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REVIEWS

Opinion

The IPBES Global Assessment: Pathways to Action

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The first Global Assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) found widespread, accelerating declines in Earth's biodiversity and associated benefits to people from nature. Addressing these trends will require science-based policy responses to reduce impacts, especially at national to local scales. Effective scaling of science-policy efforts, driven by global and national assessments, is a major challenge for turning assessment into action and will require unprecedented commitment by scientists to engage with communities of policy and practice. Fulfillment of science's social contract with society, and with nature, will require strong institutional support for scientists' participation in activities that transcend conventional research and publication.

From Assessment to Action

The first IPBES Global Assessment, released in 2019, reveals widespread, accelerating declines in our planet's biodiversity and life-support systems [1,2]. The assessment's unanimous approval by the 132 member countries, and the resounding calls by multiple stakeholders for action [3], underscore both urgency and hope for significant response[i]. The assessment concludes that nature's capacity to support humanity's wellbeing is threatened by habitat conversion, excessive resource harvesting, climate change, invasive species, and other impacts [2]. Declines in species viability, human safety, mental and physical health, and food and livelihood security will continue unless these trends are checked and reversed. The critical challenge now is to disseminate and apply the findings of the IPBES Global Assessment at national and local scales where most policy and management decisions affecting biodiversity and ecosystem services are made. This will require significant, long-term commitments by governments, non-governmental organizations (NGOs), the private sector, civil society, and the scientific community. Commitments are required not only from individual scientists but also the institutions that host and fund them. The pathways and processes necessary for successful implementation transcend business-as-usual approaches and require a broader transformation in how scientists work with decision makers.

Converting scientific knowledge to action is often complex, but the ingredients of success are clear. Effective, enduring action comes from collaborative, multidisciplinary science-policy processes that frame and cogenerate knowledge with decision makers and stakeholders from many sectors [1,4–7]. A spectrum of approaches has been developed for such so-called 'translational science' and 'knowledge coproduction' practices (e.g., [8–11]), but all share key properties, including deep multidisciplinarity, close engagement and dialogue with partners, and incorporation of diverse

Highlights

The IPBES Global Assessment released in the spring of 2019 is a significant milestone for the international scientific community; the critical challenge now is to disseminate and apply its findings at national and local scales where most policy and management decisions affecting biodiversity and ecosystem services are made.

Effective, enduring action from assessments requires collaborative, multidisciplinary science-policy processes that frame and cogenerate knowledge with decision makers and stakeholders from many sectors.

Examples of assessments driving policy responses to recover biodiversity and ecosystem services highlight the need for significant, long-term commitments by governments, non-governmental organizations (NGOs), the private sector, civil society, and the scientific community.

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sources of knowledge and ways of understanding. Scientists and stakeholders need to work together to frame analyses and inform decisions consistent with desirable ecological and societal outcomes. The ecological processes underlying biodiversity and ecosystem services take place across a broad range of scales, from local to global, as do the management decisions that influence them. Accordingly, the dialogues among scientists and stakeholders must happen in a deliberate way across local, regional, national, and global levels.

Broader, more effective, and more sustained engagement by the scientific community to support decision makers and stakeholders across these scales is called for [5,11–13]. Scientists will need to devote considerable time, energy, and resources to produce relevant results and outcomes, typically in an iterative fashion, working across disciplines, sectors, and even societies. They will need to develop and sustain long-term relationships of trust and mutual learning with other communities (stakeholders, practitioners, knowledge holders) in dynamic and often complex decision contexts. Currently, significant cultural, professional, and institutional barriers exist for scientists to engage in these practices. Those barriers can and must be surmounted through institutional commitments to support individual scientists' participation, especially early in their careers [4,5,11,14,15]. Applications of translational ecology and codevelopment frameworks, resulting

Box 1. Multiscale Assessments Linked to Recovery Planning for the Pacific Salmon Ecosystem

