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Editorial Introduction

K. Ravi Srinivas*

To state that COVID-19 pandemic had turned our world upside down and we were totally unprepared would be to state the obvious. ABDR is not an exception to that. In 2020 we had planned a special issue on Bioinformatics and Sustainable Use of Biodiversity and had worked on it. Because of COVID most of the contributors could not send their articles or could not submit the revised ones. Another issue that was planned and was in progress was also impacted on account of COVID. As a result, we had postponed the special issue and hope to publish it this year. Similarly articles that were to be part of another issue slated for last year would appear in subsequent issues. While COVID did affect our functioning and planned events and publications, that was not the end of the story. Last year despite COVID, RIS published many, including special issues of RIS Diary on COVID besides many policy briefs and discussion papers and contributed to external events and webinars and publications. Please visit www.ris.org.in to know more. Two webinars organized by RIS could be of interest to readers of ABDR.

- Webinar on "Nobel Prize for CRISPR" https://www.youtube.com/watch?v=HLXQITDGZG8
- Book Release Webinar on "Socio-Economic Impact Assessment of Genetically Modified Crops - Global Implications based on Case-studies from India"[1] https://www.youtube.com/watch?v=mu6PxVZo_ao

In this age of Anthropocene, biodiversity crisis is one of the major crises before the humankind and with global climate change; it has emerged as a key challenge for policy makers. The adoption of Convention on Biological Diversity (CBD) in 1992 was a landmark in global environmental governance and it ushered in a plethora of policies, ratifications and enactment of laws to operationalize the provisions of the CBD. However over the years despite progresses in some front and consensus on many issues, the biodiversity crisis continued. Despite many conferences, statements and emphasis given by UN agencies and scientific bodies, progress made was below the

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expectations and commitments. This stark reality has been brought out in the Global Biodiversity Outlook -5 (GBO5), published by United Nations Environment Program (UNEP).

GBO5 measure the global performance in meeting the Aichi targets which were set in 2010 and were to be achieved in the decade of 2010-2020. These targets were fixed after almost two decades of signing of CBD. The idea was countries would use the decade to ensure that what could not be achieved earlier could be prioritized and enhance their efforts. However, as the GBO5 shows the record is mixed but the overall situation is grim. As the Aichi targets have not been met substantially UNEP and those concerned with global biodiversity crisis are calling for more concentrated action and urging countries to accelerate their actions in meeting the targets. Aichi targets are not just targeting for biodiversity conservation. Achieving them will result in benefits in multiple fronts and many of these benefits will have a positive impact particularly in the long term. Thus, by achieving Aichi targets humankind in protecting itself from the negative consequences of its own actions and its resilience is enhanced. The article by Amit Kumar discusses thread bare the evolution of Aichi targets, the important findings of GBO5 and what have been the response to GBO5. It discusses the evolution of Post2020 Global Biodiversity Framework and what could constitute that.

While it is important to have a global perspective, there are greater challenges at different levels, at the national, state level and national level. India ratified CBD and passed Biological Diversity Act in 2002 and the National Biodiversity Authority was set up as the national level nodal authority for achieving the objectives of the Act, particularly in ensuring that Access and Benefit Sharing activities are conducted as per the norms and rules framed under the Act. BDA envisaged , besides the national level authority, state level institutions and local level institutions for management of biodiversity. While the former was called State Biodiversity Board (SBB), the latter was called Biodiversity Management Committee (BMC). This three tier structure was to ensure that while rules and regulations are framed at the apex level, SBB and BMC would play a greater role in biodiversity management at the state and local levels respectively. This is a compromise between excessive centralization and excessive decentralization and it makes sense as biodiversity cannot managed merely by issuing executive fiats or framing elaborate rules. However even after almost two decades this has not

worked effectively. In fact, SBB and BMC seem to be weak links in the chain and BDA will succeed only if they function effectively. Vishwas Chavan, a globally well-known expert in biodiversity conservation and management in his article, addresses the crucial issue of making SBB more effective and accountable, so that they fulfill their mandates specified in BDA. Based on his interactions with officials in SBB and studying of implementation of BDA at the state levels he has come up with many relevant suggestions.

Biodiversity management in these days is intrinsically linked with access to information, particularly databases. However access to data particularly to the ones in databases is not an easy one, as while there are many databases some of them are not available on the open access mode. Moreover fragmentation of data/information among databases is another issue. But without open access it is difficult for stakeholders to work together in governance of biodiversity. Although intellectual property rights have added complexity to access, other factors like quality of data, lack of uniformly acceptable data access policies, concerns over privacy constrain access. With Digital Sequence Information (DSI) becoming a key issue in biodiversity governance, access to biodiversity related databases will become more complex. DSI has significant implications for Access and Benefit Sharing (ABS). But access to databases is often neglected in discussions in biodiversity governance, nor is the importance of developing an ecosystem that will facilitate open access and thereby help in research and decision making has been widely discussed. The article by Shyama Kuriakose addresses precisely this issue and highlights the importance of open access to biodiversity related databases. In her analysis, she explains the constraints, the issues with current databases and points out a way forward by describing the best practices. In this also, there are issues of centralization of data access and of bottoms up approach in mapping and data creation and developing databases. Highlighting the various legal issues, she suggests that developing appropriate usage policies is a feasible solution. I hope that her suggestions are given the consideration it deserves.

Bio-cultural diversity has different components, and it is well known that biological diversity is more than a collection of ecosystems, species, landscapes and forests. The cultural dimension in biodiversity is at the center of biocultural diversity. Cultural practices and norms about sacred species and spaces, and principles on governing on them have played a key role in

biodiversity conservation and management. The Biological Diversity Act has provision for declaring biodiversity rich areas as Biodiversity Heritage Sites (BHS). Of the thirty-four biodiversity hotspots in the world, four are in India. Thirty-eight sites are part of the United Nations Education Scientific and Cultural Organization (UNESCO) World Heritage List. Whether BDA has effectively implemented to identify all the relevant BHS in India and has the identification and declaration of an area has resulted in protection of that specified area is an important issue. Again this is an issue that cannot be decided by a few by sitting in a far away city or be decided by visiting them a few times. There is an urgent need to bring in conceptual clarity and identify the relevant approach for BHS so that the objectives of identification and conversation are fulfilled. A big question is whether all the areas that deserves to be identified and declared as BHS been identified and declared. Taking Maharashtra as a case study, authors have proposed a framework for establishing Local Biodiversity Heritage Sites (LBHS). This is based on a study on two habitats of high conservation importance. They highlight how LBHS can contribute to The National Mission on Biodiversity and Human Well-Being (NHBHWB) which is one of the missions led by Office of the Principal Scientific Advisor, Government of India. Obviously SBB can play an important role in identifying and nurturing LBHS.

These four articles give us a good idea of the complexity of issues involved in biodiversity conservation and sustainable use and by getting into details of important issues, they also point out potential solutions. Some of these issues will be covered in the forthcoming issues of ABDR. The two book reviews add value to the issue and am sure that they also will be of interest to readers.

In the near future, you can expect changes for the better in ABDR. For example, we will be uploading articles accepted for publication, on the website, prior to their publication in the respective issues, as articles ahead of publication. Similarly, we are planning for special issues on different topics such as Synthetic Biology.

We thank you for your continued support and look forward to your comments, suggestions and support in the future.

Endnote

[1] https://link.springer.com/book/10.1007%2F978-981-32-9511-7

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CBD's Global Biodiversity Outlook 5: Final Assessment of Aichi Biodiversity Targets and Beyond

Amit Kumar*

Abstract: In the final year of the UN Decade on Biodiversity (2011-2020), CBD came out with its fifth edition of Global Biodiversity Outlook (GBO-5) with the final assessment of the Strategic Plan for Biodiversity and Aichi Biodiversity Targets. GBO-5 concluded that none of the 20 Aichi Biodiversity Targets have been fully achieved and only six of them have been achieved partially. The Outlook pitched for some serious re-thinking in the ways and means to realise the 2050 Vision of Living in Harmony with Nature. This article intends to provide an overview of the Strategic Plans, Aichi Biodiversity Targets, findings of the assessment and some reflections on the current state and way forward.

Keywords: CBD, GBO-5, Strategic Biodiversity Plan, Aichi Biodiversity Targets, Post-2020 Global Biodiversity Framework

Introduction

The Global Biodiversity Outlook (GBO) is a periodic flagship publication of the Convention on Biological Diversity (CBD) that summarises progress made towards achieving the objectives of the Convention, such as the goals of the Strategic Plan for Biodiversity and Aichi Targets. The fifth edition of the Global Biodiversity Outlook (GBO 5), released in September 2020, provided the final assessment of progress towards the Aichi Biodiversity Targets, It also entailed lessons for the development of the post-2020 global biodiversity framework and a set of transitions needed to realise the vision agreed by the countries for 2050 of 'Living in Harmony with Nature'.

GBO-5 made some very serious revelations about the state of biodiversity. It stated that "*Biodiversity is declining at an unprecedented rate, and the pressures driving this decline are intensifying*" (CBD, 2020). It further noted that none of the 20 Aichi Biodiversity Targets have been

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fully met and only six of them have been partially met. These findings and observations are testament to the scenario where the CBD member countries have failed to achieve the agreed objectives, goals and targets as stated in the Strategic Plan for Biodiversity, thus making "*humanity stand at the crossroads with regard to the legacy it leaves to future generations*".

Before going into further details about the assessment made by the GBO-5 report and the reflections thereon, a brief overview about the CBD and its Strategic Plans for Biodiversity is given in the following paragraphs.

Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) entered into force on 29 December 1993 with the following three main objectives:

- conservation of biological diversity
- sustainable use of the components of biological diversity
- fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

Ever since then, the Convention has been in pursuit of achieving these objectives. It has evolved various mechanisms to engage the member countries in fulfilling their commitments towards achieving these objectives. With 196 Parties, the Convention has near universal participation among countries. The Convention strives to address all threats to biodiversity, including threats from climate change, through scientific assessments, incentives and transfer of technologies and good practices with the active engagement of relevant stakeholders including governments, indigenous and local communities, youth, civil societies, women and the business community.

The Cartagena Protocol on Biosafety (CPB) and the Nagoya Protocol on Access and Benefit Sharing are two supplementary agreements to the Convention. The primary objective of the Cartagena Protocol is to protect biological diversity from the potential risks posed by living modified organisms (LMOs) resulting from modern biotechnology. It entered into force on 11 September 2003. To date, 173 Parties have ratified the Cartagena Protocol. The Nagoya Protocol aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, including by appropriate access to genetic resources and by appropriate transfer of

relevant technologies. It entered into force on 12 October 2014 and to date it has been ratified by 128 Parties.

Strategic Plans for Biodiversity

Strategic Plan I

During the Sixth Meeting of the Conference of the Parties to the CBD in 2002 at The Hague, Netherlands (COP 6), vide Decision VI/26, a "*Strategic Plan for the Convention on Biological Diversity*" was adopted with the purpose to effectively halt the loss of biodiversity so as to secure the continuity of its beneficial uses through the conservation and sustainable use of its components and the fair and equitable sharing of benefits arising from the use of genetic resources. The Strategic Plan acknowledged that the "*biodiversity is the living foundation for sustainable development and given the unprecedented rate of loss of biodiversity, the maintenance of biodiversity is a necessary condition for sustainable development, and as such constitutes one of the great challenges of the modern era*".

The stated Mission of this Strategic Plan was that the "*Parties would commit themselves to a more effective and coherent implementation of the three objectives of the Convention, to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth*".

There were following four goals as enlisted in that Plan:

- Goal 1: The Convention is to fulfill its leadership role in international biodiversity issues.
- Goal 2: Parties to have improved financial, human, scientific, technical, and technological capacity to implement the Convention.
- Goal 3: National biodiversity strategies and action plans and the integration of biodiversity concerns into relevant sectors to serve as an effective framework for the implementation of the objectives of the Convention.
- Goal 4: There is to have a better understanding of the importance of biodiversity and of the Convention, and this would lead to broader engagement across society in implementation.

Strategic Plan II

During the Tenth Meeting of the Conference of the Parties to the CBD in 2010 at Nagoya, Aichi Prefecture, Japan (COP 10), a revised and updated "*Strategic Plan for Biodiversity*", including the Aichi Biodiversity Targets, for the 2011-2020 period, was adopted vide Decision X/2.

The purpose of the Strategic Plan for Biodiversity 2011-2020 was to promote effective implementation of the Convention through a strategic approach, comprising a shared vision, a mission, and strategic goals and targets ("Aichi Biodiversity Targets") that would inspire broad-based action by all Parties and stakeholders. The Plan realized that the 2010 biodiversity target has not been achieved and "*the diversity of genes, species and ecosystems continued to decline, as the pressures on biodiversity remain constant or increase in intensity mainly, as a result of human actions*". The Plan argued that the "*better protection of biodiversity would serve as a prudent and cost-effective investment in risk reduction for the global community*" (CBD, 2010).

The stated vision of this Strategic Plan was a world of "Living in Harmony with Nature" where "*By 2050, biodiversity is valued, conserved, restored and wisely used, making ecosystem services, sustaining a healthy planet and delivering benefits for all people*" and the mission was to "*take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication*" (CBD, 2010).

There were five strategic goals which included 20 targets for 2015 and 2020 (named as the "Aichi Biodiversity Targets"). These five strategies and 20 targets were as follows:

I. **Strategic Goal A:** Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society
   - ***Target 1:*** By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
   - ***Target 2:*** By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction

strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

- ***Target 3:*** By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.
- ***Target 4:*** By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

II. **Strategic Goal B**: Reduce the direct pressures on biodiversity and promote sustainable use

- ***Target 5:*** By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.
- ***Target 6:*** By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.
- ***Target 7:*** By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.
- ***Target 8:*** By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.
- ***Target 9:*** By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

- ***Target 10:*** By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

III. **Strategic Goal C:** Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

- ***Target 11:*** By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.
- ***Target 12:*** By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.
- ***Target 13:*** By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

IV. Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

- ***Target 14:*** By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.
- ***Target 15:*** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

- ***Target 16***: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

V. **Strategic Goal E:** Enhance implementation through participatory planning, knowledge management and capacity building
   - ***Target 17:*** By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.
   - ***Target 18:*** By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.
   - ***Target 19:*** By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.
   - ***Target 20:*** By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

GBO-5 Final Assessment of the Aichi Targets

As mentioned earlier, the GBO-5 noted that at the global level none of the 20 targets have been fully achieved, though six targets have been partially achieved viz. targets 9, 11, 16, 17, 19 and 20. Element-wise, out of the 60 specific elements of the Aichi Biodiversity Targets, seven have been

achieved and 38 show progress, whereas 13 elements show no progress or indicate a move away from the target, and for two elements the level of progress is unknown.

Despite this limited achievement, the GBO-5 listed ten areas/targets where progress has been witnessed due to the affirmative actions taken by the member countries. These ten areas (including the six partially met targets) are as follows (CBD, 2020):

- *Target 2:* Almost 100 countries have incorporated biodiversity values into national accounting systems.
- *Target 5:* The rate of deforestation has fallen globally by about a third compared to the previous decade.
- *Target 6:* Where good fisheries management policies have been introduced, involving stock assessments, catch limits, and enforcement, the abundance of marine fish stocks has been maintained or rebuilt.
- *Target 9:* There have been an increasing number of successful cases of eradication of invasive alien species from islands, and of the targeting of priority species and pathways to avoid future invasive species introductions.
- *Target 11:* There has been significant expansion of the protected area estate, increasing over the 2000-2020 period from about 10 per cent to at least 15 per cent terrestrially, and from about 3 per cent to at least 7 per cent in marine areas. The protection of areas of particular importance for biodiversity (key biodiversity areas) has also increased from 29 per cent to 44 per cent over the same time period.
- *Target 12:* Recent conservation actions have reduced the number of extinctions through a range of measures, including protected areas, hunting restrictions, the control of invasive alien species, *ex situ* conservation and re-introduction. Without such actions, extinctions of birds and mammals in the past decade would likely have been two to four times higher.
- *Target 16:* The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization has come into force and is now fully operational in at least 87 countries and internationally.

- *Target 17:* National biodiversity strategies and action plans (NBSAPs) have been updated in line with the Strategic Plan for Biodiversity 2011-2020 by 170 countries, 85% of CBD Parties.
- *Target 19:* There has been a substantial increase in the data and information on biodiversity available to citizens, researchers and policy makers, including through the efforts of citizen science. Big-data aggregation, advances in modelling and artificial intelligence are opening up new opportunities for improved understanding of the biosphere.
- *Target 20:* Financial resources available for biodiversity through international flows have doubled.

