CAN THE BUILT ENVIRONMENT FUNCTION LIKE NATURE?

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Building of RDRS (Rangpur Dinajpur Rural Service) is covered with green plants in Rangpur - a NGO working to empower the rural poor in northern Bangladesh 02 May 2017. Source: Abir Abdullah / Climate Visuals Countdown.

Since 1998, Dayna's foundational work has been critical to establishing biomimicry as a fresh and innovative practice, as well as a philosophy to meet the world's sustainability challenges. With a devotion to applied natural history and a passion for sharing the genius of nature, Dayna is the senior editor of Biomimicry Resource Handbook: A Seed Bank of Knowledge and Best Practices (2014), co-founder of Biomimicry 3.8, co-Director of the Biomimicry Center at Arizona State University, and creator of the world's first Master of Science in Biomimicry at Arizona State University. Dayna has helped dozens of Fortune 500 companies and hundreds of practitioners consult the natural world for elegant and sustainable design solutions.

Nicole Miller serves as the managing director of Biomimicry 3.8, a certified BCorp and social enterprise dedicated to helping change-makers create a more sustainable world by emulating nature's designs and core principles. Since joining B3.8 in 2012, she has overseen the development of key strategic partnerships to increase access to biomimicry and worked with clients such as Google, Interface, Jacobs, Microsoft, and others to drive innovation and sustainability outcomes. Nicole has a unique grasp of how to position great science to drive commercial practice--and, ultimately, market transformation.

The Positive Performance Methodology (PPM), developed by Biomimicry 3.8, draws key principles from nature and how healthy ecosystems function. Its framework consists of four steps:

1. **IDENTIFY a reference ecosystem in the local context and the conditions of the place and/or site.**
2. **QUANTIFY baseline performance and targets based on the local reference ecosystems.**
3. **CREATE design guidelines and strategies to emulate ecosystem performance metrics.**
4. **IMPLEMENT the strategies to move towards positive and regenerative performance and assess their effectiveness.**

The PPM can be applied to the built environment at different scales – building, development, or city – and to various sectors as wide-ranging as agriculture, forestry, transportation, housing, and education. Applied appropriately, it can help projects meet specific ecological performance goals that contribute to a regenerative, harmonious urban future.

INTRODUCTION

A thriving city life heavily relies on the benefits provided by nature, such as climate control, air cleaning, water storage and purification, pollination, and soil health. Although these ecosystem services are typically provided by areas outside of cities, there's a growing awareness that cities themselves need to contribute to these services to ensure access to clean water, air, and stable ecosystems. The Sustainable Development Goals set by the United Nations stress the importance of local ecosystems and suggest that all aspects of a city - its buildings, infrastructure, and natural surroundings - should actively contribute to environmental health. This includes maintaining clean air and water, healthy soil, sequestered carbon, cycled nutrients, reduced erosion, reduced heat, and supporting biodiversity.

Regenerative design, a proactive approach aimed at developing urban infrastructure that delivers positive environmental benefits, is an essential part of this process. Current green building standards, like LEED and Net-Zero, do a good job of limiting negative environmental impacts but don't necessarily encourage or incentivize positive contributions. If we're looking to not just reduce harm but actively improve local ecosystems, we need new standards.

One promising approach is the idea of ecological performance standards. Biomimicry 3.8, a nature inspired consultancy, has developed the Positive Performance Methodology (PPM), which takes inspiration from how a healthy, native ecosystem would function in a given area and sets these conditions as the performance goals. This involves translating the services generated by local ecosystems into tangible design targets for the building sector. By setting goals based on the capabilities of the local ecosystems where our cities exist, we're working towards a more regenerative and harmonious urban development that benefits all life.

When combined with the PPM approach, technologies like green roofs, pollinator corridors and water purification systems create multifunctional benefits that enable urban areas to provide many of the same services as a healthy ecosystem, directly contributing to the overall health and well-being of the community.

Implementing ecological performance standards through the Positive Performance Methodology requires a team effort involving urban planners, ecologists, architects, engineers, and designers, as well as operations and maintenance teams, all working together to incorporate ecosystem services into urban designs. Over more than 15 years of applying this work, we have honed a four-step framework for applying PPM:

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This process encourages collaboration between those who gather information about ecosystems and those who create designs that incorporate this knowledge, working towards creating urban spaces that perform as well as, or better than, their natural counterparts.