Spurred by the listing of Chinook salmon (*Onchorhynchus tshawytscha*) as threatened under the US Endangered Species Act, scientists and stakeholders in Washington State, USA developed a consultative, cross-scale science-policy process to recover the salmon socioecological system under existing authorities and institutions. This led to a collaborative governance body and process, scaled to the watersheds and marine waters of Puget Sound, that has been in existence for over 15 years. Its composition is necessarily diverse, given treaty rights guaranteeing harvest for 21 tribal nations, a farm bureau – whose members' livelihoods depend on ample, clean water, and local businesses with a quality-of-life stake in employee recruitment and retention. Numerous government agencies (federal, tribal, state, local) participated, along with 100 city mayors and 16 fully representational watershed councils encompassing diverse stakeholders [36,37]. A technical team conducted ecosystem assessments and provided salmon recovery goals that satisfied additional social and ecological objectives defined by the governance body, for US Endangered Species Act recovery, commercial and recreational harvest (including cultural and spiritual values), and general watershed health [38].

Roles in the Puget Sound recovery governance process were clearly defined. For example, the watershed councils were responsible for identifying commitments to habitat protection and restoration, and rules of engagement reduced power imbalances among stakeholders [9,36]. A formal state and tribal comanagement process set acceptable harvest limits and hatchery practices in state waters, subject to review by federal agencies. In addition to habitat, hatchery, and harvest data, tribal nations provided information on areas of high cultural value. A technical team analyzed anticipated cumulative effects of proposed recovery actions, and incorporated climate change throughout the species' North Pacific range as well as consequences of a USA–Canada treaty dictating harvest terms. This process, with watershed councils, hatchery and fishery managers identifying actions, and a scientific team assessing likely outcomes in terms of salmon recovery goals, featured rounds of collective iteration until an acceptable recovery plan was adopted by all parties [37,38].

Federal, state, and local leaders on the governance body in this example allocated their resources according to the recovery plan, working together at national and state levels to seek funding and authorities needed for implementation. The regional process also informed harvest negotiations for the international Pacific Salmon Treaty in USA and Canadian waters. The Puget Sound process required that scientists, decision makers, and stakeholders work together persistently, patiently, and with humility to seek solutions involving difficult trade-offs [37]. The accumulated trust led to an astounding outcome: some watershed councils and tribes agreed to receive less government funding so that watersheds contributing more to overall recovery goals could receive more resources. In the decade following the implementation of the recovery plan, Chinook habitat and harvest improvements are clear, although many factors still thwart their complete recovery [39].

Leadership turnover, inconsistent federal funding, and issues arising at larger spatial and temporal scales have challenged the Puget Sound effort. However, the Shared Salmon Strategy has evolved into a state-codified successor, the Puget Sound Partnership, whose scope has expanded to recovering the broader health of Puget Sound, including federally listed orca whales (*Orcinus orca*), and human health and livelihoods. The collaborative and inclusive approach has endured in the midst of complex decisions rooted in high levels of scientific and management uncertainty. The social capital [40,41] accumulated during the original, Chinook-focused effort was critical in adapting to changing circumstances, and will continue to be important as new challenges arise.