Nevertheless, the GBO-5 observed that as per the current trajectory, biodiversity will continue to decline and in the "business as usual" scenarios, this trend is projected to continue till 2050 and beyond. The reasons for this negative projection are the increasing impacts of land and sea use change, overexploitation, climate change, pollution and invasive alien species. These pressures are in turn driven by the unsustainable patterns of production and consumption, population growth and technological developments.

GBO-5 underlined the urgent need to act swiftly to check and halt the further loss of biodiversity and reverse the current trends in the decline of biodiversity. It noted that there has been an apparent increase in the past decade in the proportion of people who have heard of biodiversity and who understand the concept (Target 1), but this needs to increase further for better sensitization among the general public about the significance of biodiversity conservation.

GBO-5 also observed that the financing for biodiversity conservation has doubled as compared to the last decade. However, lack of adequate funding was brought into focus with staggering disparity seen between global public funds for biodiversity, amounting to USD 9.3 billion, and the harmful subsidies and financial incentives worth USD 500 billion. GBO-5 acknowledged the little progress made towards phasing out of these harmful subsidies or incentives potentially harmful to biodiversity (Target 3).

The Outlook argued for wider implementation of the plans made by the governments and businesses for more sustainable production and consumption (Target 4). It further noted that though there has been a

substantial expansion of efforts to promote sustainable agriculture, forestry and aquaculture over recent years, the biodiversity continues to decline in landscapes used to produce food and timber; and the current food and agricultural production remains to pose as main drivers of biodiversity loss globally. It implies that the efforts need to be escalated to higher degrees to check the prevailing condition (Target 7).

GBO-5 strongly stated that the pollution, including from excess nutrients, pesticides, plastics and other waste, continues to be a major driver of biodiversity loss and actions taken in many countries to minimize plastic waste have not been sufficient to reduce this source of pollution (Target 8). It further highlighted the existence of multiple threats which are impacting coral reefs and other vulnerable ecosystems (Target 10).

On the genetic diversity of cultivated plants, farmed and domesticated animals, and wild relatives, the Outlook noted that it continues to be eroded and the proportion of livestock brreds and wild relatives of farm birds and mammals are moving closer to extinction. It further noted that the wild relatives of important food crops are poorly represented in *ex situ* seed banks thus jeopardizing the future food security (Target 13).

As the capacity of ecosystems to provide the essential services on which societies depend continues to decline, the poor and vulnerable communities, as well as women, are going to disproportionately affected by this decline in near future (Target 14).

GBO-5 underlined the recognition of the value of traditional knowledge and customary sustainable use, both in global policy fora and in the scientific community. However, it also noted that despite progress in some countries, there is limited information indicating that traditional knowledge and customary sustainable use have been widely respected and/ or reflected in national legislation related to the implementation of the Convention, or on the extent to which indigenous peoples and local communities are effectively participating in associated processes (Target 18).

Reflections on GBO-5 Assessment and Way Forward

There could not have been as critical time for the release of GBO-5 as this, when the world has been in the middle of the pandemic caused by COVID-19. The report aptly reiterated and highlighted the imperative to

strike a balance with nature and its biodiversity. It made people rethink their relationship with nature and to consider the profound consequences to their own wellbeing and survival that can result from the continued biodiversity loss.

The findings and observations made by GBO-5 have been echoed by two major reports too namely the IPBES's Global Assessment Report 2019 and the WWF's Living Planet Report 2020. The IPBES (2019) Report stated that the ongoing failure to stem over-exploitation, habitat destruction, pollution, climate change and the spread of invasive species will likely to push over a million species towards extinction in the coming decades. The Living Planet Report 2020 found that there has been a 68 per cent average decline in the populations of mammals, birds, amphibians, reptiles and fish in the past 50 years. It also cited unsustainable food production, deforestation, destruction of habitat and overuse of wildlife as key contributing factors to this biodiversity loss as well as to emerging zoonotic diseases such as COVID-19 (WWF, 2020).

It has now been realized even more that the biodiversity is critical to the accomplishment of both, the 2030 Agenda for Sustainable Development and the Paris Agreement under the UNFCC. The Aichi Biodiversity Targets are reflected directly in many of the SDGs targets. Biodiversity is explicitly highlighted in the SDG 14 (Life below Water) and SDG 15 (Life on land). Implicitly, biodiversity is underpinned in much wider set of SDGs. For instance, biodiversity is critical for the achievement of food and nutrition security (SDG 2), good health and well-being (SDG 3) and provision of clean water (SDG 6). Thus it would not be an exaggeration to state that conservation and sustainable use of biodiversity is foundational to the achievement of the 2030 Agenda. In fact, the vice-versa is equally true and valid. For example, some SDGs address the drivers of biodiversity loss, such as climate change (SDG 13), pollution (SDGs 6, 12 and 14) and overexploitation (SDGs 6, 12, 14 and 15). Others address unsustainable production and consumption, the efficient use of natural resources and reducing food waste (SDG 12).

GBO-5 argued that it is not too late and it is still possible to halt the loss of biodiversity and reverse the current trends in the decline of biodiversity in order to achieve the 2050 vision of "Living in Harmony with Nature". This

would majorly rely on recognizing that bold, pragmatic and interdependent actions are required across number of fronts and by all the stakeholders. GBO-5 outlined eight transitions that recognise the value of biodiversity, the need to restore the ecosystems on which all human activity depends, and the urgency of reducing the negative impacts of such activity.

The eight transitions include:

- *The land and forests transition:* conserving intact ecosystems, restoring ecosystems, combating and reversing degradation, and employing landscape level spatial planning to avoid, reduce and mitigate land-use change.
- *The sustainable agriculture transition:* redesigning agricultural systems through agro-ecological and other innovative approaches to enhance productivity while minimising negative impacts on biodiversity.
- *The sustainable food systems transition***:** enabling sustainable and healthy diets with a greater emphasis on a diversity of foods, mostly plant-based, and more moderate consumption of meat and fish, as well as dramatic cuts in the waste involved in food supply and consumption.
- *The sustainable fisheries and oceans transition***:** protecting and restoring marine and coastal ecosystems, rebuilding fisheries and managing aquaculture and other uses of the oceans to ensure sustainability, and to enhance food security and livelihoods.
- *The cities and infrastructure transition:* deploying "green infrastructure" and making space for nature within built landscapes to improve the health and quality of life for citizens and to reduce the environmental footprint of cities and infrastructure.
- *The sustainable freshwater transition:* an integrated approach guaranteeing the water flows required by nature and people, improving water quality, protecting critical habitats, controlling invasive species and safeguarding connectivity to allow the recovery of freshwater systems from mountains to coasts.
- *The sustainable climate action transition:* employing nature-based solutions, alongside a rapid phase-out of fossil fuel use, to reduce the scale and impacts of climate change, while providing positive benefits for biodiversity and other sustainable development goals.

- *The biodiversity-inclusive One Health transition:* managing ecosystems, including agricultural and urban ecosystems, as well as the use of wildlife, through an integrated approach, to promote healthy ecosystems and healthy people.

Clearly, there is a need for bold conservation and restoration action, as well as systemic change in areas driving biodiversity loss. GBO-5 rightly vouched for "*transforming the way in which we produce, consume and trade goods and services, particularly food, that rely on and have an impact on biodiversity*" (CBD, 2020). Leclere *et al* (2020) have argued that through sustainable intensification and trade, reduced food waste and more plant-based human diets, more than two thirds of future biodiversity losses could be avoided and the biodiversity trends from habitat conversion are reversed by 2050.

Vide Decision 14/34, adopted during the 14th COP Meeting at Sharm-El-Sheikh, Egypt in 2018, the CBD has initiated the process of preparation of the Post-2020 Global Biodiversity Framework, which will be adopted at its next meeting (COP-15) in Kunming, China, in May 2021. The hope is that the Framework will create a new set of biodiversity targets to address the reasons leading to the failure of achieving the Aichi Biodiversity Targets and still achieve the 2050 Vision.

Towards the development of Post-2020 Global Biodiversity Framework, GBO-5 has outlined a set of following valuable suggestions (CBD, 2020):

- Need for greater efforts to address the direct and indirect drivers of biodiversity loss, including through integrated and holistic approaches to planning and implementation, and greater interaction among government ministries, economic sectors and society generally.
- Need to strengthen further the integration of gender, the role of indigenous peoples and local communities and the level of stakeholder engagement.
- Need to strengthen national biodiversity strategies and action plans, and associated planning processes, including their adoption as "whole-of-government" policy instruments and not only as "environment ministry" prerogative.

- Need for well-designed goals and targets formulated with clear, and, simple language, and with quantitative elements (i.e. according to 'SMART' criteria i.e. specific, measurable, ambitious, realistic and time-bound).
- Need to reduce time lags in planning and implementation of biodiversity strategies and action plans, and to account for unavoidable time lags in implementation.
- Need for increased ambition of national commitments, and for the regular and effective review of national activities.
- Need for learning and adaptive management, including through greater efforts to facilitate technical and scientific cooperation, and to understand the reasons for the effectiveness or otherwise of policy measures.
- Need for greater attention to implementation, and sustained and targeted support to countries.

The second Local Biodiversity Outlooks (LBO-2) released simultaneously with GBO-5 argued that the "*ongoing disregard of the vital contributions of indigenous peoples and local communities (IPLCs) to biodiversity conservation and sustainable use—including in national biodiversity strategies and action plans—constitutes a major missed opportunity for the United Nations Decade on Biodiversity 2011–2020. This neglect has affected the under-achievement of all 20 Aichi Biodiversity Targets*" (FPP *et al*, 2020). It further emphasized that placing the cultures and rights of indigenous peoples and local communities at the core of the 2050 biodiversity strategy would deliver positive outcomes for biodiversity and climate. Drawing lessons from many successful interventions made by indigenous peoples and local communities, LBO-2 presents an optimistic scenario where the destruction of nature and the unprecedented loss of biodiversity and cultural diversity can be successfully reversed, by embracing the socio-cultural values, and building on the collective and local actions of the world's indigenous peoples and local communities.

The Post-2020 Global Biodiversity Framework should have a representation of indigenous peoples, local communities, women, youth and marginalised groups across all levels of decision-making process to promote

inclusive and responsible governance architecture. Countries should be encouraged to establish national and local mechanisms to enable full participation of IPLCs, women, youth and marginalised sections in national strategies and action plans. The efforts towards mainstreaming traditional knowledge and customary sustainable production and consumption practices needs to be undertaken by the governments. Financial and legal support should be further extended to these groups.

Schroder (2020) has argued that unless there are clear commitments by the countries in tackling drivers of the biodiversity loss, there would be no headway. He questioned the capitalist model of growth, which in its current form is not compatible with the biodiversity conservation. He stressed the need to not see environmental protection as a competing entity to human and societal welfare (as is often done under the growth narrative).

OECD has started working towards providing inputs for the drafting of the Post-2020 Framework, via its project "The Post-2020 Biodiversity Framework: Targets, Indicators and Measurability Implications at Global and National Level", which was launched in 2019. In its interim report (OECD, 2019), it quoted some studies on Aichi Biodiversity Targets done by Butchart *et al* (2016), Tittensor *et al* (2014) and Mcowen *et al* (2016) and argued that there were lack of quantifiable elements, indicators and baselines available in many of the Aichi Targets, which made its proper assessment very difficult.

In light of these concerns, there is a need to have wider deliberations around the framing of Post-2020 Global Biodiversity Framework, so that the new set of goals and targets are pragmatic, effective and measurable. As mentioned earlier, it would be pertinent to make these discussions as inclusive and participatory as possible by involving all relevant groups and stakeholders.

Finally, biodiversity conservation needs to be accorded a high-level priority at all levels, be it at global, national, regional or local; and the efforts and resources required to arrest the decline of biodiversity loss must be revamped. Unless this is undertaken, the fear of moving towards Holocene/Anthropocene extinction (planet's sixth mass extinction event driven by human activity) would not stand unsubstantiated.

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State Biodiversity Boards: Towards Better Governance

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Abstract: India's Biological Diversity Act, 2002, and the three tier implementation mechanism of the National Biodiversity Authority (NBA), the State Biodiversity Board (SBB), the Union Territory Biodiversity Council (UTBC) and the Biodiversity Management Committee (BMC) is close to two decade old. However, our collective and compounding national progress is much less than satisfactory. One of the major reasons is lack of empowerment of the SBBs, the UTBCs and resultantly passive functioning of the BMCs. Bottom-upward empowerment of BMCs to SBBs and UTBCs is crucial in order to achieve the National Biodiversity Targets (NBT) and other national biodiversity conservation and sustainable development ambitions. In this article, author proposes a five pillared work program that can help empower the SBBs and UTBCs that can result in vibrant and optimally governing BMCs. Some or all of the activities mentioned in this article may have been initiated or implemented by few SBBs and UTBCs. However, author calls for coordinated and performance evaluation mechanism being developed and steered by SBBs and UTBC to achieve the national goal of development inclusive biodiversity conservation.

Keywords: State Biodiversity Boards, BMC, Governance, Conservation, BD Act 2002

Introduction

India, one among the 17 mega-biodiverse countries with 4 hotspots harbours nearly 8% of world's biodiversity. India's 1.3 billion plus human population stands to benefit from its biodiversity in so many ways. India's forest alone provide natural services to a tune of ₹128 trillion/year (approximately USD 1.78 trillion) (Krishnan, A., 2020). However, these bio-resources are also witnessing unprecedented threats due to changes in social, economic and environmental systems.

Realising this Indian Parliament, enacted the Biological Diversity Act 2002 (hereafter referenced as ***BD Act***) which aims to conserve biological resources, manage its sustainable use and enable fair and equitable sharing

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of benefits arising from the use and knowledge of the biological resources with the local communities. The *BD Act* was also India's attempt to achieve the objectives enshrined in the United Nations Convention on Biological Diversity 1992 which recognises the sovereign rights of states to use their own biological resources.

In April 2004, Government of India notified the Biological Diversity Rules, 2004 under the ***Act***. Under the ***Act***, three tier implementation mechanism has been established with the National Biodiversity Authority (NBA) as the national coordinating arm. With the guidance and support from the NBA, the State Biodiversity Boards (SBB) and the Union Territory Biodiversity Councils (UTBC) are responsible for achieving the objectives of the BD Act within the states and union territories. The grass roots participation at panchayat (village), municipalities and corporations level is expected through the Biodiversity Management Committees (BMCs). India may be the only nation that has such a meticulously planned three tier infrastructure to implement the ***BD Act*** in letter and spirit (Venkataraman, K., 2009).

Over 19 years have passed since the enactment of the *BD Act*. Some of the experts opine that the *BD Act* in its present form is a jungle of confusion (Pisupati and Kuriakose, 2019). Others have feel that the State Biodiversity Board rules are a puzzle that is yet to be solved (Vaidyanathan and Laxmikumaran, 2019). Needless to state, in past 19 years enough has been written highlighting the weaknesses of the *BD Act*, and the implementation infrastructure - the NBA, SBBs and BMCs (Alphonsa, J., 2017). Frustrated with this snail paced progress (Dutt, 2020), the National Green Tribunal (NGT) in the case of Chandra Bhal Singh verses Union of India & others directed the Ministry of Environment, Forests and Climate Change (MoEFCC) and the NBA to ensure that 100 percent compliance in the constitution of BMCs and preparation of the People's Biodiversity Registers (PBRs) by January 31, 2020. It emphasised that in case of defaults, the states will be fined Rs. 10 lakhs per month each from February 1, 2020 (Tandon, M, 2020). As a result of this dictate from the NGT, definite progress has been done in terms of establishment of the BMCs and preparation of PBRs, the People's Biodiversity Registers. As on 31 October 2020, across the nation, 2,67,193 BMCs have been constituted and 2,14,521 PBRs have been prepared by the respective SBBs and UTBCs (Chavan and Mathur, 2020; NBA, 2020a).

SBBs and UTBCs: The State of the Art

Our collective and compounding national progress in achieving the various objectives set out by the ***BD Act*** is far from satisfaction. This is irrespective of the fact that country is losing a minimum of Rs. 30,000 crores annually by not implementing the ***BD Act***, especially its provisions for access and benefit sharing for commercial utilisation of bio-resources (Sundararaju, 2019). Recovering from such a significant loss of revenue is the primary responsibility of the SBBs and their network of BMCs. Therefore, the current state of implementation of ***BD Act*** at the states and union territories level raises few questions. Analysis of functions and powers of the SBBs highlighted two major issues (Sharma, A., 2016). The first one is the conflicting and competing interest of conservation verses the commercial utilisation of the bio-resources. Second is the understanding of the importance of biodiversity conservation and bio resources utilisation for livelihoods and commercial utilisation by different stakeholders, especially the local communities. Another challenge is to empower BMCs in being proactive in biodiversity conservation, ecological restoration and sustainable development agenda than simply being a mere legal compliance entities of the BD Act at the grass roots level.

