists from well-renowned research institutes and universities during the session. The major focus was given to limiting warming of 1.5 degrees and addressing the challenges posed by climate change and the impact of atmospheric pollution in the Himalayas and Tibetan Plateau. The committee members also suggested the requirement of integrated approaches that encompass adaptation strategies, sustainable resource management, and international cooperation. The need for robust climate policies and investments in renewable energy, water management, and conservation efforts is urgent to mitigate the impacts and protect the unique ecosystems and communities that depend on this vital region.

8. Summary of Thematic Session on Ecology and Evolutionary and Environmental Sciences

The session on the topic of Ecology, Evolutionary, and Environmental Sciences, co-chaired by Dr. Alba Abad and Dr. Susma Giri from Wellcome Center for Cell Biology, University of Edinburgh, Scotland, and Kathmandu Institute of Applied Sciences, Kathmandu, Nepal, featured four keynote speakers.

The first speaker, Susma Giri, PhD, highlighted the vital responsibilities that insects play in ecosystem maintenance in her presentation titled, "Buzzing Guardians: Acknowledging insects' vital role in ecosystem maintenance". The most taxonomically diverse group, insects are essential to ecological processes like nutrient cycling, biological pest management, and pollination. Honeybees play a crucial role in crop pollination, making them important to agricultural output. They also serve as bioindicators, indicating the health of their surroundings. The talk also emphasizes the intricate ecological relationships that insects are a part of, as well as their amazing adaptability. It, however, highlights the difficulties that insects confront as a result of climate change, such as altered dispersal patterns, phenological inconsistencies, and a rise in pest outbreaks. The slide emphasizes how crucial it is to protect insect biodiversity in order to maintain the resilience and stability of ecosystems.

The presentation "Sustainable biochemical production from carbon dioxide: Expanding the product portfolio of gas fermentation" by the second presenter, Dr. Rajesh Reddy Bommareddy, from Northumbria University, Newcastle, UK, focuses on the potential of using carbon dioxide (CO_2) as a renewable feedstock for biochemical production. The research explores the use of microbes like *Cupriavidus necator* for CO_2 conversion into valuable chemicals like isopropanol and 2,3-butanediol, achieving high carbon selectivity and productivity. Challenges addressed include the need for stable production, safety issues, and the viability of producing commodity chemicals using hydrogen as an energy source economically. The presentation highlights the integration of bio-manufacturing processes that utilize non-food biomass or waste materials, with the ultimate goal being the development of integrated, energy-efficient gas fermentation processes that support sustainable industrialization and climate action. This research aims to create a circular economy with zero net CO_2 emissions.

Mr. Sudarshan Subedi, a researcher at Tribhuvan University and the third speaker, discussed the only nomadic community in Nepal, the Raute, a unique non-tropical hunter-gatherer living in the forest with no permanent settlements, agriculture, or formal education, and their population rapidly declining due to accidents and refusal of medical treatments. He highlighted the challenges of documenting them, and with constant efforts by both government and NGOs to settle them or provide education and health care, they have remained adamant about rejecting external aid and attached to their external aid. A rare

expedition into their camp involving negotiations and cultural exchanges along with a shared feast under official permit from local and provincial authorities was made possible along with fieldwork, which included spending several months with them, helping document their lifestyle, and sample collection. Their nomadic lifestyle, dependence on forest resources, and cultural identity contrast with the settled communities around them, have led to resource competition, cultural misunderstandings, and conflicts. It also touched on the unique cultural practices of the group, such as their exclusive production of wooden materials, monkey hunting, and lack of religion, emphasizing their deep connection to the forest. The presenter concludes with the future direction of his research in terms of their cultural presentation and the challenges they face in a rapidly changing world.

Finally, the chair of the session wraps up the segment with her talk on the role of SPOUT 1 (CENP-32), an RNA methyltransferase critical for mitotic spindle organization and its connection to the neurodevelopmental disorders SPADMiSS. This protein's activity is essential for preventing developmental disorders and cancers. Mutations in SPOUT1/CENP-32 can lead to defects in centrosome and chromosome segregation, resulting in conditions like aneuploidy, often associated with cancers, and structural abnormalities in the centrosome, contributing to developmental disorders such as microcephaly. Clinical studies have identified bi-allelic missense variants in SPOUT1/CENP-32 in patients with neurodevelopmental delays and epilepsy, further emphasizing its importance in mitotic processes. These findings are supported by Zebrafish models where suppression of the SPOUT1 ortholog results in microcephaly and other similar defects. Structurally, SPOUT1/CENP-32 functions as a dimer, a formation essential for its methyltransferase activity. Mutations disrupting the cofactor binding site deactivate the enzyme, impairing its role in maintaining centrosome-spindle pole attachment, leading to chromosome missegregation and neurodevelopmental issues. In conclusion, Abad's research underscored the critical role of SPOUT1/CENP-32 in spindle organization and centrosome integrity, with mutations leading to significant neurodevelopmental disorders that call for further investigation into the molecular mechanisms by which this protein regulates these essential cellular processes.