IDENTIFYING A LOCAL REFERENCE ECOSYSTEM

Implementing the Positive Performance Methodology (PPM) starts with choosing a local reference ecosystem and its habitats. This means figuring out what type of native ecosystem would exist at the building site if left undisturbed. Often, this involves looking at protected conservation areas or wildlife preserves in the same region. Sometimes, the building site itself, if it's still in a relatively natural state, can serve as a reference. It's important to remember that a site can host a mix of ecosystems and habitats, like forests, grasslands, and wetlands, and each should be evaluated independently.

In cities like New York and San Francisco, experts have used digital recreations of historical ecosystems to help set goals. However, while historical data is informative,

Positive Performance Methodology. Source: Biomimicry 3.8

it can't replace a current, living reference ecosystem. Conditions have changed since those historical ecosystems existed, which can result in a mismatch in the PPM goals. Furthermore, actually visiting an existing ecosystem allows design teams to set clear, tangible targets and draw inspiration for their designs.

Current climate conditions and challenges, like climate change and the urban heat island effect, should also be considered when choosing a reference ecosystem. If the present context isn't considered, solutions based on the reference ecosystem may not work in reality. For instance, native plants that were once common may no longer be suitable due to changes in climate or soil chemistry.

Site visits to reference ecosystems offer the design team a first-hand experience of a functioning ecosystem, which can provide valuable design insights and allow for local community needs and cultural aspects to be incorporated into the design process

In recent years, there has been an increasing appreciation for so-called novel ecosystems, which have been directly or indirectly shaped by human activity. These could include lands impacted by past farming or areas with introduced species. Some of these novel ecosystems may hold significant cultural value and could be chosen for restoration. Ultimately, it's up to the research team to decide which aspects of an ecosystem to emulate, and in certain cases, novel ecosystems might serve as valuable reference points.

QUANTIFYING ECOSYSTEM SERVICES TO DEVELOP PERFORMANCE METRICS

Once a reference ecosystem and habitats are chosen, the next step is to measure the ecosystem services it provides. These are commonly split into four categories: provisioning (like food or fuel), regulation (like pollination), supporting (like soil formation), and cultural (like recreation). Project teams should decide which metrics to focus on for a specific project or site based on what is most important for that place. For example, water quality might be emphasized in an area that has experienced polluted groundwater due to environmental degradation.

The aim of PPM is to create metrics for infrastructure projects that equal or surpass the services provided by the reference ecosystem. However, it's unlikely that a single project can deliver all ecosystem services. Therefore, the team needs to work with project partners to choose which services to prioritize, considering factors like local environmental conditions, stakeholder needs, urgency, and budget. Both quantitative and qualitative metrics can be useful for this process, and there are many tools available to help gather this data on-site.

One such tool is the Ecological Intelligence (EI) tool (an evolution of the ESII tool) by EcoMetrix Solutions Group, which allows for easy on-site or off-site data collection and provides estimates for a variety of ecosystem services to support early planning, decision making throughout the design process and long-term monitoring of impacts. Another tool is InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) by the Natural Capital Project, which uses GIS technology to map and value a site's goods and services.

However, certain ecosystem services, like aesthetic and cultural services, are harder to quantify. In these cases, qualitative metrics can be useful. Measuring biodiversity support is also challenging, but a literature review can provide useful information about native species and biodiversity threats. Moreover, digital tools like EI, mentioned above, and iNaturalist, can assist in conducting biodiversity surveys.