Interactions by the author with experts and stakeholders reveals list weaknesses or lacunae at the level of SBBs and BMCs. An attempt has been made to summarise these existing weaknesses or lacunae (Table 1). This is in no way a complete or exhaustive list of the weaknesses or lacunae of the SBBs and UTBCs.

It is difficult to list out state specific issues or problems being faced, and that was never the objective of the interactions with these experts and stakeholders. Therefore the lacunae listed are generalised, and are in no specific order. Few of them may not be true in reality for a specific state or union territory. However, these are sufficient enough to emphasise the urgent need of holistic empowerment of the SBBs and UTBCs and their network of BMCs. Therefore, it is time that the state and union territory governments must take speedy and earnest action to empower their respective SBB or UTBC and BMCs. It is only then the nation will be able to implement the BD Act in its true spirit, and achieve the national goal of biodiversity conservation and sustainable use of bio-resources.

Table 1: Existing lacunae with the SBBs and UTBCs functioning

Sr. No.	Existing Lacunae with the SBBs and UTBCs	Brief description of the lacunae
1	Vision for development inclusive conservation	Lack of state or union territory specific development-inclusive-conservation long-term vision and mission tied up with overall progress or development related goals of the state.
2	Biodiversity Strategy and Action Plan (BSAP)	At the national level we do have National Biodiversity Strategy & Action Plan. However, it does not justify the geographic spread and biodiversity that India is bestowed with. Therefore, at least decadal (10 year duration) Strategy and Action Plan for each state is essential. Given the Vision 2050, even a 3 decade Strategy & Action Plan for a state can be developed (CBD, 2020).
3	BSAP Implementation Plan	In depth and detailed implementation plans together with requirements, evaluation metrics are developed for a period 3-5 years for the jurisdiction of the state or union territories. Such plans are in sink with and to achieve the objectives of the Biodiversity Strategy and Action Plan (BSAP).
4	Biodiversity Leadership (institutional and transformational)	To steer the programs in long-terms for a decade or two decade period. Such a leadership requires to be institutional and transformational in nature, and not person or government specific.
5	Understanding of the ***BD Act***	States do lack widespread and frequent discussions about the intent of the ***BD Act***, its various provisions and benefits that the state can accrue in mid-term and long-term period.
6	Understanding of the Biodiversity	Uniform understanding of biodiversity and biodiversity knowledge amongst the people from all cross-sections of life irrespective of their financial and social status.
7	Participation by key stakeholders	For instance decision of the biodiversity conservation and/or specific development project often misses out local communities or their participation is limited to completing legal formalities. Some of the experts group such as social scientists and bio-entrepreneurs are often missed from planning to execution stages. Panchayati Raj department is the case in point which is often missed out entity.
8	Awareness amongst the line departments	Awareness amongst the line departments regarding the role and functions of the SBB, BMCs and line departments role in biodiversity conservation activities, and need for collaboration with SBB.

Table 1 continued...

Table 1 continued...

Sr. No.	Existing Lacunae with the SBBs and UTBCs	Brief description of the lacunae
9	Engagements with community based organisations	Engagements with community based organisations such as tribal welfare communities, traditional knowledge & skills empowerment agencies, nomadic communities, etc.
10	Engagements with Non Governmental Organisations (NGOs)	Frequent and planned involvement of Non Governmental Organisations in broad activities of the SBB, and those of the BMCs
11	Capacity building	Training and capacity building efforts at regular intervals for stakeholder communities from state functionaries to stakeholders in BMCs.
12	Engagements with research and academic institutions	Collaborations with research organisations (central, state government and private) and academic institutions (universities, colleges, schools, etc).
13	Human Resources at SBB and/or UTBC	Adequate human resources with the board itself to steer its programmes on a long-term basis.
14	Communications and follow-up with BMCs	Proactive interactions and consistent follow-up with the BMCs at regular intervals.
15	Web and Social Media presence and campaigns	In today's age it is must for SBB to maintain its presence on the WEB and on various social media platforms, with current and up-to-date information about various activities by the board and its key constituents.
16	E-governance for Access and Benefit Sharing (ABS)	E-governance mechanism for granting approvals for ABS applications and subsequent monitoring and/or follow-ups
17	Leveraging from the available expertise	Proactive involvement of the board members and relevant subject experts in planning, execution and assessment of activities initiated by the Board or its constituents.
18	Biodiversity Data Publishing Framework	Infrastructure and policy framework for biodiversity data and information management including data safety, access and dissemination, data analysis, etc. (Chavan and Ingwersen, 2009; Moritz, *et.al.*, 2011; Kuriakuse, 2020)

Table 1 continued...

Table 1 continued...

Sr. No.	Existing Lacunae with the SBBs and UTBCs	Brief description of the lacunae
19	Regionalisation and thematic coverage of SBBs	Regional offices of the board in key geographic areas of the state. Provisions to ensure that key thematic issues and/or ecosystems are given due attention.
20	Sustained financial model for biodiversity conservation	Ensuring continued financial support to implement essential initiatives and projects, e.g. trainings, capacity building, outreach, PBR developments and refinements, data management, key restoration projects, etc.
21	Biodiversity Value Index (BdVI) for valuation of bio-resources	Strategies and models to assess the valuation of states biodiversity, its bio-resources, ecosystem services, etc. on continual basis.

Source: Compiled by the author.

Preceding discussion may give an impression that very little or nothing has been done locally and nationally in implementing the ***BD Act*** in its true spirit. Thus, it is essential to clarify that notable success has been achieved (Nazeer, M., 2017; Tandon, 2019; Vaidyanathan, 2019; Patnaik, A., 2020; Ghosh, S., 2020). International agencies such as the United Nations Environment Programme (UNEP) and many others have applauded several of these biodiversity conservation and sustainable development efforts in India (UNEP, 2016; 2020a and 2020b). In past few years several organisations (NGOs included) as well BMCs have been recognised through the India Biodiversity Awards jointly instituted by the MoEFCC, NBA and the UNDP. Since its institutionalisation in 2016, over 600 good cases of biodiversity conservation, sustainable use, access and benefit sharing and biodiversity governance were documented through the award process (NBA, 2020b). This only goes to demonstrate the potential of the ***BD Act*** implementation infrastructure (in collaboration with the cross-sectional stakeholders communities) in achieving 12 national biodiversity targets (MoEFCC, 2020) and exceptions set out in the India's sixth national report to the UN Convention on Biological Diversity (The Economic Times, 2018) and through other processes thereafter.

However, the natural quest is 'how can a nation perform better in terms of biodiversity governance? What are the ways and means through which SBBs, UTBCs and their network of BMCs be empowered? Intention of such an enhanced empowerment is expanding the spearheading potential of SBBs and UTBCs, and collaborative potential of BMCs in engaging with the numerous stakeholders. This is essential because, unless there is no bottom-upward empowerment of BMCs to SBBs and UTBCs; optimal biodiversity governance will continue to remain a dream.

Empowering the SBBs and BMCs: Five pillared Work Programme

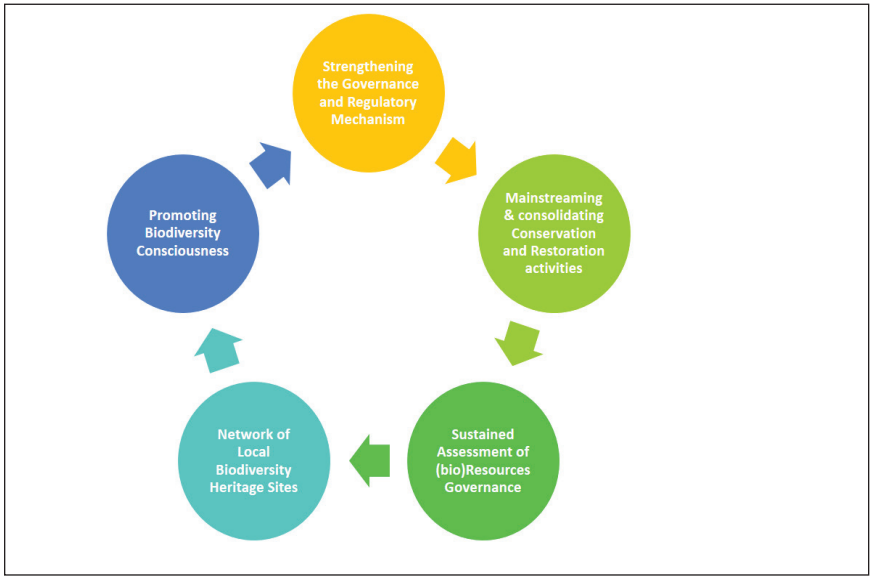
In order to address this issue of empowerment of the SBBs, UTBCs and BMCs, return on investment (RoI), studies are essential for each of the board, especially with regards to the investment in board's activities (including its network of BMCs) and its resultant impact on the ground. Authors assessment, especially in the State of Maharashtra reveals that board merely exist as the entity that fulfils requirements of legal compliance regulator of the *BD Act.* However, its role as a thought leader, initiator and implementation catalyst in spearheading biodiversity conservation, sustainable use and access-benefit sharing programmes are largely under achieved. This is predominantly due to lack of long-term (minimum for a duration of 10 years) biodiversity vision, strategy, action and implementation plan for the state or union territory. This is required to ensure that board's are leading activities those are aligned with the states development and progressive ambitions, yet in accordance with national conservation priorities as enshrined through the National Biodiversity Targets (MoEFCC, 2020) and in tune with nations committment to the UN Sustainable Development Goals (United Nations, 2015), IPBES objectives (https://www.ipbes.net/) and the UN CBD Vision 20501.

With a clear long-term development inclusive biodiversity vision, it is feasible to conceptualise, strategise, plan and prioritise various work programmes of the SBBs and UTBCs fairly quickly through a consultative process involving all relevant stakeholders. A quick review of several national and local activities across the globe reveals that these state specific strategies and action plans can be grouped in five work programs (Figure 1). These includes (1) strengthening the governance and regulatory mechanism of the SBBs, (2) mainstreaming and consolidating conservation

and restoration activities within the boards jurisdiction, (3) proactive participation towards sustained assessment of (bio)resources governance, (4) establishing network of local biodiversity heritage sites, and (5) promoting biodiversity consciousness amongst stakeholders within its jurisdiction.

These are broad and generic categories upon which a detailed work programs activities specific to a particular SBB or UTBC can be crafted along with indicators of success and performance evaluation criteria. In subsequent sections an attempt has been made to define the counters of each of these five work-programmes. Thus, it is essential to keep in mind that the activities mentioned in the subsequent sections are indicative in nature. There is a scope for additions of new activities and omission of those activities which are not relevant for a specific region. Thus, these activities be considered as a mere catalytic thoughts that needs to be brainstormed and juxtaposed with the progressive development agenda and biodiversity conservation requirements of the state or union territory government concerned.

Figure 1. Five Pillared Work Programmes for Empowering SBBs and its Network of BMCs



Source: Author's compilation.

Strengthening the Governance and Regulatory Mechanisms

Since SBBs and UTBCs are largely seen as instrument of legislative and regulatory compliances, much of the human resources employed in the board is spending their energy and time to provide routine regulatory services. As the work processes of these services are mostly manual and human dependent, SBBs core staff strength can never be used beyond the first work programme, i.e., governance and regulatory mechanism, that too without optimal outcomes.

With the advancements in information and communication technologies, the majority of work processes can be automated putting them into e-governance ambit. Some of these services includes approval for commercial utilisation, bio-resources survey, bioresearch, bio-utilization as well as ABS, the access and benefit-sharing application processing, approvals and monitoring etc. Therefore, deploying web based and mobile applications for these purposes may enhance the work efficiency and expedite outcomes. With an e-governance system implemented, such an infrastructure can also be used to collect 'approval-associated-data' and metadata for in-house analysis and planning purposes. This approach will open up novel opportunities for continual monitoring, and assessment of the bio-resources and their ecosystems.

State-level bio-trafficking, bio-safety, bio-invasions and/or bio-security regime is urgently needed through mobile & web-based 'anti bio-resources trafficking system' for customs & Immigration, forest, maritime and public health departments, as well for the BMCs, especially for ABS purposes. Such applications will simplify, expedite the ABS processes leading to increasing Returns on Investments.

Similarly, e-governance application can lead to a simplified and transparent approval process for conducting surveys, monitoring, and collection of bio-resources by researchers and stakeholders. SBB web portals restructuring, and content enrichment at regular intervals is necessary for communicating reliable and up-to-date information to the public and stakeholders. Administratively and financially as well from the regulatory standpoint, there is a need to empower most of the SBBs on lines with the Kerala State Biodiversity Board (KSBB), wherein the board the jurisdiction of the state or union territory.

One of the single most area of critique or criticism is SBBs so called ability-vis-a-vis-inability to implement ABS regime. Very few private entities submit ABS applications. As a result local communities 'chase' for benefits is not over yet and it is likely to continue in the foreseeable future (Perinchery, A., 2020). Revised ABS Guidelines, 2019 are awaiting finalisation[2] . Such revision must address a question of use of Digital Sequence Information (DSI) and ABS resulting from the same. Therefore, the role of SBB is critical in ensuring that guidelines are followed, and benefits are recovered from the user and passed on to the local communities. Local bodies and BMCs are still not at the centre of determining ABS norms. This can only happen if the SBB is sensitive to this issue and is empowered enough by its state biodiversity and political leadership. While, ***BD Act***, ABS guidelines (Ramanujan, 2019a, Ramanujan, 2019b) and regulations are under revision, SBBs can employ existing guidelines themselves to their own benefits and of their constituents benefits. SBBs need to take advantage of NBA's investment in making ABS processes simpler, timely and computerised. Increasing involvement of SBBs in e-PBR processes (Chavan and Mathur, 2020), and proactive steps towards "ABS compliant certification" will provide them additional advantage to reap maximum RoI from ABS provisions. Thus, ABS holds enormous scope in India. In recent past, states like Karnataka, Madhya Pradesh, Tripura and Uttarakhand have demonstrated that an empowered SBB and UTBC can in-deed ensure the fair and equitable ABS to its constituents. ABS can act as an innovative financing mechanism if India adopts a facilitating approach to implementing the ABS provisions under the ***BD Act***.

Mainstreaming and consolidating conservation and restoration activities

Both biodiversity conservation and ecological restoration are key activities in which SBBs are expected to play a vital role. UN has declared 2021-30 as a decade of ecosystem restoration (Venkataraman, R., 2019). Evidently, equal attention is needed for both conservation and ecosystem restoration activities (Venkataraman, R., 2020). Majority of the SBBs are handicapped in implementing its biodiversity conservation and ecological restoration plans, due to limited availability of professionals who have the expertise to plan, organise, oversee, monitor, report and assess such activities. This

is contrary to the fact that there are 1000's of local biodiversity experts and citizen scientists who can proactively engage with biodiversity stakeholders in the state. Apparently, the absence of a platform to engage them in a formal or informal way impedes achieving the conservation and restoration goals of the SBBs. These local experts and citizen scientists can be enrolled as 'biodiversity ambassadors' through a merit and competence skills-based selection process. Such 'biodiversity ambassadors' can act as the biodiversity coordinators at division, district, block, municipal and industrial zone level. The primary goal of these 'biodiversity ambassadors' shall be to plan, promote, oversee and assess the status of biodiversity and its conservation and management in the area of their jurisdiction. Select nature enthusiasts and semi-skilled local stakeholders can be enrolled as 'biodiversity champions' to support the 'biodiversity ambassadors' in ensuring localised implementation of conservation and restoration activities.

Strengthening of the network of Technical Support Groups (TSGs) as envisaged by the existing PBR process (National Biodiversity Authority, 2013) and proposed national framework for electronic PBRs (National Biodiversity Authority, 2020c) is essential to help support these 'biodiversity ambassadors' and 'local biodiversity champions' to achieve their anticipated goals. The building of the state-wide electronic directory of biodiversity experts & organisations and mapping of their competencies will be the first step in this direction. Fast-tracking collaborations with survey, explorations, research and conservation institutions (central & state governments and private) located in the state's jurisdiction and/or those working on biodiversity issues specific to the state is one more effortless way forward to empower the SBBs. These approaches of synergetic collaborations will overcome the problem of human resources deficit that SBBs often face when it comes to cost-effective and influential biodiversity conservation and ecological restoration activities.

Towards sustained assessment of (bio)resources governance

NISARG Bharat (National Initiative for Sustained Assessment of bioResources Governance) is one of the key components of the National Mission on Biodiversity and Human Well-being. NISARG Bharat aims at documenting, cataloguing, mapping, monitoring, and managing biodiversity for conservation and sustainable utilisation of biological resources (Bawa

et al., 2020). Such a programme of a national scale will only be successful if every single SBB and UTBC participate in it with full vigour.