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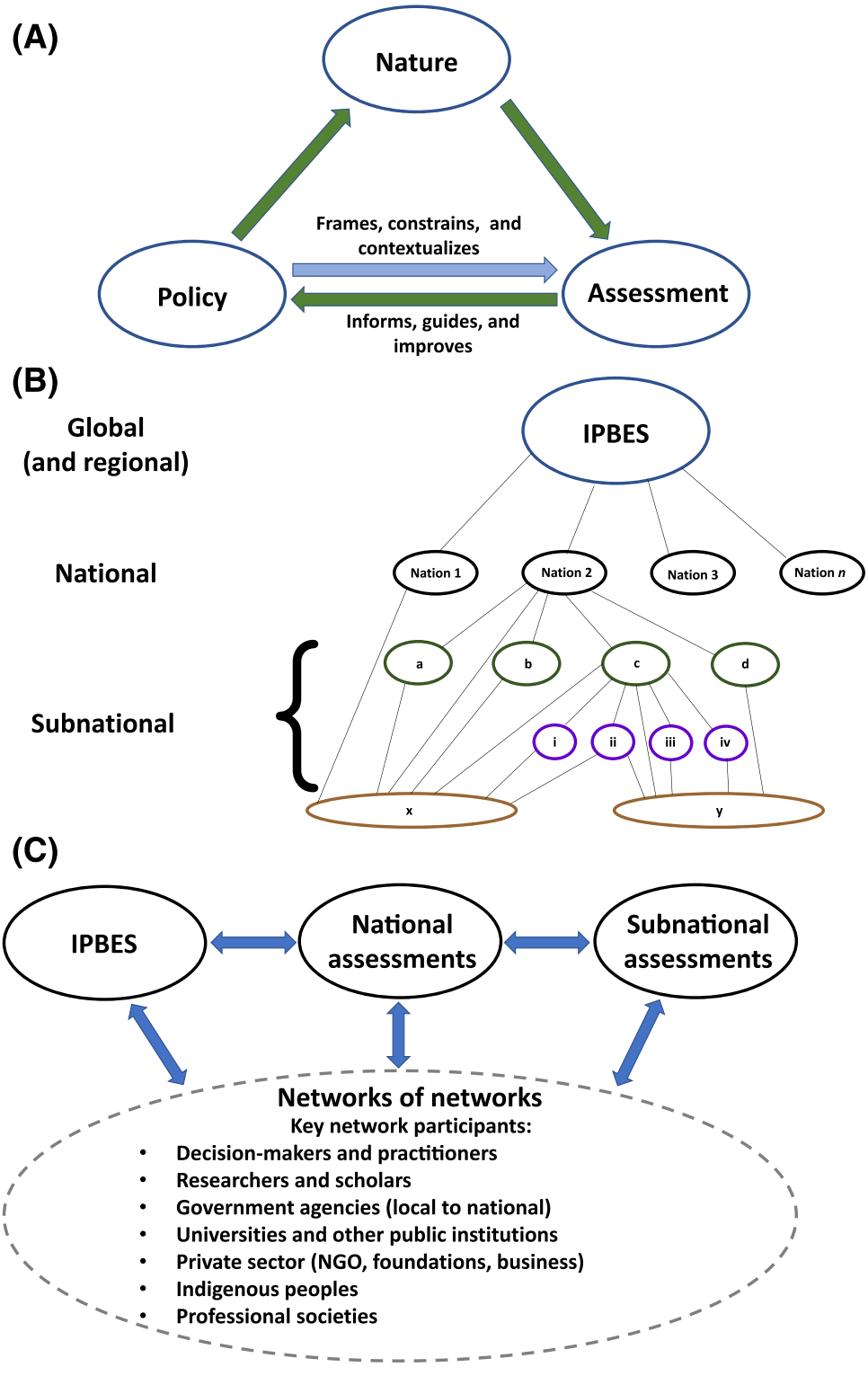

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in scientifically legitimate and relevant products that inform policy decisions, are happening now around the world [11], but not yet at sufficient pace, scale, or durability.

Science, Policy, and Governance

One example of science-policy integration driven by rigorous ecosystem assessment has been unfolding in the US Pacific Northwest for over 15 years, where a convergence of policy mandates, strong leadership, and funding incentives led to the establishment of an ad hoc but durable regional process for recovery of Pacific salmonids and their ecosystems: the Shared Strategy for Puget Sound (Box 1).

The Puget Sound recovery example illustrates the roles of deep scientific engagement, relationship building, and development of social capital required to create effective, long-lasting partnerships for science assessment and application [12,16]. Similar local-to-regional initiatives have been developed elsewhere in the USA, supported by boundary organizations, both governmental [e.g., the United States Geological Survey (USGS) – National and Regional Climate Adaptation Science Centers; US Department of Commerce – National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Sciences and Assessment (RISA); Landscape Conservation Cooperatives (LCC)] and non-governmental (e.g., Longleaf Alliance[ii], Redwoods Rising[iii], Climate Science Alliance[iv]). Although federal leadership of the LCCs has ceased, many initiatives continue under state and NGO leadership, carried forward by social capital and momentum developed by the LCCs.

