

Chapter 1 : Natural infrastructure guide for business |

Natural ecosystems like forests and wetlands provide essential services to water utilities, businesses, and communities—from water flow regulation and flood control to water purification and water temperature regulation.

Contacts What is Natural Infrastructure? Natural infrastructure sometimes called green or sustainable infrastructure is the interconnected network of natural and undeveloped areas needed to maintain and support ecosystems. They also provide a wide array of environmental, health and economic benefits such as mitigating climate change impacts and sustaining clean air and water. Our Natural Infrastructure has been declining — in quality and quantity — since the start of the industrial revolution. Government agencies and organizations faced with sprawl and other poorly planned development often conserve and restore land and waterways in a haphazard manner. This reactive approach to conservation ignores ecosystem processes. On the other hand, the Natural Infrastructure approach is proactive with an emphasis on connectivity to support long-term sustainability. This approach often results in identifying a Green Infrastructure Network -- in its simplest form, composed of hubs and corridors. Our Region has made natural infrastructure a priority with the intention of expanding and improving the efficiency and effectiveness of its programs and activities to protect and restore important ecosystems. Our Natural Infrastructure Priority Action Plan identifies four project areas of focus for this effort. These project areas were selected, in part, because the opportunity to address the stressors and achieve meaningful environmental results. In this project, Pennsylvania and a number of federal agencies will collaborate to target restoration sites and abandoned mine lands to achieve the goals of the abandoned mine lands trust funds, CWA d listed impaired waters, and the National Fish Habitat Action Plan. The Sinnemahoning watershed has already been selected by partners as a test for the Abandoned Mine Land funding process. The impact has been significant nutrient and sediment deposition into the Chesapeake Bay and its tributaries. The objective of this project is to develop a collaborative network among EPA, other governmental agencies, non-governmental organizations, and citizens to improve the water quality in the watershed and protect high quality ecosystems. The role of wetlands and best practices i. A longer term objective is to work with Frederick County, Maryland to prepare a green infrastructure assessment and protection plan. The green infrastructure assessment will include federal and state data and be enhanced by local monitoring data. Once completed, the assessment will be used to identify areas for protection and restoration. In cooperation with state agencies, federal partners, non-governmental organizations, and the coal industry areas of functioning environmental infrastructure will be mapped and formally designated to restore and protect. These areas will include upland fragmented forests to fill in and enhancing the natural systems and functions. In addition, work with the US Forest Service will identify the value of existing intact forests relative to carbon sequestration. The project is identifying high quality watershed resources to preserve and areas to restore.

Chapter 2 : Natural Infrastructure

Natural Infrastructure for Business The aim of this platform is to strengthen the business case for investing in natural infrastructure. Natural infrastructure solutions can be not only cost-efficient and reduce a company's risk exposure, but also have compelling co-benefits to society and the environment.