The goal of the SBBs must be to develop a state level framework for sustained assessment of (bio) resources governance as conceptualised by the NISARG Bharat programme. Some of the key activities of such a state-level framework can include, but not limited to are (i) transcendence form PBRs to electronic-PBRs (Chavan and Mathur, 2020), (ii) biodiversity information outlook (Chavan, et.al., 2012), (iii) biodiversity information infrastructure (Chavan and Ingwersen, 2009; Chavan and Penev, 2011 and NBA, 2012, Penev, et.al., 2017), (iv) e-repository for citizens biodiversity observations (Chandler, M. et.al., 2017), (v) BdVI, biodiversity value and utility index at the BMC and state level, (vi) genetic characterisation of the state's bio-resources using state of the art DNA barcoding and high throughput sequencing methods, (vii) creation of DSI, digital sequence information bank, (viii) establishment of seeds bank and enrichment of the natural history collections, (ix) state-level policy for bio-resources conservation vis-a-vis development, (x) biodiversity data access and sharing policy, (xi) long-term in-situ and ex-situ conservation strategies and action plan, (xii) continual assessment and valuation of states' people-centric agro-based activities, and (xiii) alert systems for invasive and detrimental species, etc.

It is must to mention these activities shall not be an independent and isolated initiatives. Rather, these shall be built upon and leverage existing investments that have gone into achieving similar objectives by collaborating with existing institutions (research, academic and policy), eminent experts, young nature enthusiast, philanthropic and non-governmental organisations, etc. To facilitate this, and to benefit maximally from such activities, establishment of a state level 'Centre for Excellence in Biodiversity Conservation and Sustainable Development' under the aegis of the SBB is worth considering. Initially it can be a virtual platform, or nested within existing institution of eminence. Such a centre will function as a policy evolvement, strategy development, conservation and restoration initiatives platform being enable of the think-tank and collaboration catalyst, including that of tapping of CSR (Corporate Social Responsibility) opportunities.

Establishing a network of local biodiversity heritage sites

One of the key functions of the SBB is to identify and conserve the local biodiversity heritage sites (LBHS) through a participatory and collaborative process involving local citizens and indigenous community. However, the progress of SBBs in this area is far from satisfaction. For instance, the state of Maharashtra harbours diverse as well as economically and ecologically important biomes. Thus, there is a potential to create a network of new age biodiversity groves by declaring sacred groves, large lakes, marine and coastal areas, key natural reserves, rural and urban biodiversity islands as LBHS, the local biodiversity heritage sites (Watve and Chavan, 2020).

Such a network of LBHS will help persevere the virgin gene pool for posterity. In becoming instrumental for this cause, SBBs must create required awareness, develop processes, encourage collaborations amongst key responsible institutions and ensure that people do participate in establishing and conserving such LBHS. Declaration of biodiversity rich areas and restored ecological sites must be seen as new age conservation approach (Times of India, 2020) and effective mechanism of empowerment of the concerned BMCs.

Promoting biodiversity consciousness

Peoples participation in biodiversity conservation and sustainable development is critical. However, people participation is directly proportional to the degree of biodiversity consciousness (Ramsay, T., 2012) of the key stakeholders and population concerned. Such a biodiversity conservation consciousness needs to be achieved through multiple activities happening concurrently at all levels of the citizenry. Some of these activities includes but not limited to are (a) awareness and promotion of biodiversity values, (b) outreach to key stakeholder groups, (c) biodiversity and ecology education & syllabus development at all levels, (d) capacity buildings & training activities to stakeholder groups in the state, (e) bio-based-culture & associated knowledge preservation & its promotions through state biodiversity Mahotsav, and fests, Utsavs, and Jatras at local and state level, (f) annual biodiversity conclave and biodiversity awards to recognise and incentivise peoples and stakeholders participation, (g) establishment of biodiversity groves as extension & educational centers, (h) development

of state and district level natural history museum, (i) development of bio-tradition and bio-based-culture centres, (j) development of nature trails, parks at district, blocks and village levels, (i) promote eco-climatic & socio-economic relevance of biodiversity through outreach initiatives, (j) connect with various Varkari Sampradaya, Sant Vangmay and others to promote spiritual significance of biodiversity, and (k) tap into CSR activities, etc.

Putting it into Action

As stated earlier these five category work programmes are a set of ideas which in no way comprehensive list of activities that SBBs can initiate. In fact, more in-depth discussions with stakeholder communities, planners, administrators and political leadership of the state would be the way forward in prioritising existing activities and identifying new activities under these five work programmes. Some of the activities listed in the article are those already being implemented by some of the SBBs. Many of these activities can run concurrently. However, all this may sound overwhelming with the existing capacities (human, finance and infrastructure) available with the SBBs. These impediments can be overcome with two approaches, viz. (1) long-term biodiversity strategy and action plan and medium-term implementation plans, and (2) biodiversity conservation finance mechanism. In order to benefit from these two approaches proactive SBB together with biodiversity leadership at the state level is a must. Such a biodiversity leadership needs to be both institutional and transformational in character (Washington, et.al., 2008 and Askeland, 2020).

Biodiversity Strategy, Action and Implementation for the state

For SBB to transform into proactive entity from its existing passive state requires meticulous phase-wise planning, implementation plan and performance assessment parameters and processes need to be chalked out. This can be best achieved by undertaking crafting of decadal (10-year) BSAP, biodiversity strategy and action plan for the sate. Usually, BSAPs are developed for the period of five years. However, such a short term BSAP fails to garner understanding, support and participation of the stakeholder communities. Therefore, long-term BSAPs are critical to enthuse all concerned stakeholders. The GBO5 has laid out pathways for achieving

2050 vision (CBD, 2020). On the similar lines, drafting of the state specific BSAP for a duration of 2021-50, will provide long-term vision, mission and goals for biodiversity conservation and sustainable development. To begin with this idea of long-term BSAP and short terms implementation plans may sound unusual and out-of-the-box. However, long-term BSAPs will also help secure sustained support from relevant stakeholders. In fact, such an approach is in tune with the first pathway of GBO5, i.e. departing from business as usual. Further, such an approach of the 2021-50 BSAP will ensure continuity of activities with ability to mid-term course correction through 3-5 years duration 'implementation plans', as conservation and restoration do take more than 5-10 years in majority of the scenarios. Long-term BSAPs along with short-term implementation for each of the Indian state is essential and requires to be steered by SBBs themselves. It needs to be seen as an instrument of creation of collaborations and participation platform leading to empowerment of the SBB and its network of BMCs.

Financing biodiversity conservation

Timely implementation of biodiversity conservation requires adequate financial resources to key implementing agencies. Financing biodiversity conservation is an enterprise in itself, as assessment of biodiversity finance needs is essential for sustainable biodiversity management (NBA, 2019). There are several ways and means of securing finances. BIOFIN, biodiversity finance initiatives offers sophisticated and country specific methological framework to assess current expenditures and finance needs for implementing NBAP, the national biodiversity action plan. It further suggests innovative and scalable financial solutions to fill the finance gap for achieving the national biodiversity targets. Approaches similar to BIOFIN needs to be evaluated for preparation of state specific BFP, Biodiversity Finance Plan. Bhattacharya and Battacharya (2019) have suggested state appropriation account analysis as one of the possible mechanism to finance biodiversity implementation plans. Their study proposes a unique method of analysing the public expenditure related to state biodiversity action plan activities.

In addition to this approach of federal funding for biodiversity conservation activities, other sources such as project based funding or loans from World Bank, Asian Development Bank and other multilateral

and international funding mechanisms can be explored. International philanthropic opportunities together with CSR activities are other ways of securing finance for biodiversity conservation.

Moving Forward

At the outset it is possible that this five pillared work programme approach to empower SBBs and its network of BMCs may sound diversion from the established practices and processes. However, biodiversity is under unprecedented threat, and there is growing pressure for development. This calls for out-of-the-box solutions and innovative as well non-traditional implementation tools, based on philosophy of global thinking and local actions. There needs a conceptual change from traditional top-down approach of implementation of biodiversity conservation activities. Rather, there is an urgent need for bottom-to-top approach of participatory conservation movement. This means at the grass-roots level it is the empowerment of BMCs is critical to empower the SBB. Such a biodiversity governance approach do hold immense and unexplored potential for implementation of development inclusive conservation activities by the SBBs. This in true sense is a way forward to implement ***BD Act*** in letter and spirit.

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RIS
Research and Information System
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Legal Aspects Revolving Open Access to Ecological Data: Addressing Present and Future Global Challenges

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Abstract: The world is set to face one crisis after another, given the increasing amount of anthropological interferences with nature. These crises can come in the form of climate change induced disasters, global pandemics, food and nutritional scarcity or other such socio-economic challenges. The need for technological innovations through a collaboration of scientific minds has never been as paramount as it is today. Herein, the importance of open access to ecological data between stakeholders arises. There are several examples of such databases with free or restricted accessibility features. This article examines the legal and technical complexities involved in providing open access to these databases. These issues may range from privacy concerns, violation of intellectual property rights to quality of this data. The role of citizen science in the times of disasters can also not be underestimated. Thus, all these issues faced during open access of data need to be addressed on a priority thereby enabling effective decision making during current as well as future challenges.

Keywords: Open Access, Traditional knowledge, International collaboration, Transparency, Right to information, Knowledge commons

Introduction

The unsustainable development practices being followed by most countries in the world has resulted in major vulnerabilities, both amongst humans and in the natural world (Barasa, 2018). Environmental degradation has led to an increase in climate change induced disasters as well as increased vulnerability in sectors such as agricultural production systems; global disease vectors; epidemiological characteristics of diseases, to name a few (Barasa, 2018). A recent study by Stanford indicates how climate change has also increased the gap between the 'haves' and the 'have-nots' (Krieger, 2019). Hence, there is a need for good quality research and data, to help us come up with innovative solutions that address the above-mentioned

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issues (Fayomi, Okokpujie & Udo, 2018). As highlighted in a 2018 paper, importance of research in achieving sustainable development cannot be overemphasized (Fayomi, Okokpujie & Udo, 2018).

In today's age of knowledge economy, all countries must take advantage of technology and science driven solutions, to collate and use the data they possess in various sectors, and to make this data openly available (Piotrowski, 2015). However, at present, there are issues of weak enabling environment, absence of good quality data, data divide between the rich and the poor, among others, which act as barriers to open data (Smith, Gerry & Truswell, 2015) These technical issues are in addition to legal and institutional complexities of open data (Rosnay & Janssen, 2014).

The purpose of this article is thus to address the benefits of having databases which are accessible to everyone rather than being locked up and available only to a select few. It would then assess the nature and trends of data and information sharing in India and globally. The law and policy framework governing data management, existing in India as well as other jurisdictions will be critiqued in this regard. The article will conclude with some recommendations meant towards making access of scientific data much more streamlined and hassle-free.

Need for Open Access Databases

Justification for such free access to information can be found in the words of Kenneth M. King, when he proposed the concept of the Electronic Superhighway Model or *universal access* model to "c*reate a knowledge management system on the network that will enable scholars to navigate through these resources in a standard, intuitive, and consistent way."* (Brownrigg, 1990)

Benefits of open access databases especially from a sustainable development perspective are as follows (Gurin, Manley and Ariss, 2015):

- **Contribution to Sustainable Development Goals (SDG):** Achieving SDGs would require governments to provide free access to data on these goals, thus contributing to both achieving these SDGs and measuring the progress made in achieving these goals.
- **Fostering economic growth and job creation:** It allows companies to operate more efficiently and profitably. For example, a very robust value-

added private industry on general and specialized weather forecasting products and services has developed in many countries. Apart from the private sector, individuals, collectives including NGOs as well as government entities have benefitted positively in their day-to-day decision making (Group on Earth Observations)

- **Increasing government transparency, accountability, and citizen participation:** It will contribute to improving governance by preventing corruption and mismanagement of resources. It will also help with improving efficiency and effectiveness of public services. Once information on these services becomes available to the citizens at their fingertips, scope for corruption and red tape drastically reduces, It will also help with measuring impact of such services so as to encourage course correction wherever necessary. It will further result in reducing uncertainties and duplications (Maeda and Torres 2012).
- **Potential for enabling local innovations:** It enables more innovations as open access would democratize research with information being made available to researchers from developed as well as developing countries (Maeda and Torres 2012). Documenting traditional knowledge (TK) on health, environment or natural phenomenon would certainly help add value to contemporary scientific research (WIPO 2017).Having thrown light on some of the benefits of open access to data, it will be vital to now look at some important initiatives taken by India in this direction.

India's Preparedness for Open Access to Data- A Status Check

India is giving due credence towards this global movement on open data (Kapoor, 2018) as can be evidenced from the number of datasets amounting to more than 12,000 prepared by atleast 85 government ministries, departments and agencies. These cover sectors such as population census, water and sanitation, health and family welfare, transportation and agriculture (Parihar, 2015). See **Table 1** for some examples of open access databases initiated in India.

Table 1: Open Access Databases initiated in India

Database	Link
Meteorological & Oceanographic Satellite Data Archival Centre by India Meteorological Department and the Indian Space Research Organisation	https://www.mosdac.gov.in/
Environmental Information System (ENVIS) by Ministry of Environment, Forests and Climate Change (MoEF&CC)	http://envis.nic.in/
National Air Quality Index by CPCB	https://app.cpcbccr.com/AQI_India/
Database of the ICAR-Indian Agricultural Statistics Research Institute (IASRI)	https://iasri.icar.gov.in/
National Bureau of Plant Genetic Resources	http://www.nbpgr.ernet.in/
Indian Council of Forestry Research and Education	https://www.icfre.org/
Central Marine Fisheries Research Institute	http://www.cmfri.org.in/
Biodiversity Information System by Department of Biotechnology and Department of Space	https://bis.iirs.gov.in/
Indian Biodiversity Information System by Foundation for Ecological Security	https://www.indianbiodiversity.org/
SeasonWatch	https://www.seasonwatch.in/
Indian Medicinal Plants Database	http://www.medicinalplants.in/

Source: Compiled by the author.

Even at the state level, State Pollution Control Boards have developed databases on individual facilities, consents, and inspection reports. A few states like Andhra Pradesh started using advanced tools like Management Information System (MIS) and Geographic Information System (GIS) to capture complete information on consents, authorisations, fee payments, inspections, violations and directives for corrective actions, etc. through different modules (OECD 2006). Independent and private research

institutions are also generating good quality data on environment, forests, wildlife and biodiversity.

Apart from the above examples of databases, the Indian law and policy framework is also mindful of the scope of publicly generated data in unleashing entrepreneurship, innovation and scientific discovery. Taking inspiration from ongoing efforts in USA, UK, Netherlands, Kenya, Indonesia, among other countries (Nugroho *et. al*. 2015), India came out with the National Data Sharing and Accessibility Policy (NDSAP) in 2012 in recognition of Principle 10 of the Rio Declaration, 1992 and Section 4 (2) of the Right to Information Act, 2005.

It lays down the contours of data proposed to be shared, benefits of such an arrangement, types of access including open/registered/restricted and responsibilities of data owners including the different government entities and the nodal authority for overseeing the implementation of this policy i.e. the Department of Science and Technology (NDSAP 2012). Pursuant to this policy, the data.gov.in was launched helping India embark on its Open Government Data enterprise (Agarwal 2016). An interesting feature with the policy is that data will remain property of the agency/department/ministry/ entity which collected them and it would be providing the necessary access. In addition, legal framework of this policy will be aligned with various Acts and rules covering the concerned data (NDSAP 2012).

Following the NDSAP, the Department of Biotechnology (DBT) had released a Zero Draft of the 'Biological Data Storage, Access and Sharing Policy of India' in 2019 for public comments. It is yet to be finalized. In tune with NDSAP, the draft Science, Technology, Innovation Policy (STIP) of 2020 also proposes implementing open-data and open-access policy, and enabling free access to journals and databases (Draft STIP 2020).

While the NDSAP is concerned with government funded public data, efforts are also on in India to come out with information privacy laws which prevent sharing of information provided by individuals unless it is for a stated purpose and not without the consent of the information provider. A legal framework on personal data protection has been developed through the recommendations of Srikrishna Committee in 2018 (Balaji 2018) and directions by the Supreme Court in *Justice K. S. Puttaswamy (Retd.) and Anr. v. Union of India And Ors.* (Supreme Court 2017). This framework has resulted in the Personal Data Protection Bill in the Parliament in 2019.

Is the Indian legal framework ready for open access?

In spite of the existence of such a vast bouquet of information, there has been no concerted attempt by the Indian government to validate these databases and bring them all under one umbrella. Currently while many of these initiatives are available within the public domain, sourcing of the same by a stakeholder becomes difficult due to their scattered locations and often, RTI applications are required to serve this purpose, which goes against the spirit of openness as prescribed in the NDSAP.