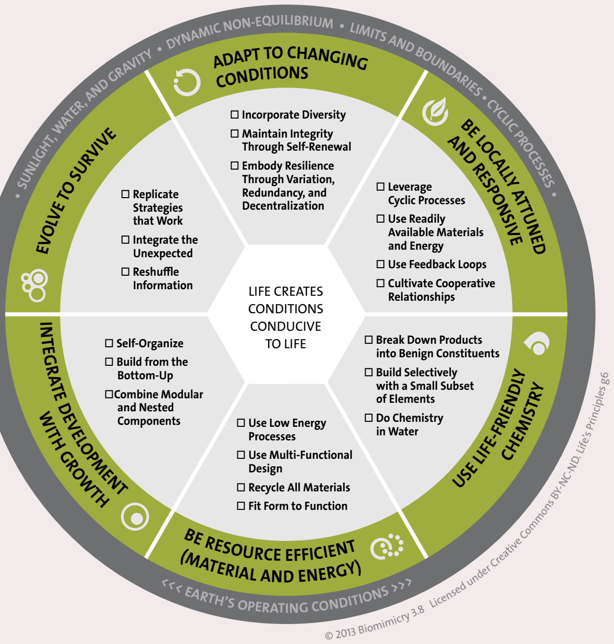
Site visits to reference ecosystems offer the design team a first-hand experience of a functioning ecosystem, which can provide valuable design insights and allow for local community needs and cultural aspects to be incorporated into the design process. To assess the performance gap, the same measurement process should be conducted at the development site to determine its current ecosystem services. While the choice of metrics might vary across projects, the comparison between the reference and development site should remain consistent. Even if detailed measurements can't be taken, qualitative metrics can still be informative when applied consistently across sites.

DESIGNING TO MEET OR EXCEED POSITIVE PERFORMANCE METRICS

Once PPM metrics are defined and the performance gap measured, the third step involves creating design guidelines and strategies to meet or advance toward the PPM goals. The early design stage, where site selection occurs, is the ideal time to develop project design guidelines for maximum impact. To ultimately achieve regenerative outcomes the design guidelines should be informed by Life's Principles, design lessons from nature.

Using the established design guidelines and performance metrics informed by nature, teams might identify areas for preservation or decide to consider alternative sites. Though the PPM is different from ecological restoration aimed at restoring native ecosystems, they can work together to maximize on-site ecosystem services. However, since it's unlikely to restore all services even with the most innovative design, restoration of functional ecosystems should be prioritized.

DesignLens: Life's Principles



Source: Biomimicry 3.8 https://biomimicry.net/the-buzz/resources/designlens-lifes-principles/

Several questions must be addressed at the start of the design phase: What's the scale of implementation? What are the budget limits? What are the project's social needs, and can it create local green jobs or start-ups? Recent restoration ecology projects have used decision science tools to create formal consensus procedures among stakeholders, which could be useful in the PP framework.

To assist decision-making, the EI tool is used to build alternate scenarios, enabling design teams to compare how different approaches impact ecosystem services. This allows clients and stakeholders to prioritize design interventions best aligned with the PPM goals, considering any budgetary or other constraints. Although it's theoretically possible for design interventions to exceed PPM goals, this hasn't been seen in practice yet. Performance metrics shouldn't be restrictive; advancements in technology may allow for exceeding performance goals in certain areas. Furthermore, projects applying PPM should take future environmental challenges into account, such as climate change.

There are already several design interventions to support advancing PPM goals. For example, bioswales, permeable pavement, and rainwater capture systems manage stormwater runoff and erosion. Composting toilets, green roofs, and carbon-sequestering cement are other common practices. The design team's task is to decide which technologies and design approaches to integrate, and where best to develop innovative, nature-inspired design interventions. The Biomimicry 3.8 team has collected a series of over 100 intervention types based on site conditions and functional needs, stakeholder priorities and community needs, and application considerations.

PPM projects also offer significant opportunities to support and improve biodiversity by emulating the functions of a reference ecosystem. Landscaping with native plants is common in regenerative design, and efforts to incorporate animal habitats into urban design plans are gaining momentum. For instance, design teams might consider how the site connects to other potential habitats through natural and constructed corridors that allow plant and animal dispersal. Other principles include minimizing threats and disturbances, facilitating natural ecological processes, and improving the potential for positive human-nature interactions. Incorporating these into design proposals can benefit a wide range of native species.