Coastal hazard maps under way Its cost advantages over grey infrastructure are huge. It develops resilient communities by conserving water, soil and habitat Natural disasters cause huge losses annually and there have been growing concerns over the measures needed, particularly with respect to the ecosystem in which society, business and government exist. In India, approximately million people were affected by around weather-related disasters during In order to avoid risk and damage, and to build resilience to these disasters, natural infrastructure solutions are increasingly being considered and implemented. Natural infrastructures are planned and managed natural or semi-natural systems, which can provide benefits or even replace a functionality that is traditionally provided by grey infrastructures. These natural or green infrastructures can be areas such as forests, agricultural lands, estuaries, coastal landscapes and wetlands. These solutions comprises coastal ecosystem mangroves, coral reefs for coastline protection from storms; watershed restoration by sustainable land management for water quality regulation; afforestation for carbon sequestration; habitat restoration or conservation for pollination; phyto-remediation to rehabilitate contaminated soil and water. Multi-pronged approach Natural infrastructure NI solutions arrayed across different scales, from buildings to landscapes in rural, urban, terrestrial, freshwater, coastal and marine areas, hold huge potential. At the local level, NI solutions include permeable pavements, trees and rainwater harvesting systems. Vegetative solutions consists of green roofs, rain gardens, and bio-swales, which can be used in cities and industrial parks to balance stormwater conveyance systems. Rain gardens capture rainwater in a depression in the ground, and prevent flash floods and erosion in streams by slowing down storm water. Bioswales are made along roadsides so that rainwater from the road flows towards them and percolates into the ground. NI solutions include constructed wetlands that are used for industrial processed water and waste-water treatment, substituting traditional waste-water treatment infrastructure. Oyster reefs and seagrass beds can decrease erosion and protect coastal areas from storms, while also filtering contaminated seawater and supporting local fisheries. Natural infrastructures offer numerous benefits to society. For example, a well-managed forest can regulate water for drinking, agriculture and energy, store carbon, support pollinators and provide recreational and tourism opportunities. Further, it can increase biodiversity and improve storm resilience. Natural infrastructure can help avoid water pollution that would otherwise need to pass through a conventional water treatment plant, thus reducing costs. Many cities have a water fund focused on NI solutions that has resulted in significant savings every year by reducing water treatment costs. NI solutions often require less initial capital investment and reduced operations and maintenance costs. These solutions often require fewer human resources for oversight. As more businesses invest in NI solutions, the demand for related skills will increase, resulting in new job opportunities. Additionally, NI can contribute to new natural resource-based industries, such as commercial fisheries. NI solutions offer the social licence to operate businesses and enhance public health. For example, parks and permeable pavements reduce noise pollution by dampening traffic noise. NI investments can even lead to increase in property values due to the enhanced aesthetics of landscapes. Mapping and assessing NI solutions is essential to ensure that their true values are considered in policies and decision-making across sectors. Global infrastructure spending amounts to trillions of dollars a year. Diverting a small fraction of this towards NI solutions ecosystem restoration, creation and enhancement can be a new business driver and primary source of environmental finance worldwide. The ability and needs related to measuring and accounting natural capital will vary, so multiple, flexible, yet rigorous approaches will be required for effective decision-making. Many countries and municipalities have regulatory guidelines in place for NI solutions. In some cities, governments and companies pay for ecosystem services to secure clean water supplies instead of paying for expensive greywater treatment facilities and processes. Similarly, reinsurance products pricing can be disrupted if the benefits and values of natural infrastructure for reducing risks from

certain hazards are integrated into risk models. Working together Many of these steps are being taken, but often in isolation. Harmonisation of tools and languages and collaboration among different stakeholders such as accountants, scientists, government, economists, NGOs and business leaders will be necessary in order to connect the dots. These collaborations will be necessary to create synergetic approaches, reporting mechanisms and tools that are compatible for assessing progress toward sustainable development across all sectors and regions. The time for action has arrived as we have the commitment and momentum for a natural world that provides benefits to society. There is a need to strength informational cooperation between cities or countries across both the developed and developing worlds. Finally, it is imperative to develop and build a collaborative environment for public institutions and private companies for the success of these initiatives, as re-imagining ways to integrate nature with the communities will help in building resilience. Sarmah is an independent management consultant focusing on Sustainability and Resource Productivity. The views are personal Published on.

Chapter 3 : Groundwater-based Natural Infrastructure (GBNI) - GRIPP | IWMI Project Site

Natural or "green" infrastructure projects rely on services produced by ecosystems, often utilizing natural landscapes to minimize flood damages, purify and store water, and reduce urban stormwater runoff.