Even the position of legally mandated databases such as PBRs under the Biological Diversity Act, 2002 (BDA) is not clear. Ever since the Act's inception in 2002, a total of 95,525 PBRs have been prepared across the length and breadth of the country (Kukreti, 2020). However, some states allow free access to these PBRs while others do not (Kuriakose 2013) thus causing conflict between the NDSAP and BDA since the former promotes open access to government funded data while the latter is unclear about the access part (Kuriakose and Pisupati, 2019). Lack of access to these PBRs create a problem for innovators as well, since those applying for patents under the Patents Act, 1970 amended in 2005, need to declare the source for the innovation, especially if it is derived out of biological resources and related TK. Without free access, it will be difficult for the innovators to proceed beyond the application stage.

At this juncture, it is important to bring up the Council of Scientific & Industrial Research (CSIR)'s initiative on the traditional knowledge digital library (TKDL). The TKDL, which is a collection of existing literature on ancient medicinal systems (Asthana 2015), acts as the first line of defence, against international patent applications. However, this database is only available to patent offices (both Indian and foreign) despite being bankrolled by public funds. Due to its restricted access, researchers and innovators cannot know whether their inventions related to information available in the TKDL are novel or not. This is detrimental to innovation (Barooah, 2015).

TKDL by itself has no legal basis to be a confidential database since there are no laws or policies which support confidentiality for the same (Reddy 2012). On a positive note, the recent National Intellectual Property Rights Policy, 2016 recommends usage of TKDL in further R&D by public research institutions and private sector (Barpujari and Sarma, 2018). It remains to be seen how this policy will pan out.

While these initiatives have organically evolved as a reflection of India's growing scientific temper, there is a real dearth of good quality information due to several reasons, ranging from failure to maintain records by government institutions, patchy information, lack of transparency, preventing public participation in gathering information despite legal mandate and most importantly failure to make information publicly available (Gadgil and Rathore 2016). It is clear that efforts to create open access databases suffer from several lacunas which need to be corrected at the earliest. It may be worthwhile to examine some of the global trends in this regard.

Global Trends and Regulatory Frameworks Governing Data Collection and Use

Some of the international and national programmes on data collection and use have been created to ensure optimal and timely availability of data and information for decision making at various levels. These initiatives have been able to serve varied purposes, whether it is tracking the status of natural resources in the world, examining effects of environmental degradation and climate change or monitoring the quality of environment or improving prediction rates for disasters, just to name a few (Breggin &Amsalem, 2014). Open access initiatives on collection of genetic data and medical records are also gaining significance (Gibbs *et. al.* 2014) As regards information on bio-chemical compounds, there are many initiatives afoot to document this data As regards information on bio-chemical compounds, there are many initiatives afoot to document this data in publicly available databases (Nicola and Gibson, 2012). See **Table 2** for an illustrative list of open access initiatives.

Table 2: Illustrative list of Global Open Access Initiatives

Database	**Link**
Global examples	
Long-Term Ecological Research (LTER) Network for environmental data from the Americas, the Eurasian region, the African continent and the East-Asia Pacific region	https://lternet.edu/international/

Table 2 continued...

Table 2 continued...

Ocean Observatories Initiative	https://oceanobservatories.org/
Knowledge Network for Biocomplexity (KNB) by National Center for Ecological Analysis and Synthesis, USA	https://knb.ecoinformatics.org/
Global Water Forum	https://globalwaterforum.org/
Extractive Industries Transparency Initiative (EITI)	https://eiti.org/
Global Biodiversity Information Facility (India is also a party to this initiative.)	https://www.gbif.org/
Citizen-led or collective-based initiatives	
Map of Life	https://mol.org/
eBird	https://ebird.org/
iNaturalist	https://www.inaturalist.org/
Integrated Digitized Biocollections (iDigBio)	https://www.idigbio.org/
Encyclopedia of Life	https://eol.org/
Biodiversity Heritage Library	https://www.biodiversitylibrary.org/
TCRB Open Access Data on DNAnexus	https://dnanexus.github.io/tcrb-data/
Harvard Personal Genome Project	https://pgp.med.harvard.edu/
BindingDB by University of Maryland	http://www.bindingdb.org/bind/index.jsp
ChEMBL by European Bioinformatics Institute	https://www.ebi.ac.uk/chembl/

Source: Compiled by the author

Access to information as a right has gained credence in several countries around the world. International legal framework on such access is discussed in following sections.

International Regime on Open Access to Information

The right to information was recognized as early as 1948 in the United Nations Declaration on Human Rights (UNDHR), 1948, which held that access to information is a fundamental human right and making environmental data freely accessible is truly in public interest. Any government policy in contradiction of the same is unethical and inequitable. Subsequently, several international instruments have promoted the need for maximum disclosure by public bodies and protection of whistle blowers, in the interest of transparency (Shodhganga INFLIBNET Centre). For example, the Stocklholm Declaration, 1972 as well as Rio Declaration, 1992 requires that states should cooperate through exchange of scientific and technological knowledge and that related information should be made accessible to all stakeholders. See **Table 3** for a chronological list of international instruments which promote open data.

Table 3: List of International Instruments which promote Open Data

Year	Instrument
1948	United Nations Declaration on Human Rights (UNDHR),
1966	International Covenant on Civil and Political Rights,
1969	American Convention on Human Rights (ACHR),
1972	Stockholm Declaration of the United Nations Conference on the Human Environment
1992	Rio Declaration on Environment and Development
1992	United Nations Framework Convention on Climate Change (UNFCCC),
1992	Convention on Biological Diversity (CBD),
1998	Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters,
2001	International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)
2002	African Union's Declaration of Principles on Freedom of Expression in Africa
2003	Cartagena Protocol on Biosafety
2004	Akwé: Kon Guidelines under CBD

Table 3 continued...

Table 3 continued...

2004	Arab Charter on Human Rights,
2007	United Nations Declaration on the Rights of Indigenous Peoples
2010	Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization
2011	Tkarihwaié:ri Code of Ethical Conduct under CBD
2018	Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters

Source: Compiled by the author.

Despite this extensive international legal framework, minimal attention has been provided towards easily accessible global databases on bio-informatics that have country support. In this respect, the Clearing House Mechanism (CHM) setup under CBD facilitating web-based information services to ensure scientific and technical cooperation, knowledge sharing and information exchange, is a good example. Further, the Bio-Safety Clearing House setup under Cartagena Protocol on Biosafety, 2003 allows for information regarding movement of living modified organisms and associated risks, if any, to be shared between parties.

As a signatory to the CBD, India is committed to developing a national clearing-house mechanism to facilitate access to biodiversity information both nationally and globally, but this has not been done effectively so far except for India becoming a participant in the GBIF, as mentioned above. The ENVIS database that is currently being used as the CHM in India has several gaps and it would take some time for this database to become an effective CHM mechanism for information pertaining to ecosystems and biodiversity.

Best Practice Examples from Other Jurisdictions

Even though the global trends on data sharing is geared towards open access (Michener 2015), there are very few countries, mostly from the developed world, which had taken advantage of this movement. Recently, however there are some emerging biodiversity rich economies which have taken huge strides in this endeavour.

To help reduce bureaucratisation of R&D in Brazil researchers of interested institutions are allowed under the New Law on Biodiversity, 2015

to apply electronically thereby generating an electronic declaration of legal compliance (Andrade, 2018). In Costa Rica, the law encourages creation of database on biodiversity information, accessible for bona fide use and teaching activities (Costa Rican Biodiversity Law, 1998). European Union's (EU) Habitat Directive of 1992 is instrumental in the creation of Natura 2000, an EU wide ecological online database which is jointly developed by both the governments as well as NGOs (Medaglia *et. al.* 2014*)*.

Philippines' Guidelines on Indigenous Knowledge Systems and Practices and Customary Laws Research and Documentation, 2012 sets the ball rolling for research and documentation of TK with adequate safeguards prescribed including detailed responsibilities of the community, researcher and the government (Agillion, 2007). Further, there is the Philippines TKDL for Health which is accessible to researchers and highlights a good example of open access for research without compromising on community rights (Acosta, 2014).

Examples of community mapping in coordination with government entities for the purpose of conservation and academic research are in plenty. For instance, five indigenous communities in Belize have carried out community mapping through gathering of comprehensive baseline data on flora, fauna, soils and geology, hydrology, socioeconomic situation, and indigenous TK in their region (Sobrevila, 2008). Indigenous rangers and traditional owners in the Tanami region from Australia have developed a dataset in collaboration with the mining industry, land council and environmental consultancy partner to help researchers understand the ecology of the region in a better manner. This data has been responsibly published without revealing the locations of any sacred cultural sites or habitats of threatened plants and animals (TERN, 2018).

Due to constant threats from extreme weather events in the Oceania region, indigenous communities within Australia, Micronesia, Melanesia and Polynesia, have developed a database including information ranging from recording animal and plant behaviour to historical observations on biological or physical factors in climate events. This database follows strict guidelines on respecting cultural sensitivities, free and open source software, portability, sustainability, ease of use and ability to be operated smoothly in environments with limited technical expertise (Chambers *et. al.* 2017). See Table 4 for open access initiatives from different jurisdictions.

Table 4: Open Access Initiatives from Different Jurisdictions.

Database	Country	Link
South African National Biodiversity Institute	South Africa	https://www.sanbi.org/
Data.gov on topics such as agriculture, climate, energy, local government, maritime, ocean, older adults' health	USA	https://www.data.gov/
Geospatial Platform	USA	https://www.geoplatform.gov/
National Ecological Observatory Network by National Science Foundation	USA	https://www.neonscience.org/
Atlas of Living Australia (ALA)	Australia	https://www.ala.org.au/
Philippine Traditional Knowledge Digital Library on Health	Philippines	https://www.tkdlph.com/
New York City Environment Open Data	New York, USA	https://opendata.cityofnewyork.us/
Shared Environmental Information System (SEIS)	Europe	https://www.eea.europa.eu/
PubChem by National Center for Biotechnology Information	USA	https://pubchem.ncbi.nlm.nih.gov/
TERN Ecosystem Research Infrastructure	Tanami Region, Australia	https://www.tern.org.au/

Source: Compiled by the author

From the above global best practices, it is clear that the data being collected so far cover a large range of subjects. However, such information is being sparingly used to fuel major scientific advancements especially in the developing countries. This state of affairs may be owing to the lack of free access, non-standard data collection methods and failure to disclose properly the source of all this data (Michener 2015). It will be useful to examine some of the legal issues plaguing open access to information.

Legal Issues related to Free Access to Information: Implications for India and Way Forward

Data Curation and Dissemination

With the advent of internet age, the type of datasets being generated, their volume and quality are of a big concern (Cho 2014) especially if it impedes with efficient decision making (Soranno *et. al*. 2015). Thus, data management plan, operational policies, quality assurance protocols and data attribution policies should be established (Michener 2015), before the start of data collection so as to ensure release of well curated, scientifically validated and updated information.

Pointers that ought to be kept in mind while creating such databases include plan with allocated budget heads; machine readable format; user-friendly; free of access and registration procedures as far as possible; availability of publisher information and data collection methods; standardised datasets; user feedback options; constant monitoring and updation; and well curated data collection from public (Michener 2015).

Possibility Of Infringing IP Rights Very High

Data sharing often involves IP questions if there are trade secrets, TK, copyrighted articles or information on patentable inventions included within the database. For instance, there may be some public databases which allow free access to any individual for any purpose wherein third parties (not the depositor of data) claims an IP right. Secondly, the IPR regimes of countries differ in the case of internationally accessible databases. For instance, members of the European Union or South Korea have sui generis database rights which prevent extraction or reuse of data from a protected database unless it is for the purpose of non-commercial research (Carroll 2015).

There is also the risk from open access of a contributor's moral rights being violated when the user of such data distorts the meaning of such data or accidentally discloses some private/sensitive information. Some remedies to avoiding infringement of above-mentioned rights include prescriptions on terms of use or conditions, non-disclosure agreements and contracts and licenses wherein the owner willing gives up his/her IP or moral rights. There may also be restrictions imposed on transfer of data across international borders (Kuriakose and Pisupati, 2019).

Concerns When Data Contains Traditional Knowledge

Establishing who owns TK can be very challenging especially when the TK is from an unidentifiable source or shared between communities spread across large territories or are transboundary in nature. The knowledge collected may also be sometimes lost in translation. One has to also be mindful of the cultural sensitivities and secretiveness shown by certain communities to divulge their knowledge (Kuriakose and Pisupati, 2019).

In India, the absence of a definition on what constitutes TK creates a hurdle in documenting this data. Along with the freedom to prevent access to sensitive information, communities must also be allowed to choose the manner in which their knowledge is being used within a research project. They must definitely have a say in the sharing of benefits in case there is a commercial utilization from such knowledge (Kuriakose and Pisupati, 2019).

Balancing Academic Research and Research for Financial Gains

Researchers with academic pursuits are often in conflict with R&D financed by corporates or MNCs on the ground that the latter would use the data painstakingly developed by the former for commercial gains without any financial benefits or attribution going to the researchers. The corporates also fund important studies for their financial gain and the information received here is seen as proprietary with no scope for being shared publicly (Alter and Vardigan, 2015).

This can be remedied by differentiating access from public databases for commercial and non-commercial utilization. In the case of the former, benefit sharing agreements maybe formalised. For private companies, incentives to open up their scientific databases should be provided which range from tax benefits to allowing such access under their CSR activities (Kuriakose and Pisupati, 2019).

Misuseof Publicly Available Data

There is a lot of fear amongst opponents of data sharing that openly available data could be misused and result in threats to national security threats, biodiversity loss and exploitation by developed countries. Open access also challenges the notion of a country's sovereignty over natural resources found within its territory and the manner that it may be utilized.

It is for this purpose that several access options ranging from open access, licensed access, restricted license access, secure remote access to the most restrictive option of data enclaves have been developed around the world while accessing databases which are described below (Alter and Vardigan, 2015). Thus access must be customised as per the sensitivity of the data sought to be accessed.

Concluding Remarks

As an expert notes, science in areas of health, environment and food security can be self-reliant but not necessarily self-sufficient (Pisupati, 2020). Therefore collaboration between stakeholders at the local, national, regional and international levels to come out with scientific solutions is the need of the hour. Access to free-flowing, substantial, good quality and reliable data is all the more relevant in the current context of COVID-19. For instance, the Ebola outbreak between 2013 and 2016 could have been handled better, had there been more open sharing of data (Pisupati and Sathyarajan, 2020) to help in the development of a cure. Even in the case of frequent climate induced disasters, technological innovations used by countries to create climate resilient infrastructure should be shared widely.

However, the perpetuating confusion over who owns the data and information, how to collect and collate it, how it can be used, how to safeguard the data and information from misuse, how to translate the data into decision making at various levels is necessitating a new paradigm in the way countries like India would like to use the data and information (Kuriakose and Pisupati, 2019). Prohibiting any access would obviously be grossly against all existing national and international norms and practices as outlined in earlier sections of this article. If India needs to strive ahead with scientific innovation, the resources and knowledge should be used more widely and by both public and private sector, with appropriate usage policies. Globally, a protectionist attitude towards data sharing will certainly keep countries from progressing into the future.

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Conceptualising Framework for Local Biodiversity Heritage Sites (LBHS): A Bio-cultural model for biodiversity conservation in Maharashtra

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Abstract: India's Biological Diversity Act 2002 is now 18 years old, and it has made it possible for the local communities to actively engage in the management of biological resources in various manners. One of the important provisions empowers the local communities to designate biodiversity rich areas as a Biodiversity Heritage Sites (BHS). However, our national progress in designating BHS has been snail-paced and far away from optimal use of such a provision for the benefit of nature itself. This calls for strategies and measures that empowers local communities to assess and designate the potential of a socio-ecological landscape as a Local Biodiversity Heritage Site (LBHS). Here we propose a conceptual framework for establishing Local Biodiversity Heritage Sites that represent the richness of the social-cultural landscape of Maharashtra state. Steps required to identify and establish a LBHS are listed based on the examples Sacred Groves and Rocky Plateaus, two habitats of high conservation importance in Maharashtra. In our opinion such sites are the humanities last chance to preserve the gene, species, ecosystem, its services, associated knowledge, culture, traditions and thereby natural heritage. It is our belief that LBHS can be a true legacy for future generations and a lasting reminder of the indelible connection of human beings with Mother Nature.