IMPLEMENTATION, ASSESSMENT, AND MONITORING

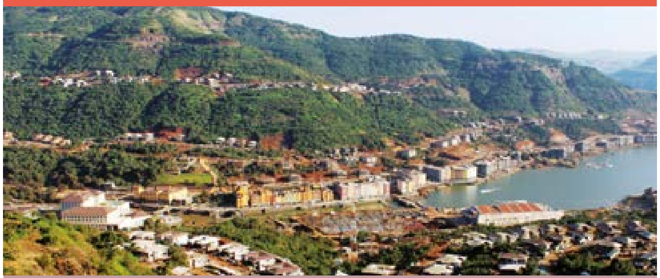
The final phase of a PPM project involves execution and evaluation. This entails implementing the proposed design strategies and intervention, which can occur as short-, medium-, or long-term actions, depending on timeline, budget, and project scale. Thus, performance metrics and biomimetic design guidelines can act as enduring targets for planners as they carry out new construction or upgrade existing structures. A well-defined evaluation strategy allows operation teams to track their progress in bridging the performance gap and achieving PPM goals. In our pilots, the opportunity to engage employees and communities also resulted in a more engaged workforce and social license to operate.

A project site emulates a healthy ecosystem when it is "functionally indistinguishable from the wildland next door"

For businesses and communities, assessing the positive ecosystem services produced by a site presents a chance to appreciate how closely they are emulating a healthy native ecosystem. B3.8 puts it as "being functionally indistinguishable from the wildland next door." Realizing these goals requires a mix of habitat restoration, biomimetics design interventions, and a mindset shift that buildings can have a positive impact on the place in which they operate.

To learn more about this work and examples provided, please visit https://biomimicry.net/project-positive/

LAVASA, INDIA: DEVELOPMENT MASTER PLAN (2008–2009)



B3.8's Positive Performance Methodology has evolved through numerous pilot projects, with public and private clients, and at different scales: building, development, and city. We present three significant case studies from more than a dozen projects in which B3.8 has been involved. These case studies represent our journey from our initial application of PPM, Lavasa, located in Pune, India, to our latest projects completed with Interface and Microsoft. Each case study illuminates our evolving methodology and the challenges and opportunities we faced with each pilot, showcasing the continuous evolution and improvement of the PPM to meet the growing environmental and social needs faced by corporations and communities.

Our first PPM pilot took place in Lavasa, India, in collaboration with the architecture firm HOK. The goal was to create a sustainable master plan for Lavasa, a private development on the shores of Dasve Lake outside of Pune, intended to house up to 200,000 residents. We focused on using biomimetic design and PPM to restore ecosystem services disrupted by the construction of Lavasa, which required clearing some forest areas. The surrounding subtropical, moist, broadleaf forest served as our reference ecosystem.

Creating accurate performance metrics that emulated the local ecosystem for this project presented a significant challenge due to the extreme monsoon season. To improve communication with the clients and builders, we grouped these complex metrics into simple categories, such as "water", "light", "earth", and "biodiversity". While we lacked the tools for direct on-site measurements, we estimated baseline values using ecological literature and qualitatively assessed proposed design interventions against these baselines.

Despite the challenges, this initial project garnered three awards from the American Society of Landscape Architects for HOK's development master plan. Key interventions included roof designs for enhanced evaporation that mimicked the leaf tips of local species (to help manage for rainfall), road modifications for erosion management that were inspired by a local mound-building ant species, and increased buffer zones along intermittent waterfalls by measuring the deep pattern of "riparian" zone dimensions.

DURBAN, SOUTH AFRICA: RESILIENT DEVELOPMENT PLAN (2014)

B3.8 joined a consortium to create an eco-friendly development plan for a project in Durban, South Africa. In this project, we utilized the InVEST tool to quantitatively model and compare the ecological performance of different design interventions. The development site in Durban was primarily under sugarcane cultivation, leading us to identify two reference ecosystems: Southern Africa mangroves and KwaZulu Natal-Cape coastal forest. With a major concern over the loss of natural mangrove habitat, we prioritized water yield and flood attenuation in the performance metrics.

Using InVEST, we provided data-driven metrics to inform a resilience framework focusing on carbon storage, water yield, flood index, sediment yield, and nitrogen and phosphorus export. Among our proposed design solutions were rehabilitating wetlands and estuaries and using infrastructure inspired by mangrove trees for storm surge protection. Ultimately, we were able to demonstrate that a development aiming for Positive Performance performed better than the sugarcane fields it was designed to replace.

MICROSOFT (2020-PRESENT)

Over the past several years B3.8 has been working with teams at Microsoft to help identify what it means to be a good steward of the lands they use, specifically the primary objective was to apply regenerative practices at various datacenter sites, with North Holland serving as the initial testing area. After researching adjacent ecosystems, we identified a series of landscape solutions that could be incorporated into the existing datacenter campus to address water issues, aesthetics and phosphorous concerns in the community. The first phase included the planting of 150 native trees and 2,300 square meters of shrubs, grasses, and groundcovers around the campus. Additional phases of this project will measure the impact on air quality, soil health, and biodiversity both on the direct campus and for the surrounding area.