Episode 17 Natural infrastructure provides effective solutions for minimizing coastal flooding, erosion, and runoff, but it has other benefits as well. This aerial photo shows the Mississippi coast with a living shoreline project that includes both natural infrastructure and artificial breakwater material to reduce shoreline erosion. Living shorelines help reduce coastal risks and improve resiliency through an integrated approach that draws from the full array of coastal risk reduction measures. Using solely "gray," or hardened infrastructure, can negatively impact coastal habitats, be visually obstructive, and result in higher up-front costs. Listen to our latest podcast Download this podcast. What can protect coastal communities, conserve natural habitats, and provide economic benefits throughout the U. The answer is natural infrastructure. Studies have shown that implementing these systems can buffer waves during storms, increase recreation and tourism opportunities, reduce runoff, and provide many other benefits to both inland and coastal communities. Hi Kim, and welcome. Thank you for having me. Can you tell me and our listeners a little bit about what you do at NOAA? I personally focus on coastal resilience for our policy team, and one of my current priorities is advancing the use of natural infrastructure for resilient coastal communities. Natural infrastructure is a term that we use to talk about the natural environment. It can include wetlands, forests and beaches, and also systems that are engineered or built to mimic natural ecosystem functions or processes. So natural infrastructure can include wetlands, forests, beaches, dunes, mangroves, coral reefs, oyster reefs. Natural infrastructure approaches or solutions associated with those systems include conservation, protection, or restoration of those habitats. And so it would include things like rain gardens, green roofs, bioswales, and permeable pavement. Those are all examples of stormwater management techniques that incorporate natural processes. Another popular nature-based approach is a living shoreline. A living shoreline is a protected, stabilized coastal edge, constructed from more natural materials, which can include marsh plantings or stone sills, restored oyster reefs. So, in my office, we are looking to advance the use of natural and nature-based infrastructure in coastal communities, because in addition to providing the benefits that you typically think of with natural systems – which include recreation and habitat, all the things that we enjoy going out into nature for – these systems provide really effective solutions for minimizing coastal flooding, erosion, and other hazards. So what is resilience? So resilience is the ability of a community to prepare for and respond to extreme weather events, climate hazards, or changing ocean conditions. We think of resilience as really critically important to our coastal communities. It provides the ability to prevent a short-term hazard event from turning into a longer-term community-wide disaster. How exactly can natural systems protect communities from natural hazards? So existing coastal natural areas, such as wetlands or dunes, can help absorb flood waters and lessen the impacts of waves. We have some success stories of locations where we saw that in tact dune systems or coastal wetlands, areas that were, communities that were behind these impact coastal systems fared better than those that were not. Also, in more urban areas, nature-based infrastructure, such as rain gardens, can help with stormwater management, including absorbing runoff during rain events, protecting water quality, and storing excess water to prevent flooding in the streets. Living shorelines can also help lessen the impact of waves and reduce shoreline erosion. One of the obvious benefits of natural infrastructure is wildlife habitat, but also recreation, like hiking, fishing and bird watching, natural areas can help to filter water, they are beautiful to look at, and they help to provide a real sense of space. Are there also economic benefits associated with using natural infrastructure? These are really important. Coastal communities are trying to weigh the costs and benefits of the resilience choices that they are making. And so the economic value of natural infrastructure comes into play as a question quite a bit. In addition to the sort of obvious economic value of some of the activities I mentioned, commercial fisheries, tourism, or recreation – these approaches can really be a cost-effective solution for mitigating against hazards. And by installing these rain gardens instead of constructing additional gray infrastructure to manage the stormwater, Aurora saved an estimated 1. Another

good example is in New York City. And as another cost savings, recently there was a comprehensive study that showed that coastal wetlands played a really important role as the first line of defense from storm surges during Hurricane Sandy. It found that coastal wetlands prevented more than million dollars in property damages from Maine to North Carolina. And in this case, even relatively degraded wetlands in urban areas of New York City and New Jersey saved communities hundreds of millions of dollars. You may need or want to incorporate some gray infrastructure to be the most effective solution. So these kind of solutions that include both green and gray components are sometimes called hybrid approaches. Another example are the living shorelines approaches that I mentioned earlier, where you may have a more gray component, such as an artificial reef or a stone sill. Bioswales are created to absorb and clean water during rain events. Where else might someone notice examples of natural infrastructure? We include natural areas that have been protected or restored as natural infrastructure. Are scientists and coastal managers the only ones that can make use of nature-based approaches? Almost anyone can really make use of nature-based approaches. In many coastal states living shorelines are becoming a protection measure of choice, actually. And even at the state level floodplain managers will opt to protect or restore floodplains at watershed scale. Again, natural and nature-based approaches can be implemented at so many different scales, that everyone can be involved. Through your neighborhood or your schools or your community groups. Volunteers can help with planting marsh grasses, or constructing a rain garden, or maintaining bioswales – there really is a great opportunity for local and state governments and nonprofits to partner, educate, and bring communities together. There are so many ways for people to get involved! Awareness is really a big one. Planners might not know where to go for the information and data necessary to incorporate natural infrastructure. So even once they choose to use a nature-based approach, how to plan for those might be encumbered. Permitting processes might not be as straightforward for nature-based solutions, as some of these techniques are really just gaining in popularity. So in some states it actually is more difficult to permit for a living shoreline than it is for a hardened shoreline, which is a barrier for, for coastal landowners. And even for those who are ready to construct their living shoreline or incorporate nature-based approaches for stormwater management, it can be really difficult to find engineers that are trained in designing those features. How is NOAA helping to address these challenges? Many of our key partners, including state coastal management programs and national estuarine research reserves, study, plan for, and implement natural and nature-based infrastructure projects within communities. So we really support them both through financial and technical assistance. Examples of the technical assistance include visualization tools, training opportunities, and access to data that can be used for community planning. I also want to say that we work really closely with our federal and non-federal partners to ensure that our efforts are coordinated and coastal management needs around natural infrastructure are addressed. There is actually a great recent one from Hurricane Harvey in Clear Lake, Texas, where the community had reclaimed an abandoned golf course and restored it to a acre urban wetland. It performed exactly how it was intended by acting as a sponge to keep floodwaters away from area homes. You can see an amazing video showing the water rising during the storm but staying within the wetland area on our webpage. The reclaimed area is called Exploration Green and the plan for the open space includes hiking, biking, pedestrian trails, athletic fields, and native grassland areas, providing those additional benefits that we talked about earlier. That is very cool. Can you think of any other success stories? So in North Carolina there was a study conducted before and after Hurricane Irene and it showed that living shorelines, in this case they were marshes, with and without sills were more durable and actually protected the shorelines better than those with bulkheads. Where can our listeners go to learn more about natural infrastructure? Of course, I hope a lot of people go to our Digital Coast website, which is a great place to start. Our partners, which include your state coastal programs or national estuarine research reserves, The Trust for Public Land, The Nature Conservancy, and many others, also can provide a wealth of information to a diversity of audiences. And many of those resources can also be accessed via links from Digital Coast. These two things help to address that awareness barrier or challenge that we talked about earlier. For our listeners, you can find the Digital Coast website that Kim mentioned at coast. I find it extremely rewarding. Natural infrastructure and coastal resilience is really something that everyone can and should get behind. As we discussed, the benefits are diverse and they really