Keywords: Local Biodiversity Heritage Sites, Biological Diversity Act 2002, Associated Knowledge, Ecosystem, Culture

Introduction

Biological diversity has been the basis of human existence on planet earth. Local communities have learnt to use, manage and respect it over centuries. Agro-biodiversity is an example of humans using culture specific ways to enhance the wild biodiversity. This is our true heritage passed from generation to generation. Recent rise in exploitative uses of nature threatens

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this very connection that has made survival possible for humans. Globally there is an agreement in the form of Sustainable Development Goals to conserve biological diversity and use it in a sustainable manner. The Biological Diversity Act, 2002 of India is a national step towards protecting India's bioresources and ensuring that the local communities can actively engage in the management of biological resources. One of the provisions of this law is designating biodiversity rich areas as a Biodiversity Heritage Sites (BHS). This is a far reaching provision to ensure an inclusive model of biodiversity conservation rather than exclusionary models used by earlier laws. In this paper we explore the theoretical basis of this provision to conceptualize a framework to be used for putting the provision in practice. The first half of the paper explores the social-ecological approach and the concept of heritage that set the BHS provision apart from other conservation approaches. The second half of the paper uses the framework to identify LBHS in Sacred Groves and Rocky Plateau habitats in Maharashtra and provides recommendations for streamlining the process that can help achieve the goals for conservation through this provision.

Socio-ecological landscape and its importance in conservation planning

Ecology as a science has undergone a paradigm shift over the past few decades. In the past ecological studies were limited to the study of different organisms in relationship with each other and environment and flow of matter and energy through different ecosystems. The western approach that accepted human-nature duality led to most ecological studies being limited to non-human organisms and environment where all activities of humans were thought to be negatively impacting the environment (Talen & Brody, 2005). This view was repeatedly questioned by scientists and led to the paradigm shift of seeing humans as part of nature. Environmental historians like Fernand Braudel and Karl Butzer recognized the importance of past and present cultures interacting and operating with the natural environment at landscape level (Moore, 2003). B. L. Cherkasskii described social-ecological systems as consisting of two interacting subsystems - biological and social (Colding and Barthel, 2019). Berkes and Folke (1998) developed a "Social-Ecological Systems" (SES) framework for the study of intertwined human and natural systems and since then the concept of SES is used widely

in environmental and social sciences especially for addressing issues of ecological resilience for mutual benefit (Colding and Barthel, 2019). The SES framework placed ecological knowledge and understanding of resource users (of local ecosystems and resource base on which they depended) as a crucial and central link between ecosystem and management practice. This is expected to lead to management practices that are framed by local often informal institutions (Colding and Folke 2001) and is similar in practice to the several models of common property governance described by Ostrom and others (Schlager and Ostrom, 1992; Ostrom & Cox, 2010).

Despite being under human use for several thousand years (Chandran, 1997) India has retained almost all of its biodiversity (Rangarajan, 2005). Sacred groves, sacred species, indigenous seeds, indigenous breeds (Ramakrishnan, 1996; Ramakrishnan, 2003) are examples of the ecological knowledge of adaptive management of biodiversity. Changing balance in human-nature relationships necessitated application of exclusionary models of conservation in the 1990s. But its limitations and resultant conflicts (Kabra, 2019) led the conservation scientists to focus on application of SES concept and ensure legal and policy support to non-exclusionary models of conservation. The participatory approaches adopted ranged from Integrated Conservation and Development Programmes (1980-90s), to community-based conservation (CBC), enterprise-based conservation(EBC), JFM in 1990s and now with the Biological Diversity Act, 2002 and The Forest Rights Act, 2006. These laws empower Panchayat or Gramsabha to govern the bioresources in a decentralised manner.

Biodiversity Heritage Sites as a protection category

Designation of National Parks and Wildlife Sanctuaries has been the accepted global strategy of wildlife conservation. But its limitations led to recognition of many other approaches. Biocultural heritage sites (Oviedo & Jeanrenaud 2007), Community Conserved Areas *(CCAs)* (Kothari, 2006; Berkes, 2009), Sacred Natural sites (Dudley, et al. 2010), and Indigenous Peoples and Indigenous Communities Conserved Territories and Areas (ICCAs) are internationally accepted terminologies. These, along with Key Biodiversity Areas (KBAs), Important Bird Area (IBA), Important Plant Areas (IPA) are included in the Other Effective area-based Conservation Measures (OECMs) which are important for biodiversity conservation and

complement the Protected Areas (Mehta & Kulkarni 2012; Maxwell, et al. 2020). These designations although important for international recognition are not useful for management of the areas unless supported by National laws. Borrini et al. (2004) suggested providing legal protection to the Community Conserved Areas *(CCAs),* to ensure management as per the national laws.

In India, the legal provision is through the Wildlife (Protection) Act, 1972 (Community Reserve, Conservation Reserves), Regional Town planning Acts (Conservation Zones) and Environmental Protection Act (Eco-sensitive Zone). These legislations help protect areas having high biodiversity values, such as threatened species, threatened habitats or specific ecosystem services. Areas of exceptionally high geological diversity, historical or archeological values can be protected through legal provisions made through other Indian laws such as The Ancient Monuments and Archaeological Sites Remains Rules, 1959 and the proposed geoheritage (Conservation and Promotion Bill), 2019. All of these are limited to a few values and have faced management problems due to lack of participation of local people and non-recognition of local cultural values of a place.

The Biological Diversity Act 2002 has made it possible for the communities to actively engage in the adaptive management of biological resources in various manners. The provision for the local communities to conserve biodiversity rich areas by designating Biodiversity Heritage Sites[1] accepts biodiversity as a form of heritage which sets it apart from other types of Protected Areas.

BHS is unique in its scope and process of designation and can be truly integrative and participatory in nature. It gives equal importance to the local cultural values of a place, ecosystem services and the global values of biodiversity. The published BHS guidelines by the National Biodiversity Authority (NBA) describe a declaration process which is participatory and involves documentation, consultation and declaration through involvement of community, experts and administration at various levels (Tandon & Dutta, 2017). If followed in its letter and spirit, this transformative social process can integrate values across different communities at local, national and global level.

Various State Biodiversity Boards have declared state rules of BHS declaration as well. As on date eighteen BHS are recognised in India (http://

nbaindia.org/content/106/29/1/bhs.html). Since then Kerala Biodiversity Board has established rules that empower Panchayat's Biodiversity Management Committees to declare "Local Biodiversity Heritage Sites" for areas of biocultural importance which has led to designation of 10 sites in Kerala alone[2]

Uniqueness of BHS

Unlike other types of legally protected areas, BHS is not limited to a species or an ecosystem alone, and extends to social-ecological landscapes, associated indigeneous practices and beliefs associated with a space. It may or may not have "*long history of human association*" which makes it possible to include areas which don't have known human association (thus making it different from other types of indigenous community conserved areas) or include areas which have only recently been considered important and are to be preserved for the future.

BHS emphasizes biological and/or cultural values of a site which could be very old, recent or even in the future (species of evolutionary significance). A sacred grove may be on government land but the local values can date back to many centuries. Conversely some areas have only recently gained an ecological and cultural value which needs to be preserved for future as per local sentiment. A most recent example is of Aarey forest of Mumbai[3]. The area was government land which had gained biodiversity values through wise management over many years. It was considered extremely important by the residents of Mumbai and many others across India. When infrastructural development was proposed on the land a public movement -"Save Aarey Forest" started and finally led to inclusion of Aarey in the forest Land.

Biodiversity as well cultural values of a site and the communities which hold them are dynamic and evolving over generations. Real strength of the concept of BHS is a broad definition and flexibility in the criteria that protects the dynamism of bio-cultural values, making it most suitable for sustainable futures.

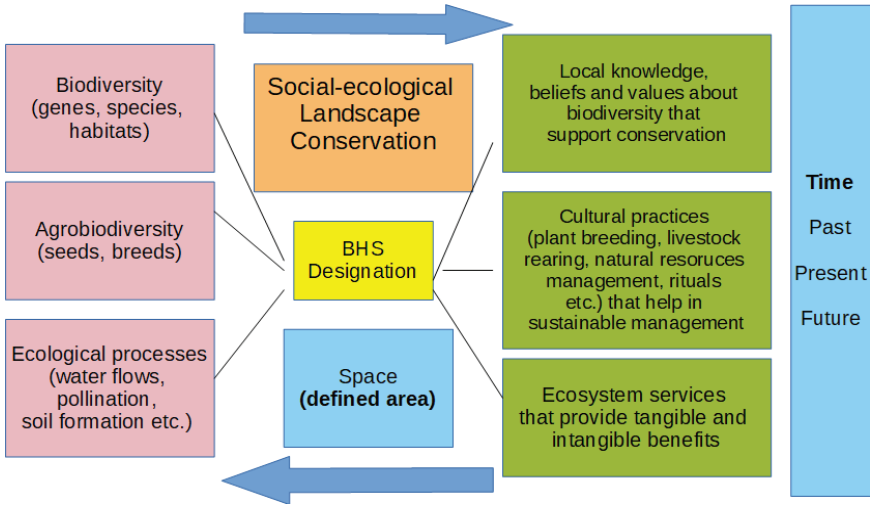
The word "Heritage" has been shown to be a social *process* (Harvey, 2001), who has emphatically argued against limiting it to physical artefacts or records as often done by the British laws, an argument which can also

be extended to Indian laws made during colonial times that share the same limitation. "Heritageisation" (in the sense used by Harvey, 2001) of artefacts (areas, buildings, museum collections or ecosystems) as a tangible product- is likely to lead to commercialization through tourism- which indeed has happened world over. But "heritageisation" as a *social process* can become a transformative process, that can aid conservation, sustainable management and inclusive development, which can ensure that the "values" are passed onto the future generation rather than just physical artefacts.

The term "heritage" as used in the Biological Diversity Act, 2002, is more in the sense of the interpretation of heritage as a *process* than as a *product*. It is indeed similar to the concept of "Warsa", (vern. Marathi) , in India, (which loosely translates to legacy in English), which could mean artefacts, practices, individual or social patterns, beliefs and ideas etc. which are seen at present, have roots in the past and are to be continued into the future. For example, a sacred grove or sacred pond or an urban plantation, when considered as heritage is not just a group of trees or a waterbody to be maintained. It is a symbol of "a value" associated with a natural area by the people which is manifested through respect, love or reverence. It is this positive value which will be passed onto future generations through local practices. Interpreting the term heritage as "*Warsa*", allows us to address the issues of identity, cultural continuum, values of pride, respect, love and ethics held by the humans towards their natural surroundings which can provide valuable support to biodiversity conservation and sustainable development through transformative social processes. The provisions of the Biological Diversity Act are already there to support this progressive and all-encompassing and fundamentally Indian concept of *Warsa*, applied to social-ecological landscapes.

The conceptual background of BHS discussed above is to set the context for the next section in which we are identifying potential local biodiversity sites in Maharashtra. It is beyond the scope of this article to list out all potential sites in the state of Maharashtra for conservation, as biocultural diversity of Maharashtra deserves thorough investigations to designate BHS in future. Therefore our attempt is to use the conceptual background of BHS as an emerging framework that helps to identify potential BHS (Figure 1).

Figure 1: Framework for identification of BHS



Source: Compiled by the author

BHS designation is central to the framework, which is a spatially defined area within a social-ecological landscape, has associated biocultural values and is not bounded by time.

Out of the rich diversity of practices, we have selected "Sacred groves" and "Rocky Plateau ecosystems" to illustrate how this framework can help in the identification of LBHS (Figure 3). The sacred groves are an example of ancient practice of nature conservation that demonstrates ecological prudence (Gadgil and Vartak, 1976) a value that needs to be culturally transferred to the future generations. The Rocky Plateaus represent a fragile ecosystem with harsh environment (Porembski et al. 2016) where indigenous practices of landscape management have ensured human-biodiversity coexistence, which is a globally unique phenomenon.

LBHS Potential for Maharashtra

Local Biodiversity Heritage Site (LBHS) is a provision made by the Kerala State rules, where BMCs can declare local BHS of importance to the state. Heritage legislation in India[4] allows sites to be protected under Central law or State law with a clear distinction between the process and the responsibility

of further management. Same principle can be applied to management of LBHS and BHS. Some LBHS can be later elevated to BHS as well.

Sacred Groves of Maharashtra

Sacred groves (*Devarai* or *Devarahat* in Marathi) are patches of old growth forest traditionally protected by the local communities in the honour of a deity (Gadgil and Vartak, 1976). These deities have associated myths and histories along with the customs and traditions that are passed down orally from one generation to the next through culture. Many local gods, goddesses, spirits and supernatural beings are associated with groves and they are worshipped by communities belonging to a variety of faiths. The values associated with sacred groves can be listed as reverence for natural spaces, management practices that focus on community rather than individual use of natural resources, ecological values (conservation of watersheds, special ecosystems (Malhotra *et al.*, 2001).

The cultural practices include many which help govern the forest as common lands. Rituals, festivals all reiterate the cultural value associated with the sacred space. Ecosystem services of the grove include protection of springs, watersheds and they have provisioning, regulating, supporting and cultural ecosystem service values (Blicharska *et al.* 2013).

Biodiversity conserved due to sacred groves includes plant endemics, rare and threatened species of plants, support of faunal diversity especially birds, old-growth vegetation of moist-deciduous, dry deciduous, semi-evergreen and evergreen nature (Kulkarni et al. 2018). A recently documented grove in South Sindhudurg protects a very unique and perhaps the only representative of *Myristica* Swamp Vegetation in Maharashtra (Sreedharan & Indulkar, 2018). Many of them are associated with sacred water bodies, sacred springs and watersheds (Chandran *et al*. 1998). They have been shown to be key reservoirs or islands of rich diversity in a landscape altered by humans (Ormsby 2011, Dudley *et al*. 2010). Their protection leads to conservation of wild biodiversity and ecological processes.

Majority of research papers on Sacred groves have documented increasing threats to the groves and degradation arising out of changing socio-cultural environments. Voluntary organizations have taken up efforts to start education and awareness about the groves with an aim to develop

understanding of ecological processes and ecosystem services to encourage local communities to take up sacred grove conservation (Blicharska *et al.* 2013). This renewed interest in the groves will be beneficial and declaration of Biodiversity Heritage Site under the law can support the conservation efforts and increase the landscape-conservation coverage of the state manifolds.

Identification of BHS in SGs

Since the first comprehensive documentation by Deshmukh (1999) the number of reported groves is growing. ENVIS database[5] shows sacred groves to be present in all the districts and different ecoregions of Maharashtra (Gaikwad *et al.* 2004) with more concentration in the western region (Table 1). Most groves are on community lands, but can also be on private or government land, making conservation planning difficult due to issues of ownership. Despite various efforts and pleas of researchers, there hasn't been any single legal protection category for these extremely important habitats. So far, none are included in Biodiversity Heritage Sites in Maharashtra (Mahabaleshwarkar & Ghayal 2018). But Goa, Meghalaya, West Bengal and Karnataka have all declared Sacred Groves as BHS.

Sacred Groves to be included in LBHS category can be identified through following steps

- Detailed documentation of biocultural values and ecosystem services of sacred groves, aided through People's Biodiversity Register process
- Mapping and georeferencing of key biodiversity elements in sacred groves
- Assessment based on indicators of biodiversity, vegetation and ecology (canopy integrity, species richness and diversity, keystone species, endemic and rare species etc.)
- Listing of associated cultural values including shrines, trees, animistic traditions, divine spirits in nature
- Assessing local support for conservation
- Selection of groves with higher values where local communities are in support of conservation

- Consultative processes to identify current values and management practices that support biodiversity this should include local communities, voluntary organizations and government agencies working in the region
- Participatory Management Planning for the selected sacred groves for sustainable natural resource management in future
- Designation of LBHS in selected sacred groves

Table 1: Sacred Groves reported by Researchers

Administrative Unit	Number of Sacred groves	Reference
Pune District .	237	(ENVIS, 2018)(Mahabaleshwarkar & Ghayal 2018)
Mawal-Mulshi, Pune dt	40	Oviedo & Jeanrenaud (2007)
Mulshi, Pune dt	15	Vipat & Bharucha 2014
Ambegao tehsil, Pune dt	34	Nipunage & Kulkarni, 2011
Junnar tehsil, Pune dt	5	Nipunage, et al. (2009).
Ratnagiri dt.	500+	(Patil 2016)Ghalme, & Deokule, (2014). Dutta, S. (2004). Gawade, et. al., Kavade and Berde, 2016
Sangli dt	3	Sathe, Lavate, & Shimpale, (2012).
Konkan	8	Blicharska, et al. 2013
Taroda, Amravati dt	1	Onkar & Bhogaonkar, (2016)

(this table is indicative as the numbers change as more research is conducted in the region)

Source: Compiled by the author

Rocky plateaus

The rocky plateaus belong to a category of habitats known as 'Rock Outcrops' recognized by the IUCN. Locally they are known as Sada or Pathar in Marathi. They are extremely rare as ecosystems and seen only in select places in Brazil, Madagascar and Australia. Extensive studies in the world

have shown that they are an endangered habitat which needs immediate attention for conservation (Poremsbki et al. 2016). The plant and animals here are adapted to climatic extremes and more than 150 endemics and around 60 species of plants and animals are narrowly endemic to only one or few plateau sites (Watve, 2013). Rocky plateaus of Maharashtra have globally unique elements that are not seen even in the adjacent states of Goa and Karnataka. They are the primary watersheds and nutrient catchments and play an important role in hydrology of the region (Buono et al. 2016). They support a very large component of wild biodiversity of Maharashtra especially in the NW Ghats hotspot region.