As Microsoft look to incorporate these strategies across it's footprint, ecosystem performance benchmarks based on local biome metrics and biomimetic design guidelines are helping to integrate and standardize a process that can scale across the company.

INTERFACE, INC.: FACTORY AS A FOREST (2015–2020)

Factory as a Forest Initiative.
Source: Interface Inc.

In 2015, in partnership with Interface, Inc., a global manufacturer of commercial flooring, B3.8 launched the "Factory as a Forest" initiative. This project involved deploying PPM at multiple locations in Australia and the U.S. With this project, B3.8 collaborated with Terrapin Bright Green and EcoMetrix Solutions Group to develop performance goals on-site using the ESII tool (the predecessor to the current EI tool). The primary focus was on water and carbon storage, reflecting Interface's Climate Take Back strategy, with design solutions including carbon sequestration in mass timbers and a focus on water harvesting and storage interventions.

This project demonstrated the potential for deeper integration of PPM into design plans, as well as the valuable role of tools like ESII in collecting ecosystem performance metrics. Moreover, it highlighted the positive impact of PPM application on employee engagement, with staff showing great enthusiasm for learning about their local ecosystems and the company's effort to improve their working environment. Interface noted a marked increase in employee retention and national recognition for the application of PPM to its Global Headquarters in downtown Atlantaprocess that can scale across the company.

CONCLUSION

These projects have shown that it is not only possible but also appealing to integrate biomimetic design and ecosystem service performance metrics into regenerative design. To expand the potential for positive impact in the built environment, we need engagement across industries, and policies to promote learning from nature as the optimal pathway to regenerative design.

It's also crucial to incorporate PPM into wider conservation strategies to enhance ecosystems on a larger scale. Beyond just buildings and sites, PPM can be applied to fields such as agriculture, forestry, transportation, housing, and education. We have extended the concept of "Factories as Forests" to "Backyards as Forests," "Campuses as Forests," and so on, enabling companies and communities to explore design for positive impact – for both people and the planet.

From our past projects, we've gleaned two key lessons for future PPM implementation. Firstly, it's vital to involve all major stakeholders from the onset to establish metrics that align with the primary developer, community and/or company's goals. These metrics, which may be quantitative, qualitative, or related to social goals, should be aligned with overall project objectives as early as possible. For instance, identifying the ideal site for development to maximize ecosystem performance should be done before finalizing site selection. Secondly, tools like EI are invaluable. These allow practitioners to easily collect ecosystem metrics and quantify performance in ways that would be nearly impossible to obtain from literature reviews or without extensive field research. The models produced by such tools enable the project team to see potential impact and support key decision making milestones, along with community engagement. Continued refinement of such tools, along with features for alternative scenario planning, will further streamline the PPM process, and potential for impact.

Looking ahead, we see several opportunities to further expedite PPM implementation. Collaborations between ecologists and built environment professionals can devise and assess methods for delivering ecosystem services through design and help designers evaluate how well their designs meet PPM goals. In addition to the scientific challenges of developing reliable ecosystem services models, we also need to understand how various design interventions will synergistically contribute to positive ecosystem services over time. Long-term case studies with proper measurement protocols will be crucial for this.

Policy will also play a key role in a more rapid integration of holistic design frameworks like PPM that deliver multifunctional design and co-benefits to meet adopted laws, regulations and guidelines – such as the Biden-Harris Administration Roadmap for Nature Based Solutions, the European Unions Nature Restoration Law, and Task Force for Nature Related Financial Disclosures.

Lastly, documenting PPM projects and case studies helps create a set of best practices for ecosystem services design. Although it can be challenging when project details are confidential, we need to push for more transparency about project successes, lessons learned, and to share best practices. If we share project outcomes, we could potentially create a global 'atlas' of ecosystem services metrics, performance targets, and biomimetic design interventions, which would make it easier to adopt Positive Performance goals, integrate solutions and apply at scale, to truly have a positive impact on "all the lands we touch".