can be enjoyed by the whole community – homeowners, children, transportation planners, and businesses. The list really goes on. I also personally really love the partnerships aspect. Needs for information and for training, for example. And then to really see the communities we work with incorporate natural solutions, and realize the benefits on the ground. And my hope is that we stop thinking about natural infrastructure as sort of new and different option, but really as an integral component of building a resilient community. As something that just makes common sense - environmental, social and economic sense. Thanks to Kim Penn for explaining the multi-faceted benefits of natural infrastructure, and its role in protecting our communities. And thanks to you for listening. To learn more about natural infrastructure, or any ocean-related subject, visit our website at oceanservice. From corals to coastal science, connect with ocean experts to explore questions about the ocean environment.

Chapter 4 : Natural Infrastructure for Water | Water, Land and Ecosystems

We empower governments, businesses, utilities, and communities to enhance water security by investing in "natural infrastructure," like forests and wetlands, as part of a portfolio of smart solutions to growing water challenges.

What is Green Infrastructure? Green infrastructure is an approach to water management that protects, restores, or mimics the natural water cycle. Green infrastructure is effective, economical, and enhances community safety and quality of life. It means planting trees and restoring wetlands, rather than building a costly new water treatment plant. It means choosing water efficiency instead of building a new water supply dam. It means restoring floodplains instead of building taller levees. Green infrastructure incorporates both the natural environment and engineered systems to provide clean water, conserve ecosystem values and functions, and provide a wide array of benefits to people and wildlife. Green infrastructure solutions can be applied on different scales, from the house or building level, to the broader landscape level. On the local level, green infrastructure practices include rain gardens, permeable pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting systems. At the largest scale, the preservation and restoration of natural landscapes such as forests, floodplains and wetlands are critical components of green infrastructure. Green infrastructure investments boost the economy, enhance community health and safety, and provide recreation, wildlife, and other benefits. Rivers, streams, wetlands, floodplains, and forests provide a suite of critical services like clean water and flood protection, and should be viewed as essential and effective components of our water infrastructure. Spending money wisely means investing in multi-purpose solutions that lower costs and provide more benefits. We must enhance community safety and enjoyment: Green solutions give communities the security and flexibility they need. Green infrastructure also supports supply chains and the jobs connected with manufacturing of materials including roof membranes, rainwater harvesting systems, and permeable pavement. The City estimates that full implementation of PlaNYC will create 4, water infrastructure jobs of all types per year. Other countries are utilizing green water technologies at a much higher rate than the United States. We cannot afford to fall behind other nations in this vital area, it is a matter of economic competitiveness as well as quality of life and community security. Traditional water infrastructure will continue to play a role, but it is static, solves only a single problem, and requires a huge expense to build and maintain. We must use this transformational moment to move from old 19th Century infrastructure to a wiser combination of green and traditional infrastructure that will meet the needs of the 21st Century.