Indigenous ecological knowledge of natural resource management of rocky plateau ecosystems includes food production and water management practices (Dandekar, 2011). The harsh and challenging landscape has been inhabited by humans since prehistoric times as evident from recent finds of habitations of ancient humans in the Sindhudurg district in a cave. Recent discovery of pre-historic humans and intriguing petroglyphs on rocky plateaus throughout Konkan region has led to new understanding regarding development of human societies in Maharashtra landscape (Garge et al. 2018).The plateaus have several ancient monuments and shrines that are worshipped even now. Specialized wetland rice cultivation, orchards around the plateau, creation of water systems to harness springs and rainwater are evidence of ecological knowledge and ingenuity of the people of Maharashtra.

The greatest threats to the plateaus are from mining for bauxite, quarrying and severe land use change. The land classification included them in wasteland (Watve, 2013), which has led to many developments without consideration of biodiversity in the past. But in the last decade several researchers have studied the ecosystem and contributed to biodiversity documentation. There is a growing interest in the wildflower diversity and tourism potential of the plateaus and one of them, Kaas plateau in Satara district, is already designated as World Natural Heritage Site .

Identification of BHS on Rocky Plateaus

In 2019, a study was undertaken to identify BHS in a Ratnagiri district of Maharashtra. The methodology followed is given below and are suggested as steps for other areas as well.

- Mapping and georeferencing of rocky plateau ecosystem, key biodiversity elements reported from previous studies
- Detailed documentation of biocultural values and ecosystem services of various plateau sites
- Information if available from People's Biodiversity Register process can be included
- Assessment of sites based on indicators of biodiversity (endemic and threatened plants and animals, special vegetation types, and ecology (species richness and diversity, springs, pollinators etc.)
- Listing of associated cultural values including petroglyphs, shrines, trees, animistic traditions, divine spirits in nature, current uses (cultivation, tourism etc.)
- Assessing local support for conservation
- Selection of plateaus with higher values where local communities are in support of conservation. Sites where local people had rejected proposals of industrial development and chosen biodiversity protection received higher ranking in the process.
- A total of 11 potential BHS on rocky plateaus were identified based on the biological, ecological and cultural criteria. One of the them is Ambolgad, where Ambolgad BMC has passed a resolution to designate Ambolgad BHS.
- The next step will include consultative processes with local communities, voluntary organizations and government agencies working in the region to identify current values and management practices that support biodiversity
- Participatory Management Planning for the selected rocky plateau sites for sustainable natural resource management in future
- Designation of LBHS in selected rocky plateaus
- Similar processes can be conducted in all the districts which rocky plateau ecosystems esp in Western Ghats and Konkan region.

Other potential sites

The two examples above show the great potential for declaration of LBHS within Maharashtra (Table 2). There has been detailed research on human nature relationships and their consequences for biodiversity

conservation in Maharashtra landscape. Conservation of indigenous seeds and breeds in different parts of Maharashtra has been documented by Patil *et al.* (2015) and Savalia *et al* (2019). Ethnobiology of plant and animals, subsistence values, cultural and spiritual aspects of worship of nature in general and some species in particular have been documented by several ethnobiologists, indologists, anthropologists and ethno-archaeologists (Feldhaus, 1995; Burman, 2000; Krishna, 2014) which helps us to understand the nature of interrelationships in past and present Maharashtra. These hold a great potential for identification of BHS in Maharashtra. Maharashtra State Biodiversity Board can conduct a detailed assessment based upon primary and secondary data from research papers, reports and PBRs, using participatory approaches to increase the coverage of OECMs leading to landscape conservation through LBHS models (Figure 2 Flow chart depicting process of identification to declaration of BHS). Similar biocultural conservation practices exist in all parts of India as shown by Ramakrishnan (1996), and the model can be used for the entire India.

Table 2: Potential LBHS in Maharashtra

BHS Guidelines	**Potential LBHS elements**	**Values**
Areas that contain a mosaic of natural, semi-natural, and man made habitats, which together contain a significant diversity of life forms.	grasslands, wetlands, outcrops, caves nakshtravan botanical gardens etc	Ecological and cultural value of specific habitats, species, management practices
b. Areas that contain significant domesticated biodiversity components and /or representative agro-ecosystems with ongoing agricultural practices that sustain this diversity.	pastoral landscapes, indigenous farming-scapes (Kumri cultivation), agroforestry aquatic farming (Lotus cultivation) and fishing	Ecological and cultural values and practices of domesticated biodiversity, agrrodiversity

Table 2 continued...

Table 2 continued...

c. Areas that are significant from a biodiversity point of view as also are important cultural spaces such as sacred groves/trees and sites, or other large community conserved areas.	various types of sacred and non-sacred but revered sites, species, individuals (Large trees), shrines etc.	Sacred values, taboos and beliefs, cultural identities,
d. Areas including very small ones that offer refuge or corridors for threatened and endemic fauna and flora, such as community conserved areas or urban greens and wetlands.	Community conserved areas, temple ponds, urban water bodies, lakes, hillscapes, migratory bird passage routes (flamingoes, winter migrants etc.) , bird feeding areas,	ecological, regulatory ecosystem services
e. All kinds of legal land uses whether government, community or private land could be considered under the above categories.	institutional areas with indigenous landscape management, butterfly and bee gardens by corporate, private gardens and private sanctuaries	sustainable development practices,
g. Areas that provide habitats, aquatic or terrestrial, for seasonal migrant species for feeding and breeding.	a range of man-made and natural habitats in Maharashtra.	ecological values
h. Areas that are maintained as preservation plots by the research wing of Forest department.	Research plots in Mahabaleshwar, Matheran etc.	Future ecological or option values, regulatory values
i. Medicinal Plant Conservation Areas.	13 established by the Maharashtra Forest Department http://envis.frlht.org/mpca/	sustenance value

Source: Compiled by the author

Future role of LBHS

UN's Sustainable Development Goals 15[6] for biodiversity conservation and sustainable management. LBHS will help in localizing the goal throughout India. *Strategic Goal C of Aichi Targets* 11[7] was to achieve atleast 17% of terrestrial and inland water conservation through *other effective area-based conservation measures by 2020.* Maharashtra's terrestrial Protected Areas are currently less than 5%[8] of the geographical area of the state.There is therefore an urgent need to increase the coverage of the community-conserved areas to ensure wider landscape scale integrated conservation. LBHS provision can help in this provided that communities are empowered for conserving the landscape, legal processes associated with the area-based conservation are streamlined and effective monitoring and management is achieved through local governance.

Socio-cultural values associated with the BHS, together with an understanding of ecological values will help build a strong association between humans and natural elements of a landscape which is necessary for the new era of conservation and sustainable development in India.

LBHS can be as

Open laboratories for nature-education. They can be integrated in environment education in a manner that stimulates and enhances Naturalistic Intelligence, prepares the future generations to take up stewardship of natural resources and learn sustainable management.

Bio-economic models in village: They can be sites of responsible tourism and sustainable biodiversity based businesses. New ideas such as biodiversity financing, Payment For Ecosystem Services (PES), Carbon Credits and Bio-currency can be linked to BHS to ensure sustained financing towards management and restoration of BHS.

Recommendations to the State of Maharashtra on institutionalising LBHS

We recommend for Maharashtra state that:

- LBHS designation should be taken up at district level through specially appointed committees

- The district heritage committees and district biodiversity committee should support the local institutions for designating LBHS
- A state level framework and guideline document should be prepared for identification and management of LBHS covering all categories in the national guidelines
- Awareness should be planned at mass scale through communication media to sensitize people about this provision
- A separate administrative mechanism should be set up for inviting suggestions for LBHS periodically and conducting rapid assessments for following up on the suggestions
- Biofinance mechanisms should be set up for supporting key LBHS
- LBHS should be promoted as sites of biocultural tourism and open learning in a responsible manner
- Regular interactions between managers of LBHS should be carried out for knowledge building

Conclusion

Biodiversity Heritage Site is an extremely important provision aimed at increasing the landscape level coverage of conservation areas in India. As an OECM, it can protect habitat, species, ecosystem services of critical importance to humans along with associated culture of prudent use of nature. Maharashtra with its rich ecological and cultural diversity has a tremendous potential for designating the LBHS throughout the landscape, which will enhance its currently meager percentage of PA cover. Through awareness and training, the process can be streamlined to include joint efforts of area managers, researchers, organizations and citizens. It will ensure peoples' participation in biodiversity conservation through participatory mechanisms and facilitate decentralized governance. It will help in achieving the SDGs and Aichi targets for the state and open up possibilities of biodiversity based economic opportunities for the future generations.

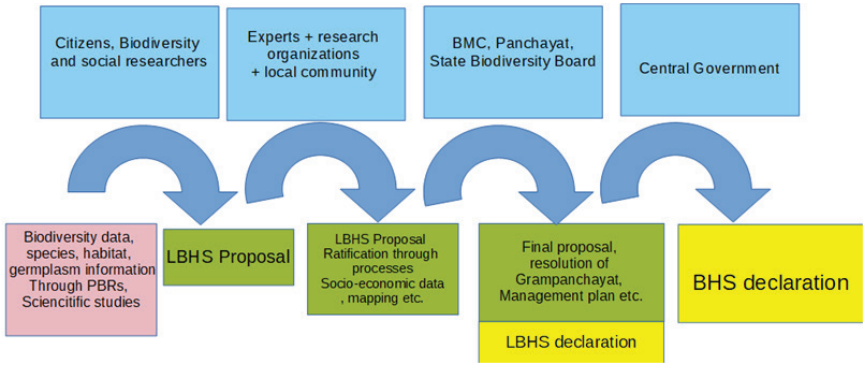
It will truly represent the integration of natural and cultural values of a landscape creating a sustainable model of conservation at local level. The National Mission on Biodiversity and Human Well-Being (NMBHWB) for India is aiming for a new approach towards conserving biodiversity

(Bawa, *et al*., 2020). LBHS can help localize the various aspects covered in the central mission. A cluster of LBHS can together conserve a significant amount of biodiversity of a region with the help of local communities.

The conservation approaches used so far have tended towards the exclusionary approach and often antagonised people in many ways (Kabra, 2019). Rising human-wildlife conflict, increased incidences of poaching, degradation and neglect of rich ecosystems and growing negligence of cultural values towards conservation are symptoms of a deeper problem-that of severing of bonds between biodiversity in a landscape and humans who should have been an integral part of it. Modernization of social and economic systems has come at the cost of ecological systems leading to unjust and inequitable systems which are harming human well being. There is a focus now on rejuvenation of ecological systems, but without restoring the nature-human connection, the restoration will only be of cosmetic nature. Resilient and dynamic social-ecological systems require rebuilding the lost connections and values step by step. The LBHS, identified through logical steps described above, will help us demonstrate to the rest of the world how this connection was in the past and how it can survive for time immemorial. Positive human values held towards biodiversity require urgent conservation measures, otherwise conservation of biodiversity alone will not sustain.

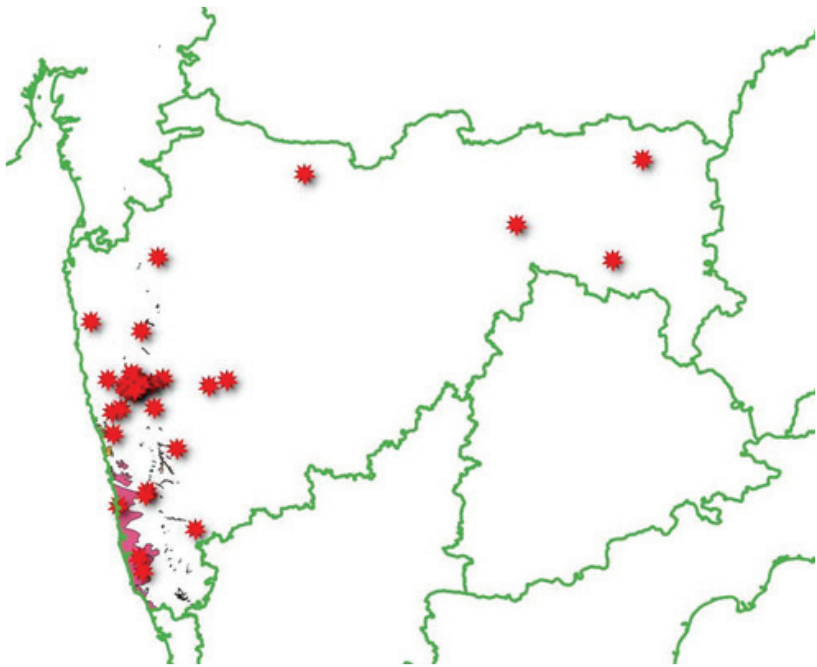
LBHS is the humanities last opportunity to preserve the genes, species, ecosystems and the ecosystem services for future generations. In an altered landscape, these will be the places for a visitor to explore and enjoy nature in its original form, learn about nature from communities which have successfully conserved them and carry back the values and practice them. On a practical level, LBHS will allow us to take a stock of our natural capital in diverse regions, understand the true value of Natural Resources Accounting and therefore also estimate the nation's true NDP - Natural Domestic Product potential. Conservation of nature is not a luxury as was thought by many in the past. The pandemic experience has clearly shown that nature conservation is a non-negotiable goal, needed for basic survival of all humans, not just a few remote communities. The redesigning of the new world can start by selecting and identifying LBHS which will be a true legacy left by the present generation for the future global citizens, and lasting symbol of the strong connection of humans with mother nature.

Figure 2 : Flow Chart Depicting Process of Identification to Declaration of LBHS and BHS



Source: Compiled by the author

Figure 3: Potential BHS Sites Illustrating Sacred Groves and Rocky Plateaus



Source: Compiled by the author

Endnotes

1 "Biodiversity Heritage Sites" (BHS) are well defined areas that are unique, ecologically fragile ecosystems, having rich biodiversity comprising of any one or more of the following components: richness of wild as well as domesticated species or intra-specific categories, high endemism, presence of rare and threatened species, keystone species, species of evolutionary significance, wild ancestors of domestic/ cultivated species or their varieties, past pre-eminence of biological components represented by fossil beds and having significant cultural, ethical or aesthetic values and are important for the maintenance of cultural diversity, with or without a long history of human association with them". (http://nbaindia.org/)

2 https://www.keralabiodiversity.org/images/2020/November/Proceedings_Local_BHS_approval.pdf

3 https://www.thestatesman.com/tag/maharashtra

4 http://www.intach.org/chapters-legal.php

5 (http://www.ecoheritage.cpreec.org/innerpageof.php?$mFJyBfKPkE6)

6 (https://www.undp.org/content/undp/en/home/sustainable-development-goals.html)

7 https://www.cbd.int/sp/targets/

8 http://mahenvis.nic.in/pdf/Databank/bio_tables.pdf

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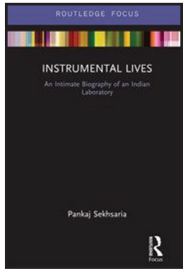
Book Review

Instrumental Lives: An Intimate Biography of an Indian Laboratory



Author: Pankaj Sekhsaria
Publisher: Routledge
Year: 2019
ISBN: 9780367856298
Pages: 148; Price: INR 695

Pankaj Sekhsaria's book '*Instrumental Lives – An Intimate Biography of an Indian Laboratory*' gives an interesting peak into a scientist's laboratory and provides a visual tour through the lab with minute details of their working space, conditions and context. It is an important step forward towards an understanding of complex interface between society and science and technology as well as intersections of various dimensions in a laboratory. There is a gap in literature within science, technology studies (STS) and social history of science on scientific institutions. Few socio-historical studies on research laboratories include works by V. V. Krishna and Shiv Visvanathan on Council of Scientific and Industrial Research (CSIR), National Physical Laboratory respectively.[1] Jahnavi Phalkey too explores the building of particle accelerator at department of Physics, Indian Institute of Science (IISc), Saha Institute of Nuclear Physics and Tata Institutute of Fundamental Research (TIFR).[2] The study of a laboratory enables us to understand the history and context of various scientific endeavours, and their working structure and role in evolution of S&T.

Sekhsaria's book is a significantccontribution to the study of life and work in a university laboratory. It is an ethnographic study of Prof. Dharmadhikari's laboratory housed at the Department of Physics, Savitribai Phule University in Pune. Sekhsaria in his book contextualises 'instrument-making' in a modern physical laboratory, which makes it one of the rare studies that delves into

the development of an instrument in a lab. The book analyses the processes of instrument-making in the physics laboratory of a university. This study is a significant work in this field and recognises the importance of understanding the conditions/challenges/constraints that scientists face while undertaking scientific research, especially in building an indigenous instrument. This novelty and the opportunity to engage with scientist's life in the lab can hook a wide spectrum of readers to the book.