9. Summary of Thematic Session on Global Health

The Global Health session showcased the integral relationship between global health initiatives and planetary health. Dr. Chaturaka Rodrigo from the University of New South Wales, Australia, emphasized the significance of multidisciplinary and international collaborations using the Colombo Dengue Study as a case study. This study demonstrated advancements such as training PhD students, developing cost-effective dengue diagnostics, and creating a machine-learning-based early risk prediction tool. These efforts highlight the necessity of respectful and mutually beneficial collaborations to address neglected tropical infections. Similarly, Prof. Jyoti U. Devkota from Kathmandu University illustrated the application of statistical techniques to model the spread of COVID-19 in Nepal, underscoring the importance of data analysis in managing infectious diseases, which is crucial for planetary health.

The session also featured insights from other notable speakers. Dr. Clement Regnault from the University of Glasgow utilized metabolomics to discover new biomarkers in Leishmania, offering potential drug targets for leishmaniasis. Dr. Anurag Adhikari of KRIBS assessed HIV-1-neutralizing antibodies in Nepalese patients, providing valuable insights for vaccine development. Dr. Richard Burchmore from the University of Glasgow discussed using omic approaches to identify new diagnostic markers and therapeutic targets for leishmaniasis. Mr. Mahesh Shakya from NAAMII highlighted the potential of artificial intelligence in healthcare, particularly in low-resource settings, while Mr. Aagat

Awasthi from Kathmandu University proposed a transdisciplinary approach to school health education to promote holistic health literacy. These discussions emphasized the need for interdisciplinary collaboration, advanced technologies, inclusive partnerships, and comprehensive education strategies to address global health challenges effectively, aligning closely with the principles of planetary health.

The Global Health session at ICBB-2024 underscored the crucial alignment between global health initiatives and planetary health principles. It highlighted the importance of interdisciplinary collaboration, technological advancements, and inclusive partnerships in addressing complex health challenges. The session emphasized the need for comprehensive education strategies to foster holistic health and well-being. By integrating these approaches, we can better tackle global health issues and contribute to the sustainability and resilience of our ecosystems, ultimately promoting a healthier planet for all.

10. Summary of the Poster Presentations

The 2024 ICBB Conference on Planetary Health brought together researchers from around the world to showcase the latest advances in the field of planetary health. The poster session buzzed with innovative ideas spanning a broad field of Planetary Health, demonstrating the connection between environmental and human well-being. Researchers have presented solutions that address challenges across various disciplines, highlighting the need for collective action to improve the well-being of the planet.

Plastic biodegradation by terrestrial invertebrates: Novel and sustainable methods for the biodegradation of plastics are highly relevant, given the staggering volume of plastic production globally. Several studies have shown that bacteria and fungi, especially those associated with soil, are promising organisms for plastic degradation. In this context, *Tenebrio molitor*, an edible insect, is increasingly recognized by the scientific community as an effective solution for the bioconversion of organic waste and plastics.

A poster presented by Aryal et al. entitled "Biodegradation of plastics by terrestrial invertebrates and the role of Gut microflora" presented interesting findings on the use of larvae of *Tenebrio molitor* for degradation of plastics. In this study, the gut microbiota was isolated from polyethylene-fed larvae and biochemically characterized. The larvae showed some ability to break down plastics; however, plastic as the sole source of nutrition for the larvae had deteriorating effects such as increased larval mortality, delayed physiological growth, deformation in the mid-gut, and poor nutritional content. Nonetheless, more research is required on different optimization approaches and the development of mass production.

Assessing Water Quality: Another prominent area presented at the conference was technology for locally assessing water quality. The posters presented ranged from the detection of human pathogenic viruses to the detection of tryptophan, free residual chlorine, low-cost graphite, and the assessment of other water quality parameters. This section describes several interesting techniques.

On-chip Raman spectroscopy was presented by Bhattarai et al. as an inexpensive, portable, and relatively fast technique for assessing the tryptophan content. Graphite electrode conductivity meters, fluorometers, laser speckle analysis, and absorption meters are presented as viable low-cost options for assessing water quality.