Transdisciplinary initiatives are underway in many other parts of the world. We provide two examples among many. The sub-Antarctic Biocultural Conservation Program[v] at the extreme end of Chile, led by Chilean scientists, has embarked on a long-term agenda to preserve cultural and biological diversity and provide sustainable livelihoods in a remote and unique area, with the participation of Chilean and foreign scientists, the local state government, politicians, the Chilean navy, and local people. The first milestone of the program was the creation, by mutual consensus, of the international Cape Horn Biosphere Reserve[vi]. In Africa, the RESILiM Olifants Programme[vii] is drawing together scientists, managers, and local peoples to bolster biodiversity and societal resilience to climate change in the Olifants River basin along the border between Mozambique and South Africa.

Science-policy efforts driven by early IPBES thematic assessment products are beginning to stimulate regional and national policy changes. Notably, the IPBES thematic assessment on

Figure 1. The Context for Spurring Action from Assessment of Biodiversity and Ecosystem Services. (A) Assessments of the state of nature are intended to influence policy, practice, and management. Assessments are most effective when they are developed with explicit context of policy (past, present, and projected) and in consultation with intended implementers. Policy decisions in turn influence the state of nature, and their impacts and effectiveness can be gauged by ongoing or future assessments. (B) Example of a nested network of networks to support decision making. Global and regional assessments [e.g., Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)] both draw from and influence national-scale assessments, which in turn draw from and inform a broad variety of subnational assessments. Such subnational assessments might include spatial-political hierarchies (e.g., a/b/c/d might represent states, provinces, districts, or tribes; while i/ii/iii/iv might represent counties, municipalities, or tribal bands) or agency hierarchies (e.g., a/b/c/d might respectively represent national fish, wildlife, park, and forest agencies; while i/ii/iii/iv might represent individual national parks). Focused or topical assessments (e.g., of a river basin, designated wilderness areas, pine-dominated ecosystems, or sockeye salmon) might inform assessments at a variety of levels (e.g., x, y), and in some cases might be transnational (e.g., x). Please note that the topology portrayed here is intended to be illustrative, not representative or exhaustive. (C) Regardless of the scale, assessments depend on and interact with one or more networks that in turn comprise many other networks. Elements of these networks are diverse, as can be seen in (B), and the topology of their relationships is typically complex. To be most effective in informing policy, these networks should be infused with diverse information, partnerships, and dialogues, particularly between stakeholders and researchers. Development and coordination of a network of diverse networks comprises an important challenge for all assessment efforts. Functional networks of networks will not arise spontaneously, but will require leadership, strategic policy commitment, and funding to develop, integrate, and sustain them. Abbreviation: NGO, non-governmental organization.

pollinators [17] has led to the EU Pollinators Initiative [18], endorsement by the Convention on Biological Diversity [19], and an international Declaration on the Coalition of the Willing on Pollinators[viii]. The IPBES pollinator assessment was used in the USA to develop a National Pollinator Health Strategy for use by all government agencies, influencing scientific direction and practical actions for crucial habitat protection [20]. The IPBES pollinator assessment is also inspiring action by scientists, educators, and agencies that are disseminating their findings to schools, mass media, farmers, and consumers [21]. In Hungary, an exhibition is currently under development, and a colorful booklet[ix] has been published to convey conclusions of the IPBES pollination report to stakeholders and identify ways for citizens to help pollinators[x].

The Role of National Assessments in Guiding Action

Converting the IPBES Global Assessment findings to actions at all scales will be more challenging than for a single-topic issue, such as pollination (Figure 1). Scientists' participation is crucial for relevant distillations of the IPBES Global Assessment at every level, from local to continental. IPBES itself can provide guidance and leadership; recruitment of individuals, with expertise and experience in connecting science to policy and management decisions, to the IPBES Multidisciplinary Expert Panel will increase the relevance of the IPBES process and the impact of its products. In addition, the scientific community can use the IPBES Global Assessment – designed to inform member governments and international bodies – in science-policy engagement approaches for national and finer-scale assessments, and for fostering actions that benefit biodiversity and ecosystem services at those scales [16]. Scientists alone cannot create such engagement processes, but they can work with IPBES signatory countries and other practitioners to advocate for the transformation to new engagement processes targeted for implementation.

