

## Possible linkage between eco-industrial parks and nature-based solutions from an Indian perspective

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*In an incessant effort globally to tackle climate change, nature-based solution (NBS) is presumably the most undermined adaptation practice. Furthermore, with the proliferation of making a 'greener' transition for Indian industries, the facets of eco-industrial parks (EIPs) have caught meaningful attention as a prospective solution for this transition. In this note, strategy advocacy is deliberated upon by linking NBS with EIPs, in a renewed sense of perspective. The acceptance of such pre-defined conventions will benefit EIPs, and provide a superior judgement by considering the factors of NBS and relating to EIPs, for developing frameworks.*

Nature-based solutions (NBS) was first introduced by the World Bank in 2008, to support naturally existing ecosystems with the rapidly increasing industrialization. This would in some manner, enable in offsetting emissions by creating natural sinks<sup>1,2</sup>. NBS are essentially classified as nature conservation, restoration and optimizing land usage that can potentially act as a carbon sink or as reinforcement during natural catastrophes<sup>3-5</sup>. The primary intention of working on NBS was to create an ecosystem that would aid in the longer sustenance of livelihood along with the proliferating industrial evolution. Though several articles have argued and presented facts in support of NBS, which can potentially be a line of defence against climate change, significant exploration is required<sup>1,2,4,6</sup>. Here we discuss the possible consequences of adopting certain NBS to aid in developing eco-industrial parks (EIPs)<sup>7,8</sup>.

Typically, in the EIPs, self-resilience and self-sustenance characteristics are strongly emphasized enabling the drivers of resource efficiency, circular economy and the 3Rs (reduce, recycle, reuse) to make a prerogative approach. Even so, adaptation and mitigation under the umbrella of climate change decisions have coherently been advocating for NBS. So, the pertinent question remains in the realms of pragmatic intervention to be curated by the EIP developers with respect to the geography and scale of deployment. Here, an Indian context is presented for a more cohesive understanding that would eventually strengthen the country's climate change goals. Generally speaking, EIPs are relatively new in the Indian context. For an EIP to be successful, the practices to be followed for establishing it should follow recommended standards, refer existing benchmarks. This would allow significant value addition by organizing EIP site planning, retrofitting technologies,

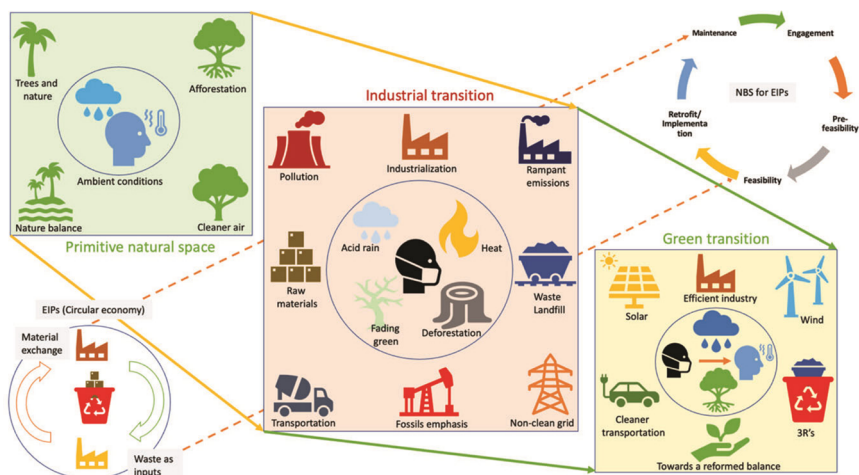
resource efficiency and adequate management.

Therefore, when benchmarks are usually spoken about, it becomes imperative to associate (i) economic standards: featuring investments, revenue, cost of services and employment creation locally; (ii) social standards: living standards, gender equality at work, safety and security provisions, and outreach; (iii) environmental standards: here cleaner production, waste management and water management play a crucial role; (iv) infrastructure standards: green buildings, energy-efficient systems and optimized supply chain which enable ease in operational processes; (v) management and legal compliances: continuous monitoring and verification standards, certification and abiding of national and local laws which add impetus to the setting up of EIPs<sup>5</sup>. Besides, the potential business models that can be established in the EIPs, can have positive reasons for adoption. For example, a textile-to-textile mill business cases relating to material exchange can be mutually exclusive, while textile-to-non textile can depend on utility level interactions such as steam networks or compressed air networks. Evidently the proposal for developing EIPs usually features segments focusing on climate change mitigation and adaptation as well as many other similar core points. Nevertheless, the identification of NBS as a distinct segment is rare. To a general understanding, NBS fundamentally forms a part of the adaptation and is often listed under the banner of 'green infrastructure', 'green corridor', 'green initiatives', etc. In my opinion the need to segregate NBS should be demarcated from its advantages. So much so that NBS becomes a distinct aspect by itself to foster the growth of EIPs.