Quest for Active Compounds from Natural Resources: Several researchers have reported natural products based on bioactive compounds. A study by RC et al. demonstrated that altitude had no significant influence on metabolite production in *Taxus wallichiana*. In addition to their inherent antioxidant and antimicrobial properties, plant extracts have demonstrated notable antibacterial effects. Another study by Tamang et al. explored

the isolation of antibiotic-producing actinomycetes from soil samples in the Annapurna Conservation Area.

Sustainability: A number of other researchers have explored the concept of sustainability locally. Ghimire et al. presented a poster on a nature-based approach for revitalizing urban wetlands in Nepal through the innovative development of biopesticides. The poster highlights the need to incorporate a circular economic framework into the local community, in addition to experiential training in biopesticide production, as a promising approach for fostering community-based skill enhancement and contributing to wetland restoration efforts.

Similarly, Maharjan et al. presented a poster on native bacterial isolates from Nepal that were fungicidal with no adverse effects on plants for the sustainable production of tomatoes. The findings of this study suggest that microbial consortia can be used to supplement fertilizers.

Conclusion: The 2024 ICBB Conference on Planetary Health showcased the diverse and dynamic research currently underway in this field. Innovative solutions for plastics, advances in water quality assessment technologies, and exploration of bioactive compounds from natural resources. The conference emphasized the urgent need for sustainable, interdisciplinary approaches and collective action for a healthier planet.

11. Exploration into the Design of a New Course on Planetary Health for the University of Nepal

As one of the organizing partners for this year's ICBB conference, several members of the University of Nepal Development Board (UoN-DB), including the Chair, Dr. Arjun Karki, attended the conference. The UoN-DB was established through a formation order by the Government of Nepal in 2021 to do the necessary foundational work to establish the proposed University of Nepal (UoN). With the UoN bill already passed, the university is now poised to commence its mission of fostering academic excellence to address critical challenges in Nepal, including those related to planetary health.

UoN has been envisioned to be a non-profit public and autonomous institution with an independent Board of Trustees, offering innovative and multi/interdisciplinary academic programs with the undergraduate program based on the Liberal Arts and Sciences approach, emphasizing building competencies in graduates to prepare them for productive and engaging lives with a strong sense of civic awareness and social responsibility. The university will be a center of excellence in higher education teaching and research practice through a community of practice of dedicated and committed academics, national and international collaboration, and purposeful community engagements.

The primary objective of the ICBB gathering was "to foster a deep understanding of the intricate relationships between human health, ecosystems, climate, and food systems to promote positive change in the society". The thought within the UoN team has been to build a curriculum that would connect the undergraduate educational experience to life, living, and the world. The purpose here is to foster an understanding of the interconnected, interdependent, and complex nature of reality in the graduates, along with a sense of their role and place in this world. In that sense, the presentations, discussions, and conversations that took place during the ICBB conference on Planetary Health were highly relevant, meaningful, and in alignment with the vision and mission of UoN.

As a result of this realization from the UoN team, a follow-up meeting was arranged with Prof. Remco Kort from Vrije Universiteit, Amsterdam, and Prajwal Rajbhandari of the Research Institute for Bioscience and Biotechnology (RIBB) to discuss the potential to include a course on Planetary Health in the curriculum of UoN. During the meeting, Prof. Remco shared his experiences and insights into designing and instructing courses on the topic and shared several resources, including information about the Planetary Health

Alliance. Mr. Rajbhandari shared about the current research projects on *gundruk* being carried out by the team at RIBB. The conversation offered new ideas and perspectives on pedagogical approaches and instructional design of interdisciplinary courses to be included in the undergraduate program. As an outcome of this meeting, a proposal was made to designate a dedicated team to further explore this and conduct the necessary work.

12. Conclusions

As the conference drew to a close, participants reflected on the insights gained, connections forged, and commitments made during the course of the event. The urgency of the planetary health crisis was palpable, yet so too was the sense of hope and determination to effect meaningful change. In the spirit of collaboration and solidarity, attendees pledged to carry forward the momentum generated at ICBB-2024 and translate ideas into action in their respective fields and communities. In conclusion, the Fifth International Conference on Bioscience and Biotechnology, ICBB-2024, stands as a testament to the power of collective action and collaboration in addressing the complex challenges of planetary health. As we look to the future, let us remain steadfast in our commitment to safeguarding the health of our planet and ensuring a brighter, more sustainable future for generations to come.

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