A natural step following the IPBES Global Assessment is for governments to lead development of sustained national assessments of biodiversity and ecosystem services[†]. Indeed, several national-scale assessments are underway and are already influencing policy (e.g., [22–25]), and many more nations are poised to begin[xi] [26]. China's national and local-scale biodiversity and ecosystem services assessments have been guiding zoning policies and eco-compensation mechanisms for reducing flood and sandstorm risk, securing water and food production, enhancing biodiversity protection, and retaining support for local livelihoods for over a decade [23,27]. Building on the UK's National Ecosystem Assessment [22], scientists and government decision makers worked with a coalition of corporations to frame practical questions and develop critical support for payment for ecosystem services (PES) schemes and other policy outcomes within the UK [28].

Brazil recently completed a nationwide IPBES-like assessment, engaging government, business, NGO, and indigenous-community sectors at the outset to help frame the content [24]. Relevance and likelihood of policy uptake was increased by pinpointing specific policies for revision and implementation [e.g., the Green Stipend (Bolsa Verde); National Plan for Agroecology and Organic Production (Planapo); National Benefit Sharing Program (PNRB)] in the assessment. Connecting national assessments to larger-scale information, such as that in the global, regional, or thematic IPBES assessments, can provide critical context for action, from global corporate commodity-sourcing decisions to international trade or harvest agreements. Similarly, the IPBES Global Assessment provides national-level agency or ministry staff with critical context for management strategies they can control, and others where they need international cooperation.

[†] The IPBES Global Assessment introduced new terminology, 'nature's contributions to people (NCP)', using rationale outlined in Diaz *et al.* (2018) [42]. Regional IPBES assessments used both BES and NCP, reflecting the preference of many policy leaders and enabling legislative guidance for the former [e.g., there is an EU MAES (mapping and assessment of ecosystems and their services) obligation for 28 member states – see: https://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/index_en.htm.

Not all national governments are positioned or committed to lead national assessments of biodiversity and ecosystem services. For example, plans for a coordinated national assessment in the USA have been stalled for nearly a decade [29]. However, lack of government leadership need not prevent or delay development of assessments or assessment processes at national or more local levels. Sustained, grassroots approaches can be developed by coalitions of scientists and diverse stakeholders at local, state, and national levels (Figure 1). Such 'polycentric approaches', through which independent, small- and medium-scale efforts contribute to the management of large-scale problems [5], are well suited to the challenge of recovering ecosystems and the flows of their benefits to people. An independent advisory committee to the US National Climate Assessment recommended using a distributed network of networks approach to future climate assessments at regional and national scales, working through professional societies to scale up from individual case studies to broad categories of solutions [30]. Such sustained assessment processes can focus on applied problems faced by practitioners, organize lasting partnerships for collaborative learning across similar case studies to identify proven practices, and assess and improve knowledge-based methods for implementation [30]. IPBES can serve as a reinforcing mechanism to help spread relevant solutions and inspiring narratives from successful science-policy outcomes at multiple decision loci and across scales [5,31,32].

Concluding Remarks

The network of networks approach is highly scalable and can be deliberately designed for application from local to national levels and beyond. In fact, the nesting of scales in a coordinated process can enrich discussions and provide opportunities for exchange of experience and effective practices [31]. Regional processes, such as the Puget Sound case, can point out key drivers and policy needs for biodiversity or ecosystem recovery at larger scales, such as international fisheries management and consumer marketing campaigns. In turn, the Puget Sound regional process will benefit from a national or global biodiversity and ecosystem services assessment that clarifies the importance of recovering Chinook salmon (*Onchorhynchus tshawytscha*) and orca (*Orcinus orca*) in broader context (e.g., how local actions relate to the global status of salmonids and cetaceans; the role of Chinook and orca in North Pacific food webs, and in international commercial and indigenous fisheries, and cultures).