The book is an outcome of Sekhsaria's doctoral journey at Maastricht University, Netherlands. Based on case studies of five laboratories (of which Prof. Dharmadhikari's lab was one), his study focused on 'cultures of innovation' in nanoscience and technology research in India. The present book draws from and further develops author's arguments published in his paper in the *Current Science* in 2013.[3] The book belongs to the Routledge's 'Focus on Modern Subjects' series which aims to explore an area/branch of learning/study through an historical analysis of the participants involved in the process. It's engaging narration of his conversation with Prof. Dharmadhikari and his research scholars at the lab and helpful visual illustration make is quite interesting.

The book is short, easy-read with eight succinct chapters. In the first chapter, author introduces the objectives and methodology for addressing the research questions, and recognises the opportunity as an STS researcher to access the laboratory and interact with scientists in tracing the trajectory of building an indigenous instrument from the mid-1980s. In an attempt to understand what happened and what Prof. Dharmadhikari and his research group did in the laboratory, Sekhsaria provides an insightful description of the laboratory illustrated through photographs, and also acknowledges that the pictures do not conform to the generally perceived image of a laboratory - as clean, organised, disciplined spaces. Prof. Dharmadhikari's efforts to build an indigenous Scanning Tunneling Machine (STM) are seen as a part of the efforts towards developing the STM since 1981. While laying at the periphery of the instrumental research and development community which remained largely restricted to Western Europe and North America,

Prof. Dharmadhikari's educational background, his induction into the 'instrumental community', participation in STM conferences from mid-1980s and geography of his location together culminated into the making of the first sophisticated STM at the frontiers of science in 1988. During 1988-2014, his research group made a series of probe microscopes, worked in various institutions in India and abroad, and published numerous papers in world's leading journals.

As author points at the successes of the group, he also takes note of the lack of acknowledgment, difficulties faced by scientists/ scientific community and absence of Indian scientists receiving Nobel prizes in general. The development of the first STM under a staircase in the department provides a glimpse of the 'lab-space' constraints that scientists worked under. Given the financial and material resources limitations faced by the scientific community in India, Prof. Dharmadhikari's first encounter with the STM left him with the feeling that it was too 'complicated' and 'expensive' to make the instrument in India. The book tries to unfold these hidden layers of instrument-making in a modern physical laboratory and contextualises the making of STM within the scientific research and innovation ecosystem in India. At the macro-level, it discusses the post-colonial ambition of building a self-reliant and scientifically and technologically advanced modern nation state and recognises post-positivist and globalisation as relevant frames for contemporary nanotechnology research and innovation in India. The centrality of scientists and technologists and nexus between scientists and politicians in the post-colonial era is evident from the beginning of the S&T policies in India. Underlining serious shortage of resources available for scientific research, author acknowledges that innovation results from a complex interplay of policies, institutions and incentive structures largely embedded in their "historical, political, cultural, social and economic factors and philosophies".

The book takes a detour and points at centrality of *jugaad* in the Indian S&T innovation system. Through a theoretical understanding of *jugaad*, the author concludes that since *jugaad* exists in all domains of Indian life (industry, social enterprise, business processes or rural innovation and adaptation), it also exists in a modern scientific

laboratory without compromising on quality and output. The author (as an STS researcher) and Prof. Dharmadhicari (as the main actor) unanimously accepted the concept of *jugaad*. The technological jugaad in STM is set within the background of an obvious resource constraint which drove Dharmadhikari and his team's innovative and creative endeavours through reconfigured materiality. Also, the knowledge of geography and overall atmosphere of the city of Pune, diversity and richness in collaborations and skills recruited, acknowledge that valuable skills, knowledge and capacities lie in spaces beyond laboratories. Given limited access to financial and material resources, Sekhsaria enumerates eight independent, dynamically interlinked characteristics of technological jugaad.

The book touches upon the state of Indian universities, challenges they face in terms of shortage of resources and tension between universities and research laboratories, 'culture' of science in India, hinting at 'enterprising' vs 'vocational' laboratory. In the background of neo-liberalism which had made inroads into the laboratories and S&T policy, Sekhsaria's focus has been on gauging the potentiality of the instrument constructed, which faced consistent criticisms on the inability to commercialism them. Prof. Dharmadhikari acknowledges the importance of possibilities of commercialisation of the instrument. However, 'doing science' and 'training of students' in making instruments themselves has far greater value.

A change in emphasis and expectation in science is visible with greater focus on its quantitative evaluation, social relevance and commercial viability. As they penetrate the world of instrument-making in a lab, they redefine the role of universities and balance between applied and basic sciences. Therefore, these certainly have implications on the process of policy making and science, technology and innovation (STI) policies. Our macro-policy formulations like STI Policy of 2013 and India Technology Vision 2035 resonate these expectations. They clearly illustrate mismatch between the experiences in the laboratories like Prof. Dharmadhikari's and S&T policies, and the technological *jugaad* and scientists engaging in these unconventional methods also has no place in S&T ecosystem. The author notes that work and innovation in laboratories in India

is messy, multi-layered and multi-locational. He urges it would be incumbent, therefore, on any policy formulation to account for and do justice to this reality. The book also acknowledges effective play of different systems and cultures of knowledge and innovation, and emphasises on the need for a de-centring the cultures of innovation.

Based on his conversation with Prof. Dharmadhikari's student, Sekhsaria briefly discusses the future of the instruments developed by them over a period of more than two decades, which form the core of the book. The inglorious future of the instruments and their fate clearly hint at lack of financial and material resources and lab scape, that author illustrates in the very first chapter. The future of these 'instruments' after the retirement of Prof. Dharmadhikari poses serious questions about the 'culture' of our innovation and the S&T ecosystem, and requires closer scrutiny. In its postscript, the study proposes future research agendas – primarily, greater engagement with the labs through more ethnographical studies and a deeper etymological exploration and understanding of *jugaad*.

The book is unique and one of the few ethnographical studies of a laboratory in India, so it certainly occupies a significant space in STS and social history of science literature. Given that the book focusses on development of a sophisticated microscope indigenously in 1988, it has immense scope to provide a wider understanding of the making of the instrument. In the background of constraints of space, finance and material resources in a university laboratory, the limitations they faced, their expectations and challenges, the book has great potential in engaging with and assessing the success of STM. The author has adequately contextualised the study however, issues around university education in India from 1950s, science-politics nexus, evolution of S&T policy, limitations faced by the scientific community in India, 'culture' of science in our research laboratories can positively add to the lucid arguments put forth in the book. The focus on technological *jugaad* can be supplemented with a detailed discussion on 'user-innovation' theory by the author. The book provides insightful snippets of innovators' world and the S&T ecosystem in India. The book prompts the readers to peak into the lives, working spaces and constraints that our innovators face.

Thus, emphasis on nurturing such innovations and innovators, and acknowledging unconventional forms and spaces of innovation is critical. Sekhsaria's engaging narrative style and visual illustrations makes the book an interesting read and encourages the readers to stretch their imagination to understand the real-working life in a laboratory. Its rich content and thematic discussion will interest wide cross-section of readers including policy-makers.

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Endnotes

1 Visvanathan, S. (1985). *Organising for science: The making of an industrial research laboratory*. New Delhi: Oxford University Press. See, V.V. Krishna's Ph.D. thesis (1987) 'Scientists in laboratories: a comparative study on the organisation of science and goal orientations of scientists in CSIRO (Australia) and CSIR (India) institutions', University of Wollongong Thesis Collections available at https://ro.uow.edu.au/cgi/viewcontent.cgi?article=2728&context=theses.

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3 See Sekhsaria, P. (2013). The making of an indigenous scanning tunneling microscope. *Current Science*, *104*(9), 1152–1157.

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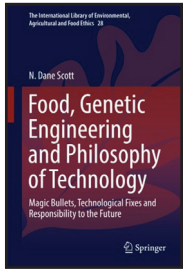
Book Review

Food, Genetic Engineering and Philosophy of Technology: Magic Bullets, Technological Fixes and Responsibility to the Future



Author: N. Dane Scott

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Year: 2018; ISBN: 978-3-319-96027-2

Price: Euro 59.27

Science has been celebrated for being an enabler and problem solver. Yet it is also criticized for not solving the development related problems like hunger or malnutrition or industrial pollution etc. In recent decades, the scientific inputs to the development policies and programmes have also been criticized. The case of genetically engineered (GE) crops is one such example. In India, the first GE crop approved and introduced for wider cultivation was cotton and then a decade later a moratorium was put on the cultivation of genetically modified Brinjal. This issue has remained controversial with one group of people (optimists) promoting the technology with recommendations to the policy makers for its implementation into cultivation and the other group (pessimists) opposing its use owing to the health and environmental risks associated to it; thereby leading to indecisiveness towards the use of the technology. The book, "*Food, Genetic Engineering and Philosophy of Technology"* by Dane Scott is a valuable and timely contribution to move beyond the current polarised debate over genetic engineering. The book meticulously captures the clash between technological optimists and technological pessimists which have created an epistemological crisis i.e., the narrative used in the GE debate is in conflict with the truth. This narrative crisis made people either dwell in extreme sides or indecisive about the role of agricultural biotechnology in shaping the future of agriculture and civilization. The book connects the debate over GE food to deepen philosophical underpinnings in order to develop a narrative of sustainability.

The first chapter explores the philosophical significance of the idea of progress in the GE debate tracing back to the Enlightenment era, which created the idea of technological optimism i.e., science and technological development as a means of progress. Later, in the second half of the twentieth century with rising concerns over the threats of nuclear war, overpopulation, resource depletion, industrial pollution etc. led people to question technology as a means of progress. The author also brings out the philosophical divide between optimistic and pessimistic view of technology in terms of 'promotion' and 'precaution' and brings out the current dominance of corporations and free markets as the driving force of technological change. The former narrative of progress promoted innovation and progress through free market competition while the latter laid back upon precautionary regulations against unintended health and environmental consequences of new biotechnologies. He also describes how free market promotes progress in technology in agriculture and finds that the free market revolution has created an internal crisis in the narrative of progress even within the technological optimists, who rejected the idea that free market competition should be the driver of technological progress. He identified few obstacles which impeded research and development on agricultural biotechnology from making greater contributions and for creating more just and sustainable societies.

They are, costly and time-consuming precautionary regulations; market failures in the private sector; and limited public sector funding for social-goods research. The author argues to reinterpret the philosophical idea of progress to move beyond the polarized debate over genetic engineering in agriculture by exploring the philosophy of technological pragmatism. This was illustrated beautifully using the case of Golden Rice (developed as a solution to Vitamin A deficiency) (Chapter 2). To correct the defects in the current incentive system that leads to market failures, a modified incentive system of the kind of Health Impact Fund (HIF) can motivate technological development with ethical considerations. HIF is a 'pay for performance' mechanism developed to address inequalities in access to medicine due to the current incentive system (Pogge, 2009), where governments would fund the HIF annually to reward pharmaceutical companies based on the (health) impacts brought about by their innovations (McMullan, *et al*. 2018). The author proposes that a publicly funded, pay-for-performance

incentive system, as opposed to private driven research agenda and profit motives, can provide an alternative system to serve social and ethical goals in a narrative of sustainability.

The third chapter deals with the magic bullets of agricultural biotechnology by drawing a parallel between biomedicine and agriculture. and provides a framework for critically examining GE crops in terms of its side effects and revenge effects i.e., unintended consequences of a technology often worse than the original problem that the technology was designed to solve. In biomedicine, the magic bullet metaphor i.e., the doctrine of specific etiology and the mono-causal model of disease, completely transformed medical science and have greatly benefited humanity. But its reductionist approach of focusing on specific target and neglecting other types of causes and solutions, generates dangerous unintended consequences and side effects. However, it fueled the search for magic bullet cures, driving huge expenditure towards medical drugs, technology, and surgery. Similarly in agriculture or GE crops, the conceptual flaw with the magic bullet strategy as reductionist has been shown in the book. The magic bullet myth has inspired scientists to continue to search for toxins that target pests and pathogens, so that diseases and pests that cause famines and plagues could be eliminated, but in the process failed to recognise the complex inter-linkages of behavioural, cultural, ecological and evolutionary factors. In chapter 4, the author uses the framework of side effects and revenge effects, to examine two magic bullets GE crops - insect resistant Bt crops and herbicide resistant crops to find revenge effect of pesticide treadmill and wide spread use of which leading to emergence of superpests and superweeds. The author concludes that if overused and misused the revenge effect will quickly render this magic bullet inoperable. So, he suggested using an ecological approach, which is holistic in nature like Integrated Pest Management and Integrated Weed Management to complement the magic bullets in mitigating the revenge effect of super pests and superweeds.

The intensification of agriculture to meet increased demand for food products, over the years led to homogenization of plant varieties and loss of biodiversity at an accelerating speed; increased use of chemical fertilizers to degrade soil quality; polluting surface and ground waters; disrupting functioning of the natural ecosystem etc. (Tilman, 1999). This yield centric

agriculture needs technological fixes to aid the production goal and it continues to guide research in agricultural biotechnology. Technological fixes offers narrow fixing strategy by offering technological solutions to address a problem. But in the process it fails to identify the multiple functions of an agro-ecological system or the local practices and institutions (attuned to the system) that are used to solve a problem. In chapter 5 and 6, the author highlights the criticism towards technological fix strategy from history of science, philosophy and environmental science literature. The criticism draws from a pessimistic view of technology that science and technology driven progress leads to degradation of natural world. The author also discusses the blanket endorsements of technological fixes in agriculture by the technological optimists, who justifies the narrative of progress as a necessity to feed the world and human needs and also believes that "*technological progress will solve the problems created by technological progress*" (p99). The author regards this optimism as more of faith than based on ethics and philosophy of technology. The author tries to find a middle path between technological optimism and technological pessimism and proposes a pragmatic approach without blanket endorsement or condemnation of agricultural biotechnology, but evaluating each case by case. Pragmatic view does not reject technological fixes but provides a cautionary tag about what a technology can accomplish and what problems can arise due to it. Using the case of two technological fixes – Enviropig (genetically engineered animal to excrete less phosphorous in its feces, developed as a solution to phosporus pollution from industrial livestock production) and Golden rice, the author provided an insight for wider deliberations to evaluate each case of GE technological fixes or magic bullets on the basis of pragmatic criticism and practical arguments.

In the final chapters the author places the precautionary principle within a philosophical and ethical framework and argues for a precautionary rule using 'ethics of responsibility' by Hans Jonas, 'planetary boundary theory', and a pragmatic philosophy of technology to regulate GE technology. He argues for democratic governance of technology with constant striving and vigilance for each GE technological fixes and magic bullets, without outrightly denying them or accepting them unquestionably. To move beyond the epistemological crisis in the GE debate and to build a narrative of sustainability, the author argues for technological pragmatism that

genetic engineering can help humanity stay within a safe operating space, by using comparative futurology and planetary boundary theory to predict the Earth's tipping points or its resilience to human impacts, and ethics of responsibility to monitor human actions in order to secure the planet for the future generation.

The author did not indulge much with the politics behind environmentalism or the relationship between science and policy in terms of democratisation of science and how decisions are made. But the framework of 'technological pragmatism' proposed in the book can serve as a handle for the decision makers. This however, requires 'scientific evidence' and not 'faith in technology' to speak truth to the power, along with development of institutions to foster social learning about different discourses on risk so as to engage in open and pluralistic appraisal of risk. Overall, the book is a good read and covered the different technological and societal aspects that govern the GE food debate.

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(c) Articles from edited volumes:

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(d) Articles from Journals:

Rao, M.G., K. P. Kalirajan and R. T. Shand. 1999. "Convergence of Income across Indian States: A Divergent View". *Economic and Political Weekly,* 34(13): pp. 769-78.

(e) Unpublished Work:

Sandee, H. 1995. "Innovations in Production". Unpublished Ph.D thesis. Amsterdam: Free University.

(f) Online Reference:

World Health Organisation. 2000. "Development of National Policy on Traditional Medicine". Retrieved on March 31, 2011 from http://www.wpro.who.int/sites/trm/documents/Development+of+National+Policy+on+Traditional+Medicine.htm

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This issue focusses on Biodiversity and the first article discusses the status of the Global Biodiversity, threats and opportunities and biodiversity in India while the second article points out how State Biodiversity Boards can be made more effective and contribute to realizing the objectives of the Biodiversity Act, and, the third article underscores the need for ecological data , the role of open access and legal mechanisms for access, and, the fourth article provides a framework and a biocultural model for Local Biodiversity Heritage Sites. The issue has two interesting book reviews, with one on biography of a laboratory of a pioneering academic in nanotechnology and the other on food, technological fixes and our responsibility.

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