Chapter 5 : What is Green Infrastructure? | American Rivers

One of the clearest places to see natural infrastructure at work is in the forested watersheds of the northeastern United States that are the inspiration for Meyer's work as a Conservancy NatureNet Science Fellow at the Yale School of Forestry and Environmental Studies.

Climate change is affecting the water cycle. Water variability is increasing and extreme events floods and droughts are becoming more common and increasingly costly. In the face of climate change managing water resources is becoming more difficult. In many places the impacts of climate change will not only have huge human costs, but also major economic costs: Farmers cultivate land next to a reservoir on the Meka River in Ethiopia. Matthew McCartney Against this background, there is a competing discourse on the need for more built infrastructure e. This situation will only get worse as populations rise and climate change bites. In this case, the argument offered is that a re-design of conventional approaches is needed; one that works with rather than against natural systems. The case made is that socio-economic development can be achieved in many ways and some alternatives are more sustainable and more equitable than others. In the context of water, solutions that support, rather than undermine, the environment are advanced as a prerequisite for sustainability. Natural infrastructure for water management - IUCN. Building a balance Both approaches attempt to balance social, economic and environmental considerations. Yet, in emphasizing different tensions that exist between these three elements, the two communities-of-practice, advocate different approaches: The reality is that a more nuanced approach is needed. One that recognizes that, without doubt, more built infrastructure is required but that in any given situation built infrastructure is not necessarily the best option. Alternative solutions should be given equal consideration in planning. Furthermore, when construction of built infrastructure, does take place it should be built in balance with nature: Clear and concerted efforts are needed to minimize adverse environmental impacts, allowing ecosystems and infrastructure to work in tandem. If river basins themselves are treated as natural infrastructure, based on the ecosystems services they provide e. It is proposed that such an approach is more likely to achieve outcomes for the multiple goals of poverty reduction, water-food-energy security, biodiversity conservation and climate resilience “ outcomes that are more equitable, effective and economically viable. Integrating society and ecology A major limitation of this approach is that evaluating options and finding an appropriate balance between development needs and safeguarding ecosystem services is far from straightforward. Current planning and decision-making processes tend to isolate water management issues within the context of engineering or hydrology and give insufficient consideration to ecosystem services. What is needed is knowledge and tools that promote much greater integration of social and ecological thinking into planning processes. In each case, this includes an analysis of the context in which decisions on investments in built water infrastructure are made, so that evidence and tools can be targeted at the institutions and stakeholders that are most amenable to change and able to influence alternative modes of thinking. This coupling of infrastructure with nature highlights two main things: First, ecosystem services and biodiversity concerns are a development challenge, and no longer just a conservation issue. If we are to achieve balanced development for all, challenging conversations need to take place. Second, a much better evidence base is required that integrates disciplinary knowledge. This is a prerequisite for identifying the correct scale, sequence, operating rules, and complementary investments required to support natural and built infrastructure solutions for water management, as well as the many co-benefits for society at large.

Chapter 6 : Natural Infrastructure | Resources for the Future

Natural infrastructure is a term that we use to talk about the natural environment. It can include wetlands, forests and beaches, and also systems that are engineered or built to mimic natural ecosystem functions or processes.

Chapter 7 : Built or natural infrastructure: a false dichotomy | Water, Land and Ecosystems

Natural infrastructure (sometimes called green or sustainable infrastructure) is the interconnected network of natural and undeveloped areas needed to maintain and support ecosystems. They also provide a wide array of environmental, health and economic benefits such as mitigating climate change impacts and sustaining clean air and water.

Chapter 8 : Breaking Down Barriers: Natural Infrastructure

fast facts Natural Infrastructure. Nature provides effective solutions for minimizing coastal flooding, erosion, and runoff, as do man-made systems that mimic natural processes—known as natural infrastructure.

Chapter 9 : Caterpillar | Natural Infrastructure

The Natural Infrastructure for Business platform developed by the World Business Council for Sustainable Development (WBCSD), CH2M (with support from The Nature Conservancy), and other member companies is designed to introduce business leaders and practitioners to natural infrastructure.