Scientific capacity for engagement in decision processes can be initiated at any level, local to national, and such processes can connect with or incorporate other, parallel efforts as they develop or are discovered. Multiscale, multistakeholder processes can link global cumulative concerns to local levels, where they can result in concrete action, and propagate local insights upward, spreading successful innovation and ensuring an aligned enabling environment for action. Effective scientific engagement is likely to manifest as thousands of local and regional pathways rather than through a single global superhighway. These paths to action can emerge from a variety of starting points, and can be amplified through mature (e.g., The Natural Capital Project[xii]) and emerging [e.g., United Nations Environment Program-World Conservation Monitoring Centre's (UNEP-WCMC) Nature Map[xiii], Biodiversity and Ecosystem Services Network (BESNet)-[xiv]] networks for data sharing, modeling, and with science-to-action capacity. Starting points can include technical advancements; for example, breakthroughs in modeling and mapping of ecosystem services at multiple scales and geographies demonstrated feasibility and legitimacy that led to policy applications [23,33,34]. Scientific advances and assessment processes should feedback to each other; for example, advances in modeling changes in nature's contributions to people at the global scale were spurred by, and informed, the IPBES Global Assessment [35]. The challenge now is to systematize such efforts in science-policy processes so that results can transform decisions.

Outstanding Questions

What metrics should be included in biodiversity and ecosystem service (BES) assessments for indicating cross-scale drivers, processes, and trends that can inform policy and management? Most assessments and their guidance are conducted at a single scale (e.g., global, national), and yet most actions that are needed to address biodiversity and ecosystem service trends are at local or mesoscales.

What principles or best practices should guide design of engagement processes that offer incentives and support for multidisciplinary scientists and key decision makers to work together for policy changes indicated by biodiversity and ecosystem service assessments? Science-policy engagement requires commitment from both scientists and decision makers who often face significant time, resource, or cultural barriers to participation.

What are compelling examples or proven strategies for spurring action from biodiversity and ecosystem service assessments? Theoretical treatments, such as complex adaptive systems, transition theory, and polycentric governance, each highlight processes and practices that are more likely to lead to the transformative change needed. What empirical evidence exists to support such conceptual frameworks, and can the theory be advanced to spur more targeted policy responses?

Two decades ago, ecologist Jane Lubchenco called for a 'new social contract for science' [14] in which scientists would address urgent societal needs, work proactively to ensure that scientific knowledge informs policy decisions, and work across disciplines and sectors with 'good judgment, wisdom, and humility.' The past two decades have seen much progress in scientific engagement with decision makers at all levels, but this progress has not kept pace with the increasing rate of biodiversity loss and ecosystem degradation (see Outstanding Questions). With world attention focused on the IPBES Global Assessment, the scientific community has an opportunity to further activate and honor that social contract, and to prepare it for the necessary transformational changes needed.

To date, individual scientists have borne costs of engagement with stakeholders, in terms of reallocating their efforts, taking on additional obligations, incurring professional risks, and foregoing traditional career advancement and recognitions, largely out of commitment to the greater good of humanity and the environment. Institutions vary widely in their degree of tolerance and support for these activities. For individual scientists, level of participation is a moral choice guided by values, risk tolerance, and institutional context. Given the high stakes, for humanity and the environment, scientific institutions and funders can help honor the social contract by lowering the risks and costs of deep public engagement incurred by scientists in addressing issues of urgent societal concern, including loss of biodiversity and decline of many of the critical benefits nature provides to people.

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Resources

[i] www.ipbes.net/media/press-releases
[ii] www.longleafalliance.org
[iii] www.savetheredwoods.org
[iv] www.climatesciencealliance.org
[v] www.umag.cl/facultades/williams/?p=86
[vi] www.ptowilliams.cl/Reserva_de_la_Biosfera.html
[vii] http://award.org.za/index.php/projects/usaid-resilm-o/
[viii] https://promotepollinators.org/
[ix] www.okologia.mta.hu/sites/default/files/Beporzok_a_kertunkben_online_verzio.pdf
[x] https://ipbes.okologia.mta.hu/
[xi] www.unep-wcmc.org/featured-projects/national-ecosystem-assessments
[xii] https://naturalcapitalproject.stanford.edu/
[xiii] https://naturemap.earth/
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