NBS are a part of living conditions that dictate the way operational transformation occurs. It must be understood that nature,

by default is present, differing in the type and demographic of the designated area or place where an EIP is intended to be developed. In the form of trees, forest covers, bushes, etc. several features of land use are widely prominent and intuitive. The need here is to identify the challenges of dealing with the existing natural form and then revise it to suit the industrial requirements. While this is not new, and industrialization has transpired so rampantly over the last century, the argument here is about EIPs and their approach with regards to land use. Geographically, EIPs planned to be established and commissioned, can be diverse and depend on several factors such as geography, local conditions, weather, etc. Therefore adopting the EIP design can pose considerable challenge to an EIP developer or designer. By definition, we know that EIPs are accountable for lower emissions and lower undesirable impacts on the natural reserves. Thus the connection to be established here is between EIPs and NBS. Figure 1 is a schematic depiction of EIPs and NBS for a plausible case that would interest policymakers in influencing their decisions.

When discussing the possible implications of NBS, it is imperative to mention the 'take back to the nature' theme, where a solution-oriented segregated approach can benefit all those involved in EIPs. For instance, in Figure 1, five distinct steps are mentioned concerning the reversibility method for underlying the protocol for NBS adoption. Policymakers can focus on NBS targeted particularly for EIPs, which can overlap with conventional climate resilience practices. The question is must policy-making for implementing NBS for EIPs be different from the regular case? Well, to answer this, the need to understand the EIP philosophy is crucial. For instance, infrastructure for central effluent treatment,



**Figure 1.** Depiction of the natural ecosystems transition to the industrial era, fostering the need to accelerate the green transition towards building a better habitat. The figure also depicts ‘take back to nature’ theme with integrated approach from renewable energy, industrial efficiency, resource efficiency, eco-industrial parks, promoting circular economy and adopting strategic steps towards nature-based solutions<sup>6,9</sup>.

desalination, waste sorting, and material recovery is needed for adaptation. To increase value, save cost and improve the environment, different industrial sectors may share services, utilities and by-product resources, thus forming an intricate network stimulating business. A water-supply network that considers climate vulnerability and extreme weather conditions, a power-supply network that considers climate vulnerability and extreme weather conditions, a road network with improved drainage capacity, a stormwater network with resilient drains and infiltration and retention facilities that can manage increased surface run-offs from extreme precipitation and flooding are all examples of resilient infrastructure or measures. While such interventions are now rapidly becoming the go-to solutions for EIPs developers, the important consideration of nature conservation, preserving natural habitats, retrofitting methods and maintenance are the keys to improving the EIPs and NBS nexus.

Finally, in an effort to understand the rapid uptake of industrial establishments in a fast-growing environment of EIPs, the poten-

tial considerations for policy-makers and regulators is the development of protocols for creating an impact by integrating NBS with EIPs, leveraging the already existing ones for conventional climate-resilient actions. Simple approach by involving various stakeholders or parties of EIP in common sessions, and brainstorming the basic requirement can be a decent starting point. Since the larger question on integrating NBS and EIPs hang in the zone of questions, it is imperative to indulge in a survey-based decision making. Besides, understanding the ‘local’ opinion to validate the developments for the benefit of the working ecosystem is crucial and an effective way forward. To articulate a general belief, the intentions can never be wrong; they must always be improved.

1. World Bank. Biodiversity, Climate Change, and Adaptation: Nature-Based Solutions from the World Bank Portfolio, Washington, DC, © World Bank, 2008; <https://openknowledge.worldbank.org/handle/10986/7785> License: CC BY 3.0 IGO (accessed on 15 May 2022).

2. Barbara, S. and Joan, G., *Nat.-Based Solut.*, 2022, **2**, 100009; <https://doi.org/10.1016/j.nbsj.2022.100009> (accessed on 20 May 2022).
3. Kabisch, N. *et al.*, *Ecol. Soc.*, 2016, **21**(2), 39; <http://dx.doi.org/10.5751/ES-08373-210239> (accessed on 15 June 2022).
4. Kumar, P. *et al.*, *Sci. Total Environ.*, 2021, **784**, 147058; <https://doi.org/10.1016/j.scitotenv.2021.147058> (accessed on 17 June 2022).
5. Anderson, C. C. and Renaud, F. G., *Ambio*, 2021, **50**, 1552–1573; <https://doi.org/10.1007/s13280-021-01502-4> (accessed on 20 June 2022).
6. Mukherjee, M. and Mondal, S., *Int. Lett. Nat. Sci.*, 2015, **47** (accessed on 21 June 2022).
7. Eco-industrial parks, UNIDO, 2021, pp. 5–55; <https://www.unido.org/our-focus-safeguarding-environment-resource-efficient-and-low-carbon-industrial-production/eco-industrial-parks> (accessed on 2 May 2022).
8. United Nations Industrial Development Organization; World Bank Group; Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). An International Framework for Eco-Industrial Parks. World Bank, Washington, DC, © World Bank, 2017; <https://openknowledge.worldbank.org/handle/10986/29110> License: CC BY 3.0 IGO (accessed on 11 June 2022).
9. Rastogi, A., Rajan, A. V. and Mukherjee, M., *In A Review of Vehicular Pollution and Control Measures in India* (eds Siddiqui, N., Tauseef, S. and Bansal, K.), Advances in Health and Environment Safety, Springer Transactions in Civil and Environmental Engineering, Springer, Singapore, 2018; [https://doi.org/10.1007/978-981-10-7122-5\\_24](https://doi.org/10.1007/978-981-10-7122-5_24) (accessed on 24 June 2022).

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